1. Agenda

   Documents: OPN_20151119_AG.PDF

2. Complete Packet

   Documents: OPN_20151119_PK.PDF

Amended
NOTICE
Fire Station Oversight Committee
Thursday, November 19, 2015
VERONA FIRE STATION
101 Lincoln Street, Verona, WI
5:00 pm.

1. Call to Order
2. Approval of September 2, 2015 Minutes
3. West Station-Exterior metal panel material alternate
4. West Station-Site Design Modifications
5. West Station-Any Other Design Issues Requiring Guidance
6. West Station-Cost Estimate, Value Engineering
7. **R-113-15** – Approving Contract Amendment With SEH For Architectural/Engineering Services a Geo-Thermal System For The West Fire Station Building
8. Announcements
   i. Next Oversight Meeting- TBD
   ii. Possible tour of station
9. Adjournment

Please note Meeting Location

Note: It is possible that members of and possibly a quorum of members of other governmental bodies of the municipality may be in attendance at the above stated meeting to gather information. No action will be taken by any governmental body at the above stated meeting other than the governmental body specifically referred to above in this notice. Please note that, upon reasonable notice, efforts will be made to accommodate the needs of disabled individuals through appropriate aids and services. For additional information or to request this service, contact City Clerk's office (270-4200), Fitchburg City Hall, 5520 Lacy Rd, Fitchburg, WI 53711

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Minutes
Fire Station Oversight Committee
Wednesday, September 2, 2015

Present: Steve Arnold, Chair; Craig Schneider, Dave Herbst, Jason Gonzalez, Pat O'Brien

Also Present: Trevor Frank, Dennis Limmex, Brian Myrland, Dave Berman, Chad Grossen, Tom Hovel

1. **Call to Order**—Meeting was called to order at 5:02 pm by Chairperson Arnold

2. **Approval of August 12, 2015 Minutes**—motion by Gonzalez, second by Herbst to approve the minutes of 8/12/15 was carried.

3. **West Station— sustainability items**
   a. **Additional sustainability items—photovoltaic, solar hot water, other**
   Architect noted that the solar hot water system will require about 170 sq ft of panel system, at a cost of $15,000. The systems estimated 25 year payback, which is higher than the Madison station, is due to lack of incentives which helped reduce the Madison cost and payback. Discussion occurred on the solar hot water system and its effectiveness.
   Motion by O'Brien second by Gonzalez to approve the use of a solar hot water system at an estimated additional cost of $15,000; motion carried.

   Architect noted that a full photovoltaic (pv) system to cover electric demand would likely require the full roof system, with solar hot water. Herbst expressed concern with locating a pv system on the roof, and the added expense when there is a need to reroof. Mayor noted work by the current solar committee and the solar committees viewing of solar installations in the Madison area. No cost estimate was available for pv panels. Myrland noted concern that sustainability measures may reduce the operational aspects of the building. After a great deal of discussion, motion by Gonzalez, second by O'Brien to approve the use of structure upgrades to handle a potential pv system, including necessary raceways. Limmex estimated the cost of the structure upgrades to accommodate pv is likely be $10,000 or less. Motion carried.

   There was general agreement that the committee has now covered the basic items for building sustainability.

   b. Update on geo-thermal testing
   Hovel noted that two quotes were received and the test well should be drilled sometime next week and that the report should be available at the end of the month. Cost is $11,150

c. Focus on Energy consulting
Hovel reviewed correspondence with Focus on Design Assistance. He noted the conservative range of credits available may not be worth the 40 or more hours of extra consultant time. Committee agreed to allow staff to use their judgment on whether or not to pursue Focus on Energy. It was noted that perhaps the ala carte program, as being used on the Verona Station, may be worthwhile. Limmex noted that Focus demanded materials usually have a higher cost.

4. **West Station Cost estimate**--Limmmix will be doing a more detailed breakdown by division of work, but the current estimate is about $272/sq ft. Discussion occurred on use of burnished block, and it was decided to only use burnished block in the locker-restroom area.

5. **Design Schedule—**Committee reviewed the design schedule. Limmex noted the bid times will be within the optimum time frame of late January into February. Committee noted that the staff committee should make the detailed decisions and if questions or policy choices are required they will come with options to the committee.

6. **Tour of Madison Stations**—Tour to be 9/9 at 12:30 pm.
Committee decided to view west station. Group desiring to car pool will meet at City Hall at noon.

7. **Announcements**
   i. Next Oversight Meeting- TBD; next meeting, when scheduled, will be held at the new Verona Fire Station.

8. **Adjournment**—motion by Gonzalez, second by Herbst to adjourn was carried at 6:48 pm.

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10-9-15

Work Division	VERONA Cost	VERONA $/ Sq. Ft.	Variance	FITCHBURG $/ Sq. Ft.	FITCHBURG Cost
1 GENERAL CONDITIONS	$366,680	$8.55	$5.31	$13.86	$275,820
2 ABATEMENT	$10,000	$0.23	($0.23)	$0.00	$0
3 CONCRETE	$1,008,665	$23.51	($2.98)	$20.53	$408,544
3.1 PRECAST CONCRETE	$135,317	$3.15	($0.89)	$2.27	$45,080
4 MASONRY	$999,800	$23.31	$2.83	$26.13	$520,000
5 STEEL	$726,630	$16.94	$7.06	$24.00	$477,550
6 CARPENTRY & SPECIALTIES	$598,838	$13.96	$0.65	$14.61	$290,800
7.1 WATERPROOFING AND WEATHER BARRIERS	$21,105	$0.49	$0.65	$1.14	$22,675
7.2 JOINT SEALANTS	$19,500	$0.45	$0.02	$0.48	$9,500
7.5 ROOFING AND SHEET METAL	$472,700	$11.02	$6.99	$18.01	$358,300
8.4 GLAZING AND ALUMINUM SYSTEMS	$220,151	$5.13	($0.58)	$4.55	$90,600
8.3 OVERHEAD AND APARATUS FOUR-FOLD DOORS	$470,632	$10.97	($4.44)	$6.53	$130,000
9.2 GYPSUM BOARD ASSEMBLIES AND INSULATION	$682,290	$15.90	($1.05)	$14.85	$295,500
9.3 HARD TILE	$48,474	$1.13	($0.72)	$0.41	$8,200
9.5 ACOUSTICAL CEILING SYSTEMS	$43,277	$1.01	$0.73	$1.74	$34,650
9.6 RESILIENT AND CARPET FLOORING	$102,500	$2.39	($0.86)	$1.53	$30,500
9.9 PAINTING & WALLCOVERING	$115,157	$2.68	$1.13	$3.82	$76,000
			$0.00		
11 EQUIPMENT	$30,000	$0.70	$0.51	$1.21	$24,000
12 WINDOW TREATMENT / SUN SHADE	$4,500	$0.10	$1.45	$1.56	$31,000
14.2 ELEVATOR & CONVEYING SYSTEMS	$52,500	$1.22	($1.22)	$0.00	$0
21 FIRE SUPRESSION	$74,000	$1.72	$1.21	$2.94	$58,500
22 PLUMBING	$502,694	$11.72	$7.13	$18.84	$375,000
23 HVAC&TEMPERATURE CONTROLS	$1,059,000	$24.69	$8.31	$33.00	$656,700
26 ELECTRICAL AND COMMUNICATION WIRING	$1,044,000	$24.34	$0.66	$25.00	$497,500
2.2 EARTHWORK & BUILDING DEMOLITION	$316,180	$7.37	$1.27	$8.64	$171,975
2.7 ASPHALT PAVING	$134,995	$3.15	($0.66)	$2.49	$49,500
32 LANDSCAPING	$112,299	$2.62	$0.18	$2.80	$55,700
33 SITE UITILITES	$94,011	$2.19	$0.05	$2.25	$44,700
SUBTOTAL	$9,465,895	$220.65	$32.53	$253.18	$5,038,294
CONTINGENCY	$262,500	$6.12	$6.65	$12.77	$254,100
CONSTRUCTION MANAGEMENT FEE	$170,990	$3.99	$3.64	$7.62	$151,700
TOTAL	$9,899,385	$230.75	$42.82	$273.57	$5,444,094

Thomas Hovel

From: Trevor Frank <tfrank@sehinc.com>
Sent: Friday, October 09, 2015 1:40 PM
To: Thomas Hovel
Cc: Dennis Limmex
Subject: RE: Fire Station panel

We are working on it.

Trevor M. Frank, AIA, NCARB, LEED AP, PMP |
Sr. Architect
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920.380.2806 direct | 920.585.4320 Cell
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From: Thomas Hovel <Thomas.Hovel@fitchburgwi.gov>
To: Dennis Limmex <dlimmex@tri-north.com>, Trevor Frank <tfrank@sehinc.com>,
Date: 10/09/2015 01:38 PM
Subject: RE: Fire Station panel

Do either of you have some other options for panels or materials?

From: Dennis Limmex [mailto:dlimmex@tri-north.com]
Sent: Friday, October 09, 2015 12:20 PM
To: Thomas Hovel; Trevor Frank
Subject: RE: Fire Station panel

Hi Tom. Trevor was given the $25/sq. ft. from Jason at Omni in Oshkosh. Jason is who I spoke with today and he gave me the $32 based on panel size and prevailing wage rates.

From: Thomas Hovel [mailto:Thomas.Hovel@fitchburgwi.gov]
Sent: Friday, October 09, 2015 11:52 AM
To: Dennis Limmex; Trevor Frank
Subject: RE: Fire Station panel

At $32, that is still fairly high, about 25% more, compared to Trevor's thought of $25/sq ft.

From: Dennis Limmex [mailto:dlimmex@tri-north.com]
Sent: Friday, October 09, 2015 11:46 AM
To: Trevor Frank; Thomas Hovel
Subject: RE: Fire Station panel

Gentlemen. I just spoke with both contractors and I believe I have a number to use in the budget. The cost appears to vary based on panel size and detail. The larger the panel the lower the unit cost. The Omni number needs to go up to cover costs for

installation over glass board versus plywood. It also needed to be adjusted for white sheet wages. The attached budget reflect the corrected plumbing number and metal panel system installed at $32.00/sq. ft.
Dennis

From: Trevor Frank [mailto:tfrank@sehinc.com]
Sent: Friday, October 09, 2015 9:51 AM
To: Thomas Hovel
Cc: Dennis Limmex
Subject: Re: Fire Station panel

Before we go off and research other metal panels, did Dennis hear from the OMNI folks in Madison? Is the $25/s.f. a more realistic cost?

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From: Thomas Hovel <Thomas.Hovel@fitchburgwi.gov>
To: "Trevor Frank (tfrank@sehinc.com)" <tfrank@sehinc.com>, "Dennis Limmex (dlimmex@tri-north.com)" <dlimmex@tri-north.com>,
Date: 10/09/2015 09:32 AM
Subject: Fire Station panel

Any more idea on panel cost?

Thomas Hovel

From: Dennis Limmex <dlimmex@tri-north.com>
Sent: Friday, October 09, 2015 11:46 AM
To: Trevor Frank; Thomas Hovel
Subject: RE: Fire Station panel
Attachments: Fitchburg FS Budget 10-9-2015.pdf

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From: Thomas Hovel <Thomas.Hovel@fitchburgwi.gov>
To: "Trevor Frank (tfrank@sehinc.com)" <tfrank@sehinc.com>, "Dennis Limmex (dlimmex@tri-north.com)" <dlimmex@tri-north.com>,
Date: 10/09/2015 09:32 AM
Subject: Fire Station panel

Any more idea on panel cost?

Thomas Hovel

From: Dennis Limmex <dlimmex@tri-north.com>
Sent: Wednesday, October 14, 2015 5:23 PM
To: Thomas Hovel
Cc: Trevor Frank
Subject: RE: fire Station

Hi Tom.

I will work on getting budget numbers for the alternative wall panels to compare against the current system.

The exterior finish of a building is hard to make budget sacrifices to without seeing these forever. We are talking about just under 5800 sq. ft. of surface. Given this information the budget is reduced about $50K for every $10/ sq. ft. we reduce the costs. Finishes can range from;

Installed costs

$10-$12 for EIFS and basic siding
$15-$20 for siding systems
$20-$25 for basic brick* - utility size brick
$25-$35 for basic stone*, detailed brick* or basic metal panel systems
$35-$45 for detailed metal panel systems
*Brick/stone work will require additional structural costs

I never saw a budget for the type and style of building we are now designing. The design has been driving the budget, not the other way around. We should go through the entire budget line by line to determine the need or desire to look at reducing the budget for each division.

I will continue working to provide input and budget updates. Thank you.

Dennis

From: Thomas Hovel [mailto:Thomas.Hovel@fitchburgwi.gov]
Sent: Wednesday, October 14, 2015 7:55 AM
To: Dennis Limmex
Cc: Trevor Frank
Subject: RE: fire Station

HI Dennis—
I hope this finds you well.
Can you take a look at the materials that Trevor has suggested and provide an opinion on suitability and cost?
Also, we would appreciate any options of which you are aware that Trevor has not identified that may be suitable for the exterior.

Finally, do you have any ideas, at this early stage, of other items that we should value engineer? I think it best to know what those are earlier rather than later. Trevor noted that, depending upon panel decision, they may be nearing 30% complete on the plan set by the end of the week.

I look forward to your input. If we need to sit down and discuss that would be fine. We could dial Trevor up.

Thanks.

Tom H

From: Trevor Frank [mailto:tfrank@sehinc.com]
Sent: Wednesday, October 14, 2015 7:45 AM
To: Thomas Hovel
Cc: Dennis Limmex (dlimmex@tri-north.com)
Subject: Re: fire Station

Good morning, these are some suggested products. I feel our basis of design (the OMNI RS product) is the right panel for the NW station application. If we had our say in the matter this would be our preferred material.

Dennis, As CM, if you feel we need to reduce cost we will consider your recommendation from any of the following products or any others that you feel are acceptable alternates.

cost estimates from Dennis L.

http://www.mbci.com/products/wall/concealed-fastening-wall-systems/designer--series---flat/?_vsrefdom=ppcgoogle&ex=27u202d-eep549-o32ffk&gclid=CNWl5qn8wcgCFZCFaQodFm0BTQ ~$20/s.f.

up to $30/s.f.

http://www.centriaperformance.com/products/wall/architectural_insulated_metal_panel_systems/formawall_graphix_series/formawall_graphix_series_reveal.aspx

http://www.firestonemetal.com/products/wall-panel-systems/composite-series-1200.php $25-$35/s.f.

http://www.mbci.com/products/insulated-metal-panels/insulated-wall-panels/eco-ficient--grand-h/

https://www.pac-clad.com/wall-panels/pac-precision-series/

Least cost material $15-$20/s
Highest cost " $30-40/s

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From: Thomas Hovel <Thomas.Hovel@fitchburgwi.gov>
To: "Trevor Frank (tfrank@sehinc.com)" <tfrank@sehinc.com>, "Dennis Limmex (dlimmex@tri-north.com)" <dlimmex@tri-north.com>,
Date: 10/14/2015 07:32 AM
Subject: FIre Station

Any news on different material to replace the one metal panel type?

Thomas Hovel

From: Dennis Limmex <dlimmex@tri-north.com>
Sent: Thursday, October 22, 2015 9:22 AM
To: Thomas Hovel
Subject: RE: Metal Panel

Promega Type 2

Hi Tom. Sorry I did not get back to you yesterday. This is a metal panel system that is not made from composite material. The cost of this panel will fall in between the metal only and the composite material. $25.00 - $30.00 per sq. ft.
Dennis

From: Thomas Hovel [mailto:Thomas.Hovel@fitchburgwi.gov]
Sent: Wednesday, October 21, 2015 3:13 PM
To: Dennis Limmex
Subject: RE: Metal Panel

Is that for both, or just the ribbed panel? They also have a blue-colored panel they noted as: Type 2 was FormaWall by Centria which is an insulated metal panel.
Does the type 2 also fall within the basic range?

From: Dennis Limmex [mailto:dlimmex@tri-north.com]
Sent: Wednesday, October 21, 2015 3:08 PM
To: Thomas Hovel
Cc: Trevor Frank (tfrank@sehinc.com)
Subject: RE: Metal Panel

Promega Type 1

Hi Tom. This is the material that I had on my list as basic siding. This material is a visual skin only. The water barrier must be developed behind the metal because water will get through it at some point some time. Once again I believe the pricing needs to be adjusted for inflation, prevailing wage, and bonding. This gets us to the $15-$20 range plus cost of the water proofing and drainage system. Each one of these options will function as the siding wear surface but will alter the look of the building as seen by the public.

Dennis

From: Thomas Hovel [mailto:Thomas.Hovel@fitchburgwi.gov]
Sent: Wednesday, October 21, 2015 2:52 PM
To: Dennis Limmex
Cc: Trevor Frank (tfrank@sehinc.com)
Subject: Metal Panel

Dennis—Any opinion on the metal panels used on the Nobel Drive Promega Building that I sent earlier this week?

Promega Kepler Center

Nobel Drive

Thomas Hovel

From: Steve Wellenstein <Carlo@uihlein-wilson.com>
Sent: Monday, October 19, 2015 5:36 PM
To: Thomas Hovel
Subject: RE: Promega

Tom
Sorry it took me a while to get some cost out of Kraemer.

We have 2 types of metal panels on the Kepler Center.

Type 1 is the Centria Super Rib and Econolap.
These are the very large ribbed metal panels running horizontal and the small (corrugated look) metal panels running vertical.
Both of these metal panels are just the thickness of the metal screwed to metal furring. There is also rigid insulation between the furring.
The furring is attached to a Concrete Masonry Unit (CMU) back-up wall.
The cost of this is around $12-13 a sq. ft. installed (This includes the metal panels, metal furring and insulation, CMU back-up is a separate number.

Type 2 was FormaWall by Centria which is an insulated metal panel.
This is a layer of metal on each side of a foam insulation core.
This system still requires the metal furring behind it to attach to, but no insulation.
This system came in around $21 a sq. ft.
Our type 2 system was curved so that adds to the cost of it as well and a custom color.

If you compare this to brick you need to just look at the brick and it's labor.

We were going to have a CMU back-up system regardless of what we used as a veneer.
The CMU gives us a long term 100 year building in our minds.
We opted for the metal panels not as much for a cost savings but for an aesthetic approach.
Since the scale of our building is so large the Super Rib panels help to bring down the scale.
We also choose a large CMU size brick to also help with the scale.

For us the other reason to go with the metal panels had to do with the future expansions.
We didn't want to use brick on the side walls and then have to dispose of it later when the building expands.
We still have to do that for the small band at the base but not the whole wall.
The metal panels could be reused in the additions or simply recycled.

I hope this helps you, if you have any questions don't hesitate to ask, if I can help I will.

Steve

Steven C Wellenstein
Uihlein-Wilson Architects
322 East Michigan Street
Milwaukee WI 53202
Phone 1-414-271-8899

Fax 1-414-271-8942
stevew@uihlein-wilson.com

From: Thomas Hovel [mailto:Thomas.Hovel@fitchburgwi.gov]
Sent: Friday, October 16, 2015 9:43 AM
To: Steve Wellenstein <Carlo@uihlein-wilson.com>
Subject: Promega

Hi Steve—
Could you please provide me with the metal panel systems used on the new Promega processing facility? We are looking at a fire station design and that information may be helpful.

Thanks.

TH

SITE DATA:
TOTAL AREA: 72,295 SF (1.6 ACRES)
25% GREEN SPACE REQUIRED: 18,073
GREEN SPACE SHOWN: 25,264 SF
GREEN SPACE OVER REQUIREMENT: 7191 SF
BUILDING AREA: 20,070 SF
35 PARKING STALLS

1 Level 1
1/16" = 1'-0"

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SEH
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425 West Water Street, Suite 300
Appleton, WI 54911-6058
920.380.2800 main | 888.908.8166 fax
888.413.4234 toll free | www.sehinc.com

PRELIMINARY

MARK	DATE	DESCRIPTION

FITCHBURG FIRE
Enter address here

SEH FILE NO. Project Number
ISSUE DATE JUNE 29, 2015
DESIGN BY TWF
DRAWN BY MJZ
PROJECT MGR TWF

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SHEET CONTENTS
FIRST LEVEL PLAN

A100

1 Level 2
1/16" = 1'-0"

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PRELIMINARY

MARK	DATE	DESCRIPTION

FITCHBURG FIRE

Enter address here

SEH FILE NO.	Project Number
ISSUE DATE	JUNE 29, 2015
DESIGN BY	TMF
DRAWN BY	MJZ
PROJECT MGR	TMF

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SHEET CONTENTS

SECOND LEVEL PLAN

A101

1 3D View 5

2 3D View 4

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PRELIMINARY

MARK	DATE	DESCRIPTION

FITCHBURG FIRE

Enter address here

SEH FILE NO. Project Number
ISSUE DATE JUNE 29, 2015
DESIGN BY TMF
DRAWN BY MJZ
PROJECT MGR TMF

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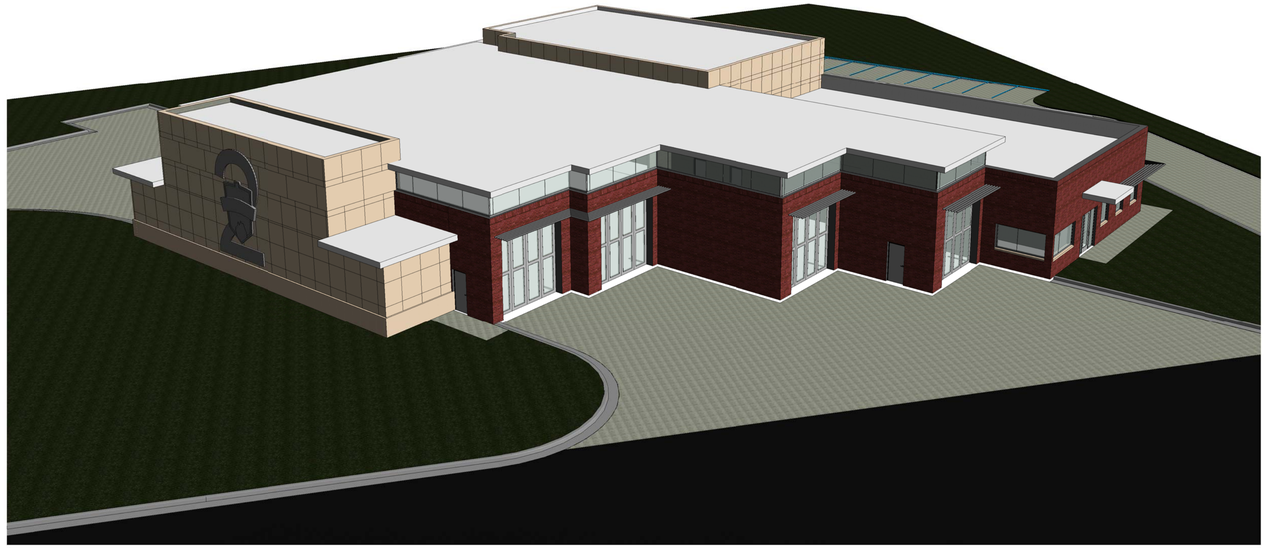
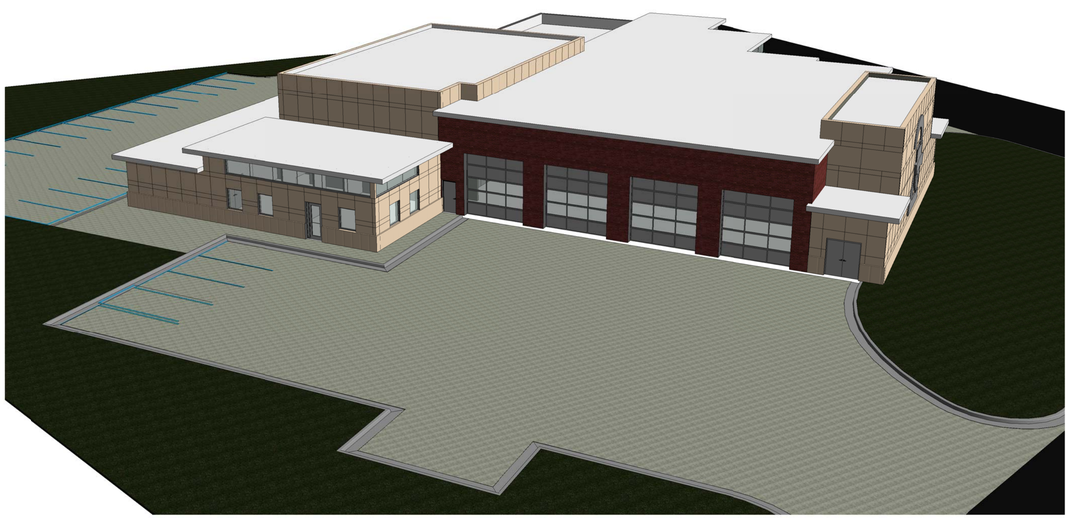
SHEET CONTENTS
Unnamed

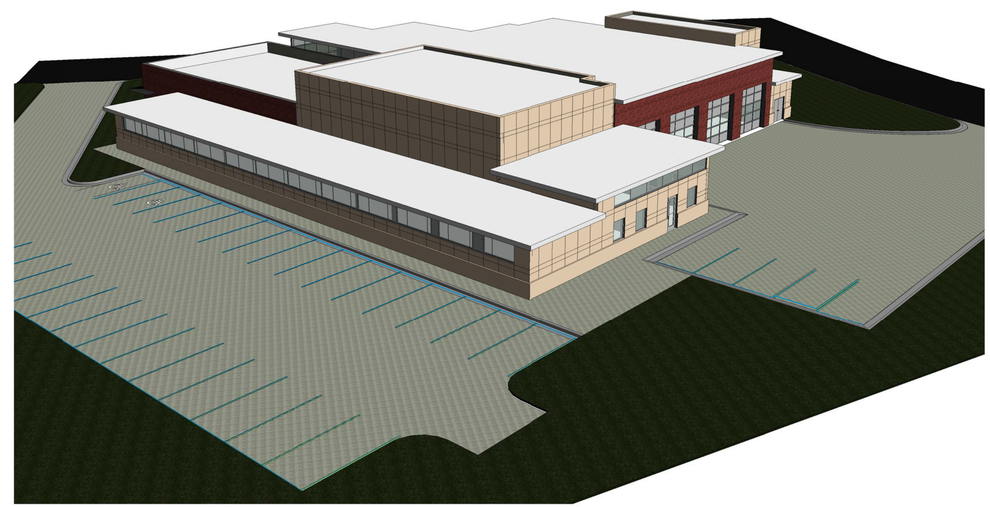
A102



1 3D View 1



2 3D View 7



3 3D View 8

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PRELIMINARY

MARK	DATE	DESCRIPTION

FITCHBURG FIRE

Enter address here

SEH FILE NO. Project Number
ISSUE DATE JUNE 29, 2015
DESIGN BY TMF
DRAWN BY MJZ
PROJECT MGR TMF

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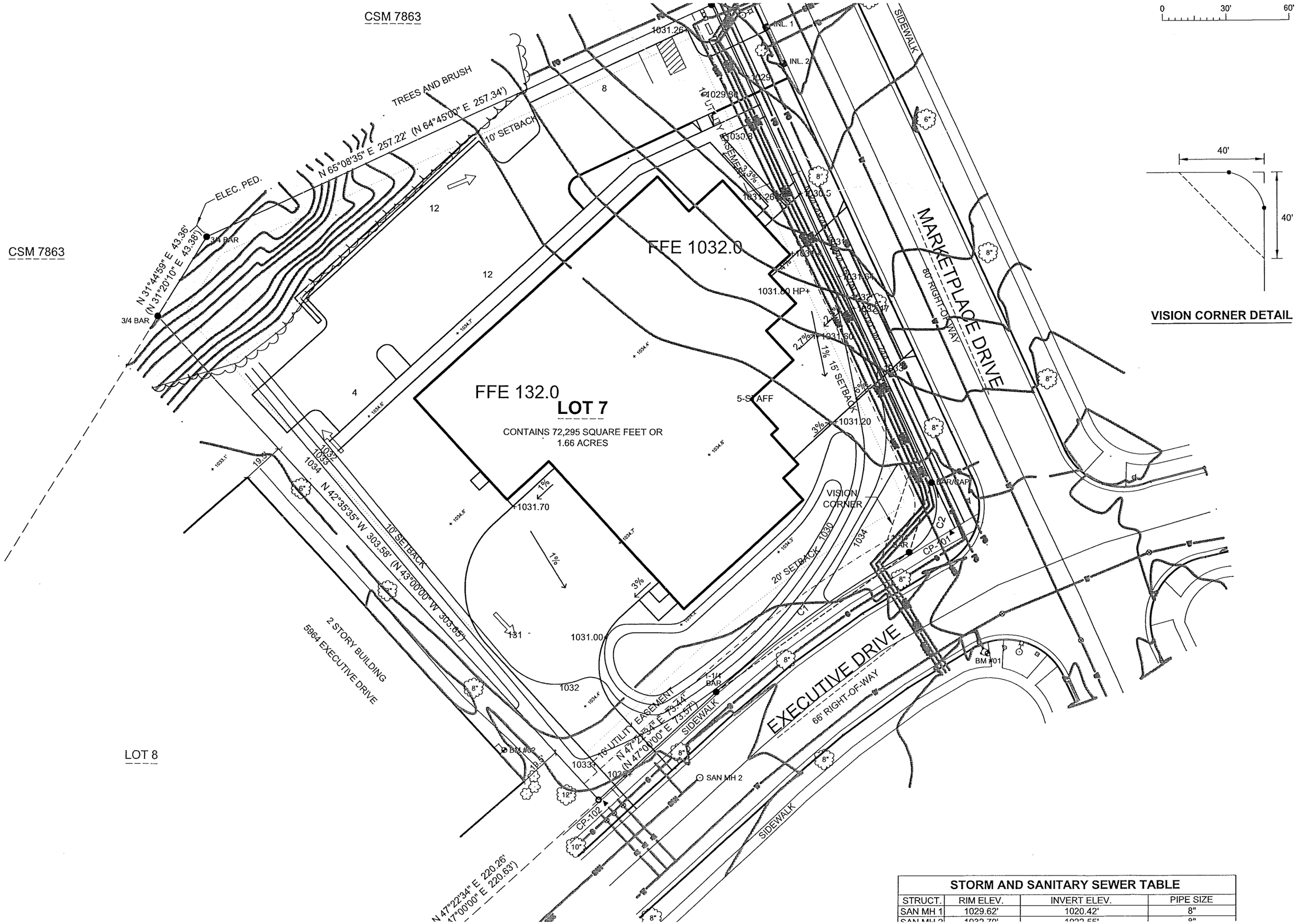
SHEET CONTENTS
Unnamed

A103



STORM AND SANITARY SEWER TABLE			
STRUCT.	RIM ELEV.	INVERT ELEV.	PIPE SIZE
SAN MH 1	1029.62'	1020.42'	8"
SAN MH 2	1032.79'	1023.55'	8"

Steve Arnold, Mayor
Introduced by

Planning
Prepared by

Finance
Referred to

October 8, 2015
Date

RESOLUTION R-113-15
APPROVING CONTRACT AMENDMENT WITH SEH FOR ARCHITECTUAL/ENGINEERING SERVICES A GEO-THERMAL SYSTEM FOR THE WEST FIRE STATION BUILDING

WHEREAS, the Fire Station Oversight Committee has decided to pursue a geo-thermal heating and cooling system for the west fire station, and

WHERAS, this requires a higher level of design services than originally contemplated in the original contract with SEH, and

WHEREAS, the Finance Committee has reviewed the contract amendment and recommends approval.

NOW, THEREFORE, BE IT HEREBY RESOLVED, that the Common Council hereby approves the contract amendment with SEH for design services for a geo-thermal heating and cooling system for the West Fire Station in the amount of $24,530. (The original contract amount was for $216,125 and the revised amount , with this amendment, will now be $240,655.)

BE IT FURTHER RESOLVED, that it authorizes the City Engineer and City Attorney to negotiate any necessary amendments with SEH, and for the Mayor and City Clerk to sign.

Adopted this_____day of October, 2015.

Approved:_____
Stephen L. Arnold, Mayor

Attested By:_____
Patti Anderson, City Clerk

THE CITY OF
Fitchburg
PLANNING

MEMORANDUM

CITY OF FITCHBURG
PLANNING DEPARTMENT
5520 LACY ROAD
FITCHBURG, WI 53711
(608) 270-4200
FAX: (608) 270-4275
EMAIL: planning@city.fitchburg.wi.us

To: **Finance Committee**
From: **Thomas D. Hovel**
Date: **November 2, 2015**
Subject: **West Fire Station Design Services Amendment**

The request for an amendment to the design contract for the west fire station for geo-thermal services was tabled pending additional information on firm selection, payback and the borings.

Relative to firm selection, the contract amendment is the provision of services by Sustainable Engineering Group (SEG) to design the geo-thermal field. SEG is a sub-consultant to the project architect, SEH. Hence the agreement is with SEH. The architect has worked with SEG in the past. The services for the architect went through a RFP process; the sub-consultants have been chosen by the architect and not gone through such a process. The architect noted that he recalled attempting to get a price from a different firm, but received no response. We did get two quotes for the test bore, and SEG was the lower of the two quotes. Please note, that the architect made an error and the increase for the geo-thermal is actually $24,530, not the previously provided $40480. The resolution has been updated to reflect this amount.

Second, in regard to payback I spoke with Jon Evans of SEG on October 28. He noted that the cost premium for a geothermal system is about $100,000 above a conventional Variable Air Volume (VAV) system. Mr. Evans noted estimated that annual savings from a geo-thermal system compared to the VAV system would be about $10,000 per year. With a system estimate of $100,000 and adding in the fees and the test bore, the estimated cost comes to $135,680. This would mean a payback of about 14 years. The geo-thermal bore field has a 50 year pipe warranty, although the life span of the bore field components is estimated at 100 years. Mr. Evans has noted that when you factor in maintenance savings, utility cost increases, and equipment replacement a typical payback is two to three years sooner than the simple payback calculation.

Third, a test bore and report were completed in September. Given the estimated building loads received from the design team at the time of the report (September 2015), there is the need for 16 bores each at 400' deep. A bore field report is attached.

For your information, the Oversight Committee has also decided to pursue the following:
LED lighting, with an estimated simple payback of less than five years
Solar hot water, with simple payback estimated at 25 years.
Structure for future photo-voltaic, at a cost estimated to be less than $10,000.

AIA® Document G802™ – 2007

Amendment to the Professional Services Agreement

Amendment Number: 001 (Revised)

TO: Thomas Hovel
(Owner or Owner's Representative)

In accordance with the Agreement dated: February 13, 2015

BETWEEN the Owner:
(Name and address)
City of Fitchburg
5520 Lacy Road
Fitchburg, WI 53711

and the Architect:
(Name and address)
Short Elliott Hendrickson Inc. (SEH)
425 West Water Street, Suite 300
Appleton, WI 54911

for the Project:
(Name and address)
Northwest Fire Station

Authorization is requested
☒ to proceed with Additional Services.
☒ to incur additional Reimbursable Expenses.

As follows:
Architect to coordinate additional services between the geothermal engineer and the mechanical engineer to provide a complete and fully operational ground source geothermal heating and cooling system for the NW fire station. These professional services are in addition to the basic mechanical system design services previously approved as part of the overall design of the NW fire station.

The following adjustments shall be made to compensation and time.
(Insert provisions in accordance with the Agreement, or as otherwise agreed by the parties.)

Compensation:
Twenty Four Thousand Five Hundered Thirty Dollars ($24,530.00)

Time:
No additional design time will be built into the delivery schedule at this time

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User Notes: (860256836)

SUBMITTED BY:	AGREED TO:
(Signature) Trevor Frank, AIA, Project Manager	*(Signature)* Steve Arnold, Mayor
	Patti Anderson, City Clerk City of Fitchburg
(Printed name and title)	*(Printed name and title)*
11/1/15	11/1/15
(Date)	*(Date)*

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User Notes: (860256836)

Formation & Thermal Conductivity Test Results Report

City of Fitchburg –
Northwest Firestation
Near Intersection of Marketplace Drive and Executive Drive

September 24, 2015

Prepared for:

Prepared by:

7475 Hubbard Ave, Suite 201 • Middleton, WI 53562 • 608.836.4488 • Fax 608.836.4477 • www.sustaineng.com

Introduction

Sustainable Engineering Group was requested to provide services for the execution of a formation and thermal conductivity test for the new ~20,000 ft^2 Fitchburg Northwest Fire Station located in Fitchburg, WI.

The formation and thermal conductivity test is used for sizing the geothermal field. The test consists of drilling a geothermal well to the desired depth and inserting an approved polyethylene u-bend assembly. The well is then sealed using an approved grouting material in the bore annulus. After a period of five days a control/data box and a generator is connected to the vertical loop. The control box then pumps heated water into the loop and the data logger records the geologic formations ability to accept and dissipate the heat. The results of the test will document the ground formation's thermal conductivity, thermal diffusivity, and undisturbed temperature. The results then allow the design team to more accurately size the geothermal field and ultimately reduce the installation cost.

The following figure illustrates the location of the test bore on the site plan. The test bore is located ~146' from the east side of the property (Marketplace Drive) and ~275' from the south side of the property (Executive Drive). Also shown is the approximate outline of the geothermal borefield that was sized based on the test bore results.

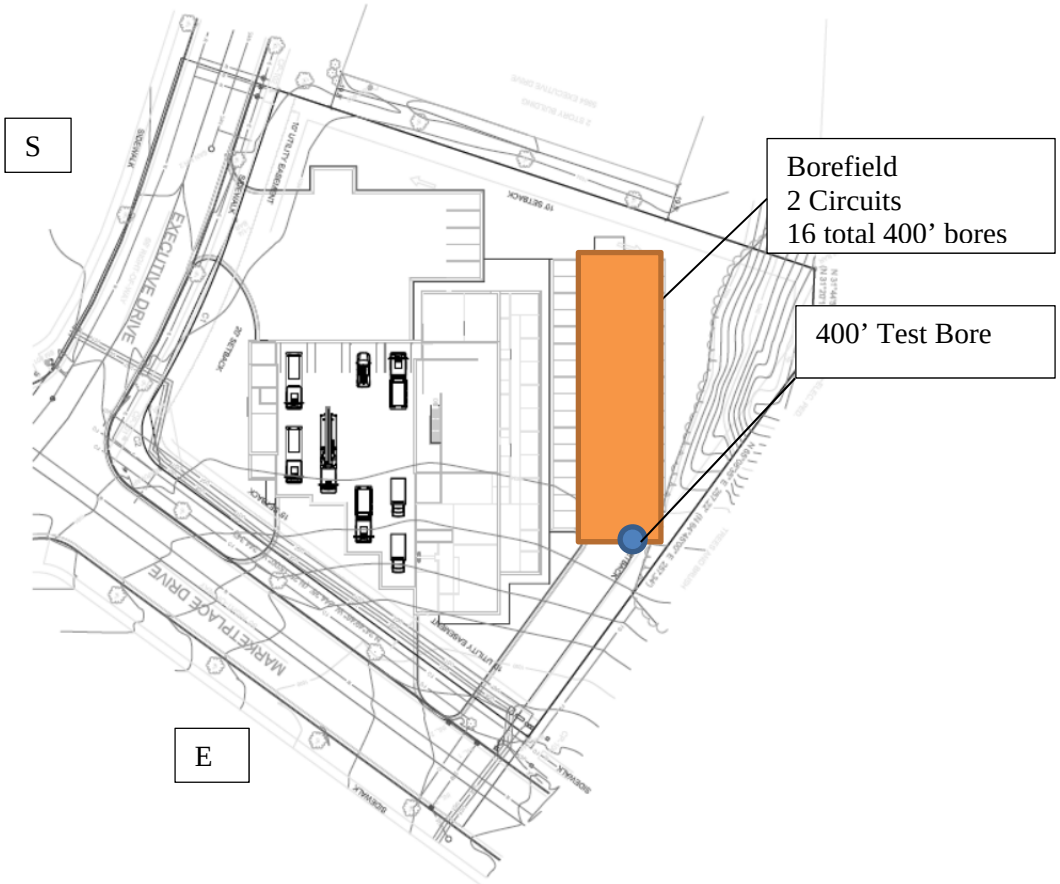

Figure 1. Site plan showing test bore location and proposed geothermal borefield relative to building.

Since only two circuits are needed, an exterior manifold vault could be eliminated if space in the building can be provided for the header manifold. Room for (4) 4” pipes would need to be provided in the south west corner. Manifold would run along west wall.

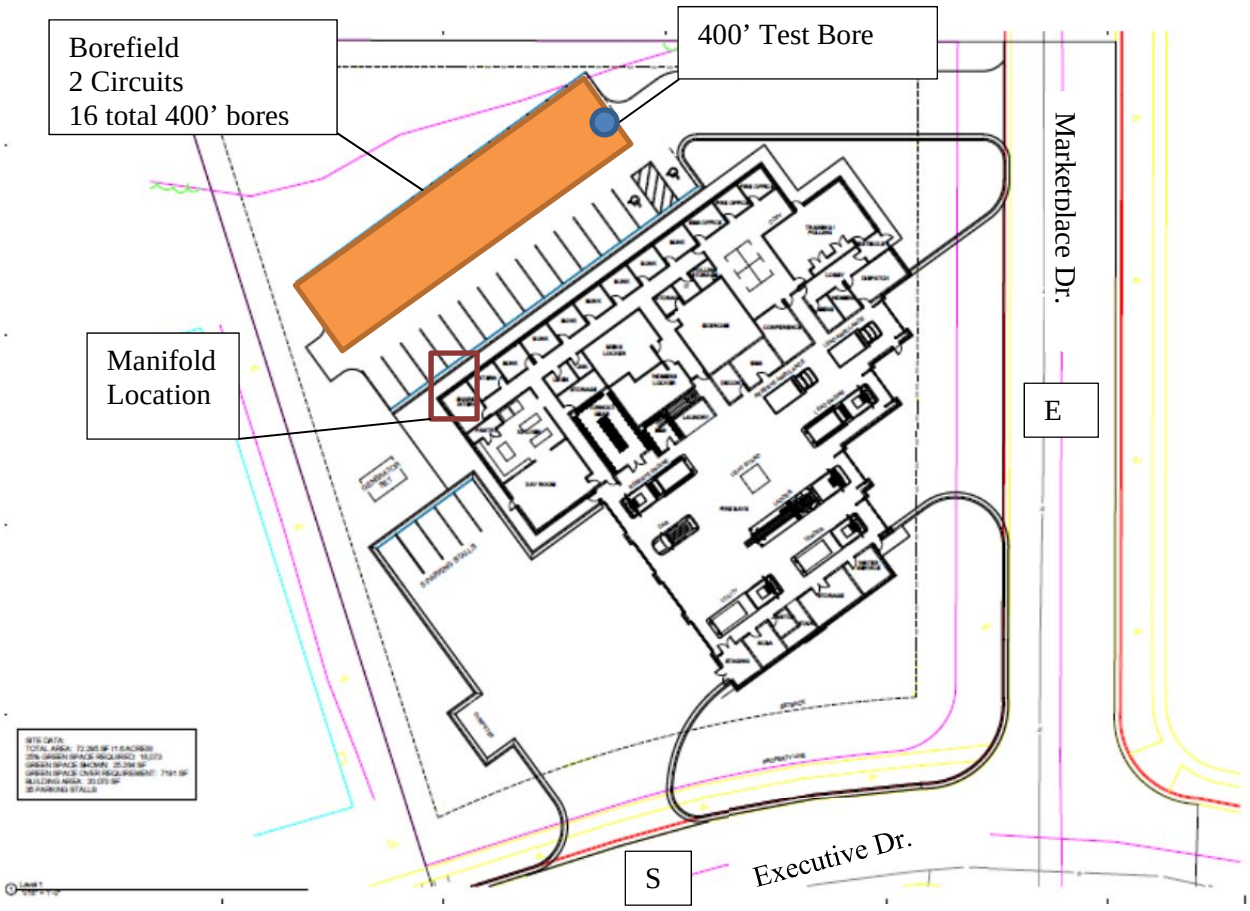

Figure 2. Options for Building Manifold Location (box shown in red)

Figure 3. Similar building manifold in Mt. Pleasant Village Hall & PD

Timeline

A summary of the geothermal test bore installation schedule can be seen below.

- Tuesday, September 1st, 2015
  - Sustainable Engineering Group went to site to review site conditions.
- Thursday, September 10th, 2015
  - Diggers hotline cleared site
- Monday, September 14th, 2015
  - Drilling started by Ground Source
- Wednesday, September 16th, 2015
  - Drilling completed by Ground Source
- Monday, September 21st, 2015
  - Data logger and test apparatus was connected to test bore and began recording data – Installed by GO Loop
- Wednesday, September 24th, 2015
  - Data collection complete. Data logger and test apparatus was removed by GO Loop
- Thursday, September 24th, 2015
  - Data analysis complete and test report submitted to design team.

Figure 4. Test bore location at site looking south

Results

The bore was started with a mud-rotary rig. The upper bore to 107' was drilled mud rotary. Due to fractures in the formation, drilling fluid loss was experienced at 45'. Therefore, 60' of 6" temporary casing was installed and the process continued with mud rotary after installing casing. Additional fluid loss at 107' and large amount of water use (due to fractures washing away drilling fluid and not being able to recirculate) caused the drilling crew to pause and assess the approach. Up to this point 7200 gallons water used to drill, which is much higher than typical.

The crew changed drill method to Air Rotary due to continuous fluid loss. The air rotary drilling technique in fractured formations produces water from the ground as opposed to requiring water from the surface. Bore produced considerable amounts of water while drilling air rotary. Drilled to 400' and installed u-bend loop. Bentonite chips were used at 107' fracture during grouting. Minimal grout settling occurred after 5 days after drilling.

Since this formation will require air rotary drilling to be economical, water management on the site during the drilling process will be critical and construction staging should be reviewed. During active drilling up to 100 gpm may need to be managed. It can be directed to the swale at the northwest area of the site, settled and clear water can be pumped to the storm drain. Ideally the bores would be drilled in the winter when the ground is frozen to minimize construction staging issues in the spring.

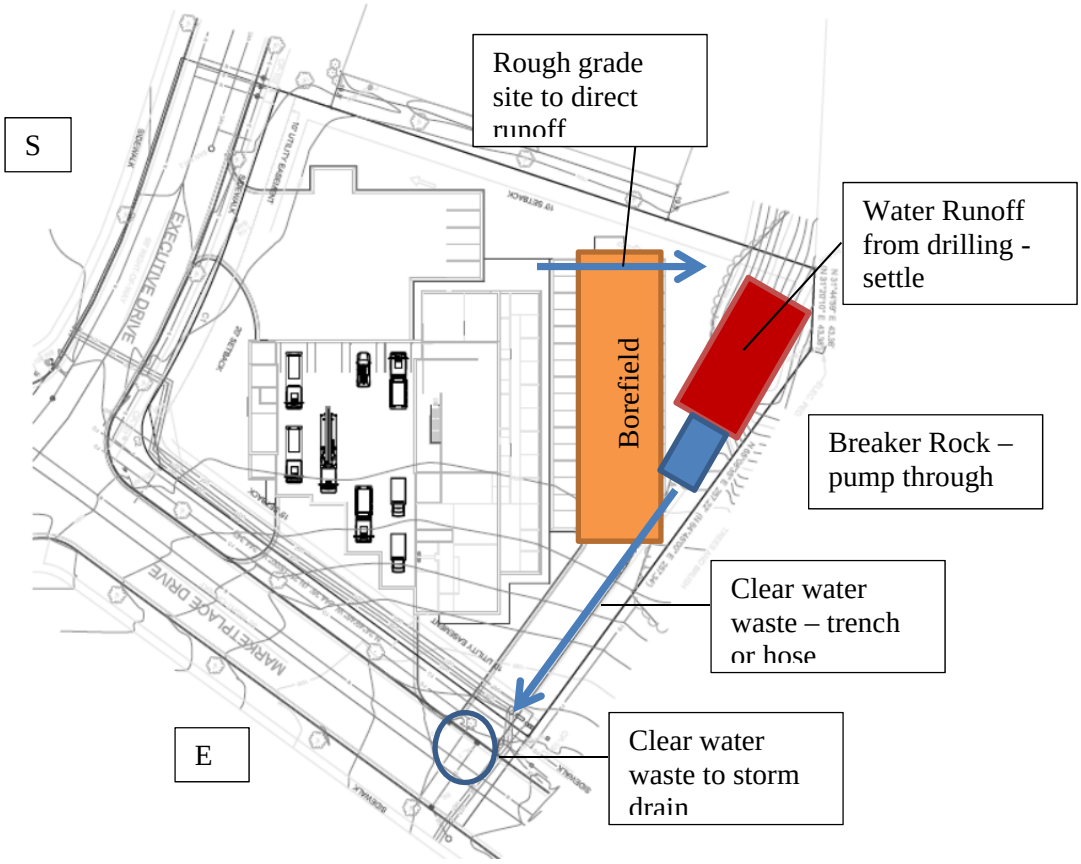

Figure 5. Options for water management during drilling

Overall, the results from the formation and thermal conductivity analysis show very good values for a 400' bore, which will reduce costs. High static water level provides for very good conductivity. The numeric values for the ground thermal conductivity, the ground thermal diffusivity, and the undisturbed ground temperature can be seen below. Detailed formation and conductivity report provided by GO Loop is attached to this report.

- Ground Thermal Conductivity: 2.22 Btu/ft-hr-°F
- Ground Thermal Diffusivity: 1.38 ft^2/day
- Undisturbed Ground Temperature: 50.9°F

The following figure illustrates the estimated number of bores that would most likely be necessary for the installation of this facility at three different thermal conductivity values. A higher ground thermal conductivity value decreases the number of bores needed; and, therefore, the cost of installing a geothermal system. Average conductivity for a 400' bore is 1.8 – 1.9 with 2.0 being typical with a lot of ground water. A value of 2.22 is very good. Since the building is small the differences are not too dramatic, but the higher value is resulting in first cost savings from a smaller borefield (~$10,000-$15,000).

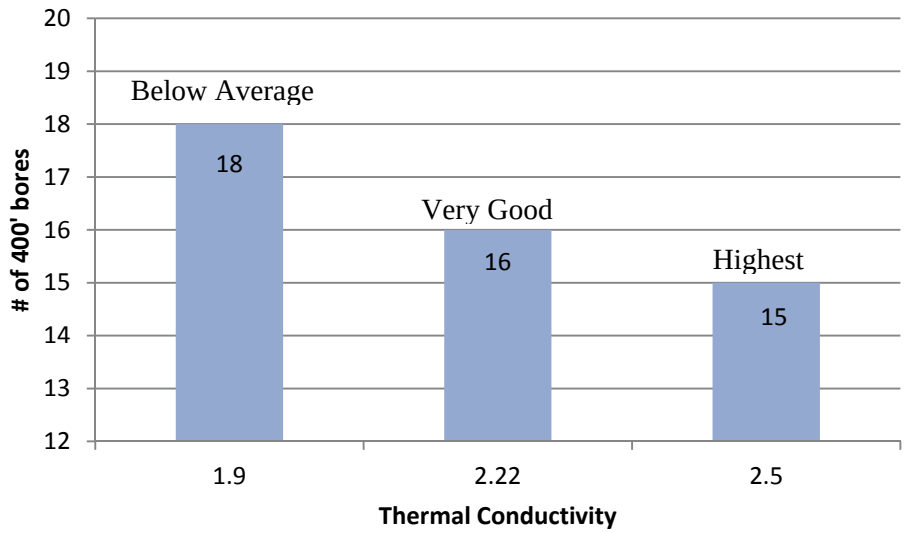

Figure 6. Ground Conductivity Comparison

Based on a 20,000 ft^2 area being conditioned by geothermal heat pumps with a peak load of 44 tons (16) 400' bores will be needed. The final quantity will be dependent on the building's heating and cooling loads, which are still being determined. Based on drilling conditions we are assuming drilling costs to install a borefield and lateral piping to the building will be $17.50-$18.00/LF.

- Our opinion of borefield cost drilled in spring 2016, assuming a header pit vault <u>is not</u> used (deduct $15,000) and the test bore <u>is</u> reused (deduct $5,000), is $85,000 - $95,000.
- If the borefield can be drilled over the winter of 2015/16 then our opinion of borefield cost is $80,000-90,000. This reflects a $0.50/LF drilling deduct.
- If it is desirable to carry a single number in the cost estimate use $90,000.

SD Borefield Sizing Results

GSHPCalc Software - Version 5.0
Energy Information Services

Project Name: Fitchburg NW Firestation
Location: Fitchburg, WI
Job Number: 2015
Notes: 20000 sf.

Run Data: 9-24-15
By: JCE

Design Lengths ***** Heat Pump Series: ClimateMaster Tranquility 20 with ECM *****

Required BORE length with minimal groundwater movement = 6140 ft (384 ft/bore)
(Design based on HEATING mode - net annual heat extraction from ground)

Required BORE lengths with high rates of groundwater movement (or year 1)
Cooling: L= 5320 ft (333 ft/bore), Heating: L= 6100 ft (382 ft/bore)

Unit Inlet (cooling) = 90.0 degrees F
Unit Outlet (cooling) = 100.0 degrees F
Unit Inlet (heating) = 32.0 degrees F
Unit Outlet (heating) = 26.0 degrees F
Normal ground temp = 50.9 degrees F

Cooling Load/Demand = 533 kBtuh / 38 kW
Heating Load/Demand = 500 kBtuh / 37 kW
Cooling EER (Ht Pump/Sys) = 13.9 / 13.5
Heating COP (Ht Pump/Sys) = 4.0 / 3.9
Loop Pump Head/Flow Rate = 30 ft / 133 gpm
Loop Pump Power/Demand = 1.4 hp / 1.3 kW

Total Heat Pump Capacity = 574.3 kBtuh (cooling)
Total Heat Pump Capacity = 521.4 kBtuh (heating)

U-tube Diameter = 1.25 inch
Separation dist. = 20.0 ft
Grid = 2 wide by 8 deep
Grout Conductivity = 1.00 Btu/hr-ft- degrees F
Bore Diameter = 6.00 inches

Bore Resistance = 0.169 hr-ft-F/Btu
Ground Resistance (Cooling) = 0.349 hr-ft-F/Btu
Ground Resistance (Heating) = 0.356 hr-ft-F/Btu

Thermal Conductivity = 2.22 Btu/hr-ft-degrees F
Thermal Diffusivity = 1.38 ft^2/day

Ground Temperature = 50.9 degrees F

Long Term Temperature Change of Ground (assume <25% is dry based on static water level at 60')

10 Year Values:
Percent of Formation that is Dry or Non-porous / Ground Field Temperature Change
<5% / 0.0 degrees F
25% / -0.1 degrees F
50% / -0.1 degrees F
75% / -0.1 degrees F
100% / -0.2 degrees F

25 Year Values:
Percent of Formation that is Dry or Non-porous / Ground Field Temperature Change
<5% / 0.0 degrees F
25% / -0.1 degrees F
50% / -0.1 degrees F
75% / -0.2 degrees F
100% / -0.3 degrees F

DNR Well Construction Report

Well Construction Report
WISCONSIN UNIQUE WELL NUMBER **YO475**

State of WI - Private Water Systems-DG/5
Department of Natural Resources, Box 7921
Madison, WI 53707
Form 3300-077A (R 7/10)

Property Owner: Fitchburg West Fire Station
Telephone Number: ( )
Mailing Address: Marketplace Drive
City: Fitchburg
State: WI
Zip Code: 53711-
County of Well Location: DANE
Co. Well Permit No.: W 1
Well Completion Date (mm-dd-yyyy): 9/ - 5/ - 015

1. Well Location
☐ Town ☒ City ☐ Village of Fitchburg
Fire # (If avail.)
Street Address or Road Name and Number: Marketplace Drive
Subdivision Name
Lot #
Block #
Gov't Lot # ___ or NE 1/4 of NW 1/4 of
Section 8, T 6 N; R 9 ☒ E ☐ W
Latitude Deg. 43 Min. 0.81
Longitude Deg. 89 Min. 27.518

Well Constructor (Business Name): Ground Source
License #: 4462
Facility ID Number (Public Wells)
Address: 3671 Monroe Road
Well Plan Approval #
City: De Pere State: WI Zip Code: 54115-
Date of Approval (mm/dd/yyyy)
Hicap Permanent Well #
Common Well #
Specific Capacity gpm/ft

2. Well Type ☒ New ☐ Replacement ☐ Reconstruction (see item 12 below)
of previous unique well # ___ constructed in ___
Reason for replaced or reconstructed well?
Lat/Long Method: GPS008
☒ Drilled ☐ Driven Point ☐ Jetted ☐ Other

3. Well serves 1 # of GeoTestBore
(For example: home, barn, restaurant, church, school, industry, etc.)
High Capacity: Well? ☐ Yes ☒ No; Property? ☐ Yes ☒ No

4. Is the well located upslope or sideslope and not downslope from any contamination sources, including those on neighboring properties? ☒ Yes ☐ No (If no, explain on back side.)
Well located within 1,200 feet of a quarry? ☐ Yes ☒ No If yes, distance in feet from quarry:
Well located in floodplain? ☐ Yes ☒ No

Distance in feet from well to nearest: (include proposed)
___ 1. Landfill
___ 2. Building Overhang
___ 3. Septic ☐ Holding Tank ☐
___ 4. Sewage Absorption Unit
___ 5. Nonconforming Pit
___ 6. Buried Home Heating Oil Tank
___ 7. Buried Petroleum Tank
___ 8. Shoreline ☐ Swimming Pool ☐
___ 9. Downspout/Yard Hydrant
___ 10. Privy
___ 11. Foundation Drain to Clearwater
___ 12. Foundation Drain to Sewer
___ 13. Building Drain ☐ Cast Iron or Plastic ☐ Other
___ 14. Building Sewer ☐ Gravity ☐ Pressure ☐ Cast Iron or Plastic ☐ Other
___ 15. Collector Sewer: ☐ sanitary ___ units ___ in. diam. ☐ storm ☐ ≤ 6" ☐ > 6"
___ 16. Clearwater Sump
___ 17. Wastewater Sump
___ 18. Paved Animal Barn Pen
___ 19. Animal Yard or Shelter
___ 20. Silo
___ 21. Barn Gutter
___ 22. Manure Pipe ☐ Gravity ☐ Pressure ☐ Cast Iron or Plastic ☐ Other
___ 23. Other Manure Storage
___ 24. Ditch
___ 25. Other NR 812 Waste Source

5. Drillhole Dimensions and Construction Method

Dia. (in.)	From (ft.)	To (ft.)	Upper Enlarged Drillhole	Lower Open Bedrock
8	surface	60	☒ 1. Rotary - Mud Circulation	☐
			☐ 2. Rotary - Air	☒
			☐ 3. Rotary - Air and Foam	☐
6	60	400	☐ 4. Drill-Through Casing Hammer	
			☐ 5. Reverse Rotary	
			☐ 6. Cable-tool Bit ___ in. dia.	☐
			☒ 7. Temp. Outer Casing 6 in. dia. Removed? 60 depth ft. ☒ Yes ☐ No - If no, explain on back side.	
			☐ 8. Dual Rotary	☐

Geology Codes	8. Geology Type, Caving/Noncaving, Color, Hardness, etc.	From (ft.)	To (ft.)
- - Y -	Sand & Gravel	0	10
- B N G	Broken, Sandstone, w/Gravel/Cobbles/Bould	10	20
- S N -	Soft/Loose, Sandstone	20	50
R - N H	Red, Sandstone, Shaley	50	80
R - H -	Red, Shale	80	106
- S H -	Soft/Loose, Shale	106	108
- - H -	Red Shale	108	110
- - N -	Sandstone	110	330
- B N -	Broken, Sandstone	330	360
- - N -	Sandstone	360	400

6. Casing, Liner, Screen

Dia. (in.)	Material, Weight, Specification Manufacturer & Method of Assembly	From (ft.)	To (ft.)
6	1-1.25" SDR11 4710 200 PSI HDPE	surface	400

Dia. (in.)	Screen type, material & slot size	From	To

9. Static Water Level
___ ft. above ground surface
60 ft. below ground surface

10. Pump Test
Pumping level 80 ft. below surface
Pumping at 120 GPM for 1 Hrs.

11. Well Is:
12 in. ☒ Above ☐ Below Grade
Developed? ☒ Yes ☐ No
Disinfected? ☒ Yes ☐ No
Capped? ☒ Yes ☐ No

7. Grout or Other Sealing Material
Method: Tremie Pipe - Pumped

Kind of Sealing Material	From (ft.)	To (ft.)	# Sacks Cement
TG Lite 1.0	surface	400	26
(Gravel pack if applicable) Bentonite Chips/bag	105	110	6

12. Did you permanently abandon and fill all unused, noncomplying or unsafe wells on this property? ☒ Yes ☐ No If no, explain on reverse.

13. Signature of Well Constructor or Supervisory Driller: tv
Date Signed: 9/18/2015
Print Name of Drill Rig Operator (Mandatory unless same as above): cp
Date: 9/18/2015

Make additional comments on reverse side about geology, additional screens, water quality, etc.
Comments on reverse side X (CHECK √, IF YES) Variance Issued ☐ Yes ☒ No
Notification # 56464582

DNR

Formation Thermal Conductivity
Test & Data Analysis

Test Location **Fitchburg West Fire Station**
Fitchburg, WI

Test Date September 21-23, 2015

Analysis For G.O. Loop
W11366 Blanecae Road
Randolph, WI 53956
Phone: (920) 326-2050
Fax: (920) 326-2051

Test Performed By G.O. Loop

Executive Summary

A formation thermal conductivity test was performed at the Fitchburg West Fire Station site at a GPS location of N 43° 0.810' (latitude), W 89° 27.518' (longitude) in Fitchburg, Wisconsin. The vertical bore was completed on September 5, 2015 by G.O. Loop. Geothermal Resource Technologies' (GRTI) test unit was attached to the vertical bore on the afternoon of September 21, 2015.

This report provides an overview of the test procedures and analysis process, along with plots of the loop temperature and input heat rate data. The collected data was analyzed using the "line source" method and the following average formation thermal conductivity was determined.

Formation Thermal Conductivity = 2.22 Btu/hr-ft-°F

Due to the necessity of a thermal diffusivity value in the design calculation process, an estimate of the average thermal diffusivity was made for the encountered formation.

Formation Thermal Diffusivity ≈ 1.38 ft^2/day

The undisturbed formation temperature for the tested bore was established from the initial loop temperature data collected at startup.

Undisturbed Formation Temperature ≈ 50.6-51.2°F

The formation thermal properties determined by this test do not directly translate into a loop length requirement (i.e. feet of bore per ton). These parameters, along with many others, are inputs to commercially available loop-field design software to determine the required loop length. Additional questions concerning the use of these results are discussed in the frequently asked question (FAQ) section at www.grti.com.

Test Procedures

The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) has published recommended procedures for performing formation thermal conductivity tests in the ASHRAE HVAC Applications Handbook, Geothermal Energy Chapter. The International Ground Source Heat Pump Association (IGSHPA) also lists test procedures in their Design and Installation Standards. GRTI's test procedures meet or exceed those recommended by ASHRAE and IGSHPA, with the specific procedures described below:

Grouting Procedure for Test Loops – To ensure against bridging and voids, it is recommended that the bore annulus is uniformly grouted from the bottom to the top via tremie pipe.

Time Between Loop Installation and Testing – A minimum delay of five days between loop installation and test startup is recommended for bores that are air drilled, and a minimum waiting period of two days for mud rotary drilling.

Undisturbed Formation Temperature Measurement – The undisturbed formation temperature should be determined by recording the loop temperature as the water returns from the u-bend at test startup.

Required Test Duration – A minimum test duration of 36 hours is recommended, with a preference toward 48 hours**.**

Data Acquisition Frequency - Test data is recorded at five minute intervals.

Equipment Calibration/Accuracy – Transducers and datalogger are calibrated per manufacturer recommendations. Manufacturer stated accuracy of power transducers is less than ±2%. Temperature sensor accuracy is periodically checked via ice water bath.

Power Quality – The standard deviation of the power should be less than or equal to 1.5% of the average power, with maximum power variation of less than or equal to 10% of the average power.

Input Heat Rate – The heat flux rate should be 51 Btu/hr (15 W) to 85 Btu/hr (25 W) per foot of installed bore depth to best simulate the expected peak loads on the u-bend.

Insulation – GRTI's equipment has 1 inch of foam insulation on the FTC unit and 1/2 inch of insulation on the hose kit connection. An additional 2 inches of insulation is provided for both the FTC unit and loop connections by insulating blankets.

Retesting in the Event of Failure – In the event that a test fails prematurely, a retest may not be performed until the bore temperature is within 0.5°F of the original undisturbed formation temperature or until a period of 14 days has elapsed.

Data Analysis

Geothermal Resource Technologies, Inc. (GRTI) uses the "line source" method of data analysis to determine the thermal conductivity of the formation. The line source method assumes an infinitely thin line source of heat in a continuous medium. A plot of the late-time temperature rise of the line source temperature versus the natural log of elapsed time will follow a linear trend. The linear slope is inversely proportional to the thermal conductivity of the medium. When a u-bend grouted in a borehole is used to inject heat into the ground at a constant rate in order to determine the average formation thermal conductivity, the test must be run long enough to allow the finite dimensions of the u-bend pipes and the grout to become insignificant. Experience has shown that approximately ten hours is required to allow the error of early test times and the effects of finite borehole dimensions to become insignificant.

In order to analyze real data from a formation thermal conductivity test, the average temperature of the water entering and exiting the u-bend heat exchanger is plotted versus the natural log of elapsed testing time. Using the Method of Least Squares, linear coefficients are then calculated to produce a line that fits the data. This procedure is repeated for various time intervals to ensure that variations in the power or other effects are not producing inaccurate results.

The calculated results are based on test bore information submitted by the driller/testing agency. GRTI is not responsible for inaccuracies in the results due to erroneous bore information. All data analysis is performed by personnel that have an engineering degree from an accredited university with a background in heat transfer and experience with line source theory. The test results apply specifically to the tested bore. Additional bores at the site may have significantly different results depending upon variations in geology and hydrology.

Through the analysis process, the collected raw data is converted to spreadsheet format (Microsoft Excel®) for final analysis. If desired, please contact GRTI and a copy of the data will be made available in either a hard copy or electronic format.

Contact: Chad Martin
Regional Managing Engineer
Asheville, NC
(828) 225-9166
cmartin@grti.com

Test Bore Details
(As Provided by G.O. Loop)

Site Name ..... Fitchburg West Fire Station
Location ..... Fitchburg, WI
Driller ..... G.O. Loop
Installed Date ..... September 5, 2015
Borehole Diameter ..... 8 inches, 0-60 ft
6 inches, 60-400 ft
Casing ..... Temporary 6 inch casing to 60 ft
U-Bend Size ..... 1 1/4 inch DR-11 HDPE
U-Bend Depth Below Grade ..... 400 ft
Grout Type ..... GeoPro Thermal Grout Lite
Grout Mixture ..... 250 lb sand per 50 lb bentonite
Grouted Portion ..... Entire bore
Note: Bore was grouted with bentonite chips from 105-110 ft.

Drill Log

Formation Description	Depth (ft)
Sand & gravel	0'-10'
Broken sandstone w/gravel/cobbles/boulders	10'-20'
Soft/loose sandstone	20'-50'
Red sandstone, shaley	50'-80'
Red shale	80'-106'
Soft/loose shale	106'-108'
Red shale	108'-110'
Sandstone	110'-330'
Broken sandstone	330'-360'
Sandstone	360'-400'

Thermal Conductivity Test Data

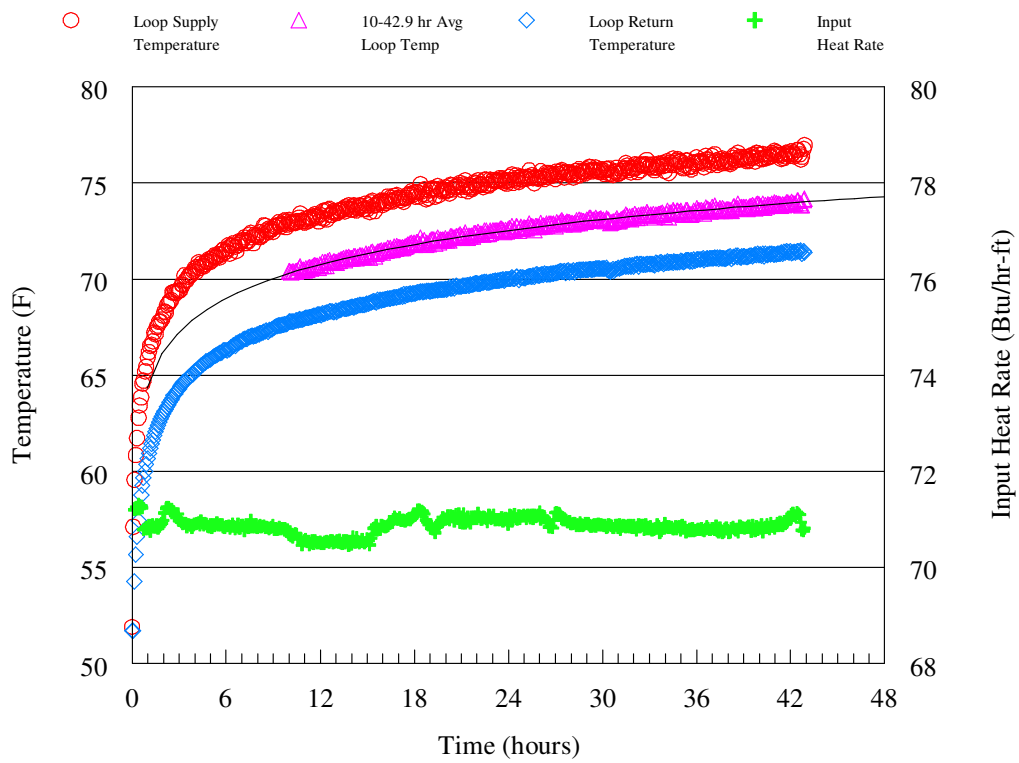

Fig. 1: Temperature & Heat Rate Data Vs Time

Figure 1 above shows the loop temperature and heat input rate data versus the elapsed time of the test. The temperature of the fluid supplied to and returning from the U-bend are plotted on the left axis, while the amount of heat supplied to the fluid is plotted on the right axis on a per foot of bore basis. In the test statistics below, calculations on the power data were performed over the analysis time period listed in the Line Source Data Analysis section.

Summary Test Statistics

Test Date	September 21-23, 2015
Undisturbed Formation Temperature	Approx. 50.6-51.2°F
Duration	42.9 hr
Average Voltage	239.1 V
Average Heat Input Rate	28,343 Btu/hr (8,305 W)
Avg Heat Input Rate per Foot of Bore	70.9 Btu/hr-ft (20.8 W/ft)
Calculated Circulator Flow Rate	11.1 gpm
Standard Deviation of Power	0.24%
Maximum Variation in Power	0.57%

Line Source Data Analysis

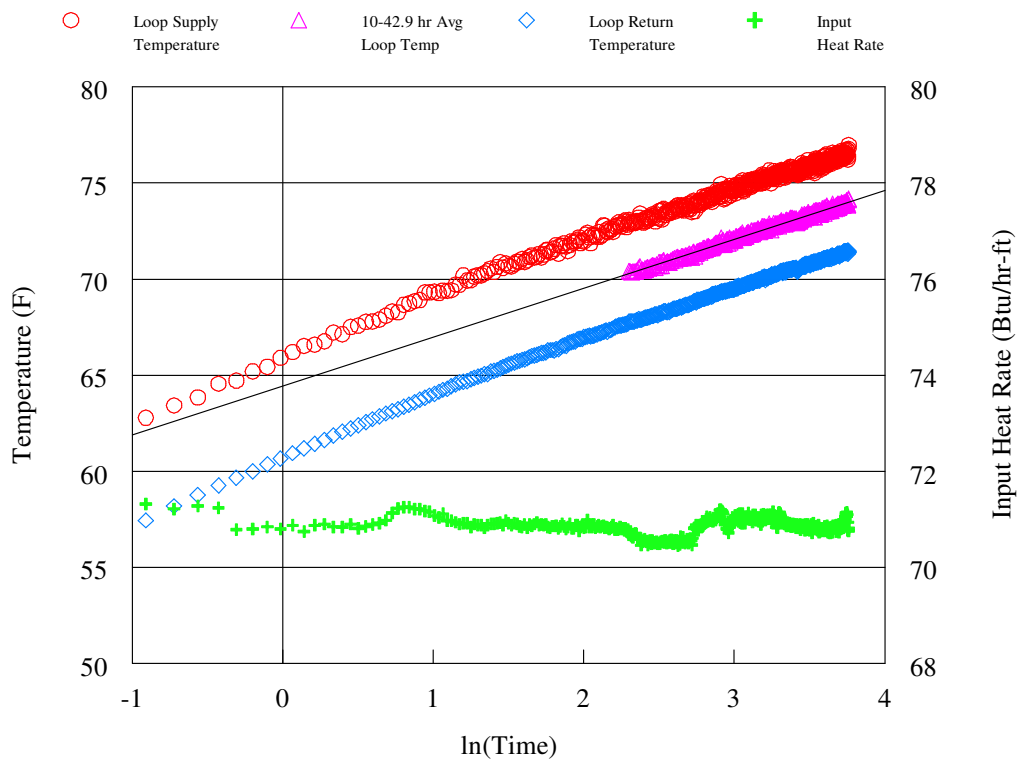

Fig. 2: Temperature & Heat Rate Vs Natural Log of Time

The loop temperature and input heat rate data versus the natural log of elapsed time are shown above in Figure 2. The temperature versus time data was analyzed using the line source method (see page 3) in conformity with ASHRAE and IGSHPA guidelines. A linear curve fit was applied to the average of the supply and return loop temperature data between 10 and 42.9 hr. The slope of the curve fit was found to be 2.55. The resulting thermal conductivity was found to be **2.22 Btu/hr-ft-°F**.

Thermal Diffusivity

The reported drilling log for this test borehole indicated that the formation consisted of sand, gravel, cobbles, boulders, shale, and sandstone. Heat capacity values for shale and sandstone were calculated from specific heat and density values listed by Kavanaugh and Rafferty (Ground-Source Heat Pumps - Design of Geothermal Systems for Commercial and Institutional Buildings, ASHRAE, 1997). A weighted average of heat capacity values based on the indicated formation was used to determine an average heat capacity of 38.5 Btu/ft^3-°F for the formation. A diffusivity value was then found using the calculated formation thermal conductivity and the estimated heat capacity. The thermal diffusivity for this formation was estimated to be **1.38 ft^2/day**.

Certificate of Calibration

GRTI maintains calibration of the datalogger, current transducer and voltage transducer on a biannual schedule per the manufacturers recommendations. The components are calibrated by the manufacturer using recognized national or international measurement standards such as those maintained by the National Institute of Standards and Technology (NIST).

FTC Unit 204

DA Unit 19

Primary Equipment		
Component	Last Calibration Date	Calibration Due Date
Datalogger	12/2/2014	12/2/2016
Current Transducer	12/5/2014	12/5/2016
Voltage Transducer	12/5/2014	12/5/2016

GRTI periodically verifies the combined temperature sensor/datalogger accuracy via an ice water bath. Temperature readings are simultaneously taken with a digital thermometer that has been calibrated using instruments traceable to NIST.

Date	12/12/2014	3/9/2015		
Thermocouple 1 (°F)	32.1 32.1 32.1	32.1 32.1 32.0		
Thermocouple 2 (°F)	31.9 31.9 31.9	31.9 31.9 32.0		
Thermocouple 3 (°F)	32.0 32.0 32.0	31.9 31.9 31.9		
Thermocouple 4 (°F)	32.1 32.1 32.1	32.1 32.1 32.1		
Digital Thermometer (°F)	32.1 32.0 32.0	32.1 32.1 32.0		