SDA
NJ SCHOOLS DEVELOPMENT AUTHORITY

Bovis
Lend Lease

# Addendum No. 2

**DATE:** August 18, 2009

**PROJECT #:** Marshall Street Elementary School
Paterson, NJ
SDA Contract #PA-0006-C03

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**The following revisions to the Bid Documents by Addendum #2 are:**

**A. Changes to the Front-End Documents:**

1. **REPLACE Supplementary Conditions Paragraph 4.1.6 with the following:** "The Contractor shall include in the Lump Sum proposal the cost of cleaning NJ Transit Rip Rap drainage Channel from all debris whether caused by the Contractor or not a total distance of 400 feet, 200 feet along the track on both sides of the bridge. In addition, the Contractor shall include the cleaning of the entire ditch length between the bridge and the concrete channel at Pacific Street".

2. **REPLACE Supplementary Conditions Paragraph 6.24.2.8 with the following:** "The **Engineer** shall provide all laboratory analytical testing of air gas samples collected from the interior and exterior of the building to confirm the level of Total Volatile Organics is within the acceptable limits".

3. **ADD to the end of Section 01010, Summary of Work Article 1.4, A14:** "The Contractor may modify the perimeter fence and gate, provide additional fencing and vehicular and man gates to provide a safe and orderly entering, exiting, loading and unloading at the site of labor and material. Additionally, the Contractor shall provide the necessary fencing and gates, whether shown on the drawings or not, around all work areas of the bridge to protect the public"

4. **ADD to the end of Section 01010, Summary of Work Article 1.4 A19:** "The current wage rate for NJ Transit flagman and /or Inspectors is $77.65 per hour. The rate is effective between 7/1/09 and 6/30/2010 and may change as of 7/1/2010. The Contractor shall anticipate and include in the lump sum bid the cost of 5% additional increase starting 7/1/2010. Should the rate increase be higher or lower than the anticipated 5%, the NJSDA will compensate the Contractor for the additional cost or request a credit for the lower cost. The additional cost and or credit amount will be based on the difference between the $77.65 and the new rate multiplied by the hours charged by NJ transit for all work performed after 7/1/2010."

5. **ADD to the end of Section 01010, Summary of Work, Article 1.4. A20 as follows:** "Unforeseen concrete removal is part of this contract. The contractor shall include in the lump sum bid the **removal of 500 tons of underground concrete structures.** The unit prices part of the price proposal will be used to adjust the contract lump sum for additional or less quantity than the specified

above. Any unused portions of the identified quantity will be credited back to the Owner using the unit prices listed in the price proposal.

6. **ADD to end of Section 01010, Summary of Work, Article 1.5 F:**
"The Contractor may modify the perimeter fence and gate, provide additional fencing and vehicular and man gates to provide a safe and orderly entering, exiting, loading and unloading at the site of labor and material. Additionally, the Contractor shall provide the necessary fencing and gates, whether shown on the drawings or not, around all work areas of the bridge to protect the public"

7. **ADD to end of Section 01500, Temporary Facilities, Article 1.2 C Item 3, the following:**
"The CM / Owner field office trailer shall be completely installed with all utilities services and security within thirty days (30) calendar days after Notice to Proceed or later as directed by the CM.

The General Contractor is required to furnish all labor and material to relocate the CM / Owner into the school once the trailers are removed from the site. This move is based on the General Contractors construction time-frame. All cost to relocate phone, fax, computer lines, desks, chairs, tables etc. will be the responsibility of the GC. The relocation process will commence on a Friday and be complete by that following Monday. This will minimize any disruption to the CM / Owner field staff."

8. **ADD to end of Section 01100, Coordination, Article 1.6 "Work Sequence" the following;**
"The General Contractor will be required to utilize the SDA web-based Primavera Expedition and P5 management tool for the complete duration of the project. All submittals, change orders, RFI's, issues, etc. will be required to be inputted by the General Contractor and maintained by the General Contractor. Any cost for computer upgrades, programs, etc. will be the responsibility of the General Contractor. Primavera Contract Manager 12.1 SP1 (aka Expedition) Client Requirements are attached, 2 pages. Adobe Reader, AutoCAD Viewer DWG TrueView and Java are available from the website at no charge.

9. **ADD to Table of Contents** (after Section 02970), end of Volume 2:
Appendix E Geothermal Test Boring Report and Formation Thermal Conductivity Test and Data Analysis – 16 pages.

10. **ADD to end of Volume 2 the following:**
**Appendix E:**
Geothermal Services Test Boring Report dated Nov. 17 & 18, 2004 – 4 pages
Attachment #1 Site Location Plan – 1 page
Attachment #2 "As-Drilled" Location Plan – 1 page
Attachment #3 Geothermal Services Field Test Boring Log – 2 pages
Attachment #4 Formation Thermal Conductivity Test and Data Analysis dated Dec. 30, 2004 – 8 pages

B. **Changes to Specifications and Drawings**

1. **ADD to end of Section 01351 LEED Requirements, the following:**
**LEED Checklist, attached – 2 pages**

2. **ADD: Section 19100 General Commissioning Requirements – 11 pages**

3. **ADD to Section 08800 GLAZING, Part 2 – PRODUCTS, Paragraph 2.2 COMPONENTS, Subparagraph C: Guardian Sunguard SN68 is an acceptable manufacturer and product for Insulating Glass Units.**

4. **ADD to Section 12486 FLOOR MATS, Part 2 PRODUCTS, Paragraph 2.1 Manufacturers: 5. Kadee Industries.**

5. **REPLACE the enclosed Drawing R-1, Sub-Slab Collection System with the Drawing R-1 issued under Addendum #1. Note #2 was added.**

C. **Clarifications**

1. **Q:** Provide 3rd shift hourly rates for N.J. Transit flagmen and inspector.
   **A:** See Item A.4 above.

2. **Q:** How many hours per day we have to keep N.J. Transit flagmen and inspector on-site?
   **A:** See Section 01010, Article 1.4, A.19 and Supplementary Conditions Article 4.0.

3. **Q:** Are there any existing underground structure or underground storage tank do we have to remove? Please advise.
   **A:** See Item A.5 above.

4. **Q:** As mentioned at pre-bid, we have to install prefab bridge on 3rd shift, is this correct?
   **A:** See Supplementary Conditions Article 4.0

5. **Q:** Is existing on-site soil suitable for building foundation, building pad & site improvement?
   **A:** The geotechnical information provided in Appendix B of the site specifications indicates seven (7) test borings were advanced in the area of the proposed building. Based upon these borings it is anticipated the soils encountered at the proposed bearing depths are competent in terms of their structural support and bearing capacity for the proposed building provided the recommended design parameters for footings and foundations were followed and that excavated subgrades are protected during construction. It is recommended that additional foundation subgrade preparation occur in the area of TB-1 due to loose soil encountered at a depth of 6 feet. Generally, the uncontaminated soils should be adequate if left undisturbed and if the site preparation recommendations contained in section 6.1 of the geotechnical report dated October 8, 2003 are followed. Soil within the deed notice area cannot be reused in other areas at the site, and excess material must be properly disposed off-site. See notes #3 and #4 on Drawing R-2 "Proposed Areas of Soil Remediation Plan" which clarify this in Addendum #1.

6. **Q:** Can existing on-site soil be used as backfill in foundation, building and site improvements?
   **A:** The soils encountered below the topsoil stratum may be difficult to place and compact once disturbed due to increased amounts of silt, which will be moisture sensitive. It is recommended uncontaminated excavated materials not be reused

for structural fills in foundations and within buildings due to their moisture sensitivity. However, these materials can be used as backfill material in site improvements and for structural areas if they are properly handled, moisture conditions are controlled and weather conditions permit. In the event the material is not carefully handled to control moisture and/or placement does not occur during optimal weather conditions it will not be suitable for reuse. Soil within the deed notice area cannot be reused in other areas at the site, and excess material must be properly disposed off-site. See notes #3 and #4 on Drawing R-2 "Proposed Areas of Soil Remediation Plan" which clarify this in Addendum #1.

The geotechnical recommendations are based upon the anticipation that earthwork operations will be observed by a site geotechnical engineer during construction as indicated in the report.

7.

**Q:** Do we have to do any field finish paint work on new bridge structure? If it is, provide color and type of paint.
**A:** Refer to Specification Section 13130-Part II K. Manufacturers shall submit full range of color samples for the type of finish specified.

8.

**Q:** Are there any requirements for surveying existing rail tracks? Please clarify.
**A:** NJ Transit does not require the Contractor the survey the existing tracks unless the Contractor performs sheetpile driving operation.

9.

**Q:** Regarding the geothermal system, Specification Section 15999 Paragraph 1.1.D notes, "The geothermal wells must be installed in a way that the soil and groundwater contaminants will not contaminate...the water at the bottom of the wells." Contractor proposes to install well casing from the top of the well to 5' into the bedrock. This will "case off" the soil and groundwater. Is this an allowed method?
**A:** According to the geothermal test bore report, a 6" steel casing was installed to a depth of 10' to seal off overburden. Contractor to provide a 10' steel casing.

10.

**Q:** Regarding the geothermal system, Specification Section 15999 Paragraph 2.4.A notes that "The grout shall be pre-blended dry at the factory and delivered to the jobsite in sealed bags. No additives except water shall be added in the field." A contractor who experienced problems with pre-mixed grout requested permission to mix the cement, sand and minor additives 'on-site'. Specification Section 15999 Paragraph 2.4.A further notes that "No additives except water shall be added in the field." The superplasticizer is required by New Jersey Regulations and is a liquid. It must be added 'on-site'. The bentonite is another minor ingredient and must be mixed 'on-site' to assure uniformity.
**A:** While what the contractor is stating is true, that the bags can absorb moisture and 'form' rocks in the bag, we suggest the contractor pre-blend dry mix and haul to the site in bulk, rather than mix in the field. This is what is done on other projects.

11.

**Q:** Regarding the geothermal system, Specification Section 15999 Paragraph 2.4.E , the bidder is unaware of any continous grout mixer that has been used with the cementitious grout. Per "Guidelines for Mixing and Placing Thermally Conductive Cementitious Grout", M.L. Allen (one of the inventors of the grout), "The grout can be mixed with either a low shear (paddle) or high shear (Colloidial) mixer." The grout was qualified with the GeoLoop batch grouter by the inventors. Bidder requests permission to use the GeoLoop grouter.

**A:** The GeoLoop grouter is acceptable.

**12.**

**Q:** We received a fax from Insulation Solutions claiming that their Viper Vaporcheck II 15-mil product is approved as an under-slab vapor barrier for this project. Please confirm.
**A:** The only underslab vapor barrier product approved for this project is the proprietary "Liquid Boot" product described in Addendum #1.

**This addendum shall be considered part of the Bid Documents issued in connection with the referenced project. Should information conflict with the Bid Documents, this Addendum shall supersede the relevant information in the Bid Documents.**

**End of Addendum No. 2**

**NJ Schools Development Authority 8/18/09**
**Jack Coco, Project Manager**

# Addendum No. 2

DATE: August 18, 2009

PROJECT #: Marshall Street Elementary School
Paterson, NJ
Contract #PA-0006-C03

## Acknowledgement of Receipt of Addendum

Contractor must acknowledge the receipt of the Addendum by signing in the space provided below and returning via fax to 609-951-0038. Signed acknowledgement must be received prior to the Bid Due Date. Acknowledgement of the Addendum must be made in Section E.6 of the Price Proposal Submission.

| | |
|---|---|
| Signature | Print Name |
| Company Name | Date |

# Primavera Contract Manager 12.1 SP1 (aka Expedition)

# Client Requirements

## Client Machine Requirements

On the client machines, Contract Manager System runs entirely through a browser interface. The majority of pages are HTML with JavaScript code in them. There are a few applets that require the Java JRE. There is an optional ActiveX control for higher quality printing of reports and forms.

Operating Systems

- Windows 2000 All Types (SP3 & SP4)
- Windows XP Home & Professional (SP1 & SP2)
- Windows Vista (All Editions)

Browser*

- Internet Explorer 6.0 SP1 & higher
- Internet Explorer 7.0

*Note: IE can be mixed-matched with any OS listed above. Internet Explorer 8 IS NOT SUPPORTED AT THIS TIME.

Other Requirements:

- Java Run-Time Engine 1.6 Update 3 (Java 6.3)
    - On Login page, application will check for correct Java Run-Time Engine, and will prompt for installation if one is lacking.
    - Windows users must have installation rights [Power User or Administrator] to install the JRE. Once installed, Windows users rights can be reduced.
- Microsoft Word 2000 or greater (for the Letters module)
- Microsoft Excel XP or greater (for Send to Excel feature)

## Client Machine Specifications

The client workstation requires enough available RAM to properly display all of the data returned to the browser. Variables to consider; operating system resource requirements, number of projects contained in the active group, report and form sizes, other process active outside of Contract Manager requirements. The varying size of report and form processing will increase the RAM requirement. Additionally, each project listed in a project tree requires additional RAM to display. As the number of projects increase, so too does the memory requirements for the client.

| Client Machine | | |
|---|---|---|
| **Greatest Number of projects in a Group** | **Required RAM** | **Minimum CPU Speed** |
| 1 – 1500 | 128 MB | 300 MHz |
| > 1500 | 256 MB | 400 MHz |

## HTTPS

To enable Secure Socket Layer (SSL) communications the user needs a set of public and private keys and a certificate. The keys are provided by the SSL implementer, which is installed with Contract Manager. The certificate can be signed certificate from a third party like Verisign or the user can generate an unsigned certificate with the tool provided.

| HTTPS | |
|---|---|
| **HTTPS Resource** | **Provided with Contract Manager** |
| SSL Implementer | javax.net.ssl.SSLServerSocket |
| Key & Certificate Management Tool | Keytool from Sun |

APPENDIX "E"

GEOTHERMAL Services Inc.

P.O. Box 427 Mays Landing, NJ 08330 · (609) 625-5433 · fax (609) 625-4306 · gsi@geothermalservicesinc.com

# GEOTHERMAL TEST BORING REPORT

Client: NJ / K-12 Architects, LLC
104 Bayard Street
New Brunswick, NJ 08901

Project: Marshall Street School
Marshall Street & Paxton Street
Paterson, NJ 07502

Date of Drilling: November 17 & 18, 2004

Weather: Mostly Sunny 40°F 8:00AM (11/17/04)
Partly Cloudy 37°F 7:00AM (11/18/04)

Equipment: Ingersoll Rand T3
900 CFM / 350 PSI Air Compressor

## Site Location

A geothermal ground coupling is proposed for installation to serve the heating & cooling needs for the proposed new Marshall Street Elementary School. The site in question is bounded by Marshall Street to the north, Paxton Street to the east, Hazel Street to the west and a NJ Transit rail line to the south. The school is positioned in a residential neighborhood, adjacent to single family homes located on Paxton Street. The location for the proposed school is shown in the Site Location Plan included in this report. (See Attachment #1). The final location of the proposed geothermal loop field is proposed to be installed along the eastern side of the property adjacent to Paxton Street south of the intersection of Marshall Street and will be evaluated on the drilling conditions and thermal conductivity test results included in this report.

At the time of our initial site visit, the test bore site (B-1) was an open, rough graded area that is relatively flat with a decreasing grade from northeast to south, southwest. The location of the test bore is shown on the "as-drilled" boring location plan that includes global positioning system (GPS) coordinates. (See Attachment #2).

Local Geology/Subsurface Condition

The local geology of the site in question was researched utilizing the Bedrock Geologic Map of Northern New Jersey and Engineering Soil Survey of New Jersey (Passaic County). The surficial soils in the area consist of unassorted, heterogeneous material including clay, silt, sand sizes with varying amounts of gravel, cobble and boulders.

The surficial soils are underlain by the Passaic Formation, which consists of reddish-brown to brownish-purple and grayish-red siltstone and shale. This formation has a maximum thickness of eleven-thousand-eight-hundred (11,800) feet and locally contains areas of reddish-brown to brownish-red sandy mudstone. The test boring data is consistent with the characteristics of both the surficial soils and underlying formation.

The borings penetrated unconsolidated sand and clay for the first five (5) feet drilled. Below this depth competent red shale was encountered that continued to the final bore depth of 590 feet. The vast majority of the materials penetrated by the boring are consolidated rock which are present throughout the Paterson area. A detailed boring log is included reflecting transitions in the subsurface materials encountered on the site. (See Attachment #3)

Drilling Technique

One (1) five and one half (5½) inch diameter test bore were performed on November 17th and 18th, 2004 using an air rotary drilling technique. Representatives from Concord Engineering Group provided site plans for the final boring location that was marked on site by Mr. Jim Moench of Geothermal Services. The test bore was advanced with an Ingersoll-Rand T3W drill rig with a 900 CFM / 350 PSI air compressor using an air rotary percussion hammer drilling method to the full depth of exploration, which was 590 feet. Upon completion of each boring a 1¼" diameter high-density polyethylene (HDPE) "loop" with U-Bend was installed to a depth of 590 feet. The borehole was then tremie grouted (from bottom to top) with thermally enhanced cement grout (Mix 111) in accordance with New Jersey Department of Environmental (NJDEP) regulations for closed loop geothermal installations.

Thermal Conductivity

Geothermal Services, Inc. performed a 48-hour thermal conductivity tests on the test bore installed at the subject site. The tests were performed by Mr. Jeff Craig of Geothermal Services Inc., utilizing a "Geothermal Resources Technologies, Inc. Test Unit", powered by a 17Kw diesel generator to ensure a consistent source of electrical energy throughout the course of testing..

Thermal conductivity testing for the test bore began on Monday, December 20, 2004 and was completed on Wednesday morning December 22, 2004. The average

thermal conductivity (k) for test bore #1 (B-1) was 2.30 BTU/hr-ft-°F. This is average conductivity per foot for the borehole.

This value represents the rate at which the borehole and soil will transfer heat. It is an important variable in determining the amount of ground heat exchanger required for a given system.

The complete Geothermal Resources Technologies, Inc. report is included as Attachment #4.

Discussion and Recommendations

The drilling conditions encountered included consolidated rock formations of red shale throughout the majority of the test bore. The first five feet consisted of coarse, silty medium and fine sand with some clay and coarse gravel. At a depth of five feet weathered rock was present. A six-inch steel casing was advanced to a depth of ten feet to seal off the overburden. Below this level, competent rock was encountered for the remaining depth of the test bore. At a depth of 25 feet water was first encountered with a yield of approximately 2 gallons per minute. Water was also encountered at a depth of 75 feet with a yield of approximately 5 gallons per minute. Additional water was encountered at 130 feet, producing an aggregate yield of approximately 10 gallons per minute, and again at 280 feet with approximately 25 gallons per minute. A large amount of water was encountered at a level of approximately 420 feet of approximately 95 gallons per minute. The drill logs show a significant drop in penetration rate at this point (approximately a 20% reduction) reflecting the added difficulty of dealing with a large volume of water. At final depth, the total water discharge rate was approximately 100 gallons per minute.

While these varying volumes of water did not present any significant difficulty or adverse impact in terms of drilling productivity, it is recommended that a shallower drill depth be considered in order to maximize daily productivity when a full scale drilling operation is in place to complete this project. The average penetration rate for test bore was 1.0 ft/min, which translates to nearly 10 hours required just to drill a 590 foot bore. An additional 3 ½ hours was required to install the loop and complete grouting the bore.

We recommend the depth of the bores not to exceed 425 feet in order to avoid the productivity impact when dealing with significant amounts of water below this depth. If this alternate drill depth is unacceptable, due to space restrictions on the site, provisions will need to be made in order to deal with water management issues. This recommendation is made within the limits of the full depth of our exploration (590 feet) and is dependent upon whatever depth best accommodates the pressure drop and pumping capacity determined by the mechanical engineering analysis completed for the design of the ground heat exchanger.

Our analysis of the test boring data obtained during this investigation indicates that the subsurface conditions of the site are favorable for the installation of a closed loop geothermal ground coupling.

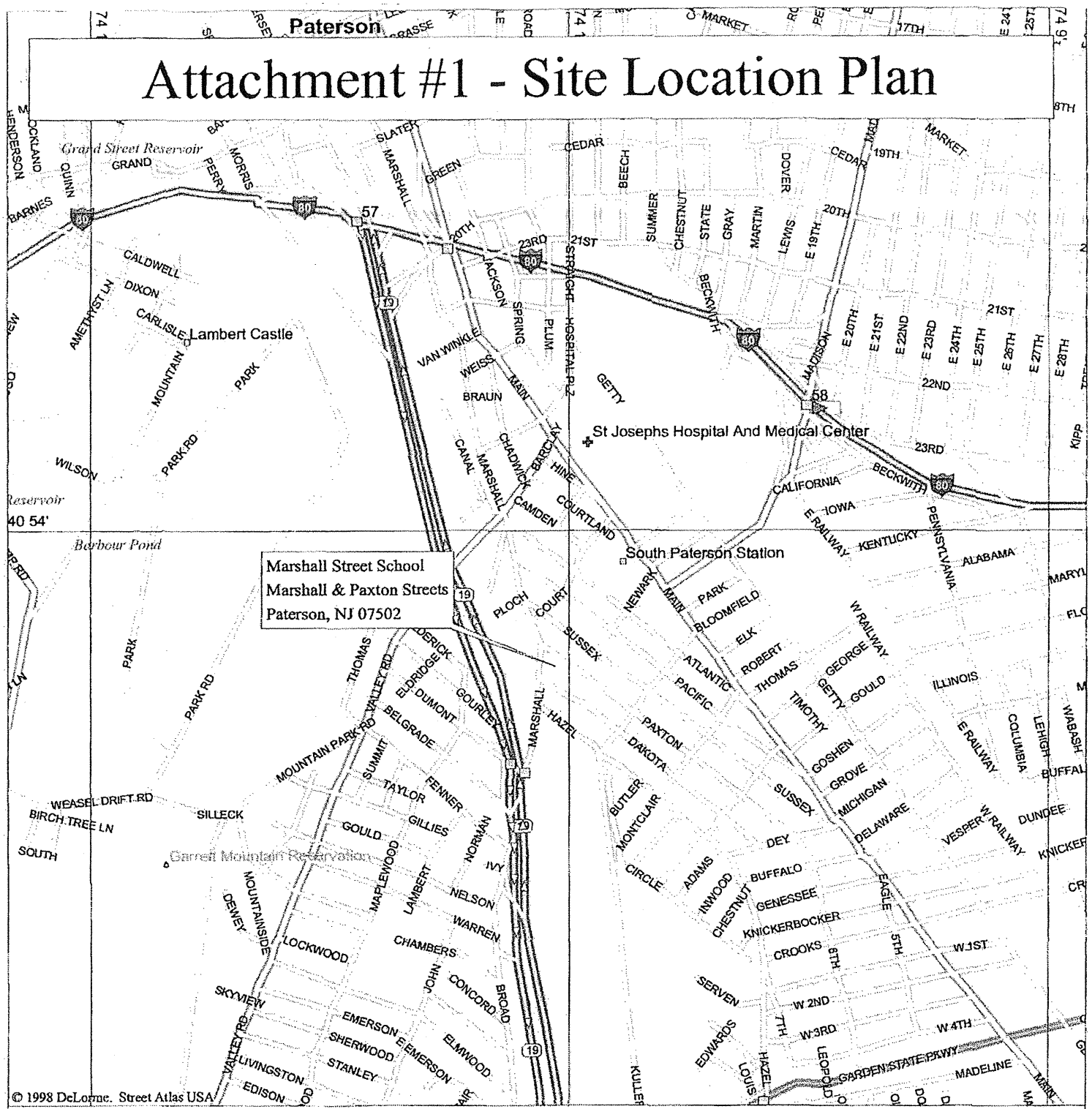
Attachment #1 - Site Location

Attachment #2 - As Drilled Boring Locations

Attachment #3 - Record of Boring Logs

Attachment #4 - Geothermal Resources Technologies, Inc. Reports

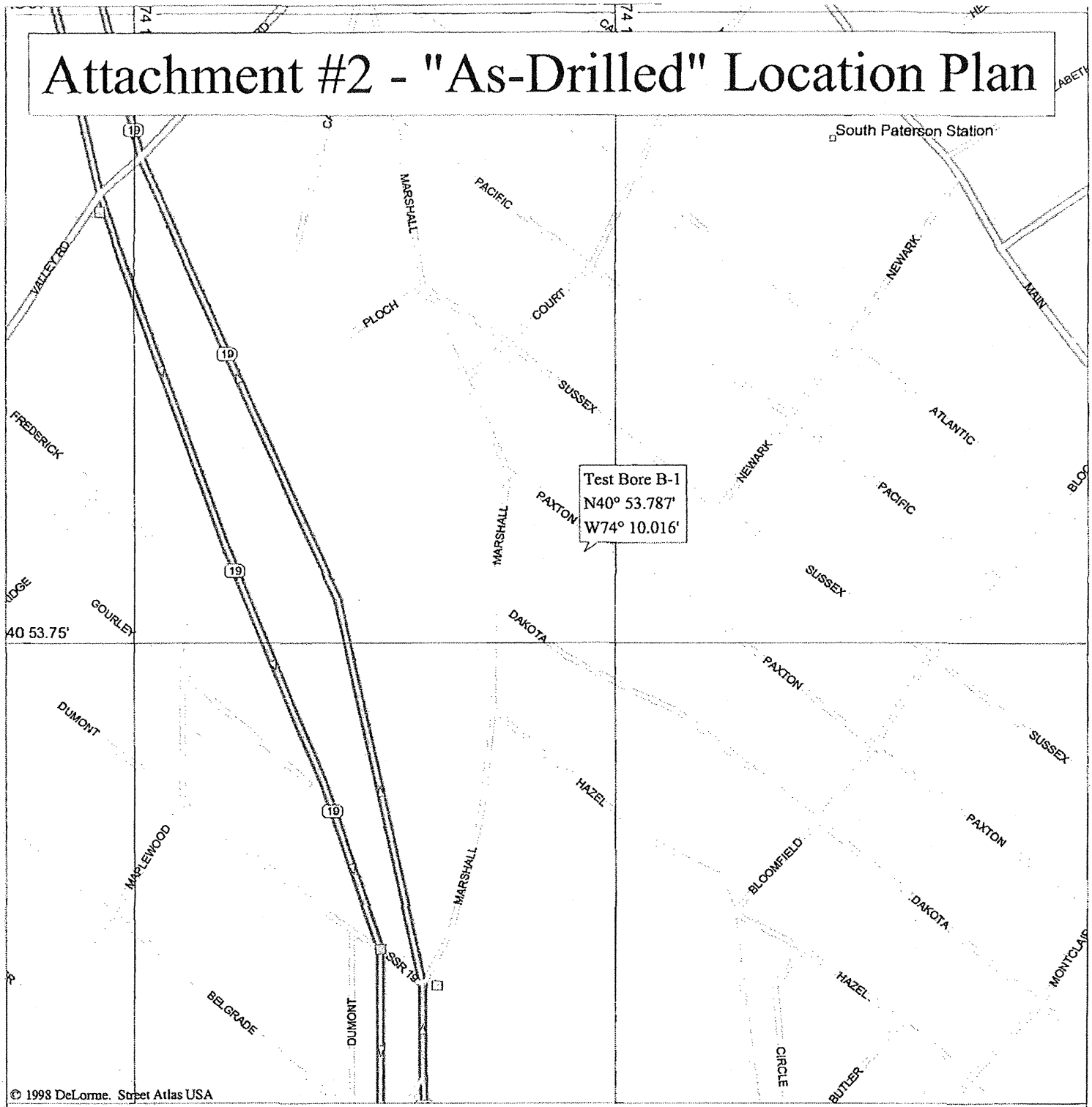
# Attachment #1 - Site Location Plan




Mag 15.00
Wed Dec 22 14:26 2004
Scale 1:15,625 (at center)
1000 Feet
500 Meters

- Local Road
- Major Connector
- Interstate/Limited Access
- Toll Highway
- Exit
- Railroad
- Point of Interest
- Large City
- Hospital
- Park/Reservation
- Exit/Food
- Exit/Other Services
- Water
- Woodland

# Attachment #2 - "As-Drilled" Location Plan




Mag 17.00
Wed Dec 22 14:23 2004
Scale 1:3,906 (at center)

200 Feet

100 Meters

Local Road
Major Connector
Interstate/Limited Access
Exit
Railroad
Point of Interest

ATTACHMENT #3

GEOTHERMAL Services Inc.

P.O. Box 427 • Mays Landing, NJ 08330-2203 • Toll Free (877) 349-4689 • (609) 625-5433 • FAX (609) 625-4306 fax • Email: GEOSERV.net

# FIELD TEST BORING LOG

**CLIENT** NJ/K-12 ARCHITECTS, LLC **DATE** 11-18-04

**PROJECT** MARSHALL STREET SCHOOL **LAB NO.** 48027

**Boring No.** B-1 **Sheet 1 of 2** **Ground Surface Elev.**

| Ground Water Data | | | | * - Method of Advancing Boring | | Depth |
|---|---|---|---|---|---|---|
| Depth | Hour | Date | Hrs. After Completion | A | AIR ROTARY | 0 to 590' |
| | | | | B | | to |
| | | 11-18-04 | | C | | to |

| DEPTH | * | Sample No. | Sample Depth | Sample N | Soil Classification | Remarks |
|---|---|---|---|---|---|---|
| 0 | | | 0'-5' | | C-M F SAND WITH SOME SILT, CLAY AND GRAVEL | WATER AT 25' 2 GPM |
| 50 | | | | | | |
| | | | | 1.3 FT/MIN TO 100' | | WATER AT 75' 5 GPM |
| 100 | | | | | | |
| | | | | | | WATER AT 130' 10 GPM |
| 150 | | | | | RED SHALE | |
| | | | | 1.9 FT/MIN TO 200' | | |
| 200 | | | | | | |
| 250 | | | | | | |
| | | | | .9 FT/MIN TO 300' | | WATER AT 280' 25 GPM |
| 300 | A | | | | | |

☐ S - 2" O.D. Split Spoon Sample ■ U - Undisturbed Sample, 3" Diameter ☒ - Core Drilling ☐ - No Recovery

N - Standard Penetration Resistance per 6" (140# Hammer, 30" drop)

**Driller** N. SANTANA

# GEOTHERMAL SERVICES, INC.

## FIELD TEST BORING LOG

**Boring No.** B-1 **Sheet 2 of 2**

| DEPTH | * | Sample No. | Sample Depth | Sample N | Soil Classification | Remarks |
|---|---|---|---|---|---|---|
| 300 | | | | | | |
| 350 | | | | | | |
| 400 | | | | 1.0 FT/MIN TO 400' | RED SHALE | WATER AT 420' 95 GPM |
| 450 | | | | | | |
| 500 | | | | .8 FT/MIN TO 500' | | |
| 550 | | | | | | |
| 600 | | | 5'-590' | .7 FT/MIN TO 590' | TEST BORING COMPLETED @ 590' | WATER AT 590' 100 GPM |
| 650 | | | | | | |
| 700 | | | | | | |

☐ S - 2" O.D. Split Spoon Sample ■ U - Undisturbed Sample, 3" Diameter ☒ - Core Drilling ☐ - No Recovery

N - Standard Penetration Resistance per 6" (140# Hammer, 30" drop)

**Driller** N. SANTANA

ATTACHMENT #4

GRTI Geothermal Resource Technologies, Inc.

MAIN OFFICE:
1444 Rogers Court
ALLEN, TX 75013
(972) 390-1537
Fax: (972) 390-1851

REGIONAL OFFICES:
BROOKINGS, SD
(605) 692-9069
Fax: (605) 692-2604

ASHEVILLE, NC
(828) 225-9166
Fax: (828) 281-4139

WEB SITE:
www.GRTI.com

# FORMATION THERMAL CONDUCTIVITY TEST AND DATA ANALYSIS

Analysis for: **Geothermal Services, Inc.**
**5435 Harding Highway**
**Mays Landing, NJ 08330**
**Phone: (609) 625-5433**
**Fax: (609) 625-4306**

Test location: **Marshall Street School**
**Paterson, NJ**

Report Date: December 30, 2004

Test Performed by: **Geothermal Services, Inc.**

## Executive Summary

A formation thermal conductivity test was performed at the Marshall Street School site in Paterson, New Jersey. The vertical bore was completed on November 18, 2004 by Geothermal Services, Inc. GRTI's test unit was attached to the vertical bore on the morning of December 20, 2004. Geothermal Resource Technologies, Inc. analyzed the collected data using the "line source" method.

This report provides a general overview of the test and procedures that were used to perform the thermal conductivity test along with a plot of the data in real time and in a form used to calculate the formation thermal conductivity. The following average formation thermal conductivity was found from the data analysis.

⇒ Formation Thermal Conductivity = 2.30 Btu/hr-ft-°F

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

⇒ Formation Thermal Diffusivity ≈ 1.78 $ft^2$/day

An estimate of the undisturbed soil temperature range was determined from the initial temperature data at startup.

⇒ Undisturbed Soil Temperature Range ≈ 55.5°F

A copy of the original collected data is available either in a hard copy or an electronic format upon request.

## Test Procedures

The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) recently adopted and published a set of recommended procedures for performing formation thermal conductivity tests for geothermal applications. GRTI is committed to adhering to ASHRAE recommendations. Some of these recommended procedures are listed below:

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

(2) Power Quality – The standard deviation of the power should be ≦ 1.5% of the average power, with maximum power variation of ≦ 10% of the average power. The heat flux rate should be 51 Btu/hr (15 W) to 85 Btu/hr (25 W) per foot of borehole depth to best simulate the expected peak loads on the u-bend.

(3) Undisturbed Soil Temperature Measurement – The undisturbed soil temperature should be determined by recording the minimum loop temperature as the water returns from the u-bend at test startup.

(4) Installation Procedures for Test Loops – The bore diameter is to be no larger than 6 inches, with 4.5 inches being the target diameter. To ensure against bridging and voids, the bore annulus is to be uniformly grouted from the bottom to the top using a tremie pipe.

(5) Time Between Loop Installation and Testing – A minimum delay of five days between loop installation and test startup is recommended if the formation is expected to have a low thermal conductivity or if low conductivity grouts (< 0.75 Btu/hr·ft·°F) are used. A minimum delay of three days is recommended for all other conditions.

GRTI's testing procedures deviate slightly from those above with regard to item (5). While item (5) bases the delay between installation and testing on the expected formation conductivity, GRTI bases its delay on the type of drilling used in the installation. When air drilling is required, a five-day delay is recommended to allow the bore to return to its undisturbed temperature. For mud rotary drilling, a minimum waiting period of two days is sufficient.

For a complete list of recommended procedures, refer to ASHRAE's 2003 HVAC Applications handbook, page 32.14.

## Data Analysis

Geothermal Resource Technologies, Inc. uses the "line source" method of data analysis. The line source equation used is not valid for early test times. Also, the line source method assumes an infinitely thin line source of heat in a continuous medium. If 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 the amount of time required to allow early test time error and finite borehole dimension effects to become insignificant is approximately ten hours.

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 time. Using the Method of Least Squares, the linear equation coefficients are then calculated that produce a line that fits the data. This procedure is normally repeated for various time intervals to ensure that variations in the power or other effects are not producing erroneous results.

Through the analysis process, the collected raw data is converted to spreadsheet format (Microsoft Excel®) for final analysis. A copy of this data can be obtained either in a hard copy or electronic copy format at any time. If desired, please contact Geothermal Resource Technologies, Inc. and provide a ship-to address or e-mail address at one of the following:

Phone: (972) 390-1537
Fax: (972) 390-1851
E-mail: askouby@grti.com

# Formation Thermal Conductivity Test Report

Date ..... December 20 - 22, 2004
Location ..... Paterson, NJ

## Borehole Data

Undisturbed Soil Temperature ..... Approx. 55.5°F
Borehole Diameter ..... 5 1/2 inches

Drill Log .....

| | |
|---|---|
| C-M-F sand, some silt, clay, and gravel | 0'-5' |
| Red shale | 5'-590' |

Water flow: 2 gpm at 25 ft, 5 gpm at 75 ft, 10 gpm at 130 ft, 25 gpm at 280 ft, 95 gpm at 420 ft, 100 gpm at 590 ft.

U-bend Size ..... 1 ¼ inch HDPE
U-Bend Length ..... 590 ft
Grout Type ..... Mix 111
Grout Solids ..... NA
Grouted Portion ..... Entire bore

## Test Data

Test Duration ..... 47.5 hrs.
Average Voltage ..... 228.2 V
Average Power ..... 9,271 W
Total Heat Input Rate ..... 31,641 Btu/hr
Calculated Circulator Flow Rate ..... 3.2 gpm

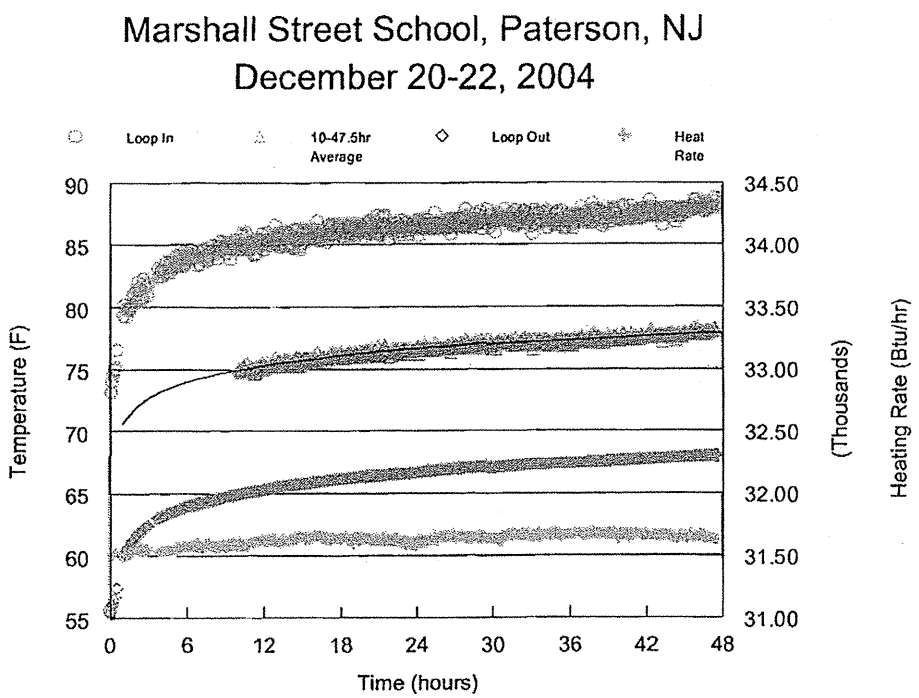



**Figure 1: Temperature versus Time Data**

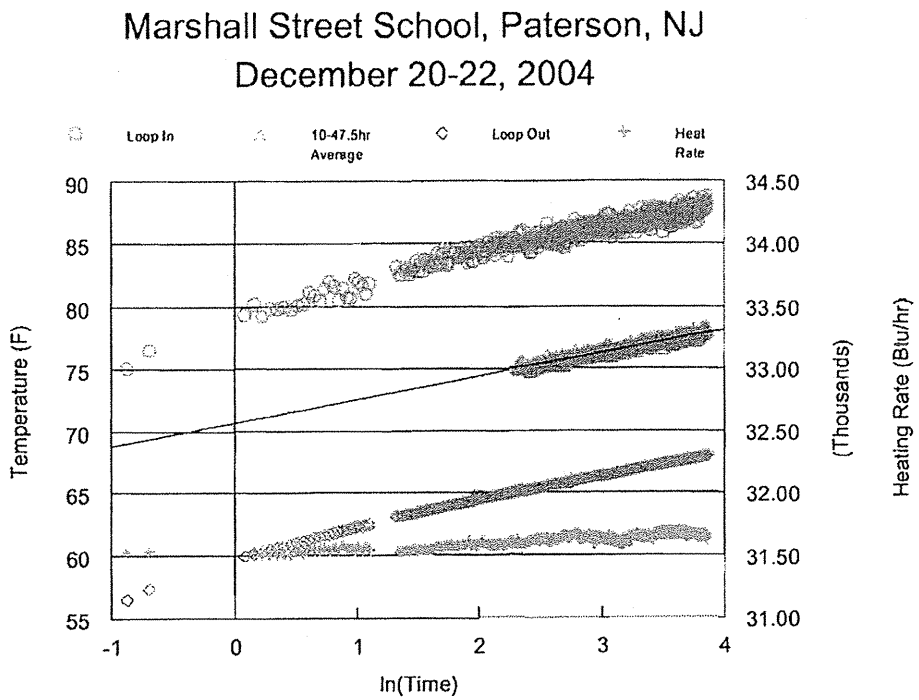



**Figure 2: Temperature versus Natural Log of Time**

| Time Period | Slope: $a_1$ | Average Heat Input (Btu/hr-ft) | (W/ft) | Thermal Conductivity (Btu/hr-ft-°F) |
|---|---|---|---|---|
| 10 – 47.5 hrs | 1.86 | 53.6 | 15.7 | 2.30 |

The temperature versus time data was analyzed using the line source analysis for the time period shown above. An average linear curve fit was applied to the data between 10 and 47.5 hours. The slope of the curve ($a_1$) was found to be 1.86. The resulting thermal conductivity was found to be 2.30 Btu/hr-ft-°F.

## Estimated Thermal Diffusivity

The reported drilling log for this test borehole indicated that the formation consisted primarily of shale. A heat capacity value for shale was 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 the heat capacity values based on the indicated formation was used to develop an average heat capacity for the formation. An estimated 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 approximately 1.78 $ft^2$/day.

| Est. Average Heat Capacity (Btu/$ft^3$ °F) | Thermal Conductivity (Btu/hr-ft-°F) | Est. Thermal Diffusivity ($ft^2$/day) |
|---|---|---|
| 31.1 | 2.30 | 1.78 |

## Frequently Asked Questions (FAQ's) Regarding FTC Testing

**Q:** Thermally-enhanced grout is specified for the final loop field design. The test bore was grouted with a low conductivity, 20% solids, bentonite grout. How do I adjust the thermal conductivity value to account for this?

**A:** While the conductivity of the grout is important for the loop field design, it is not important for determining formation thermal conductivity. We use the "line source" method to analyze data, which assumes an infinitely thin line rejecting heat at a constant rate into an infinite medium. The initial ten hours, which is influenced by the bore dimensions and grout conductivity, is ignored in the analysis. However, once the heat has penetrated into the formation, the temperature rise of the formation approaches steady-state. It is the slope of the temperature rise that is used in the analysis. Hence, no adjustment to the reported formation thermal conductivity is required.

**Q:** The software I use to design the loop field requires that I input a value for "soil conductivity". Is this the same as formation thermal conductivity?

**A:** Absolutely. Formation, soil, and ground are all used interchangeably to describe the conditions in which the u-bends will be installed. The use of the word "formation" simply implies that the installation conditions may be soil, rock, or some combination of the two.

**Q:** I've just received your report. I have a formation conductivity of 1.54 Btu/hr·ft·°F. How do I translate that into a loop length requirement, in terms of bore depth (in feet) per ton?

**A:** The formation thermal conductivity test provides values for three key parameters required for the ground loop design. These are the "Undisturbed Soil Temperature, Formation Thermal Conductivity, and Formation Thermal Diffusivity." These parameters, along with many others, are inputs to commercially available loop design software (e.g. GchpCalc, available at GeoKiss.com/software). The software uses all of the inputs to determine the required loop length in bore depth per ton.

**Q:** Is the "Undisturbed Soil Temperature" value listed in the report the temperature that I enter into my loop design software where it calls for the "Deep-Earth Temperature"?

**A:** Generally, yes. The "Undisturbed Soil Temperature" is the constant temperature of the formation. We attempt to determine this value by measuring the temperature of the water entering the test unit at the beginning of the test. However, the value we measure and report may be inaccurate if the test is initiated too quickly after the installation of the test bore, or if the testing operator failed to activate the data acquisition unit prior to energizing the heating elements. If you suspect the temperature we are reporting to be too high or too low, we recommend that you investigate further through other sources.

# LEED for New Construction v2.1
# Registered Project Checklist

Project Name: Marshall/Hazel Elementary School
Project Address: Paterson, NJ

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 5 | 4 | 5 | **Sustainable Sites** | | 14 Points |
| Y | | | Prereq 1 | **Erosion & Sedimentation Control** | Required |
| | | 1 | Credit 1 | **Site Selection** | 1 |
| | 1 | | Credit 2 | **Development Density** | 1 |
| 1 | | | Credit 3 | **Brownfield Redevelopment** | 1 |
| 1 | | | Credit 4.1 | **Alternative Transportation**, Public Transportation Access | 1 |
| | 1 | | Credit 4.2 | **Alternative Transportation**, Bicycle Storage & Changing Rooms | 1 |
| | 1 | | Credit 4.3 | **Alternative Transportation**, Alternative Fuel Vehicles | 1 |
| | | 1 | Credit 4.4 | **Alternative Transportation**, Parking Capacity and Carpooling | 1 |
| | | 1 | Credit 5.1 | **Reduced Site Disturbance**, Protect or Restore Open Space | 1 |
| | | 1 | Credit 5.2 | **Reduced Site Disturbance**, Development Footprint | 1 |
| 1 | | | Credit 6.1 | **Stormwater Management**, Rate and Quantity | 1 |
| 1 | | | Credit 6.2 | **Stormwater Management**, Treatment | 1 |
| | | 1 | Credit 7.1 | **Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof | 1 |
| | 1 | | Credit 7.2 | **Landscape & Exterior Design to Reduce Heat Islands**, Roof | 1 |
| 1 | | | Credit 8 | **Light Pollution Reduction** | 1 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 5 | | | **Water Efficiency** | | 5 Points |
| 1 | | | Credit 1.1 | **Water Efficient Landscaping**, Reduce by 50% | 1 |
| 1 | | | Credit 1.2 | **Water Efficient Landscaping**, No Potable Use or No Irrigation | 1 |
| 1 | | | Credit 2 | **Innovative Wastewater Technologies** | 1 |
| 1 | | | Credit 3.1 | **Water Use Reduction**, 20% Reduction | 1 |
| 1 | | | Credit 3.2 | **Water Use Reduction**, 30% Reduction | 1 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 2 | 3 | 3 | **Energy & Atmosphere** | | 17 Points |
| Y | | | Prereq 1 | **Fundamental Building Systems Commissioning** | Required |
| Y | | | Prereq 2 | **Minimum Energy Performance** | Required |
| Y | | | Prereq 3 | **CFC Reduction in HVAC&R Equipment** | Required |
| 1 | | | Credit 1 | **Optimize Energy Performance** | 1 to 10 |
| | | | 1 | 15% New Buildings or 5% Existing Building Renovations | 1 |
| | | | | 20% New Buildings or 10% Existing Building Renovations | 2 |
| | | | | 25% New Buildings or 15% Existing Building Renovations | 3 |
| | | | | 30% New Buildings or 20% Existing Building Renovations | 4 |
| | | | | 35% New Buildings or 25% Existing Building Renovations | 5 |
| | | | | 40% New Buildings or 30% Existing Building Renovations | 6 |
| | | | | 45% New Buildings or 35% Existing Building Renovations | 7 |
| | | | | 50% New Buildings or 40% Existing Building Renovations | 8 |
| | | | | 55% New Buildings or 45% Existing Building Renovations | 9 |
| | | | | 60% New Buildings or 50% Existing Building Renovations | 10 |
| 1 | | | Credit 2.1 | **Renewable Energy**, 5% | 1 |
| | 1 | | Credit 2.2 | **Renewable Energy**, 10% | 1 |
| | | 1 | Credit 2.3 | **Renewable Energy**, 20% | 1 |
| | | 1 | Credit 3 | **Additional Commissioning** | 1 |
| | 1 | | Credit 4 | **Ozone Depletion** | 1 |
| | | 1 | Credit 5 | **Measurement & Verification** | 1 |
| | 1 | | Credit 6 | **Green Power** | 1 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 3 | 1 | 9 | **Materials & Resources** | | 13 Points |
| Y | | | Prereq 1 | **Storage & Collection of Recyclables** | Required |
| | | 1 | Credit 1.1 | **Building Reuse**, Maintain 75% of Existing Shell | 1 |
| | | 1 | Credit 1.2 | **Building Reuse**, Maintain 100% of Shell | 1 |
| | | 1 | Credit 1.3 | **Building Reuse**, Maintain 100% Shell & 50% Non-Shell | 1 |
| 1 | | | Credit 2.1 | **Construction Waste Management**, Divert 50% | 1 |
| 1 | | | Credit 2.2 | **Construction Waste Management**, Divert 75% | 1 |
| | 1 | | Credit 3.1 | **Resource Reuse**, Specify 5% | 1 |
| | | 1 | Credit 3.2 | **Resource Reuse**, Specify 10% | 1 |
| | | 1 | Credit 4.1 | **Recycled Content**, Specify 5% (post-consumer + ½ post-industrial) | 1 |
| | | 1 | Credit 4.2 | **Recycled Content**, Specify 10% (post-consumer + ½ post-industrial) | 1 |
| 1 | | | Credit 5.1 | **Local/Regional Materials**, 20% Manufactured Locally | 1 |
| | | 1 | Credit 5.2 | **Local/Regional Materials**, of 20% Above, 50% Harvested Locally | 1 |
| | | 1 | Credit 6 | **Rapidly Renewable Materials** | 1 |
| | | 1 | Credit 7 | **Certified Wood** | 1 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 11 | 1 | 3 | **Indoor Environmental Quality** | | 15 Points |
| Y | | | Prereq | **Minimum IAQ Performance** | Required |
| Y | | | Prereq 2 | **Environmental Tobacco Smoke** (ETS) **Control** | Required |
| 1 | | | Credit 1 | **Carbon Dioxide** ($CO_2$) **Monitoring** | 1 |
| 1 | | | Credit 2 | **Ventilation Effectiveness** | 1 |
| 1 | | | Credit 3.1 | **Construction IAQ Management Plan**, During Construction | 1 |
| 1 | | | Credit 3.2 | **Construction IAQ Management Plan**, Before Occupancy | 1 |
| 1 | | | Credit 4.1 | **Low-Emitting Materials**, Adhesives & Sealants | 1 |
| 1 | | | Credit 4.2 | **Low-Emitting Materials**, Paints | 1 |
| 1 | | | Credit 4.3 | **Low-Emitting Materials**, Carpet | 1 |
| 1 | | | Credit 4.4 | **Low-Emitting Materials**, Composite Wood & Agrifiber | 1 |
| 1 | | | Credit 5 | **Indoor Chemical & Pollutant Source Control** | 1 |
| | | 1 | Credit 6.1 | **Controllability of Systems**, Perimeter | 1 |
| | | 1 | Credit 6.2 | **Controllability of Systems**, Non-Perimeter | 1 |
| 1 | | | Credit 7.1 | **Thermal Comfort**, Comply with ASHRAE 55-1992 | 1 |
| | 1 | | Credit 7.2 | **Thermal Comfort**, Permanent Monitoring System | 1 |
| 1 | | | Credit 8.1 | **Daylight & Views**, Daylight 75% of Spaces | 1 |
| | | 1 | Credit 8.2 | **Daylight & Views**, Views for 90% of Spaces | 1 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 1 | 4 | | **Innovation & Design Process** | | 5 Points |
| | 1 | | Credit 1.1 | **Innovation in Design**: Provide Specific Title | 1 |
| | 1 | | Credit 1.2 | **Innovation in Design**: Provide Specific Title | 1 |
| | 1 | | Credit 1.3 | **Innovation in Design**: Provide Specific Title | 1 |
| | 1 | | Credit 1.4 | **Innovation in Design**: Provide Specific Title | 1 |
| 1 | | | Credit 2 | **LEED™ Accredited Professional** | 1 |

| Yes | ? | No | | |
|---|---|---|---|---|
| 27 | 13 | 20 | Project Totals (pre-certification estimates) | 69 Points |

**Certified:** 26-32 points, **Silver:** 33-38 points, **Gold:** 39-51 points, **Platinum:** 52-69 points

## SECTION 19100 – GENERAL COMMISSIONING REQUIREMENTS

### PART 1 - GENERAL

### 1.1. DESCRIPTION

A. Summary. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner's operational needs. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training.

B. Purpose. Commissioning during the construction phase is intended to achieve the following specific objective according to the Contract Documents:

1. Verify that applicable equipment and systems are installed according to the manufacturer's recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.
2. Verify and document proper performance of equipment and systems.
3. Verify that O&M documentation left on site is complete.
4. Verify that the Owner's operating personnel are adequately trained.

### 1.2. COORDINATION

A. Commissioning Team. The members of the commissioning team consist of the designated representative of the NJSDA, Commissioning Authority (CxA), the Architect and Design Engineers (particularly the mechanical engineer), the General Contractor and building envelope subcontractors, the Mechanical Subcontractor (MC), the TAB representative, the Electrical Subcontractor (EC), the Controls Subcontractor (CC) and the Plumbing Subcontractor (PC). If known, the Owner's building or plant operator/engineer is also a member of the commissioning team.

B. Management. The CxA has been hired by the CM. The CxA directs and coordinates the commissioning activities and is part of the design team. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.

C. Scheduling. The CxA will work with the Cx team according to established protocols to schedule the commissioning activities. The CxA will provide sufficient notice to the Cx team for scheduling commissioning activities. The General Contractor will integrate all commissioning activities into the master schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

### 1.3. COMMISSIONING PROCESS

A. Commissioning Process. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.

1. Commissioning during construction begins with a scoping meeting conducted by the CxA where the commissioning process is reviewed with the commissioning team members.

2. Additional meetings will be required throughout construction, scheduled by the CxA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.
3. Equipment documentation is submitted to the CxA during normal submittals, including detailed start-up procedures.
4. The C CxA works with the CM, GC and the Subcontractors/equipment suppliers in developing startup plans and startup documentation formats.
5. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with pre-functional checklists being completed before functional testing.
6. The Subs, under their own direction, execute and document the pre-functional checklists and perform startup and initial checkout. The CxA documents that the checklists and startup were completed according to the approved plans. This will include the CxA witnessing start-up of selected equipment.
7. The CxA develops specific equipment and system functional performance test procedures. The Subcontractors review the procedures.
8. The procedures are executed by the Subcontractors, under the direction of, and documented by the CxA.
9. Items of non-compliance in material, installation or setup are corrected at the Subcontractors' expense and the system retested.
10. The CxA reviews the O&M documentation for completeness.
11. Commissioning is completed before Substantial Completion.
12. The CxA reviews, pre-approves and coordinates the training provided by the Subcontractors and verifies that it was completed.
13. Deferred testing is conducted, as specified or required.

1.4. RELATED WORK

Specific Commissioning (Cx) requirements will be coordinated by the General Contractor with its subcontractors and suppliers associated with the systems identified in Paragraph 1.6.A SYSTEMS TO BE COMMISSIONED, below.

1.5. RESPONSIBILITIES

A. The responsibilities of various parties in the commissioning process are provided in this section. It is noted that the services for the Construction Management Firm, Architect, HVAC Designers/Engineers, and Commissioning Authority are not provided for in this contract. That is, the Contractor is not responsible for providing their services. Their responsibilities are listed here to clarify the commissioning process.

B. <u>All Parties</u>

1. Follow the Commissioning (Cx) Plan.
2. Attend commissioning scoping meeting and additional Cx meetings, as necessary.

C. <u>Construction Manager (CM)</u>
*Design, Construction and Acceptance Phase*

1. Manage the CxA contract.

D. Mechanical, Electrical and Plumbing Designers/Engineers

*Design, Construction and Acceptance Phase*

1. Perform normal submittal review, construction observation, as-built drawing preparation, etc., as contracted. One site observation should be completed just prior to system startup.
2. Provide any design narrative and sequences documentation requested by the CxA. The designers shall assist (along with the contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
3. Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.
4. Prepare and submit the final as-built design intent and operating parameters documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.
5. Edit and update one-line diagrams developed as part of the design narrative documentation and those provided by the vendor as shop drawings for the various HVAC, Electrical, and Plumbing systems.

E. Commissioning Authority CxA

The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CxA may assist with problem-solving non-conformance or deficiencies, but ultimately that responsibility resides with the general contractor and the A/E. The primary role of the CxA is to develop and coordinate the execution of a testing plan, observe and document performance. The Contractors will provide all tools or the use of tools to start, check-out and functionally test equipment and systems.

*Design, Construction and Acceptance Phase*

1. Coordinate the commissioning work and, with the A/E, ensure that commissioning activities are being scheduled into the master schedule.
2. Plan and conduct a commissioning scoping meeting, start-up and deficiency meetings as required.
3. Request and review additional information required to perform commissioning tasks, including O&M materials, control sequences, contractor start-up and checkout procedures.
4. Before startup, gather and review the current control sequences and interlocks and write detailed testing procedures.
5. Review and approve normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs.
6. Write and distribute pre-functional tests and checklists.
7. Perform site visits, as necessary, to observe component and system installations. Attends selected planning and job-site meetings to obtain information on construction progress.
8. Witness all or part of the HVAC/Plumbing piping test and flushing procedure, sufficient to be confident that proper procedures were followed. Document this testing and include the documentation in O&M manuals. Notify the A/E of any deficiencies in results or procedures.
9. Approve pre-functional tests and checklist completion by reviewing pre-functional checklist reports and by selected site observation and spot-checking.

10. Approve systems startup by reviewing start-up reports and by selected site observation.
11. Review TAB execution plan.
12. Analyze any functional performance trend logs and monitoring data to verify performance.
13. Compile and maintain a commissioning record and building systems book(s).
14. Review and approve the preparation of the O&M manuals.
15. Provide a final commissioning report.

F. Architect/Engineering Firm

*Design, Construction and Acceptance Phase*

1. Facilitate the coordination of the commissioning work by the CxA, and, with the CxA, ensure that commissioning activities are being scheduled into the master schedule.
2. Review and approve the final *Construction Commissioning Plan.*
3. Attend a commissioning scoping meeting and other commissioning team meetings as needed.
4. When necessary, observe and witness pre-functional checklists, startup and functional testing of selected equipment
5. Review commissioning progress and deficiency reports.

G. Equipment Suppliers

1. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
2. Assist in equipment testing per agreements with Subcontractors.
3. Include all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing equipment according to these Contract Documents in the base bid price to the Contractor. Through the contractors they supply products to, analyze specified products and verify that the designer has specified the newest most updated equipment reasonable for this project's scope.
4. Provide information requested by CxA regarding equipment sequence of operation and testing procedures.
5. Review test procedures for equipment installed by authorized factory representatives.

1.6. SYSTEMS / ASSEMBLIES TO BE COMMISSIONED

A. This project will require integrated total building commissioning to include all of the following systems:

SYSTEMS / ASSEMBLIES TO BE COMMISSIONED

| Building Envelope, Specialties, and Life Safety Systems, Assemblies, and Components to be Commissioned | Required Scope |
|---|---|
| **BUILDING ENVELOPE ASSEMBLIES** | |
| *Foundation / Basement Floor Slab including water drainage system* | ● |
| *Below Grade Exterior Walls inc. waterproofing and water management system(s)* | ● |
| *Above Grade Exterior Walls including air barrier and water management systems* | ● |
| *Above Grade Exterior Wall Penetrations (Pipe, Duct, etc.)* | ● |
| *Exterior Windows, Doors, and Louvers (Fenestration)* | ● |
| *Roof System(s) including parapet copings and vegetated (green) roof and plaza deck systems* | ● |
| *Roof System Penetrations (Pipe, Duct, etc.)* | ● |
| *Skylights, Sloped Glazing, and Hatches (Fenestration)* | ● |
| *Expansion Joints, Control Joints, and Sealant Systems* | ● |
| *Interface Connections between each of the above listed components* | ● |
| *Flashing, including all transitions and end dams, etc.* | ● |
| *Smoke and Fire stopping / separation* | ● |
| *Interface Connections to existing structures* | ● |
| Special Architectural elements, equipment and controls (*shading devices, etc*) | ● |
| Special Envelope Performance Criteria (blast, hurricane, thermal, infiltration) | ● |
| **SPECIALTIES** | |
| Elevators | ● |
| Kitchen/food service *(Ansul Fire Suppression System)* | ● |
| Automatic doors | ● |
| Renewable Energy Systems (Electrical, Biomass, Geo-Thermal, etc.) | ● |
| **LIFE SAFETY AND SECURITY SYSTEMS** | |
| Fire Suppression/protection systems | ● |
| Egress pressurization/Atrium smoke purge | ● |
| Fire Alarm | ● |
| Emergency lighting systems | ● |
| General egress (panic hardware, etc.) | ● |
| Elevator recall | ● |
| Access control | ● |
| Alarm monitoring | ● |
| Surveillance | ● |

| Mechanical, Electrical, and Plumbing (MEP) Systems, Assemblies, and Components to be Commissioned | Required Scope |
|---|---|
| **HEATING, VENTILATING, AIR CONDITIONING, & Refrigeration (HVAC&R)** | |
| Thermometers | ● |
| Vibration isolation | ● |
| Steam condensate systems | ● |
| Hot water heating systems | ● |
| Computer room air conditioning units | ● |
| Chemical water treatment systems | ● |
| Liquid chillers | ● |
| Cooling towers | ● |
| Condenser water system | ● |
| Chilled water system | ● |
| Refrigeration system | ● |
| Air terminal unit system/VAV units | ● |
| Duct silencers | ● |
| Fire and smoke/fire dampers | ● |
| Variable speed drives | ● |
| Air distribution systems | ● |
| Exhaust air systems | ● |
| Laboratory fume hoods | ● |
| **PLUMBING SYSTEMS AND COMPONENTS** | |
| Cleaning/flushing water systems | ● |
| Thermometers & gauges | ● |
| Sump pumps and ejectors | ● |
| Trap primers | ● |
| Water heaters, water coolers | ● |
| Domestic water booster pumps | ● |
| Emergency shower/eyewashes | ● |
| Fuel oil/gas systems | ● |
| Showers/Lavatories/Toilets (*Hands Free*) | ● |
| **ELECTRICAL SYSTEMS** | |
| Electrical primary voltage system (*voltage only*) | ● |
| Emergency power system | ● |
| Generators | ● |
| Lighting controls (scheduled/occupancy sensors) | ● |
| Daylight dimming controls | ● |
| Variable speed drives | ● |
| Thermographic Survey | ● |
| Data & communication system | ● |
| Paging system | ● |
| Renewable Energy Systems | ● |

| **Building Automation / Energy Management Systems, Assemblies, and Components to be Commissioned** | **Required Scope** |
|---|---|
| Component FPT and calibration | ● |
| Control air supply | ● |
| Air terminal units, non lab | ● |
| Air terminal units, lab supply/fume exhaust | ● |
| *Full Operation of Sequence as described by the Operations Documentation, specifically including the following:* | ● |
| Sequence control, AHU, 100% OSA | ● |
| Sequence control, EAHU | ● |
| Sequence control, AHU, H&V | ● |
| Sequence control, exhaust air fans | ● |
| Sequence control, differential bypass valve | ● |
| Sequence control, air terminal units, CV | ● |
| Sequence control, air terminal units, VAV/CV | ● |
| Sequence control, air terminal units, VAV | ● |
| Sequence control, heat exchanger | ● |
| Sequence control, variable speed pumps | ● |
| Sequence control, cabinet unit heaters | ● |
| Sequence control, condenser water system | ● |
| Sequence control, steam humidifiers | ● |
| Sequence control, water heaters | ● |
| Sequence control, heating coils/radiant panels | ● |
| Sequence control, labs with VAV fume hoods | ● |
| Sequence control, condenser water filters | ● |
| Sequence control, steam generator | ● |
| Graphic display | ● |
| Trend logs | ● |
| Status review screens, checks, & alarming | ● |
| Network communication | ● |

B. The Scope of Services for Total Building Commissioning is located at the end of this specification section and includes Parts A, B, and C in their entirety. Integrated total building commissioning services and associated documentation shall be performed as per the procedures, methods, requirements and documentation described by the following:

i. ASHRAE Guideline 0-2005
ii. ASHRAE Guideline 1.1-2007
iii. NIBS Guideline 3-2006
iv. ASHRAE Guideline 4-2008
v. USGBC-LEED for Schools EA Prerequisite 1 and EA Credit 3 (Enhanced Cx)
vi. 21st Century Schools Design Manual, May 15, 2007

C. The commissioning services provided by the CxA will also include the following:

i. Performance tests are to include testing for maximum background noise per ANSI/ASA standards. Tests to be taken in 20% of instructional spaces.
ii. Light levels are to be tested under night time and daytime conditions in the 20% estimated worst case classrooms and offices to ensure Visual Comfort uniformity and light levels.
iii. Airborne mold samples will be taken every three months during construction after the building is closed in (all walls and 90% windows on all sides). Samples will be taken every three weeks, three times in the last nine (9) weeks prior to occupancy. Each set of tests will include five (5) air samples at the estimated worst case locations in the building. Three (3) outside air samples will be taken at the same time to compare between indoor and outdoor conditions. Sampling and testing to be performed by a certified industrial hygienist (CIH).
iv. Hydrocarbon Vapor (Volatile organic compounds, VOC) samples will be taken weekly for the last four weeks prior to occupancy with disposable test elements. At a minimum, tests will be performed for benzene, formaldehyde, "paint thinner", and adhesive solvents.

PART 2 – PRODUCTS – (NOT APPLICABLE)

PART 3 - EXECUTION

3.1. REPORTING

A. The CxA will provide regular field reports to the CM as construction and commissioning progresses.

B. The CxA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos and progress reports.

C. A final summary report by the CxA will be provided to the CM. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report. Pre-functional checklists, functional tests and monitoring reports will not be part of the final report, but will be stored in the Commissioning Record in the O&M manuals.

3.2. START-UP, PREFUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

A. The following procedures apply to all equipment to be commissioned, according to Section 1.6, "Systems to be Commissioned".

1. Pre-functional checklist.
2. Start-up: The start-up plan shall consist of:
   a. The CxA's prefunctional checklist.
   b. The manufacturer's standard start-up procedure
   c. The manufacturer's standard field checkout sheets.

B. <u>Execution of Pre-functional Checklists and Startup.</u>

1. The CxA shall observe, at minimum, the procedures for each piece of primary equipment, unless there are multiple units. In no case will the number of units witnessed be less than 25% of the total number of identical or very similar units.

2. For lower-level components of equipment, (e.g., unit heaters, sensors, controllers), the CxA shall observe a sampling of the pre-functional and start-up procedures. The sampling procedures are identified in the commissioning plan.
3. The Subs and vendors shall execute startup and provide the CxA with a signed and dated copy of the completed start-up and pre-functional tests and checklists.

C. Deficiencies, Non-Conformance and Approval in Checklists and Startup.

1. The Subs shall clearly list any outstanding items of the initial start-up and pre-functional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CxA within two days of test completion.
2. The CxA reviews the report and submits either a non-compliance report or an approval form to the A/E. The CxA shall work with the Subs and vendors to correct and retest deficiencies or uncompleted items. The installing Subs or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the CxA as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA recommends approval of the execution of the checklists and startup of each system.

3.3. FUNCTIONAL PERFORMANCE TESTING

A. This sub-section applies to all commissioning functional testing for all divisions.

B. The general list of equipment to be commissioned is found in Section 1.6 of this specification

C. Objectives and Scope. The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required.

D. Development of Test Procedures. Before test procedures are written, the CxA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Sub or vendor responsible to execute a test shall provide assistance to the CxA in developing the procedures review. Prior to execution, the CxA shall provide a copy of the test procedures to the Sub(s) who shall review the tests for feasibility, safety, equipment and warranty protection. The CxA shall review owner-contracted, factory testing or required owner acceptance tests which the CA is not responsible to oversee, including documentation format, and shall determine what further testing or format changes may be required to comply with the *Specifications*. Redundancy of testing shall be minimized.

E. Coordination and Scheduling. The Subs shall provide sufficient notice to the CxA regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems. The CxA will schedule functional tests through the A/E and affected Subs. The CxA shall direct, witness and document the functional testing of selected equipment and systems. The Subs shall execute the tests.

In general, functional testing is conducted after pre-functional testing and startup has been satisfactorily completed. The control system is sufficiently tested and approved by the CxA before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems. Testing proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.

3.4. DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF TESTS

A. Documentation. The CxA shall witness and document the results of all functional performance tests using the specific procedural forms developed for that purpose. Prior to testing, these forms are provided to the CxA for review and approval and to the Subs for review.

B. Non-Conformance.

1. The CxA will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the CM.
2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA.
3. Every effort will be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues, unless there is an overriding reason to do so at the request of the Owner.

C. Approval. The CxA notes each satisfactorily demonstrated function on the test form. Formal approval of the functional test is made later after review by the CxA.

3.5. OPERATION AND MAINTENANCE MANUALS

A. Commissioning Record in O&M Manuals.

1. The CxA is responsible to compile, organize and index the following commissioning data by equipment into labeled, indexed and tabbed, three-ring binders and deliver it to the Owner. Three copies of the manuals will be provided.
2. Final Report Details. The final commissioning report shall include an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the commissioning authority regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas: 1) Equipment meeting the equipment specifications, 2) Equipment installation, 3) Functional performance and efficiency, 4) Equipment documentation and design intent, and 5) Operator training. All outstanding non-compliance items shall be specifically listed. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented.

3.6 TRAINING OF OWNER PERSONNEL

A. The GC shall be responsible for training coordination and scheduling, and ultimately for ensuring that training is completed.

B. The CxA shall be responsible for approving the content and adequacy of the training of owner personnel for commissioned equipment.

3.7 DEFERRED TESTING

A. Unforeseen Deferred Tests. If any check or test cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional testing may be delayed upon approval of the Owner. These tests will be conducted in the same manner as the seasonal tests as soon as possible.

B. Seasonal Testing. During the warranty period, seasonal testing shall be completed as part of this contract. The CxA shall coordinate this activity. Tests will be executed, documented and deficiencies corrected by the appropriate Subs, with facilities staff and the CxA witnessing. Any final adjustments to the O&M manuals and as-builds due to the testing will be made.

END OF SECTION 19100