BVH ARCHITECTURE

ADDENDUM

PROJECT:	NSC HVAC Replacement and Window Restoration	**PROJECT NO.:**	BVH: L14077 OCC: 201405
TO:	Prospective Bidders	**DATE:**	05/14/2018
FROM:	BVH Architecture	**ADDENDUM NO.:**	4

This Addendum is issued by the Architect to all bidders of record prior to receipt of proposals. Bidders shall acknowledge receipt of this addendum by so indicating on the Proposal Form. Failure to do so may subject Bidder to disqualification.

All information and instructions given herein shall become a part of the Contract Documents.

GENERAL

1. See the attached Addendum form from Alvine Engineering for additional items.

DRAWINGS

1. S1.0 PA – FOUNDATION PLAN
    a. Modified/added notes – See attached replacement sheet.

END OF ADDENDUM

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This addendum is hereby made a part of the contract documents to the same extent as though it were originally included therein. Specifications and drawings shall be considered modified or revised as hereinafter described. Revisions to the drawings are referenced by the drawing number.

Changes to the Project Manual

Mechanical Specification Items – **Phases A and 1**

4MS1. Section 210400 – Common Requirements for Fire Suppression

1. Page 210400 – 23, Article 3.18: Add the following:

"H. Apply firestopping to at least all floor penetrations."

4MS2. Section 220400 – Common Requirements for Plumbing

1. Page 220400 – 23, Article 3.18: Add the following:

"H. Apply firestopping to at least all floor penetrations."

4MS3. Section 230130.51 – HVAC Air Duct Cleaning

1. Replace this section with the attached updated Section 230130.51.

4MS4. Section 230400 – Common Requirements for HVAC

1. Page 230400 – 16: Delete Article 2.11 in its entirety.
2. Page 230400 – 17: Delete Article 2.12 in its entirety.
3. Page 230400 – 29, Article 3.18: Add the following:

"H. Apply firestopping to at least all floor penetrations."

4MS5. Section 230913.13 – Instrumentation and Control Devices for HVAC

1. Page 230913 – 18, Subparagraph 2.16.B.1: Add the following:

"b. Badger Meter."

4MS6. Section 232113 – Hydronic Piping

1. Page 232113 – 9: Delete Article 2.9 in its entirety.

4MS7. Section 232114 – Hydronic Specialties

1. Page 232114 – 3, Paragraph 2.1A: Add the following:

"8. Patterson."

2. Page 232114 – 3, Paragraph 2.2A: Add the following:

   "4. Armstrong Fluid Technologies."

3. Page 232114 – 4, Paragraph 2.4A: Add the following:

   "8. Wessels
   9. Lochinvar"

4. Page 232114 – 6, Paragraph 2.8A: Add the following:

   "9. Armstrong Fluid Technologies."

5. Page 232114 – 8, Subparagraph 2.12.C.2: Modify as follows:

   "2. Supply fitting with combination ball valve, wye strainer with 20 mesh screen, and union with one dual seat pressure/temperature test fitting, air vent and hose end drain valve with cap and chain."

6. Page 232114 – 8, Paragraph 2.12.C.3: Modify as follows:

   "3. Return balance fitting with two dual seat pressure/temperature test fittings, air vent, union, balance valve, and ball valve."

7. Page 232114 – 8, Paragraph 2.12C: Add the following:

   "4. Provide line sized full port ball valves."

4MS8. Section 235700 – Heat Exchangers for HVAC

1. Page 235700 – 4, Article 2.3: Modify "(**HX-3**)" to read "(**HX-3A** and **HX-3B**)."

2. Page 235700 – 4, Paragraph 2.3A: Add the following:

   "8. Kelvion.
   9. Patterson."

4MS9. Section 237300 – Packaged Indoor Central Station Air Handling Units

1. Page 237300 – 3, Paragraph 2.2A: Add the following:

   "6. VTS."

4MS10. Section 237313 – Modular Central-Station Air-Handling Units

1. Page 237313 – 4, Paragraph 2.2D: Add the following:

   "2. Governair.
   3. Huntair.
   4. Ventrol."

2. Page 237313 – 4, Paragraph 2.3A: Modify as follows:

   "1. Construct of structural steel."

3. Page 237313 – 4: Delete Subparagraph 2.3.B.4.a.

4. Page 237313 – 5: Delete Paragraph 2.3D.

5. Page 237313 – 5, Paragraph 2.3G: Modify as follows:

   "2. Provide minimum thermal thickness of R-9 on walls, roof, and doors for ERU-3SW1. Provide minimum thermal thickness of R-18 on walls, roof, and doors for all other AHUs and MAU."

6. Page 237313 – 6, Paragraph 2.5B: Modify as follows:

   "1. A minimum of two fans shall be provided for all AHUs, and for the ERU and MAU. Fan arrays specified with more than two fans can be provided with fewer and larger fans only if the specified minimum fan airflow and the airflow specified with one fan failed can be met."

7. Page 237313 – 7, Paragraph 2.5J: Add the following:

   "2. Alternatively, the use of fan acoustic diffusers (Twin City Model AREO or equal) is acceptable if the specified sound power levels can be met."

8. Page 237313 – 7, Article 2.5: Modify as follows:

   "L. The array shall be installed such that the optimum system operating efficiency may be achieved by automatically enabling or disabling fans in the array to provide the minimum connected HP for the fan array that is necessary to produce the required airflow and pressure in the system. Alternatively, the array can also be modulated to produce the minimum required airflow and pressure in the system instead of enabling or disabling fans in the array as long as the specified minimum fan airflow is met."

9. Page 237313 – 7, Article 2.5: Modify as follows:

   "Q. Provide OSHA fan safety guards on all fans."

10. Page 237313 – 8, Article 2.5: Add the following:

    "T. Provide fan vibration isolators as required by the manufacturer."

11. Page 237313 – 9, Article 2.12: Modify as follows:

    "B. Damper Leakage: Leakage Class 1A at 1 in w.g. static pressure differential per ANSI/ AMCA Standard 500-D."

12. Page 237313 – 10, Paragraph 2.12H: Modify as follows:

    "1. Blades are a maximum 6" deep extruded aluminum (6063-T5) with airfoil profiles. All blades shall be symmetrically pivoted. Blades used for outside air, exhaust air, and return air (return air for AHU-BNE1 only) dampers shall be internally insulated with expanded polyurethane foam and thermally broken for a minimum blade insulating value of R-2.29."

13. Page 237313 – 10, Paragraph 2.12H: Modify as follows:

    "2. Blade and frame seals shall be extruded silicone for reduced air leakage at colder temperatures. Blade and frame seals are secured in an integral slot within the aluminum extrusions and are mechanically fastened to prevent shrinkage and movement over the life of the damper. Bearings shall be composed of Celcon (or equal) inner bearing fixed around an aluminum hexagon blade pivot pin, rotating within a polycarbonate outer bearing inserted in the frame. Provide with adjustable hexagonal drive rod, U-bolt fastener, and hexagonal retaining nuts that are zinc-plated steel.

14. Page 237313 – 10, Article 2.12: Add the following:

    "I. Provide an extruded aluminum (6035-T5) damper frame that is not less than 0.080" in thickness. Frames used for outside air, exhaust air, and return air (return air for AHU-BNE1 only) dampers shall have the entire frame thermally broken by means of polyurethane resin pockets complete with thermal cuts."

15. Page 237313 – 14, Subparagraph 2.19.B.1: Modify as follows:

    "a. See specification Section 230913.53.

16. Page 237313 – 14, Subparagraph 2.19.B.2: Modify as follows:

    "c. The controller provides a means to indicate fan and motor status, operating mode, and horsepower and/or amps."

17. Page 237313 – 15: Delete Paragraph 3.1D.

18. Page 237313 – 17, Paragraph 3.6F: Modify the first sentence to read: "The fan shall be assembled in the factory complete with motor, protective screening, and guards."

4MS11. Section 237433 – Packaged Heating and Cooling Makeup Air Units

1. Delete this section in its entirety. The Makeup Air Unit MAU-1 will now fall under Section 237313 instead.

4MS12. Section 238415 – Steam and Atomizing Humidifiers

1. Page 238415 – 5, Paragraph 2.4D: Add the following sentence to the end of the paragraph: "Stainless steel piping shall be 316 type. Plastic piping shall be Schedule 80 PVC type."

Mechanical Specification Items – **Phase B**

4MS13. Section 220517 – Sleeves and Sleeve Seals for Plumbing

1. Delete this section in its entirety.

4MS14. Section 230517 – Sleeves and Sleeve Seals for HVAC

1. Delete this section in its entirety.

4MS15. Section 232113.33 – Ground-Loop Heat-Pump Piping

1. Replace this section with the attached updated Section 232113.33, which includes the geothermal test well data.

Changes to the Drawings

Mechanical Drawing Items – **Phases A and 1**

3MD1. Sheet M6.1 P1 – Mechanical Schedules

1. Panel Radiator Schedule (Phase 1): Modify Remark 3. as follows:

   "3. PROVIDE WITH MEDIUM PRESSURE 85 PSI PANELS, AN INTEGRAL HEAVY GAUGE (0.09" THICK MINIMUM) ALL-WELDED PERFORATED TOP GRILLE TO COVER THE TOP OF ALL OF THE FINNED AREAS, AND BOTTOM MOUNTED OPPOSITE END PIPING CONNECTIONS."

3MD2. Sheet M6.4 P1 – Mechanical Schedules

1. Modular Air Handling Unit Schedule (Phase 1):

   A. Change the "Reference Specification" row for MAU-1 to be "237313."

   B. Change the "AIRFLOW (EACH/ TOTAL) (CFM)" row of the "RETURN FAN/ ARRAY DATA" to be worded as "AIRFLOW (EACH/ TOTAL/ TOTAL WITH ONE FAN FAILED) (CFM)." Update the row data for the following Return Fan:

      RF-BNE1: "2,500/ 10,000/ 10,000"

   C. Change the "AIRFLOW (EACH/ TOTAL) (CFM)" row of the "SUPPLY FAN/ ARRAY DATA" to be worded as "AIRFLOW (EACH/ TOTAL/ TOTAL WITH ONE FAN FAILED) (CFM)." Update the row data for the following Supply Fans:

      SF-AHU-BNW1: "2,250/ 4,500/ 4,500"

      SF-AHU-BNW2 : "2,250/ 4,500/ 4,500"

      SF-AHU-3SW1: "3,350/ 6,700/ 4,390"

SF-AHU-BNE1: “2,500/ 10,000/ 10,000”

SF-MAU-1: “2,150/ 4,300/ 4,300”

3MD3. Sheet FP1.2.1 P1 – Second Floor Attic Plan – SW – Fire Protection

1. Modify General Note 4 to read: “FIRE PROTECTION PIPING MUST USE THE STRUCTURALLY DESIGNED SUPPORT SYSTEM OR STRUCTURAL BEAMS FOR CONNECTING PIPE HANGERS. COORDINATE ANY SPECIAL REQUIREMENTS OR ADDITIONAL HANGING POINTS WITH THE BASE BUILDING STRUCTURAL ENGINEER. NO DEVICES ARE ALLOWED TO ATTACH TO THE ROOF DECK.”

3MD4. Sheet FP1.3 P1 – Third Floor Plan – SW – Fire Protection

1. Modify General Note 1 to read: “HANGING CONNECTION POINTS ALLOWED ONLY FROM STRUCTURAL BEAMS. NO DEVICES ARE ALLOWED TO ATTACH TO THE ROOF DECK. ADD TRAPEZE HANGERS AND COORDINATE WITH THE BASE BUILDING STRUCTURAL ENGINEER AS NECESSARY IF ADDITIONAL HANGING POINTS ARE REQUIRED.”

Mechanical Drawing Items – **Phase B**

3MD5. Sheet M0.0 PB – Mechanical Symbols, Abbreviations, Schedules, and General Notes

1. Add the following to the General Notes:

“14. SEE CIVIL FOR THE SPECIFICATION AND INSTALLATION OF HYDROSTATIC PIPE WALL CLOSURES AT ALL PIPE THROUGH WALL LOCATIONS.”

END

NTB-PAB/mdg

04/23/2018

SECTION 230130.51 - HVAC AIR DUCT CLEANING

PART 1 GENERAL

1.1 ADMONITION

A. The United States Department of the Interior has recognized the Nebraska State Capitol as a registered National Historic Landmark (NHL) possessing exceptional architectural, historic and cultural value for our nation. Original building and site details, finishes and furnishings are of the highest quality available, both in terms of material and craftsmanship. It is the mission of the Office of the Capitol Commission to insure that the work performed under construction and service contracts be of a quality equal or superior to the original construction. Only qualified, experienced contractors/craftsmen who recognize the exceptional value of this landmark and can perform to the highest standards will be employed.

1.2 SECTION INCLUDES

A. Cleaning of HVAC duct system, equipment, and related components.

B. Testing and inspection agency employed by OCC.

1.3 DEFINITIONS

A. HVAC System: For purposes of this section, the surfaces to be cleaned include all interior surfaces of the heating, air-conditioning and ventilation system from the points where the air enters the system to the points where the air is discharged from the system, as indicated with ductwork cross-hatching and flag notes on the Phase 1 drawings; see NADCA ACR for more details.

1.4 REFERENCE STANDARDS

A. NADCA ACR - Assessment, Cleaning and Restoration of HVAC Systems.

B. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

C. UL 181A - Closure Systems for Use with Rigid Air Ducts.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Manufacturer's data sheets on each product to be used.

C. Qualifications Statement: Submit qualifications of proposed cleaning contractor for approval.

D. Qualifications Statement: Submit qualifications of proposed testing and inspection agency for approval.

E. Project Cleanliness Evaluation and Cleaning Plan, as specified.

F. Material Safety Data Sheets (MSDS): For all chemical products proposed to be used in the cleaning process; submit directly to OCC.

G. Project Closeout Report: Include field quality control reports, evidence of satisfactory cleaning, and documentation of items needing further repair.

1.6 QUALITY ASSURANCE

A. Information Available to Contractor: Upon request, OCC will provide the following:
   1. One copy of original construction drawings of HVAC system.
   2. One copy of original construction specifications of HVAC system.

B. Cleaning Contractor Qualifications: Company specializing in the cleaning and restoration of HVAC systems as specified in this section.
   1. Certified by one of the following:
      a. NADCA, National Air Duct Cleaners Association: www.nadca.com
   2. Having a minimum of five years documented commercial duct cleaning experience.
   3. Employing for this project a supervisor certified as an Air Systems Cleaning Specialist by NADCA.
   4. Acceptable Cleaning Contractors:
      a. DuctMedic..
      b. Midland's Duct Cleaning, Inc..
      c. Substitutions: See Section 016000 - Product Requirements.

C. Testing and Inspection Agency Qualifications: Experienced in inspection and testing using methods defined in NADCA ACR.

PART 2 PRODUCTS

2.1 TOOLS AND EQUIPMENT

A. Vacuum Devices and Other Tools: Exceptionally clean, in good working order, and sealed when brought into the facility.

B. Vacuum Devices That Exhaust Air Inside Building, Including Hand-Held and Wet Vacuums: Equipped with HEPA filtration with 99.97 percent collection efficiency for minimum 0.3-micron size particles and DOP test number.

C. Vacuum Devices That Exhaust Air Outside Building, Including Truck- and Trailer-Mounted Types: Equipped with particulate collection including adequate filtration to contain debris removed from the HVAC system; exhausted in manner that prevents contaminant re-entry to building; compliant with applicable regulations as to outdoor environmental contamination.

2.2 REPLACEMENT PRODUCTS

A. Fibrous Glass Insulation: Provide material complying with UL 181 equivalent to existing material in quality and thickness.

2.3 SURFACE TREATMENTS

A. Anti-Microbial Materials: EPA registered specifically for use on non-porous HVAC system surfaces and applied per manufacturer's instructions.

PART 3 EXECUTION

3.1 PROJECT CONDITIONS

A. Comply with applicable federal, state, and local requirements.

B. Perform cleaning, inspection, and remediation in accordance with the recommendations of NADCA "Assessment, Cleaning and Restoration of HVAC Systems" (ACR) and as specified herein.

C. Where NADCA ACR uses the terms "recommended", "highly recommended", or "ideally" in regard to a certain procedure or activity, do that unless it is clearly inapplicable to the project.

D. Take precautions to prevent introduction of additional hazards into occupied spaces.

E. Obtain OCC's approval of proposed temporary locations for large equipment.

F. Designate a decontamination area and obtain OCC's approval.

G. When portions of the facility are to remain occupied or in operation during cleaning activities, provide adequate controls or containment to prevent access to spaces being cleaned by unauthorized persons and provide detailed instructions to OCC as to these controls or containment. Coordinate schedule cleaning of each system and space with OCC. Cleaning may be suspended when Courts or Hearing Rooms are in use.

H. If unforeseen mold or other biological contamination is encountered, notify Architect immediately, identifying areas affected and extent and type of contamination.

3.2 EXAMINATION

A. Prior to the commencement of any cleaning work, prepare and submit to Architect a project evaluation and plan for this project, including considerations recommended in NADCA ACR.

B. Inspect the system as required to determine appropriate methods, tools, equipment, and protection.

C. Start of cleaning work constitutes acceptance of existing conditions.

D. When concealed spaces are later made accessible, examine and document interior conditions prior to beginning cleaning.

E. Document all instances of mold growth, rodent droppings, other biological hazards, and damaged system components.

3.3 PREPARATION

A. When cleaning work might adversely affect life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with authorities having jurisdiction.

B. Ensure that electrical components that might be adversely affected by cleaning are de-energized, locked out, and protected prior to beginning work.

C. Air-Volume Control Devices: Mark the original position of dampers and other air-directional mechanical devices inside the HVAC system prior to starting cleaning.

D. Access to Concealed Spaces: Use existing service openings and make additional service openings as required to accomplish cleaning and inspection.
   1. Do not cut openings in non-HVAC components without obtaining the prior approval of OCC.
   2. Make new openings in HVAC components in accordance with NADCA Standard 05; do not compromise the structural integrity of the system.
   3. Do not cut service openings into flexible duct; disconnect at ends for cleaning and inspection.
   4. When new duct openings are required, the first preference is to locate them on top of the duct; second preference is to locate them on the side of duct; and third preference is to locate them on the bottom of the duct.

E. Ceiling Tile: Lay-in ceiling tile may be removed to gain access to HVAC systems during the cleaning process; protect tile from damage and reinstall upon completion; replace damaged tile.

F. The Duct Cleaning Contractor shall be responsible for providing/making provisions for any required temporary power for their cleaning equipment.

3.4 CLEANING

A. Use any cleaning method recommended by NADCA ACR unless otherwise specified; do not use methods prohibited by NADCA ACR, or that will damage HVAC components or other work, or that will significantly alter the integrity of the system.

B. Obtain OCC's approval before using wet cleaning methods; ensure that drainage is adequate before beginning.

C. Reference Standard: SMACNA - Duct Cleanliness for New Construction.

D. Ducts: Mechanically clean all portions of ducts.
   1. Duct Cleaning Process:
      a. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.
      b. Use service openings, as required, for physical and mechanical entry and for inspection.
         1) Create other openings to comply with duct standards.
         2) Disconnect flexible ducts as needed for cleaning and inspection.
         3) Remove and reinstall ceiling sections to gain access during the cleaning process.

c. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.
d. Clean the following metal duct systems by removing surface contaminants and deposits:
1) Air outlets and inlets (registers, grilles, and diffusers).
2) Return-air and exhaust-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.
3) Supply-air ducts, dampers, actuators, and turning vanes.

2. Mechanical Cleaning Methodology:
a. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
b. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
c. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
d. Provide operative drainage system for washdown procedures.

E. Ductwork Cleanliness:
1. Intermediate Level:
a. Under this level of ductwork cleanliness it is acknowledged that ductwork leaving the premises of the manufacturer will include some or all of the following:
1) Internal and/or external self-adhesive labels or marking for part(s) identification.
2) Exposed mastic sealant.
3) Light zinc oxide coating on the metal surface.
4) A light coating of oil on machine formed ductwork.
5) Minor protrusions into the airway of rivets, screws, bolts and other jointing devices.
6) Internal insulation and associated fasteners.
7) Discoloration marks from plasma cutting process.
b. Site storage: The area provided for storage shall be clean, dry and exposure to dust minimized.
c. The working area should be clean and dry and protected from the elements.
d. The internal surfaces of ductwork shall be wiped to remove excess dust immediately prior to installation.
e. Open ends on completed ductwork and overnight work-in-progress shall be sealed.

F. Hoses, Cables, and Extension Rods: Clean using suitable sanitary damp wipes at the time they are being removed or withdrawn from their normal position.

G. Registers, Diffusers, and Grilles: When removing, take care to prevent containment exposure due to accumulated debris.

H. Collect debris removed during cleaning; ensure that debris is not dispersed outside the HVAC system during the cleaning process.

I. Store contaminated tools and equipment in polyethylene bags until cleaned in the designated decontamination area.

3.5 REPAIR

A. Repair openings cut in the ventilation system so that they do not significantly alter the airflow or adversely impact the facility's indoor air quality.

B. At insulated ducts and components, accomplish repairs in such a manner as to achieve the equivalent thermal value.

C. Reseal new openings in accordance with NADCA Standard 05.

D. Reseal rigid fiber glass duct systems using closure techniques that comply with UL 181 or UL 181A.

E. When new openings are intended to be capable of being re-opened in the future, clearly mark them and report their locations to OCC in project report documents.

3.6 FIELD QUALITY CONTROL

A. Ensure that the following field quality control activities are completed prior to application of any treatments or coatings and prior to returning HVAC system to normal operation.

B. Visually inspect all portions of the cleaned components; if not visibly clean as defined in NADCA ACR, re-clean and reinspect.

C. Notify Architect when cleaned components are ready for inspection.

D. Notify OCC's testing and inspection agency when cleaned components are ready for inspection.

E. OCC reserves the right to verify cleanliness using NADCA ACR Surface Comparison Testing or NADCA Vacuum Test.

F. When directed, re-clean components until they pass.

G. Contractor shall bear the costs of retesting due to inadequate cleaning.

H. Submit evidence that all portions of the system required to be cleaned have been cleaned satisfactorily.

3.7 ANTI-MICROBIAL TREATMENT

A. Biocidal Agents and Coatings:
   1. Apply biocidal agents if fungus is present. Apply biocidal agents according to manufacturer's written instructions after removal of surface deposits and debris.

B. Apply anti-microbial agent to the surface deposits and debris locations after their removal.

C. Apply anti-microbial treatments and coatings in strict accordance with the manufacturer's written recommendations and EPA registration listing.

3.8 ADJUSTING

A. After satisfactory completion of field quality control activities, restore adjustable devices to original settings, including, but not limited to, dampers, air directional devices, valves, fuses, and circuit breakers.

3.9 WASTE MANAGEMENT

A. Double-bag waste and debris in 6 mil, 0.006 inch thick polyethylene plastic bags.

B. Dispose of debris off-site in accordance with applicable federal, state and local requirements.

END OF SECTION

SECTION 232113.33 - GROUND-LOOP HEAT-PUMP PIPING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. This Section includes piping for vertical, direct-buried, ground-loop, heat-pump systems that operate between 25 and 115 deg F.

B. A combination of thermally-enhanced bentonite grout, high solids bentonite chip seal, and high grade silica sand shall be used to seal and backfill each vertical u-bend bore of the closed-loop ground heat exchanger to insure proper thermal contact with the earth and to ensure the environmental integrity of each vertical bore column. See the "Typical Geothermal Heat Pump Well Detail" on the drawings for the locations of each material in the well. The grouting material shall remain in a plastic state (moldable) throughout the life of the system and shall not generate heat during the hydration process. No other backfill materials shall be accepted.

C. Attached to the end of this Section is the testing data for two test wells installed at the site. One test well is located at the northwest corner and a second test well is located at the southeast corner of the site. See the drawings for the exact locations of the test wells. The test wells are intended to be used as part of the finished well field.

1.2 ABBREVIATIONS

A. IGSHPA: International Groung Source Heat Pump Association.

1.3 REFERENCE STANDARDS

A. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications.

B. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.

C. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.

D. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.

E. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

F. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Material.

G. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.

H. ASTM F1055 - Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing.

I. IGSHPA - Comply with IGSHPA "Close-Loop/Geothermal Heat Pump System Design and Installation Standards" in designing, installing and commissioning of heat exchanger.

J. IGSHPA (GROUT) - Grouting Procedures for GHP Systems; International Ground Source Heat Pump Association.

K. IGSHPA (GVERT) - Grouting for Vertical GHP Systems; International Ground Source Heat Pump Association.

L. IGSHPA (INSTALL) - Closed-Loop/Geothermal Heat Pump Systems Design and Installation Standards; International Ground Source Heat Pump Association.

M. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

N. PPI TR-4 - PPI Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings For Thermoplastic Piping Materials or Pipe.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week before starting work of this section. Require attendance by all installers involved with site work and HVAC work.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner. Construct well field in three separate phases. Schedule each phase with OCC.

1.5 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide for piping, fittings and joining methods.

C. Grout: Manufacturer's published product submittal information sheets which shall include mixing instructions, minimum thermal conductivity performance, permeability, percent solids, grout weight, linear shrinkage potential and unit yield along with verification of the required listings.

D. High solids bentonite chip seal and high grade silica sand product data.

E. Thermal grout thermal conductivity verification report.

F. Thermal conductivity permeability report.

G. Thermal fusion certificates.

H. Field quality control test reports.

I. Warranty: Submit manufacturer warranty and ensure that forms have been completed in OCC's name and registered with manufacturer.

J. Test Reports, Piping: Indicate test method and results of hydrostatic pressure tests.

K. Record actual GPS coordinates of all wells, underground piping, and vaults, etc. on the site of the well field. Submit all coordinates to Engineer for approval before the wells and piping are backfilled.

L. The well field will be constructed in three sequences, see the general notes on the drawings for a description of each sequenced area of the site. To aid in well field construction, record GPS coordinates of the temporary ends of all horizontal piping that are intended to be buried and later re-excavated and extended into an adjacent sequenced part of the site. Tracer wire for the horizontal piping shall be extended to three feet above grade and wrapped around steel or wooden "T" posts between the sequences to also aid in piping location. Paint the "T" posts a bright color to aid in identification on site.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years of documented experience and accredited by IGSHPA.

C. Heat Fusion Technician Certification: IGSHPA training and certification, certified within three years from the date of project commencement.

D. IGSHPA Compliance: Comply with IGSHPA in designing, installing, and commissioning vertical ground heat exchangers for ground-coupled heat pumps in excess of 10 tons aggregate cooling capacity.

E. Grouting compound (bentonite-based and silica sand additive) shall be certified and listed by NSF (National Sanitation Foundation International) to ANSI/NSF Standard 60, "Drinking Water Treatment Chemicals - Health Effects".

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping and fittings to project site in shipping containers with labeling in place.
   1. Comply with local and state regulations.
   2. Verify that labels on piping indicate manufacturer's name, pipe or tube size, and PE cell classification.
   3. Verify that piping complies with specifications and is undamaged.

B. Protect from weather, humidity and temperature variations, dirt and dust, and other environmental contaminants.

C. Store piping capped or plugged until time of installation.

1.8 FIELD CONDITIONS

A. Ambient Conditions: Do not mix grout when ambient temperature is below 32 degrees F.

1.9 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

C. Provide 50 year manufacturer warranty for HDPE piping and fittings.

PART 2 PRODUCTS

2.1 HEAT EXCHANGER

A. Contractor is responsible for execution of the closed-system ground-coupled heat exchanger, to the requirements of and within the limitations of the Contract Documents.
   1. Install in accordance with methodology in IGSHPA (INSTALL) - Geothermal Heat Pump Systems Design and Installation Standards or ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications, Geothermal Energy Chapter.

B. Heat Exchanger Configuration: Closed system; polyethylene piping in vertical boreholes located under parking area, as indicated on drawings.
   1. Pipe Diameter: 1 1/4 inch.
   2. Borehole Depth: 670 feet. The total vertical piping length shall be long enough to account for the borehole depth plus the excess pipe needed to stake the piping at 2 feet to 5 feet above grade.
   3. Borehole Diameter: 7.5 inches.
   4. Borehole Spacing: 20 feet, minimum.
   5. Total Number of Boreholes: as indicated.

2.2 MATERIALS

A. Pipe: High density polyethylene pipe, type PE4710, with minimum ASTM D3350 cell classification of PE445474C.
   1. Pipe Used in Vertical Bore Applications: DR 9, Comply with ASTM D3035 with minimum working pressure rating of 250 psi.
   2. Horizontal Pipe of 1.25 Inches Diameter and Larger: DR 11, Comply with ASTM D3035 or ASTM F714, with minimum working pressure rating of 200 psi.
   3. Long Term Hydrostatic Design Basis: 1600 psi at 73 degrees F, when tested in accordance with ASTM D2837; appropriate listing in current edition of PPI TR-4 will constitute evidence of compliance with this requirement; otherwise, submit independent test results.
   4. U-Bend Assembly: Factory fabricated with embossed depth stamp every 36 inches from U-bend.
   5. Joints and Fittings: Polyethylene of same type as pipe, of sizes and types suitable for the pipe being used; use only heat fusion fittings that are quality controlled to provide a leak-free union between piping ends that is stronger than the piping itself. Do not use barbed fittings or hose clamps.
      a. Electrofusion Type Fittings: Comply with ASTM F1055.
      b. Butt Fusion Fittings: Comply with ASTM D3261.
      c. Socket Type Fittings: Comply with ASTM D2683.

d. Where threaded fittings must be used for connection to equipment or dissimilar piping, use fittings and thread sealant compatible and effective with chemicals used.
e. Fittings shall include P/T plugs in each zone supply and return and butterfly valves with stainless steel stems on supply and return mains and zone run outs. Provide one balance valve per zone.

6. Manufacturers:
   a. Performance Pipe
   b. Charter Plastics
   c. Centennial Plastics LLC
   d. Central Plastics, Georg Fisher.
   e. ISCO Industries, Inc..

B. Heat Exchange Fluid: Potable water with chemical inhibitors. All chemical treatment provided by the Phase 1 mechanical contractor.

C. Detectable Underground Tape: Magnetic detectable conductor in 2 inch wide rot-resistant plastic tape or mesh, brightly colored, imprinted with "Water Line" in large letters.

D. Borehole Backfill
1. Manufacturers:
   a. Black Hills Bentonite GeoPro.
   b. Baroid Industries
   c. CETCO
2. A combination of thermally enhanced bentonite grout, high solids bentonite chip seal, and high-grade silica sand shall be used where indicated on the drawings. Enhancement material in the bentonite grout shall be high-grade silica sand compound.
3.
4. Thermal Conductivity: The thermal conductivity of the grouting compound must be 1.00 Btu/hr-ft-°F or greater as determined when tested in accordance to ASTM D-5334, "Standard Test Method for Determination of Thermal Conductivity of Soils and Soft Rock by Thermal Needle Probe Procedure" per International Ground Source Heat Pump Association (IGSHPA) Standard 2B.1.2.1.
   a. The reported thermal conductivity value of the grout shall be verified by an independent company which has a minimum of 5 years experience in measuring thermal conductivity using this method.
   b. Total Solids and Enhancement Compound Percentage: The thermally enhanced bentonite grout used shall have a minimum manufacturer's recommended mixture. The thermal enhancement compound (high-grade silica compound) shall constitute a minimum of 45.0% by weight of the total aqueous slurry.
5. Permeability: The grout mixture shall also have a maximum permeability rate of less than 8.0 x 10-8 cm/s as determined by using ASTM D-5084, "Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter, Method C-test with increasing tailwater level", per IGSHPA Standard 2B.1.2.2, with a 5 psi confinement pressure (to simulate an approximate sample depth of 5 foot).
   a. The reported permeability shall be verified by an independent, lab which has been certified by AMRL (American Association of State Highway & Transportation Officials, Materials Reference Laboratory) and validated by the US Army Corps of Engineers to perform ASTM D-5084 at the time of verification as found on the internet at "www.wes.army.mil/SUMTC/ValidatedLabsList.htm" per IGSHPA Standard 28.1.2.3.
   b. Credentials of the independent laboratory shall also be supplied upon request from the engineer.
6. Where only sand is indicated on the "Typical Geothermal Heat Pump Well Detail" on the drawings, provide the following: Provide high-grade silica sand mixed with bentonite and

water until the viscosity of the mixture is between 30 and 40 seconds as measured with a Marsh funnel. Submit written documentation for each well that the viscosity was measured at least once per well and what the viscosity was each time.

PART 3 EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Verify location of existing structures and utilities prior to excavation.

B. Verify soil composition and rock depth, if any, before beginning excavation.

C. Protect adjacent structures from the effects of excavation.

D. Verify that layout dimensions are correct and that available land is sufficient for design.

E. Notify Architect of unsatisfactory conditions.

F. Do not proceed with installation until unsatisfactory conditions have been corrected.

G. Coordinate work with site grading, site backfilling, and foundation construction.

3.2 HORIZONTAL PIPING INSTALLATION

A. Separate trenches by 10 feet minimum, unless otherwise indicated. Remove rocks in trenches that could contact pipe.

B. Backfill to 24 inches above pipe with sand. Backfill from sand level to grade with excavated soil. Install piping with 14 gauge tracer wire. Tracer wire shall be tested and verified by contractor. Connect with Fastenal 14 AWG butt connectors.

C. Install HDPE piping in trenches according to ASTM D 2774 or ASTM F 645
   1. Clean PE pipe and fittings and make heat-fusion joints according to ASTM D 2657. Minimize number of joints.

D. Do not bend piping beyond manufacturer allowable bend radius.

E. Purge, flush, and pressure test piping before backfilling trenches.

F. Install continuous detectable warning tape for underground piping. Locate tape at the depth below finished grade as indicated on the drawings and install directly over piping. Install tape at 36 inches on center across width of trench.

G. Coordinate termination of tracer wires at building with inside subcontractors and owner.

3.3 VERTICAL PIPING INSTALLATION

A. Purge, flush, and pressure test piping before backfilling boreholes.

B. Thermally enhanced bentonite grouting material shall be mixed according to manufacturer's written instructions.

C. Grout and sand material shall be pressure pumped through a one (1) inch, one and one-quarter (1-1/4) inch or a one and one-half (1-1/2) inch inside diameter tremie pipe and placed in the bore column from the bottom to the top. Grouting process shall conform to the manufacturer's instructions and "Grouting for Vertical Geothermal Heat Pump Systems --Engineering Design and Field Procedures Manual", as published by the IGSHPA, Oklahoma State University (OSU), 2000. Completed grouted surface shall be placed at ground level to ensure complete fill of the bore column.

D. Fill loop/well piping with water as the loop pipe is inserted into the borehole and pump backfill into borehole to discharge at base of borehole. The piping should protrude above grade two to five feet and shall be held off the ground with a brightly painted steel or wooden 'T' post. Cap all pipe ends firmly in place.

E. Fill borehole with grout to grade and add grout to top off the borehole as needed through construction.

F. Water source heat pump system wells shall comply with the State of Nebraska Department of Health and Human Services Water Well Standards program regulations.

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

3.5 FIELD QUALITY CONTROL

A. Piping Tests: Fill piping 24 hours before testing and apply test pressure to stabilize piping. Use potable water only.

B. Grout Tests:
   1. Since some settling may occur after initial placement of the grout material, the installer shall monitor each borehole and continue adding grout as required continuously through substantial completion.
   2. Since there usually is a direct correlation between thermal conductivity and permeability, only thermal conductivity shall be field inspected. The grouting manufacturer shall provide testing of site mixed grouting material in accordance to ASTM D-5334 to verify thermal conductivity. Manufacturer shall provide a minimum of four, sample analysis for this project.
   3. At a minimum, sampling shall be taken once at the beginning of the project, once at approximately one-quarter of completion, one-half of completion, and finally at approximately three-fourths of completion. In the event that the analysis indicates a thermal conductivity value below the minimum specified value, corrective action shall be taken to increase thermal conductivity value back to minimum specified requirement. A written report will be submitted defining corrective action taken. Owner and Engineer shall receive a copy of the grout conductivity test.

C. Prepare reports of testing activity.

3.6 FLUSHING AND PURGING OF BUILDING PIPING

A. Filling: Fill the pipe with clean potable water. The loop field must be and remain isolated at the valve vaults during this process. Loop field and building will not be hydraulically connected until

each segment is flushed, purged and accepted by authorized personnel. Remove as much air as possible before connection of the flush unit. Hydrostatic test the building and repair any leaks. Building must pass a twenty-four (24) hour test before flush unit is connected. The water source heat pumps are to be bypassed during this phase of the process. A flexible hose or hard piping can be used to bypass the units during initial fill and flush. Hose or piping must be the same or larger diameter than the pipe size of the heat pump connections. (Heat pumps are not to be a part of the circuit until lines are completely flushed.) Bypass all strainers, solenoid valves, circuit setters and flow controls at the units.

B. A spool is to be placed in the space where the check valve or triple function valve (where it is noted to be installed) is located above the pumps. A pump by-pass may be piped in temporarily. This will allow the flow to be reversed during flushing. This will dislodge any debris in the piping system. If the pump remains in the circuit, the strainers will need to be checked periodically to keep them open and flowing. Pump in the direction of designed flow to allow strainers in the pump to work. Once the water has circulated and flushed in designed direction, check strainer(s) and reverse the flow. Check and clean the strainers. Reversing the flow on initial flushing will cause debris to lodge in complete system without the assistance of the house pumps. The house pumps may assist the purge unit pump only when pumping in the proper direction.

C. The building must be inspected and tested for leaks with a hydrostatic test at 100 psi for twenty-four (24) hours. Drain down to repair any leaks and drips. No chemicals, solutions or substance are to be added to the system to stop leaks. This system requires a tight seal and is designed to be a closed system with no make-up water.

D. Flushing: The system requires velocities of the water in the system to be two feet (2') per second or greater and maintained for a minimum of thirty (30) minutes with the capability to reverse flow for an additional thirty (30) minutes in the opposite direction. Flush each segment of the project to reach two feet (2') per second. Flow rates will be verified at each of the segments with designated flow rate observation points during flushing and purging. This procedure will verify that velocities of two feet (2') per second or greater are met. If check valves are removed, flow will reverse through the pumps. Do not attempt to run the house pumps while flow is reversed. It may be necessary to reverse the flow several times to insure cleanliness. Save all debris in sample bags to show owner and engineers. Reversing the flow insures that any debris in the system, lodged in a tight place or resting place, has an opportunity to move the opposite direction for an exit. A calibrated flow meter, ultrasonic flow meter or orifice flow device that is accurate within two percent (2%) is to be used during the flushing and purging of this system. Flow rates equal to two feet per second or greater must be documented in order for owner to give final acceptance of this step. Flushing is not considered purging and therefore this process will be duplicated after the VRF equipment and heat recovery chiller are tied into the circuit.

E. Chemical Cleaning (Complete this in coordination with the Phase 1 Mechanical Contractor): When using steel piping a solution of tri-sodium phosphate is to be circulated through the building piping system (not necessary for PE pipe) for forty-eight (48) hours and replaced with potable water with environmentally friendly inhibitors approved by the state authority governing ground water protection. House pumps can be used to circulate the cleaning agents for the forty-eight (48) hour cleaning. Replace the water with clean potable water and check ph. Ph levels are to be tested and maintained above seven-point-five (7.5). If ph is less than seven-point-five (7.5) repeat the chemical cleaning. Clean water is needed to flush HDPE pipe. Submit manufacturer data (including MSDS) on inhibitors and cleaning chemicals. Inhibitors are not to be installed until approved by engineer and regulatory agency governing ground water protection.

F. Flushing Chemical Treatment (Complete this in coordination with the Phase 1 Mechanical Contractor): Drain and replace the water used for chemical treatment. Soft water will be put in

the system if any chemicals are to be added to the system. Softness and water quality will be determined by chemical manufacture's guidelines. This information will be part of the submittal package. The chemical treatment representative is to verity water quality before chemicals are added.

G. Flow rates will be met in order for owner to give final acceptance. Flushing is not considered purging and therefore this process will be duplicated after units are tied into the circuit.

H. Testing. Once the system has been tested for leaks and purged of debris the heat pump units can be permanently connected to the piping system. The check valve(s) and triple function valves are to be installed permanently. Test for any leaks at the units and recent connections before proceeding. The system is to be tested at one-hundred (100) psi with water pressure before the final purging. Mechanical contractor and loop contractor are to complete this pressure test before the final purge.

I. Purging: Purging the system of air is done by the purge unit capable of velocities of two feet (2') per second or greater. Flow will be in service direction and not reversed. Purge each segment of the project to reach two feet (2') per second. Micro bubbles are a result of high velocities and therefore excessive flow may need to be avoided. Contractor must have an ultrasonic flow meter to verify velocities in the building piping.

J. Flow rates will be verified on each of the segments with flow rate observation points during flushing and purging. This is done to assure the owner of velocities of two feet per second or greater are met.

K. Adding Chemicals (Complete this in coordination with the Phase 1 Mechanical Contractor): Once all of the air is removed the inhibitor/chemical is ready to be installed. The chemicals are to be thoroughly mixed with the water in the circuit and tested for proper levels. Quantities and concentrations of inhibitor/chemicals should be applied according to manufacturer specifications and approved submittals. Keep records of concentrations, velocities and softness, etc. An owner's representative, engineer, general contractor or their representatives will be given notice of this final process in order to witness the final purging. A forty-eight (48) hour notice is to be given and ample time for the witnesses to attend or this process will be duplicated before final acceptance is given.

L. Antifreeze solutions will not be used.

M. Completing the circuit: When the building and the loop field piping systems have been approved and accepted, the isolation valves can be opened and place in service position. VRF equipment and heat recovery chiller startup can proceed when the circulator pumps are activated.

N. Sealing: Upon acceptance of the purging process by the owner or his representative, the system is to be sealed with a pressure as verified with the mechanical engineer. Purge valves are to be sealed using blind flanges or plugs. A tag will be attached to the purge valves with list of chemicals and concentration.

O. Purge unit requirements: Contractor must have a pump on the purge unit that will meet or exceed the volume required to flush and purge this system. A pump curve on the purge unit will be submitted and approved by the engineer before process begins. Head pressures are in direct correlation to volume required to achieve two feet (2') per second, therefore, pump curve will verify sufficient head to reach volume required. A field test of pressure at shut-off will be used to verify head capacity. Flush unit will have a working flow meter.

P. Purge unit will have a tank for air separation large enough to insure air separation before water is re-circulated.

Q. Purge unit will have a filter system with minimum of one-hundred (100) mesh filter or smaller.

R. Purge unit will have valves to reverse flow without having to disconnect from the system. It must be equipped with isolation shut off valves.

S. Purge unit will have a water metering device accurate within two percent (2%) to verify flow or furnish an ultrasonic flow meter that could be attached to verify flow.

T. Purge unit is to have a pressure gauge in order to verify pressure during the flushing and purging process.

U. Purge unit to include enough hose of ample size and length to meet the flow requirements of the system.

V. Contractor must have an ultrasonic flow meter to verify velocities in the building at check points designated by the engineer.

3.7 FLUSHING AND PURGING OF LOOP FIELD AND HEAT EXCHANGERS

A. Filling: Fill the pipe with clean potable water. Connect purge unit to purge ports. Remove as much air as possible before starting of the flush unit. The building must remain isolated from the loop field for this process.

B. Purge unit must be able to flush and purge the complete system without the assistance of the house pumps. The loop field must be inspected and tested for leaks with a hydrostatic test at one-hundred (100) psi for twenty-four (24) hours. Repair any leaks. No chemicals, solutions or substance are to be added to the system to stop leaks. This system requires a tight seal and is designed to be a closed system with no make-up water.

C. No chemicals are to be used in cleaning or flushing of the ground heat exchanger. Inhibitors to protect the steel pipe are not to be installed until they are approved by engineer and regulatory agency governing ground water protection and water quality is approved.

D. Flushing: Velocities of the water in the system are minimum of two feet (2') per second and maintained for a minimum of thirty (30) minutes with the capability to reverse flow for an additional thirty (30) minutes in the opposite direction. It may be necessary to reverse the flow several times to insure cleanliness. Each circuit or zone is to be flushed independently. Save all debris in sample bags to show owner and engineers. Reversing the flow insures that any debris in the system lodged in tight or resting places have an opportunity to move the opposite direction for an exit. A calibrated flow meter, ultrasonic flow meter or an orifice flow device that is accurate within two percent (2%) must be used during the flushing and purging of this system. Flow rates to get to two feet per second must be met and verified in order for architect/engineer to give final acceptance. Flushing is not considered purging and therefore this process will be duplicated after all zones are thoroughly flushed. Verify that water is clear and clean.

E. Testing: Once the system has been tested for leaks and purged of debris. The system should be tested at one-hundred (100) psi with water pressure (hydrostatic) for twenty-four (24) hours.

F. Purging: Purging the system of air is done by the purge unit capable of velocities of two feet (2') per second or greater but not to exceed seven (7) feet per second in both directions. Each zone or circuit must be purged until all air is removed. Micro bubbles are a result of high velocities and therefore excessive flow may need to be avoided.

G. Adding Chemicals (Complete this in coordination with the Phase 1 Mechanical Contractor): Once all of the air is removed the inhibitor/chemicals/glycol can be installed (if any). Water quality is to be checked by representing the chemicals used. The chemicals are to be thoroughly mixed with the water in the circuit and tested for proper levels. Keep records of concentrations, velocities and softness, etc. Quantities and concentrations of inhibitor/chemicals/glycol should be applied according to manufacturer specifications and approved submittals. The owner, engineer and general contractor will be given notice of this final process in order to have someone present to witness the final purging. A forty-eight (48) hour notice is to be given and ample time for the witnesses to attend or this process will be duplicated before final acceptance.

H. Inhibitors to protect the steel pipe are not to be installed until they are approved by engineer and regulatory agency governing ground water protection. Chemicals used will be part of the submittal process.
   1. Antifreeze solutions will not be used.

I. Sealing: Upon acceptance of the purging process by the owner or his representative, the system is to be sealed with a pressure as verified with the mechanical engineer. Purge valves are to be sealed using blind flanges or plugs. A tag will be attached to the purge valves with list of chemicals and concentration.

J. Completing the circuit: When the building and the loop field heat exchanger have been approved and accepted, the isolation valves can be opened and placed in service position. VRF equipment and heat recovery chiller startup can proceed when the circulating pumps are activated.

K. The contractor will flush and purge each segment of the project to reach two feet (2') per second. Flow rates shall be verified on each of the segments with designated flow rate observation points during flushing and purging to insure owner of velocities achieved.

L. Purge unit requirements: Contractor must provide a pump on the purge unit that will meet or exceed the volume required to flush and purge this system. A pump curve on the purge unit will need to be submitted and approved by the engineer before process begins. Head pressures are in direct correlation to volume required to achieve two feet (2') per second, therefore, pump curve will verify sufficient head to reach volume required. A field test of pressure at shut-off will be used to verify pump capacity.

M. Purge unit will have a tank for separation of air which will be large enough to insure air separation before water is re-circulated.

N. Purge unit will have a filter system capable of removing particles one-hundred (100) mesh filter or smaller.

O. Purge unit will have valves to reverse flow without having to disconnect from the system. It is also to have isolation shut off valves.

P. Purge unit will have a water metering device accurate within two percent (2%) to verify flow or have an ultrasonic flow meter that could be attached to verify flow.

Q. Purge unit is to have a pressure gauge in order to verify pressure during the flushing and purging process.

R. Purge unit to include enough hose of ample size and length to meet the flow requirements of the system.

3.8 EXCAVATION

A. Excavate in accordance with requirements of authorities having jurisdiction.

B. Vertical Boreholes: Drill to depths required.
   1. Minimize over-drilling; fill over-drilled areas with backfill or excavated materials.
   2. Piping: Assemble heat exchanger piping and test before installation.

C. Trenches: Excavate trenches for piping to lines and grades shown on drawings.
   1. Minimize over-excavation; fill over-excavated areas with backfill or excavated materials.
   2. Excavate to accommodate grade changes.
   3. Maintain trenches free of debris, material, and obstructions that may damage pipe.
   4. Piping: Assemble heat exchanger piping and test before backfilling.

3.9 POLYETHYLENE PIPING

A. Join piping and fittings using heat fusion or electrofusion; do not use solvents, adhesives, or mechanical fittings.

B. Provide flanges or unions to connect heat exchanger piping to equipment or piping of different type; locate all transitions between piping of different types inside the building or otherwise accessible (i.e. above grade).

C. Keep dirt, water, and debris out of pipe assemblies; cap or plug open ends until connected to adjacent piping.

D. Do not bend piping to shorter radius than recommended by pipe manufacturer; do not kink piping; use elbow or other fittings for sharp bends.

E. Partially backfill radius bends in narrow trenches by hand to ensure that piping is properly supported and to prevent kinking.

F. Test piping to be installed in boreholes after assembly but before installation in boreholes; re-cap tested assemblies before installation.

G. Test piping to be installed in trenches after installation but before backfilling.

H. Testing: Perform hydrostatic test on all piping; portions of assembled piping may be tested separately.
   1. Prior to testing, isolate piping from all connections to building systems.
   2. Flush all dirt and debris using potable water flowing at twice the normal operating flow rate for a minimum of four hours or until no dirt or debris is visible, whichever is longer.
   3. Plug or cap piping.
   4. Pressurize piping to 100 psi for 90 minutes and monitor.
      a. Increase pressure in 20-psig increments and inspect each joint between increments. Hold at test pressure for 30 minutes. Slowly increase to next test pressure increment and hold for 30 minutes. After testing at maximum test pressure, reduce pressure to 30 psig. Hold for 90 minutes, and measure pressure at 30-minute intervals. Repair leaks and retest until no leaks exist.
   5. If there is any pressure loss or visible leakage, identify leak and repair in accordance with manufacturer's recommendations.
   6. Repeat test until there is no loss of pressure for the duration of the test.

I. After connection of piping to building systems and installation of equipment served by heat exchanger, fill piping with heat exchange fluid and pressurize.
   1. Water Temperature of 70 to 90 degrees F: Pressurize to 20 to 30 psi, minimum.
   2. Water Temperature of 40 to 50 degrees F: Pressurize to 40 to 50 psi, minimum.
   3. After pressurization, remove charging valve handles, or plug ports, whichever is applicable, and deliver handles to OCC.
   4. Install system label at charging valves, indicating:
      a. Heat exchange fluid.
      b. Service date.
      c. Company name.
      d. Company phone number and responsible person.

3.10 BACKFILLING

A. Install in compliance with local authorities having jurisdiction.

B. Vertical Boreholes: Backfill after pipe installation in accordance with IGSHPA (GROUT) - IGSHPA Grouting Procedures for GHP Systems.

C. Trenches:
   1. Provide minimum cover over piping as indicated on the drawings.
   2. Backfill trenches after pipe has been installed and tested, using fill free of rocks and other debris.
   3. Install detectable warning tape continuously above the top of all buried pipe at the depth indicated on the drawings.
   4. Provide pipe bedding, backfill, and compaction using the procedures specified in Section 221113.
   5. Backfill to original grades with sufficient overfill to allow for settlement.

D. Protect piping from displacement.

3.11 CLEANING

A. Leave adjacent paved areas broom clean.

B. Clear debris, including excess backfill and excavated dirt and rock, from heat exchanger area.

3.12 PROTECTION

A. Protect area during excavation from excess runoff and erosion.

B. Protect pipe protrusions from damage until final connections are installed.

END OF SECTION

your energy partner®
OPPD
Omaha Public Power District

May 8, 2018

Alvine Engineering
Mr. Paul Bauman, P.E.
1800 O Street, Suite 104
Lincoln, NE 68508

SUBJECT: Thermal Conductivity Test Results for State Capital Building Project – NW Test Loop

Dear Mr. Bauman,

The Commercial and Industrial Energy Solutions Department has completed the ground thermal conductivity test for the northwest test loop of the Nebraska State Capital Building project located southeast of South 17th Street and L Street in Lincoln, NE. The test results are essential design input to size the geothermal loop heat exchanger (GLHE) properly for this project. OPPD performed the test on a 670-feet long vertical test loop installed by K2 Geothermal. The attached well drilling log indicates the soil formations encountered. The on-site testing was performed for 69.92 hours from 05/04/18 until 05/07/18.

> **The calculated thermal conductivity of the ground (Kg) at this test bore location is 1.35 Btu/hr-ft-°F.**

The ground thermal diffusivity can be estimated from published data and the actual test well log report. For this test well, the thermal diffusivity is estimated to be **1.16 ft^2/day**.

The best approximation for an undisturbed soil temperature is 54-59° F based upon published annual earth temperatures and previous ground thermal conductivity testing in the area. The initial loop water temperature was approximately **59.3° F** during our test. I recommend consideration of a higher ground temperature for cooling design and a lower ground temperature for heating design due to potential ground water movement, which can create variations in deep-earth temperature throughout the year.

Attached is the raw data gathered from the 69.92-hour test. The data is provided in tabular and graphical formats for your review. Approximately 10,791 watts (36,855 Btu per hour) of heat was continuously added to the test loop during the test. At the end of the test, the water temperature was approximately 88.7°F going into the ground and 79.4°F coming out of the ground.

The results of this test must be properly used to size the GLHE. The following precautions (next page) should be considered before applying this data.

Design Precautions:

1. When designing the GLHE, the borehole backfill material becomes very important and affects the overall thermal conductivity, thus loop performance. The thermal conductivity determined by this test is for the **ground only** and does not include the effect of the borehole construction.

2. Bore hole construction (e.g. the diameter of the bore hole, diameter of the pipe loop, pipe loop material, and the type of backfill material) may impact the overall thermal conductivity of the heat exchanger and must be incorporated into the GLHE sizing calculations.

3. The calculated ground thermal conductivity is the average conductivity over the entire length of the single borehole tested. Significant changes between the depth of the borehole tested herein and any upcoming actual GLHE installation may result in change in thermal conductivity. Reference the attached test well log.

4. Changes in soil conditions may influence the overall thermal conductivity. Changes in soil conditions may be the result of variations in subsurface moisture content, change in pipe loop length from that used in the test loop, and/or changes in geological materials.

If you have any questions or need further information, please call me at (402) 636-3507.

Sincerely,

Timothy S. Rauscher, P.E., C.E.M.
C & I Energy Solutions Supervisor

Encl.

cc: OPPD Project File

THERMAL CONDUCTIVITY TEST - SUMMARY

Project Name: **NE State Capital - NW Test Loop**

Thermal Conductivity Test Date (Start): 5/4/2018

1. TEST WELL DESIGN

Well Length (L_c) =	670	ft
Nominal Pipe Size =	1 1/4	in
Diameter Ratio (DR) =	11	
Average Test Flow Rate =	8.2	gpm
Borehole Size (dia.) =	8.0	in
Loop Configuration =	One Bore Per Parallel Loop	
Backfill Material =	Hole Plug (top) and Sand	
Backfill Material Thermal Conductivity (K_{bf}) =	0.90	Btu/hr*ft*ºF

2. DATA LOGGED

Time to Circulate Non-Heated Water in Loop =	11.0	min.
Average Water Temp. From Ground during Initial Test =	64.5	ºF
Undisturbed Ground Temp (T_g) =	59.3	ºF
Duration of Test =	69.92	hours
Final Water Temp. Into Ground =	88.7	ºF
Final Water Temp. Out of Ground =	79.4	ºF
Maximum Average Loop Temperature =	84.2	ºF
Average Loop Delta-T =	9.4	ºF

3. POWER INPUT QUALITY

Average Heat Input into Loop =	10,791	Watts
Average Heat Input into Loop =	36,855	Btu/hr
Standard Deviation (σ) =	16.8	Watts
Standard Deviation Limit* =	161.7	Watts
% Standard Deviation =	0.16%	
% Standard Deviation Limit* =	1.5%	
Minimum Power Input =	10,752	Watts
Minimum Power Input Limit* =	9,701	Watts
Peak Power Input =	10,812	Watts
Peak Power Input Limit* =	11,857	Watts
Power Input Meets ASHRAE 1118 TRP Guidelines?	Yes	

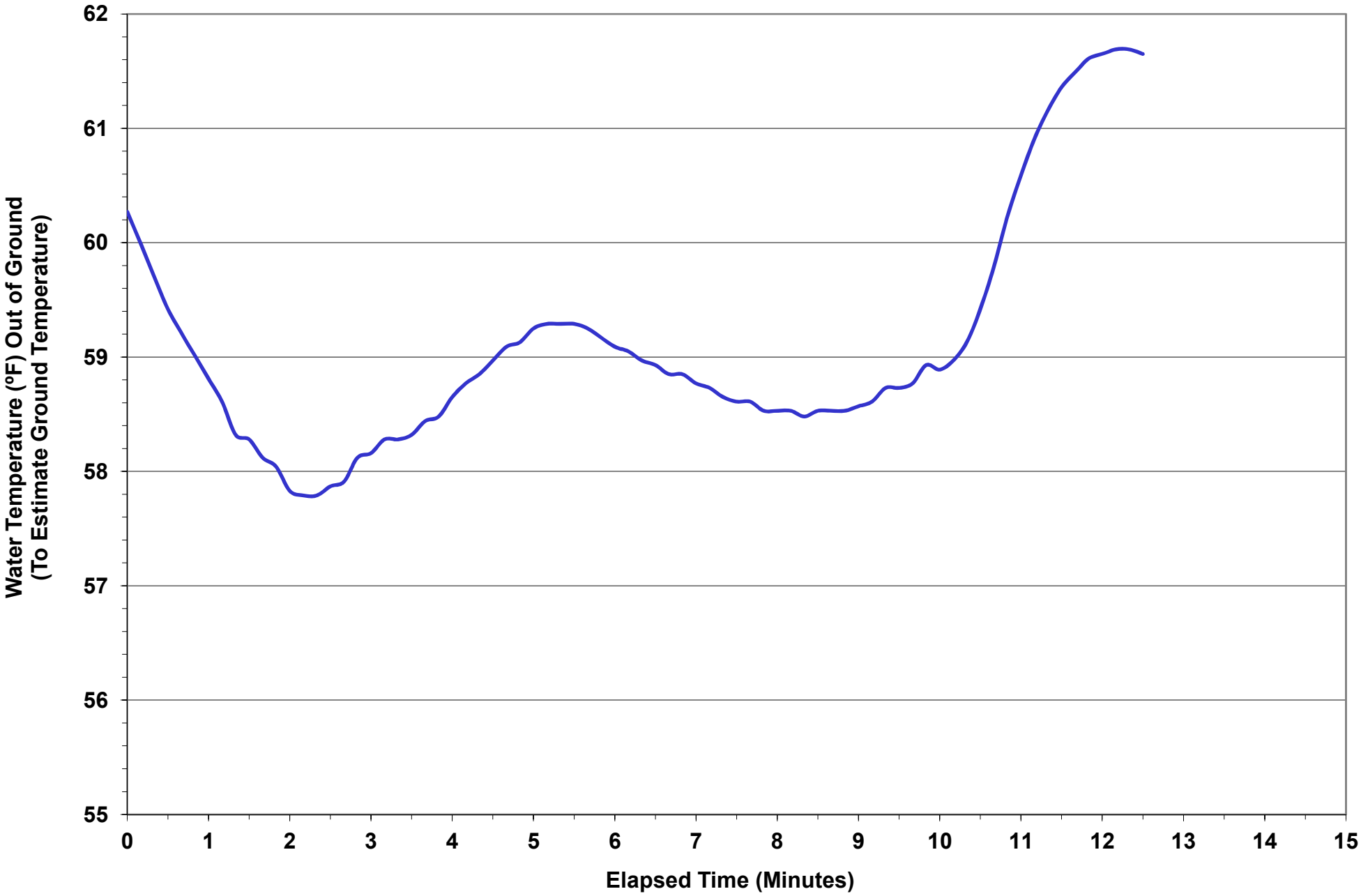
4. TEST RESULTS

Calculated Ground Thermal Conductivity (K_g) =	1.35	Btu/hr*ft*ºF
Estimated Ground Thermal Diffusivity (α_g) =	1.16	ft^2/day

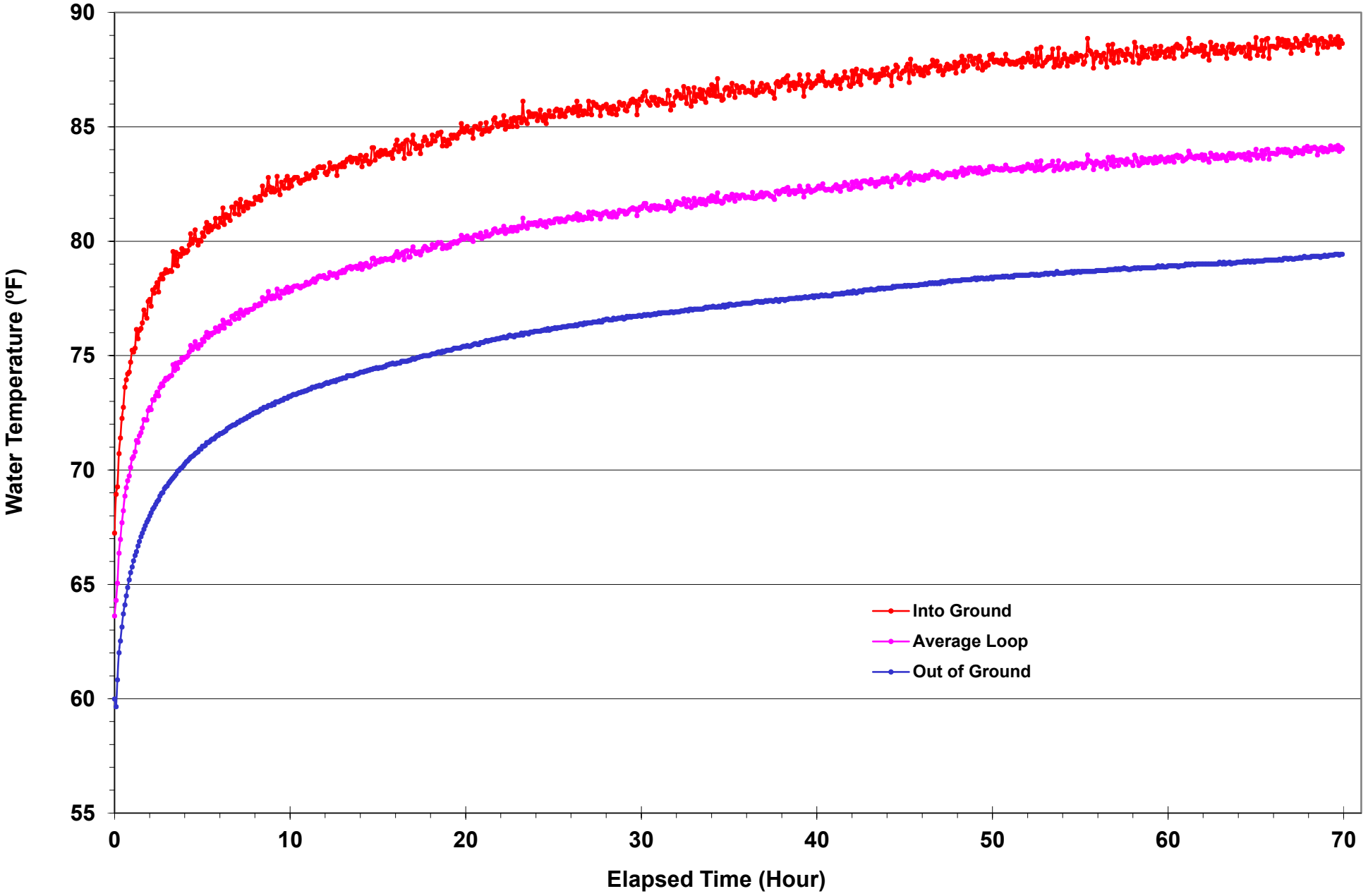
Notes:

*Per ASHRAE 1118-TRP

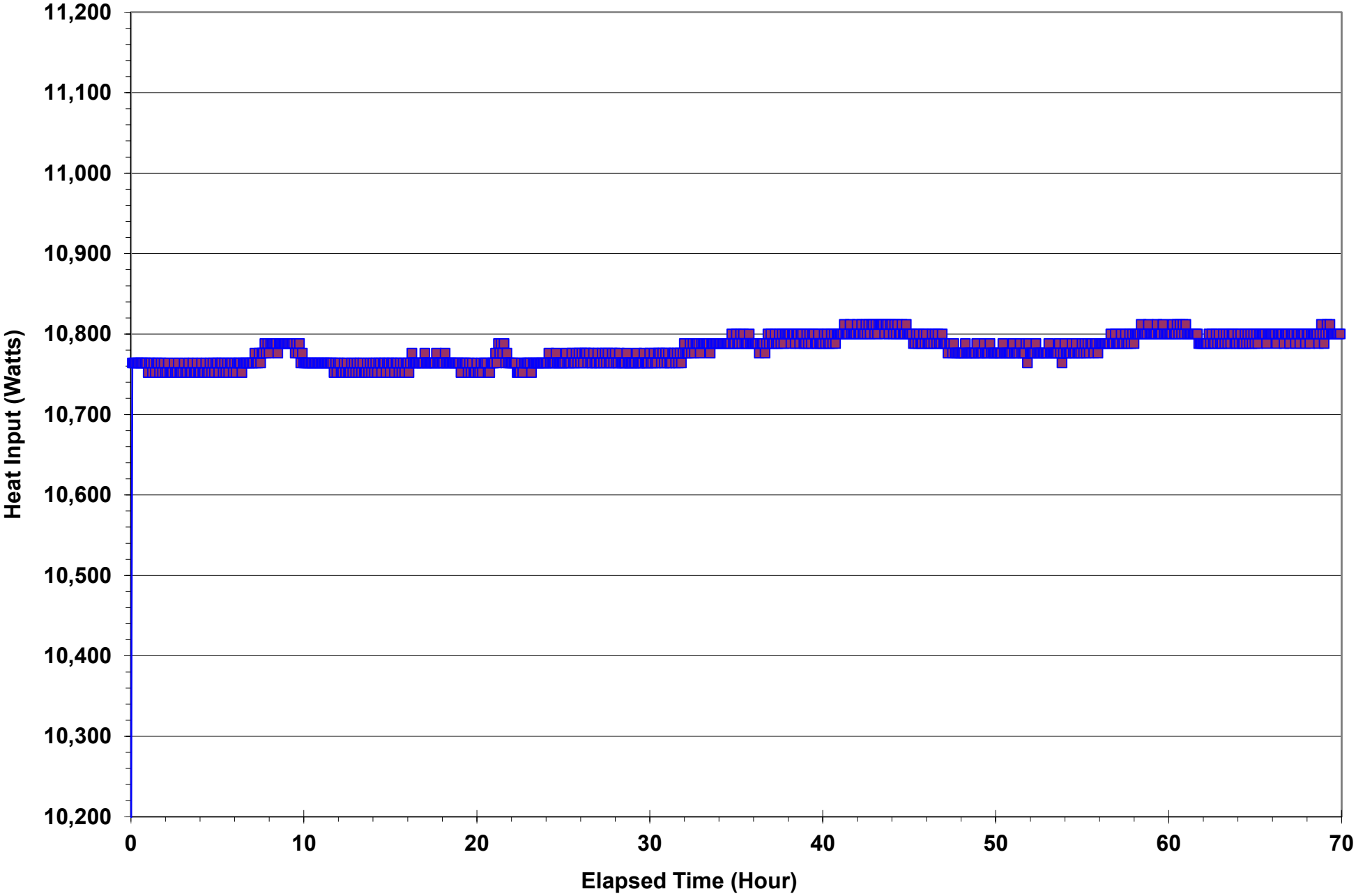
K2 Geothermal		
NE State Capital		
Well Drilling Log		
Hole Number:	**NW Corner Well**	
Material	**From**	**To**
Clay	0	8
Course Yellow Sand	8	45
Gray Clay	45	65
Medium Sand w/ dark chips	65	80
Soft Orange Clay	80	90
Sand w/ sandstone	90	105
Medium Sand/Sandstone	105	160
Soft Red Shale	160	170
Red/Gray Clay	170	260
Gray Shale	260	275
Maroon Clay	275	280
Gray Clay w/ shale	280	350
Limestone	350	385
Hard Gray Shale	385	395
Limestone	395	420
Black Shale	420	445
Clay	445	450
White Shale w/ limestone layers	450	465
Soft Gray Clay	465	485
Brown Shale	485	500
Soft Red Clay	500	515
Limestone	515	525
Gray Shale	525	535
Limestone	535	555
Soft Red Clay	555	630
Limestone	630	640
Gray Clay	450	660
Shale	660	675


NE State Capital - NW Test Loop
Ground Thermal Conductivity Test
Initial Water (Deep Earth) Temperature
Water Temperature (ºF) Out of Ground
(To Estimate Ground Temperature)
62
61
60
59
58
57
56
55
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Elapsed Time (Minutes)

NE State Capital - NW Test Loop
Ground Thermal Conductivity Test
Test Loop Water Temperatures



NE State Capital - NW Test Loop
Ground Thermal Conductivity Test
Test Loop Heat Input



NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

LOGGED DATA INITIALLY TO DETERMINE UNDISTURBED SOIL TEMPERATURE

Approximate Flow Rate: 9.0 gpm Frequency of Samples: 10.0 sec.

Rdg. No.	Hour Min.	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
0	0.0	05/04/18	2:50:31 PM	73.2	60.3	84.9	81.9	0	0	60.3
1	0.2	05/04/18	2:50:41 PM	72.5	60.0	84.9	81.9	1	12	60.0
2	0.3	05/04/18	2:50:51 PM	72.4	59.7	84.9	82.0	0	0	59.7
3	0.5	05/04/18	2:51:01 PM	71.6	59.4	84.8	82.0	1	12	59.4
4	0.7	05/04/18	2:51:11 PM	71.2	59.2	84.8	82.0	0	0	59.2
5	0.8	05/04/18	2:51:21 PM	70.7	59.0	84.8	82.0	1	12	59.0
6	1.0	05/04/18	2:51:31 PM	70.2	58.8	84.8	82.1	0	0	58.8
7	1.2	05/04/18	2:51:41 PM	69.8	58.6	84.9	82.2	1	12	58.6
8	1.3	05/04/18	2:51:51 PM	69.4	58.3	84.9	82.3	0	0	58.3
9	1.5	05/04/18	2:52:01 PM	68.9	58.3	84.9	82.2	1	12	58.3
10	1.7	05/04/18	2:52:11 PM	68.4	58.1	84.8	82.1	0	0	58.1
11	1.8	05/04/18	2:52:21 PM	68.0	58.0	84.9	82.0	1	12	58.0
12	2.0	05/04/18	2:52:31 PM	67.3	57.8	84.9	82.1	0	0	57.8
13	2.2	05/04/18	2:52:41 PM	67.0	57.8	85.0	82.1	1	12	57.8
14	2.3	05/04/18	2:52:51 PM	66.6	57.8	85.0	82.2	0	0	57.8
15	2.5	05/04/18	2:53:01 PM	66.2	57.9	85.1	82.3	1	12	57.9
16	2.7	05/04/18	2:53:11 PM	65.8	57.9	85.1	82.4	0	0	57.9
17	2.8	05/04/18	2:53:21 PM	65.4	58.1	85.1	82.5	1	12	58.1
18	3.0	05/04/18	2:53:31 PM	65.2	58.2	85.2	82.5	1	12	58.2
19	3.2	05/04/18	2:53:41 PM	64.8	58.3	85.3	82.6	0	0	58.3
20	3.3	05/04/18	2:53:51 PM	64.7	58.3	85.3	82.5	1	12	58.3
21	3.5	05/04/18	2:54:01 PM	64.6	58.3	85.3	82.3	0	0	58.3
22	3.7	05/04/18	2:54:11 PM	64.2	58.4	85.2	82.2	1	12	58.4
23	3.8	05/04/18	2:54:21 PM	64.0	58.5	85.1	82.0	0	0	58.5
24	4.0	05/04/18	2:54:31 PM	63.8	58.7	85.0	82.0	1	12	58.7
25	4.2	05/04/18	2:54:41 PM	63.5	58.8	84.9	82.0	0	0	58.8
26	4.3	05/04/18	2:54:51 PM	63.3	58.9	84.9	82.0	1	12	58.9
27	4.5	05/04/18	2:55:01 PM	63.1	59.0	84.9	81.9	0	0	59.0
28	4.7	05/04/18	2:55:11 PM	62.9	59.1	84.8	81.8	1	12	59.1
29	4.8	05/04/18	2:55:21 PM	62.8	59.1	84.7	81.8	0	0	59.1
30	5.0	05/04/18	2:55:31 PM	62.7	59.3	84.7	81.8	1	12	59.3
31	5.2	05/04/18	2:55:41 PM	62.5	59.3	84.6	81.7	0	0	59.3
32	5.3	05/04/18	2:55:51 PM	62.5	59.3	84.5	81.3	1	12	59.3
33	5.5	05/04/18	2:56:01 PM	62.3	59.3	84.3	81.1	0	0	59.3
34	5.7	05/04/18	2:56:11 PM	62.2	59.3	84.2	80.7	1	12	59.3
35	5.8	05/04/18	2:56:21 PM	62.1	59.2	84.1	80.6	0	0	59.2
36	6.0	05/04/18	2:56:31 PM	62.0	59.1	84.0	80.6	1	12	59.1
37	6.2	05/04/18	2:56:41 PM	61.9	59.1	83.9	80.8	0	0	59.1
38	6.3	05/04/18	2:56:51 PM	61.7	59.0	83.9	80.9	1	12	59.0
39	6.5	05/04/18	2:57:01 PM	61.6	58.9	83.8	80.6	0	0	58.9
40	6.7	05/04/18	2:57:11 PM	61.6	58.9	83.8	80.7	1	12	58.9
41	6.8	05/04/18	2:57:21 PM	61.4	58.9	83.8	80.9	0	0	58.9
42	7.0	05/04/18	2:57:31 PM	61.4	58.8	83.8	81.0	1	12	58.8
43	7.2	05/04/18	2:57:41 PM	61.3	58.7	83.8	81.1	0	0	58.7
44	7.3	05/04/18	2:57:51 PM	61.1	58.7	83.9	81.2	1	12	58.7
45	7.5	05/04/18	2:58:01 PM	61.0	58.6	83.9	81.2	0	0	58.6
46	7.7	05/04/18	2:58:11 PM	61.0	58.6	84.0	81.2	1	12	58.6
47	7.8	05/04/18	2:58:21 PM	60.9	58.5	83.9	81.3	1	12	58.5
48	8.0	05/04/18	2:58:31 PM	60.9	58.5	84.0	81.4	0	0	58.5
49	8.2	05/04/18	2:58:41 PM	60.8	58.5	84.0	81.4	1	12	58.5
50	8.3	05/04/18	2:58:51 PM	60.6	58.5	84.0	81.5	0	0	58.5
51	8.5	05/04/18	2:59:01 PM	60.6	58.5	84.1	81.7	1	12	58.5
52	8.7	05/04/18	2:59:11 PM	60.6	58.5	84.2	81.6	0	0	58.5
53	8.8	05/04/18	2:59:21 PM	60.5	58.5	84.2	81.5	1	12	58.5
54	9.0	05/04/18	2:59:31 PM	60.4	58.6	84.2	81.7	0	0	58.6
55	9.2	05/04/18	2:59:41 PM	60.4	58.6	84.3	82.0	1	12	58.6
56	9.3	05/04/18	2:59:51 PM	60.3	58.7	84.4	82.2	0	0	58.7
57	9.5	05/04/18	3:00:01 PM	60.2	58.7	84.5	82.2	1	12	58.7
58	9.7	05/04/18	3:00:11 PM	60.2	58.8	84.6	82.2	0	0	58.8
59	9.8	05/04/18	3:00:21 PM	60.2	58.9	84.6	82.3	1	12	58.9
60	10.0	05/04/18	3:00:31 PM	60.2	58.9	84.7	82.4	0	0	58.9

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
61	10.2	05/04/18	3:00:41 PM	60.1	59.0	84.7	82.5	1	12	59.0
62	10.3	05/04/18	3:00:51 PM	60.1	59.1	84.8	82.7	0	0	59.1
63	10.5	05/04/18	3:01:01 PM	60.0	59.4	84.9	82.8	1	12	59.4
64	10.7	05/04/18	3:01:11 PM	60.1	59.8	85.0	82.9	0	0	59.8
65	10.8	05/04/18	3:01:21 PM	60.1	60.2	85.1	83.1	1	12	60.2
66	11.0	05/04/18	3:01:31 PM	60.1	60.6	85.2	83.1	0	0	60.6
67	11.2	05/04/18	3:01:41 PM	60.2	60.9	85.3	83.2	1	12	60.9
68	11.3	05/04/18	3:01:51 PM	60.3	61.2	85.4	83.3	0	0	61.2
69	11.5	05/04/18	3:02:01 PM	60.3	61.4	85.4	83.3	1	12	61.4
70	11.7	05/04/18	3:02:11 PM	60.4	61.5	85.4	83.3	0	0	61.5
71	11.8	05/04/18	3:02:21 PM	60.5	61.6	85.5	83.5	1	12	61.6
72	12.0	05/04/18	3:02:31 PM	60.6	61.7	85.6	83.5	0	0	61.7
73	12.2	05/04/18	3:02:41 PM	60.6	61.7	85.6	83.5	1	12	61.7
74	12.3	05/04/18	3:02:51 PM	60.7	61.7	85.5	83.4	1	12	61.7
75	12.5	05/04/18	3:03:01 PM	60.8	61.7	85.5	83.4	0	0	61.7
76	12.7								0	
77	12.8								0	
78	13.0								0	
79	13.2								0	
80	13.3								0	
81	13.5								0	
82	13.7								0	
83	13.8								0	
84	14.0								0	
85	14.2								0	
86	14.3								0	
87	14.5								0	
88	14.7								0	
89	14.8								0	
90	15.0								0	

Water Volume of Loop in Ground = 13.48 ft^3, or = 100.82 gallons

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)

LOGGED DATA TO CALCULATE SOIL THERMAL CONDUCTIVITY

Number of Hours:	69.92	hours	Total Accumulative Pulses Read:	754,501	Pulses
Calculated Meter Reading:	754,501	Watt*hrs	Average Pulses/Hour:	10,791	Pulses/hr
Multiplier:	1.0	Watt*hrs/pulse	Average Heat Input:	10,791	Watts
Approximate Flow Rate	8.2	gpm	Frequency of Samples:	5.0	minutes

0	0.00	05/04/18	3:09:22 PM	67.3	60.0	87.2	83.6	840	10,080	63.6
1	0.08	05/04/18	3:14:22 PM	68.9	59.7	89.8	83.2	897	10,764	64.3
2	0.17	05/04/18	3:19:22 PM	69.3	60.8	91.2	82.3	897	10,764	65.1
3	0.25	05/04/18	3:24:22 PM	70.7	62.0	91.9	82.3	897	10,764	66.4
4	0.33	05/04/18	3:29:22 PM	71.4	62.5	92.0	80.0	897	10,764	67.0
5	0.42	05/04/18	3:34:22 PM	72.3	63.1	92.3	82.8	897	10,764	67.7
6	0.50	05/04/18	3:39:22 PM	72.7	63.7	93.2	81.9	897	10,764	68.2
7	0.58	05/04/18	3:44:22 PM	73.6	64.1	93.8	82.5	897	10,764	68.9
8	0.67	05/04/18	3:49:22 PM	74.0	64.5	94.0	82.8	897	10,764	69.2
9	0.75	05/04/18	3:54:22 PM	74.2	64.9	94.7	83.9	897	10,764	69.5
10	0.83	05/04/18	3:59:22 PM	74.3	65.2	95.4	82.7	897	10,764	69.7
11	0.92	05/04/18	4:04:22 PM	74.7	65.5	95.9	83.4	897	10,764	70.1
12	1.00	05/04/18	4:09:22 PM	75.2	65.8	96.4	83.8	896	10,752	70.5
13	1.08	05/04/18	4:14:22 PM	75.2	66.0	96.7	82.2	897	10,764	70.6
14	1.17	05/04/18	4:19:22 PM	75.3	66.3	96.5	83.3	897	10,764	70.8
15	1.25	05/04/18	4:24:22 PM	76.2	66.4	97.0	83.8	896	10,752	71.3
16	1.33	05/04/18	4:29:22 PM	75.7	66.7	97.2	84.8	897	10,764	71.2
17	1.42	05/04/18	4:34:22 PM	76.1	66.9	97.7	84.9	896	10,752	71.5
18	1.50	05/04/18	4:39:22 PM	76.2	67.1	98.3	83.9	897	10,764	71.6
19	1.58	05/04/18	4:44:22 PM	76.4	67.3	98.9	84.9	897	10,764	71.8
20	1.67	05/04/18	4:49:22 PM	77.0	67.4	99.4	84.0	896	10,752	72.2
21	1.75	05/04/18	4:54:22 PM	76.8	67.6	99.4	84.7	897	10,764	72.2
22	1.83	05/04/18	4:59:22 PM	76.6	67.7	99.5	84.4	896	10,752	72.2
23	1.92	05/04/18	5:04:22 PM	77.4	67.8	99.9	84.5	897	10,764	72.6
24	2.00	05/04/18	5:09:22 PM	77.5	68.0	100.1	84.9	896	10,752	72.7
25	2.08	05/04/18	5:14:22 PM	77.2	68.1	100.3	85.1	896	10,752	72.6
26	2.17	05/04/18	5:19:22 PM	77.9	68.3	100.1	84.7	897	10,764	73.1
27	2.25	05/04/18	5:24:22 PM	77.7	68.4	99.8	84.0	896	10,752	73.1
28	2.33	05/04/18	5:29:22 PM	78.0	68.5	100.1	85.2	896	10,752	73.2
29	2.42	05/04/18	5:34:22 PM	78.2	68.6	100.2	84.4	896	10,752	73.4
30	2.50	05/04/18	5:39:22 PM	77.8	68.7	100.1	84.3	897	10,764	73.2
31	2.58	05/04/18	5:44:22 PM	78.4	68.9	99.9	84.0	896	10,752	73.6
32	2.67	05/04/18	5:49:22 PM	78.6	69.0	99.8	84.1	896	10,752	73.8
33	2.75	05/04/18	5:54:22 PM	78.4	69.0	99.9	83.9	897	10,764	73.7
34	2.83	05/04/18	5:59:22 PM	78.6	69.2	100.1	83.8	896	10,752	73.9
35	2.92	05/04/18	6:04:22 PM	78.8	69.3	100.0	81.8	896	10,752	74.0
36	3.00	05/04/18	6:09:22 PM	78.6	69.3	99.7	82.8	896	10,752	74.0
37	3.08	05/04/18	6:14:22 PM	78.7	69.4	99.5	82.8	897	10,764	74.1
38	3.17	05/04/18	6:19:22 PM	78.7	69.5	99.6	82.2	896	10,752	74.1
39	3.25	05/04/18	6:24:22 PM	78.7	69.6	99.6	82.5	896	10,752	74.1
40	3.33	05/04/18	6:29:22 PM	79.6	69.7	99.1	81.7	897	10,764	74.6
41	3.42	05/04/18	6:34:22 PM	79.0	69.7	98.5	81.2	896	10,752	74.4
42	3.50	05/04/18	6:39:22 PM	79.5	69.8	97.9	81.5	896	10,752	74.7
43	3.58	05/04/18	6:44:22 PM	78.9	70.0	97.1	80.7	897	10,764	74.4
44	3.67	05/04/18	6:49:22 PM	79.4	70.0	96.6	80.7	896	10,752	74.7
45	3.75	05/04/18	6:54:22 PM	79.3	70.1	96.1	80.2	896	10,752	74.7
46	3.83	05/04/18	6:59:22 PM	79.7	70.1	95.4	79.3	897	10,764	74.9
47	3.92	05/04/18	7:04:22 PM	79.5	70.2	94.9	79.7	896	10,752	74.8
48	4.00	05/04/18	7:09:22 PM	79.6	70.3	94.3	79.5	896	10,752	74.9
49	4.08	05/04/18	7:14:22 PM	79.5	70.4	93.7	78.9	897	10,764	74.9
50	4.17	05/04/18	7:19:22 PM	79.6	70.4	93.2	78.4	896	10,752	75.0
51	4.25	05/04/18	7:24:22 PM	79.8	70.5	92.7	78.1	896	10,752	75.2
52	4.33	05/04/18	7:29:22 PM	80.3	70.6	92.1	78.1	897	10,764	75.4
53	4.42	05/04/18	7:34:22 PM	79.9	70.6	91.6	78.2	896	10,752	75.3
54	4.50	05/04/18	7:39:22 PM	80.1	70.6	91.2	78.0	896	10,752	75.4
55	4.58	05/04/18	7:44:22 PM	80.5	70.7	90.8	77.7	897	10,764	75.6
56	4.67	05/04/18	7:49:22 PM	80.1	70.8	90.3	77.5	896	10,752	75.4

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
57	4.75	05/04/18	7:54:22 PM	79.8	70.8	89.9	77.0	897	10,764	75.3
58	4.83	05/04/18	7:59:22 PM	80.1	70.9	89.5	76.9	896	10,752	75.5
59	4.92	05/04/18	8:04:22 PM	80.0	70.9	89.1	76.8	897	10,764	75.5
60	5.00	05/04/18	8:09:22 PM	80.4	71.0	88.9	76.6	897	10,764	75.7
61	5.08	05/04/18	8:14:22 PM	80.2	71.0	88.4	76.3	896	10,752	75.6
62	5.17	05/04/18	8:19:22 PM	80.6	71.1	88.2	76.2	897	10,764	75.8
63	5.25	05/04/18	8:24:22 PM	80.8	71.2	87.9	75.7	897	10,764	76.0
64	5.33	05/04/18	8:29:22 PM	80.4	71.2	87.6	75.6	896	10,752	75.8
65	5.42	05/04/18	8:34:22 PM	80.7	71.2	87.3	75.4	897	10,764	76.0
66	5.50	05/04/18	8:39:22 PM	80.5	71.3	87.0	75.1	896	10,752	75.9
67	5.58	05/04/18	8:44:22 PM	80.6	71.4	86.7	74.8	897	10,764	76.0
68	5.67	05/04/18	8:49:22 PM	80.7	71.4	86.4	74.6	896	10,752	76.0
69	5.75	05/04/18	8:54:22 PM	81.0	71.4	86.1	74.4	897	10,764	76.2
70	5.83	05/04/18	8:59:22 PM	80.7	71.5	85.9	74.2	897	10,764	76.1
71	5.92	05/04/18	9:04:22 PM	80.6	71.5	85.6	73.9	896	10,752	76.1
72	6.00	05/04/18	9:09:22 PM	81.0	71.6	85.5	73.7	897	10,764	76.3
73	6.08	05/04/18	9:14:22 PM	80.8	71.6	85.2	73.2	896	10,752	76.2
74	6.17	05/04/18	9:19:22 PM	81.5	71.6	85.0	73.0	897	10,764	76.6
75	6.25	05/04/18	9:24:22 PM	80.7	71.7	84.8	72.8	897	10,764	76.2
76	6.33	05/04/18	9:29:22 PM	81.2	71.7	84.6	72.5	897	10,764	76.4
77	6.42	05/04/18	9:34:22 PM	81.0	71.8	84.3	72.3	896	10,752	76.4
78	6.50	05/04/18	9:39:22 PM	81.1	71.9	84.1	72.1	897	10,764	76.5
79	6.58	05/04/18	9:44:22 PM	80.9	71.9	83.9	71.6	897	10,764	76.4
80	6.67	05/04/18	9:49:22 PM	81.5	71.9	83.7	70.5	897	10,764	76.7
81	6.75	05/04/18	9:54:22 PM	81.5	72.0	83.5	70.3	897	10,764	76.7
82	6.83	05/04/18	9:59:22 PM	81.2	72.0	83.3	70.2	897	10,764	76.6
83	6.92	05/04/18	10:04:22 PM	81.7	72.0	83.1	70.3	897	10,764	76.8
84	7.00	05/04/18	10:09:22 PM	81.6	72.1	82.8	69.9	897	10,764	76.9
85	7.08	05/04/18	10:14:22 PM	81.2	72.1	82.6	69.4	897	10,764	76.6
86	7.17	05/04/18	10:19:22 PM	81.8	72.2	82.4	69.1	898	10,776	77.0
87	7.25	05/04/18	10:24:22 PM	81.5	72.2	82.2	68.8	897	10,764	76.8
88	7.33	05/04/18	10:29:22 PM	81.3	72.2	82.0	68.5	897	10,764	76.8
89	7.42	05/04/18	10:34:22 PM	81.5	72.3	81.8	68.0	898	10,776	76.9
90	7.50	05/04/18	10:39:22 PM	81.7	72.3	81.5	67.3	897	10,764	77.0
91	7.58	05/04/18	10:44:22 PM	81.5	72.3	81.3	67.3	898	10,776	76.9
92	7.67	05/04/18	10:49:22 PM	81.7	72.3	81.0	67.0	898	10,776	77.0
93	7.75	05/04/18	10:54:22 PM	81.6	72.4	80.7	66.6	899	10,788	77.0
94	7.83	05/04/18	10:59:22 PM	81.6	72.4	80.5	66.3	898	10,776	77.0
95	7.92	05/04/18	11:04:22 PM	81.6	72.5	80.3	66.3	899	10,788	77.1
96	8.00	05/04/18	11:09:22 PM	81.9	72.5	80.1	66.4	898	10,776	77.2
97	8.08	05/04/18	11:14:22 PM	81.8	72.5	79.9	66.1	899	10,788	77.2
98	8.17	05/04/18	11:19:22 PM	81.8	72.5	79.6	65.8	899	10,788	77.2
99	8.25	05/04/18	11:24:22 PM	82.0	72.6	79.4	65.7	899	10,788	77.3
100	8.33	05/04/18	11:29:22 PM	81.8	72.7	79.2	65.2	899	10,788	77.2
101	8.42	05/04/18	11:34:22 PM	82.4	72.7	79.0	64.7	899	10,788	77.5
102	8.50	05/04/18	11:39:22 PM	82.1	72.7	78.8	64.2	898	10,776	77.4
103	8.58	05/04/18	11:44:22 PM	82.0	72.7	78.6	63.6	899	10,788	77.4
104	8.67	05/04/18	11:49:22 PM	82.3	72.7	78.3	63.7	899	10,788	77.5
105	8.75	05/04/18	11:54:22 PM	82.8	72.8	78.1	63.8	899	10,788	77.8
106	8.83	05/04/18	11:59:22 PM	82.4	72.8	78.0	64.2	899	10,788	77.6
107	8.92	05/05/18	12:04:22 AM	82.2	72.8	77.8	64.0	899	10,788	77.5
108	9.00	05/05/18	12:09:22 AM	82.3	72.9	77.6	63.5	899	10,788	77.6
109	9.08	05/05/18	12:14:22 AM	82.2	72.9	77.4	62.5	899	10,788	77.5
110	9.17	05/05/18	12:19:22 AM	82.2	73.0	77.1	62.5	899	10,788	77.6
111	9.25	05/05/18	12:24:22 AM	82.8	73.0	77.0	62.9	899	10,788	77.9
112	9.33	05/05/18	12:29:22 AM	82.3	73.0	76.8	62.5	899	10,788	77.6
113	9.42	05/05/18	12:34:22 AM	82.0	73.0	76.6	61.9	899	10,788	77.5
114	9.50	05/05/18	12:39:22 AM	82.6	73.1	76.5	61.8	898	10,776	77.8
115	9.58	05/05/18	12:44:22 AM	82.4	73.1	76.3	61.8	899	10,788	77.7
116	9.67	05/05/18	12:49:22 AM	82.3	73.1	76.1	61.3	898	10,776	77.7
117	9.75	05/05/18	12:54:22 AM	82.7	73.1	76.0	61.1	899	10,788	77.9
118	9.83	05/05/18	12:59:22 AM	82.8	73.1	75.7	60.7	897	10,764	78.0
119	9.92	05/05/18	1:04:22 AM	82.3	73.2	75.4	61.0	898	10,776	77.8
120	10.00	05/05/18	1:09:22 AM	82.7	73.2	75.2	61.0	897	10,764	77.9
121	10.08	05/05/18	1:14:22 AM	82.4	73.3	75.2	60.7	897	10,764	77.8
122	10.17	05/05/18	1:19:22 AM	82.7	73.3	74.9	60.4	897	10,764	78.0

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
123	10.25	05/05/18	1:24:22 AM	82.8	73.3	74.6	60.1	897	10,764	78.0
124	10.33	05/05/18	1:29:22 AM	82.8	73.3	74.4	59.8	897	10,764	78.0
125	10.42	05/05/18	1:34:22 AM	82.8	73.3	74.3	60.0	897	10,764	78.1
126	10.50	05/05/18	1:39:22 AM	82.6	73.4	74.0	60.0	897	10,764	78.0
127	10.58	05/05/18	1:44:22 AM	82.5	73.4	73.7	59.8	897	10,764	78.0
128	10.67	05/05/18	1:49:22 AM	82.7	73.4	73.5	59.7	897	10,764	78.0
129	10.75	05/05/18	1:54:22 AM	82.7	73.4	73.4	59.2	897	10,764	78.0
130	10.83	05/05/18	1:59:22 AM	82.7	73.5	73.2	59.1	897	10,764	78.1
131	10.92	05/05/18	2:04:22 AM	83.0	73.5	72.9	58.9	897	10,764	78.2
132	11.00	05/05/18	2:09:22 AM	82.8	73.5	72.8	58.9	897	10,764	78.1
133	11.08	05/05/18	2:14:22 AM	82.8	73.5	72.7	58.6	897	10,764	78.1
134	11.17	05/05/18	2:19:22 AM	82.9	73.5	72.5	58.5	897	10,764	78.2
135	11.25	05/05/18	2:24:22 AM	82.9	73.6	72.2	58.5	897	10,764	78.3
136	11.33	05/05/18	2:29:22 AM	83.1	73.6	71.9	58.4	897	10,764	78.4
137	11.42	05/05/18	2:34:22 AM	82.8	73.6	71.4	57.3	897	10,764	78.2
138	11.50	05/05/18	2:39:22 AM	83.0	73.7	71.2	57.2	897	10,764	78.3
139	11.58	05/05/18	2:44:22 AM	83.2	73.7	71.1	57.1	897	10,764	78.4
140	11.67	05/05/18	2:49:22 AM	83.3	73.7	71.0	57.1	897	10,764	78.5
141	11.75	05/05/18	2:54:22 AM	83.2	73.7	71.0	56.9	896	10,752	78.4
142	11.83	05/05/18	2:59:22 AM	83.2	73.7	71.0	56.9	897	10,764	78.5
143	11.92	05/05/18	3:04:22 AM	83.3	73.8	70.8	56.6	896	10,752	78.5
144	12.00	05/05/18	3:09:22 AM	83.0	73.8	70.8	56.7	897	10,764	78.4
145	12.08	05/05/18	3:14:22 AM	82.9	73.8	70.7	56.5	897	10,764	78.4
146	12.17	05/05/18	3:19:22 AM	83.1	73.8	70.6	56.2	896	10,752	78.4
147	12.25	05/05/18	3:24:22 AM	83.4	73.8	70.4	56.4	896	10,752	78.6
148	12.33	05/05/18	3:29:22 AM	83.2	73.9	70.3	56.6	897	10,764	78.5
149	12.42	05/05/18	3:34:22 AM	83.2	73.9	70.2	56.5	896	10,752	78.5
150	12.50	05/05/18	3:39:22 AM	83.3	73.9	70.2	57.1	897	10,764	78.6
151	12.58	05/05/18	3:44:22 AM	83.3	73.9	70.2	57.3	896	10,752	78.6
152	12.67	05/05/18	3:49:22 AM	82.9	74.0	70.2	57.3	896	10,752	78.4
153	12.75	05/05/18	3:54:22 AM	83.3	74.0	70.1	57.2	897	10,764	78.6
154	12.83	05/05/18	3:59:22 AM	83.3	74.0	70.0	56.7	896	10,752	78.7
155	12.92	05/05/18	4:04:22 AM	83.3	74.0	69.9	56.8	897	10,764	78.6
156	13.00	05/05/18	4:09:22 AM	83.4	74.0	69.9	56.8	896	10,752	78.7
157	13.08	05/05/18	4:14:22 AM	83.3	74.0	69.8	56.5	897	10,764	78.6
158	13.17	05/05/18	4:19:22 AM	83.5	74.0	69.7	56.6	896	10,752	78.8
159	13.25	05/05/18	4:24:22 AM	83.6	74.1	69.7	56.7	897	10,764	78.9
160	13.33	05/05/18	4:29:22 AM	83.6	74.1	69.7	56.4	896	10,752	78.9
161	13.42	05/05/18	4:34:22 AM	83.7	74.1	69.6	56.7	897	10,764	78.9
162	13.50	05/05/18	4:39:22 AM	83.5	74.1	69.5	56.5	896	10,752	78.8
163	13.58	05/05/18	4:44:22 AM	83.6	74.1	69.5	56.5	896	10,752	78.9
164	13.67	05/05/18	4:49:22 AM	83.6	74.2	69.4	56.7	897	10,764	78.9
165	13.75	05/05/18	4:54:22 AM	83.6	74.2	69.4	56.4	896	10,752	78.9
166	13.83	05/05/18	4:59:22 AM	83.4	74.2	69.3	56.3	897	10,764	78.8
167	13.92	05/05/18	5:04:22 AM	83.6	74.2	69.2	56.4	896	10,752	78.9
168	14.00	05/05/18	5:09:22 AM	83.8	74.3	69.1	56.5	897	10,764	79.0
169	14.08	05/05/18	5:14:22 AM	83.3	74.3	69.0	56.2	896	10,752	78.8
170	14.17	05/05/18	5:19:22 AM	83.5	74.3	69.0	56.2	897	10,764	78.9
171	14.25	05/05/18	5:24:22 AM	83.7	74.3	68.9	56.0	896	10,752	79.0
172	14.33	05/05/18	5:29:22 AM	83.8	74.3	68.9	56.2	897	10,764	79.0
173	14.42	05/05/18	5:34:22 AM	83.5	74.4	68.8	56.1	897	10,764	78.9
174	14.50	05/05/18	5:39:22 AM	83.4	74.4	68.8	56.3	896	10,752	78.9
175	14.58	05/05/18	5:44:22 AM	83.5	74.4	68.7	56.4	897	10,764	78.9
176	14.67	05/05/18	5:49:22 AM	84.1	74.4	68.7	56.2	897	10,764	79.2
177	14.75	05/05/18	5:54:22 AM	84.1	74.4	68.7	56.2	896	10,752	79.3
178	14.83	05/05/18	5:59:22 AM	83.6	74.4	68.7	56.0	897	10,764	79.0
179	14.92	05/05/18	6:04:22 AM	83.8	74.5	68.6	56.2	897	10,764	79.1
180	15.00	05/05/18	6:09:22 AM	83.9	74.4	68.6	56.3	896	10,752	79.2
181	15.08	05/05/18	6:14:22 AM	83.7	74.5	68.6	56.4	897	10,764	79.1
182	15.17	05/05/18	6:19:22 AM	84.0	74.5	68.6	56.9	897	10,764	79.2
183	15.25	05/05/18	6:24:22 AM	83.8	74.5	68.5	57.2	896	10,752	79.1
184	15.33	05/05/18	6:29:22 AM	83.9	74.5	68.5	57.4	897	10,764	79.2
185	15.42	05/05/18	6:34:22 AM	84.0	74.5	68.5	57.5	897	10,764	79.2
186	15.50	05/05/18	6:39:22 AM	83.8	74.6	68.5	57.5	896	10,752	79.2
187	15.58	05/05/18	6:44:22 AM	83.8	74.6	68.5	57.5	897	10,764	79.2
188	15.67	05/05/18	6:49:22 AM	83.8	74.6	68.5	57.6	896	10,752	79.2

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
189	15.75	05/05/18	6:54:22 AM	83.9	74.6	68.5	57.7	897	10,764	79.3
190	15.83	05/05/18	6:59:22 AM	83.6	74.7	68.6	58.0	896	10,752	79.2
191	15.92	05/05/18	7:04:22 AM	84.0	74.6	68.7	58.3	897	10,764	79.3
192	16.00	05/05/18	7:09:22 AM	84.2	74.6	68.7	58.4	897	10,764	79.4
193	16.08	05/05/18	7:14:22 AM	84.4	74.7	68.8	58.8	896	10,752	79.6
194	16.17	05/05/18	7:19:22 AM	83.9	74.7	68.8	59.2	897	10,764	79.3
195	16.25	05/05/18	7:24:22 AM	84.2	74.7	68.9	59.3	898	10,776	79.4
196	16.33	05/05/18	7:29:22 AM	84.1	74.8	68.9	59.5	897	10,764	79.4
197	16.42	05/05/18	7:34:22 AM	84.3	74.8	69.0	59.8	897	10,764	79.5
198	16.50	05/05/18	7:39:22 AM	83.6	74.8	69.1	60.2	897	10,764	79.2
199	16.58	05/05/18	7:44:22 AM	84.4	74.8	69.3	60.4	897	10,764	79.6
200	16.67	05/05/18	7:49:22 AM	84.4	74.8	69.4	60.7	897	10,764	79.6
201	16.75	05/05/18	7:54:22 AM	83.8	74.8	69.6	61.0	897	10,764	79.3
202	16.83	05/05/18	7:59:22 AM	83.8	74.8	69.7	61.4	897	10,764	79.3
203	16.92	05/05/18	8:04:22 AM	84.3	74.8	70.0	61.7	897	10,764	79.6
204	17.00	05/05/18	8:09:22 AM	84.6	74.9	70.1	62.0	898	10,776	79.8
205	17.08	05/05/18	8:14:22 AM	84.3	74.8	70.3	62.2	897	10,764	79.6
206	17.17	05/05/18	8:19:22 AM	84.1	74.9	70.6	62.7	897	10,764	79.5
207	17.25	05/05/18	8:24:22 AM	84.1	74.9	70.8	62.7	897	10,764	79.5
208	17.33	05/05/18	8:29:22 AM	84.2	74.9	71.1	63.1	897	10,764	79.5
209	17.42	05/05/18	8:34:22 AM	83.8	75.0	71.4	63.7	897	10,764	79.4
210	17.50	05/05/18	8:39:22 AM	84.2	75.0	71.7	64.2	897	10,764	79.6
211	17.58	05/05/18	8:44:22 AM	84.4	75.0	72.0	63.8	897	10,764	79.7
212	17.67	05/05/18	8:49:22 AM	84.6	75.0	72.3	64.0	898	10,776	79.8
213	17.75	05/05/18	8:54:22 AM	84.4	75.0	72.7	65.2	897	10,764	79.7
214	17.83	05/05/18	8:59:22 AM	84.2	75.0	73.1	65.5	897	10,764	79.6
215	17.92	05/05/18	9:04:22 AM	84.3	75.0	73.4	65.7	897	10,764	79.6
216	18.00	05/05/18	9:09:22 AM	84.3	75.0	73.8	66.9	897	10,764	79.7
217	18.08	05/05/18	9:14:22 AM	84.6	75.1	74.4	67.0	897	10,764	79.9
218	18.17	05/05/18	9:19:22 AM	84.4	75.1	74.6	67.3	898	10,776	79.7
219	18.25	05/05/18	9:24:22 AM	84.4	75.1	74.9	67.8	897	10,764	79.7
220	18.33	05/05/18	9:29:22 AM	84.6	75.1	75.5	68.3	897	10,764	79.9
221	18.42	05/05/18	9:34:22 AM	84.7	75.2	75.9	68.6	897	10,764	79.9
222	18.50	05/05/18	9:39:22 AM	84.7	75.2	76.4	69.7	897	10,764	79.9
223	18.58	05/05/18	9:44:22 AM	84.8	75.1	77.0	70.0	897	10,764	79.9
224	18.67	05/05/18	9:49:22 AM	84.2	75.2	77.6	70.2	897	10,764	79.7
225	18.75	05/05/18	9:54:22 AM	84.5	75.2	77.8	70.5	897	10,764	79.8
226	18.83	05/05/18	9:59:22 AM	84.4	75.2	78.1	70.7	897	10,764	79.8
227	18.92	05/05/18	10:04:22 AM	84.2	75.2	78.6	71.0	897	10,764	79.7
228	19.00	05/05/18	10:09:22 AM	84.4	75.2	79.1	71.9	897	10,764	79.8
229	19.08	05/05/18	10:14:22 AM	84.3	75.2	79.4	71.6	896	10,752	79.8
230	19.17	05/05/18	10:19:22 AM	84.6	75.2	80.0	72.5	897	10,764	79.9
231	19.25	05/05/18	10:24:22 AM	84.5	75.3	80.7	73.8	897	10,764	79.9
232	19.33	05/05/18	10:29:22 AM	84.6	75.3	81.5	74.7	897	10,764	80.0
233	19.42	05/05/18	10:34:22 AM	84.6	75.3	82.2	75.3	897	10,764	80.0
234	19.50	05/05/18	10:39:22 AM	84.5	75.3	82.8	75.3	896	10,752	79.9
235	19.58	05/05/18	10:44:22 AM	84.7	75.3	83.3	75.0	897	10,764	80.0
236	19.67	05/05/18	10:49:22 AM	84.8	75.3	83.7	75.1	896	10,752	80.1
237	19.75	05/05/18	10:54:22 AM	85.2	75.4	84.1	75.1	897	10,764	80.3
238	19.83	05/05/18	10:59:22 AM	84.9	75.4	84.3	75.0	896	10,752	80.2
239	19.92	05/05/18	11:04:22 AM	84.8	75.4	84.6	76.3	896	10,752	80.1
240	20.00	05/05/18	11:09:22 AM	84.9	75.4	84.9	76.4	897	10,764	80.2
241	20.08	05/05/18	11:14:22 AM	85.0	75.5	85.4	77.0	896	10,752	80.2
242	20.17	05/05/18	11:19:22 AM	84.8	75.4	86.0	77.4	896	10,752	80.1
243	20.25	05/05/18	11:24:22 AM	84.8	75.4	86.5	78.0	897	10,764	80.1
244	20.33	05/05/18	11:29:22 AM	84.9	75.5	87.1	78.5	896	10,752	80.2
245	20.42	05/05/18	11:34:22 AM	84.5	75.5	87.5	79.0	897	10,764	80.0
246	20.50	05/05/18	11:39:22 AM	85.0	75.5	88.1	79.3	897	10,764	80.3
247	20.58	05/05/18	11:44:22 AM	85.0	75.5	88.6	80.6	897	10,764	80.3
248	20.67	05/05/18	11:49:22 AM	84.9	75.5	89.0	81.5	896	10,752	80.2
249	20.75	05/05/18	11:54:22 AM	84.9	75.5	89.6	80.6	896	10,752	80.2
250	20.83	05/05/18	11:59:22 AM	85.2	75.6	90.3	82.0	897	10,764	80.4
251	20.92	05/05/18	12:04:22 PM	84.7	75.6	90.6	82.0	897	10,764	80.1
252	21.00	05/05/18	12:09:22 PM	84.9	75.6	91.1	83.1	897	10,764	80.2
253	21.08	05/05/18	12:14:22 PM	84.8	75.6	91.6	83.3	898	10,776	80.2
254	21.17	05/05/18	12:19:22 PM	85.2	75.7	92.3	84.3	897	10,764	80.4

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
255	21.25	05/05/18	12:24:22 PM	84.9	75.6	92.7	83.8	899	10,788	80.2
256	21.33	05/05/18	12:29:22 PM	84.8	75.7	93.1	84.3	898	10,776	80.2
257	21.42	05/05/18	12:34:22 PM	84.9	75.7	93.5	84.6	899	10,788	80.3
258	21.50	05/05/18	12:39:22 PM	85.0	75.7	94.1	84.9	898	10,776	80.3
259	21.58	05/05/18	12:44:22 PM	85.3	75.7	94.2	84.6	899	10,788	80.5
260	21.67	05/05/18	12:49:22 PM	85.4	75.7	94.6	84.7	897	10,764	80.6
261	21.75	05/05/18	12:54:22 PM	85.2	75.7	95.1	85.6	898	10,776	80.4
262	21.83	05/05/18	12:59:22 PM	85.0	75.7	95.4	85.0	897	10,764	80.4
263	21.92	05/05/18	1:04:22 PM	85.1	75.7	95.9	87.5	897	10,764	80.4
264	22.00	05/05/18	1:09:22 PM	85.2	75.8	96.5	86.6	897	10,764	80.5
265	22.08	05/05/18	1:14:22 PM	85.1	75.8	96.5	85.9	897	10,764	80.4
266	22.17	05/05/18	1:19:22 PM	85.5	75.8	96.8	86.8	897	10,764	80.7
267	22.25	05/05/18	1:24:22 PM	84.9	75.8	97.2	87.6	897	10,764	80.3
268	22.33	05/05/18	1:29:22 PM	85.2	75.8	97.6	87.2	896	10,752	80.5
269	22.42	05/05/18	1:34:22 PM	85.0	75.9	98.2	88.4	896	10,752	80.4
270	22.50	05/05/18	1:39:22 PM	85.0	75.9	98.8	87.4	896	10,752	80.5
271	22.58	05/05/18	1:44:22 PM	85.4	75.9	98.8	86.6	897	10,764	80.6
272	22.67	05/05/18	1:49:22 PM	85.0	75.9	98.6	86.3	896	10,752	80.4
273	22.75	05/05/18	1:54:22 PM	85.4	75.8	98.7	86.2	897	10,764	80.6
274	22.83	05/05/18	1:59:22 PM	85.3	75.9	98.6	85.5	897	10,764	80.6
275	22.92	05/05/18	2:04:22 PM	85.0	75.9	98.4	84.9	897	10,764	80.5
276	23.00	05/05/18	2:09:22 PM	85.4	75.9	98.0	84.4	897	10,764	80.7
277	23.08	05/05/18	2:14:22 PM	85.4	75.9	97.5	84.3	897	10,764	80.7
278	23.17	05/05/18	2:19:22 PM	85.2	76.0	96.7	83.3	896	10,752	80.6
279	23.25	05/05/18	2:24:22 PM	86.1	75.9	95.2	79.8	897	10,764	81.0
280	23.33	05/05/18	2:29:22 PM	85.4	76.0	94.2	79.3	897	10,764	80.7
281	23.42	05/05/18	2:34:22 PM	85.3	76.0	93.3	78.6	897	10,764	80.6
282	23.50	05/05/18	2:39:22 PM	85.2	76.0	92.9	78.1	897	10,764	80.6
283	23.58	05/05/18	2:44:22 PM	85.7	76.0	92.6	78.4	897	10,764	80.8
284	23.67	05/05/18	2:49:22 PM	85.5	76.0	92.4	79.0	897	10,764	80.7
285	23.75	05/05/18	2:54:22 PM	85.6	76.0	92.5	80.1	897	10,764	80.8
286	23.83	05/05/18	2:59:22 PM	85.5	76.0	92.5	80.0	897	10,764	80.7
287	23.92	05/05/18	3:04:22 PM	85.6	76.1	92.2	79.3	897	10,764	80.8
288	24.00	05/05/18	3:09:22 PM	85.6	76.1	91.8	79.6	897	10,764	80.8
289	24.08	05/05/18	3:14:22 PM	85.3	76.1	91.9	81.8	897	10,764	80.7
290	24.17	05/05/18	3:19:22 PM	85.5	76.1	92.8	84.1	898	10,776	80.8
291	24.25	05/05/18	3:24:22 PM	85.7	76.1	93.7	83.4	897	10,764	80.9
292	24.33	05/05/18	3:29:22 PM	85.4	76.1	94.0	83.3	897	10,764	80.8
293	24.42	05/05/18	3:34:22 PM	85.3	76.1	94.8	84.9	897	10,764	80.7
294	24.50	05/05/18	3:39:22 PM	85.5	76.2	95.7	84.8	897	10,764	80.8
295	24.58	05/05/18	3:44:22 PM	85.2	76.1	95.6	84.2	898	10,776	80.6
296	24.67	05/05/18	3:49:22 PM	85.5	76.2	95.4	84.2	897	10,764	80.8
297	24.75	05/05/18	3:54:22 PM	85.7	76.1	95.2	83.8	897	10,764	80.9
298	24.83	05/05/18	3:59:22 PM	85.5	76.2	95.0	83.3	897	10,764	80.8
299	24.92	05/05/18	4:04:22 PM	85.5	76.2	95.0	83.2	897	10,764	80.8
300	25.00	05/05/18	4:09:22 PM	85.5	76.2	95.6	84.6	897	10,764	80.8
301	25.08	05/05/18	4:14:22 PM	85.7	76.2	96.1	84.3	897	10,764	81.0
302	25.17	05/05/18	4:19:22 PM	85.8	76.2	96.2	84.5	898	10,776	81.0
303	25.25	05/05/18	4:24:22 PM	85.7	76.2	96.2	84.3	897	10,764	81.0
304	25.33	05/05/18	4:29:22 PM	85.5	76.2	96.0	83.9	897	10,764	80.8
305	25.42	05/05/18	4:34:22 PM	85.7	76.2	95.9	83.8	897	10,764	81.0
306	25.50	05/05/18	4:39:22 PM	85.5	76.3	95.9	83.1	898	10,776	80.9
307	25.58	05/05/18	4:44:22 PM	85.6	76.3	95.6	82.2	897	10,764	80.9
308	25.67	05/05/18	4:49:22 PM	85.5	76.3	95.3	81.7	897	10,764	80.9
309	25.75	05/05/18	4:54:22 PM	85.7	76.3	95.0	81.8	898	10,776	81.0
310	25.83	05/05/18	4:59:22 PM	85.8	76.3	94.9	81.8	897	10,764	81.1
311	25.92	05/05/18	5:04:22 PM	85.7	76.3	94.5	82.0	898	10,776	81.0
312	26.00	05/05/18	5:09:22 PM	85.7	76.3	94.1	81.9	897	10,764	81.0
313	26.08	05/05/18	5:14:22 PM	85.6	76.3	93.7	81.9	898	10,776	81.0
314	26.17	05/05/18	5:19:22 PM	85.9	76.3	93.3	80.7	897	10,764	81.1
315	26.25	05/05/18	5:24:22 PM	85.7	76.4	93.1	80.1	898	10,776	81.0
316	26.33	05/05/18	5:29:22 PM	86.1	76.3	92.9	80.1	898	10,776	81.2
317	26.42	05/05/18	5:34:22 PM	85.5	76.4	93.1	80.8	897	10,764	80.9
318	26.50	05/05/18	5:39:22 PM	85.9	76.4	93.5	80.9	898	10,776	81.2
319	26.58	05/05/18	5:44:22 PM	85.7	76.4	93.7	80.7	897	10,764	81.0
320	26.67	05/05/18	5:49:22 PM	85.5	76.4	93.6	80.3	897	10,764	80.9

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Wc (Watts)	Average Loop Temp. Amb (ºF)
321	26.75	05/05/18	5:54:22 PM	85.7	76.4	93.3	79.9	898	10,776	81.1
322	26.83	05/05/18	5:59:22 PM	85.6	76.4	93.1	79.7	897	10,764	81.0
323	26.92	05/05/18	6:04:22 PM	85.6	76.4	92.9	79.9	897	10,764	81.0
324	27.00	05/05/18	6:09:22 PM	86.1	76.4	92.7	79.7	898	10,776	81.3
325	27.08	05/05/18	6:14:22 PM	85.8	76.4	92.5	79.4	897	10,764	81.1
326	27.17	05/05/18	6:19:22 PM	85.5	76.4	92.3	79.8	897	10,764	81.0
327	27.25	05/05/18	6:24:22 PM	86.1	76.5	92.0	79.8	898	10,776	81.3
328	27.33	05/05/18	6:29:22 PM	86.0	76.5	91.7	80.0	897	10,764	81.2
329	27.42	05/05/18	6:34:22 PM	86.0	76.5	91.6	79.6	898	10,776	81.2
330	27.50	05/05/18	6:39:22 PM	85.9	76.5	91.4	79.0	897	10,764	81.2
331	27.58	05/05/18	6:44:22 PM	85.9	76.5	91.2	78.5	898	10,776	81.2
332	27.67	05/05/18	6:49:22 PM	85.5	76.5	91.1	78.5	897	10,764	81.0
333	27.75	05/05/18	6:54:22 PM	85.8	76.5	90.8	78.0	897	10,764	81.1
334	27.83	05/05/18	6:59:22 PM	85.9	76.6	90.5	77.7	898	10,776	81.2
335	27.92	05/05/18	7:04:22 PM	85.9	76.6	90.3	77.7	897	10,764	81.2
336	28.00	05/05/18	7:09:22 PM	86.0	76.6	90.1	77.3	898	10,776	81.3
337	28.08	05/05/18	7:14:22 PM	85.8	76.6	89.9	76.9	897	10,764	81.2
338	28.17	05/05/18	7:19:22 PM	85.6	76.6	89.6	76.8	897	10,764	81.1
339	28.25	05/05/18	7:24:22 PM	85.9	76.6	89.4	76.9	898	10,776	81.2
340	28.33	05/05/18	7:29:22 PM	85.6	76.6	89.1	76.5	897	10,764	81.1
341	28.42	05/05/18	7:34:22 PM	85.9	76.6	88.8	76.7	897	10,764	81.3
342	28.50	05/05/18	7:39:22 PM	85.8	76.6	88.4	76.6	897	10,764	81.2
343	28.58	05/05/18	7:44:22 PM	85.5	76.6	88.2	76.6	897	10,764	81.1
344	28.67	05/05/18	7:49:22 PM	85.8	76.6	87.9	76.5	898	10,776	81.2
345	28.75	05/05/18	7:54:22 PM	86.1	76.6	87.7	76.2	897	10,764	81.4
346	28.83	05/05/18	7:59:22 PM	86.0	76.6	87.6	75.9	897	10,764	81.3
347	28.92	05/05/18	8:04:22 PM	86.0	76.7	87.2	75.7	897	10,764	81.3
348	29.00	05/05/18	8:09:22 PM	86.0	76.6	86.9	76.4	897	10,764	81.3
349	29.08	05/05/18	8:14:22 PM	85.7	76.6	86.7	75.9	897	10,764	81.2
350	29.17	05/05/18	8:19:22 PM	85.7	76.7	86.4	75.0	897	10,764	81.2
351	29.25	05/05/18	8:24:22 PM	85.9	76.7	86.0	74.6	898	10,776	81.3
352	29.33	05/05/18	8:29:22 PM	86.0	76.7	85.6	74.7	897	10,764	81.4
353	29.42	05/05/18	8:34:22 PM	86.2	76.7	85.3	73.9	897	10,764	81.4
354	29.50	05/05/18	8:39:22 PM	86.2	76.7	84.9	73.6	897	10,764	81.5
355	29.58	05/05/18	8:44:22 PM	86.1	76.7	84.8	73.2	897	10,764	81.4
356	29.67	05/05/18	8:49:22 PM	86.1	76.7	84.3	73.3	898	10,776	81.4
357	29.75	05/05/18	8:54:22 PM	85.5	76.7	84.1	72.8	897	10,764	81.1
358	29.83	05/05/18	8:59:22 PM	86.0	76.8	83.8	72.7	897	10,764	81.4
359	29.92	05/05/18	9:04:22 PM	86.2	76.8	83.5	72.2	897	10,764	81.5
360	30.00	05/05/18	9:09:22 PM	86.2	76.7	83.3	72.2	898	10,776	81.4
361	30.08	05/05/18	9:14:22 PM	86.3	76.8	83.2	71.9	897	10,764	81.6
362	30.17	05/05/18	9:19:22 PM	86.5	76.8	83.0	71.8	897	10,764	81.7
363	30.25	05/05/18	9:24:22 PM	86.6	76.8	82.8	71.6	898	10,776	81.7
364	30.33	05/05/18	9:29:22 PM	86.1	76.8	82.7	71.4	897	10,764	81.5
365	30.42	05/05/18	9:34:22 PM	86.0	76.8	82.5	71.1	897	10,764	81.4
366	30.50	05/05/18	9:39:22 PM	86.0	76.8	82.3	70.8	898	10,776	81.4
367	30.58	05/05/18	9:44:22 PM	86.3	76.8	82.1	70.4	898	10,776	81.5
368	30.67	05/05/18	9:49:22 PM	86.2	76.8	81.9	70.1	897	10,764	81.5
369	30.75	05/05/18	9:54:22 PM	86.3	76.8	81.7	69.9	898	10,776	81.6
370	30.83	05/05/18	9:59:22 PM	86.0	76.8	81.5	69.7	897	10,764	81.4
371	30.92	05/05/18	10:04:22 PM	86.0	76.8	81.4	69.4	898	10,776	81.4
372	31.00	05/05/18	10:09:22 PM	86.2	76.9	81.3	69.5	897	10,764	81.5
373	31.08	05/05/18	10:14:22 PM	86.1	76.8	81.2	69.7	898	10,776	81.5
374	31.17	05/05/18	10:19:22 PM	86.2	76.9	81.2	69.9	897	10,764	81.5
375	31.25	05/05/18	10:24:22 PM	86.0	76.9	81.0	69.9	897	10,764	81.5
376	31.33	05/05/18	10:29:22 PM	86.0	76.9	80.9	69.7	898	10,776	81.5
377	31.42	05/05/18	10:34:22 PM	86.0	76.9	80.7	69.7	898	10,776	81.5
378	31.50	05/05/18	10:39:22 PM	86.6	76.9	80.3	69.1	897	10,764	81.7
379	31.58	05/05/18	10:44:22 PM	86.4	76.9	80.2	68.6	898	10,776	81.6
380	31.67	05/05/18	10:49:22 PM	85.7	76.9	80.1	68.2	897	10,764	81.3
381	31.75	05/05/18	10:54:22 PM	86.0	76.9	79.9	68.1	898	10,776	81.5
382	31.83	05/05/18	10:59:22 PM	86.0	76.9	79.8	67.8	897	10,764	81.4
383	31.92	05/05/18	11:04:22 PM	86.3	76.9	79.6	67.5	898	10,776	81.6
384	32.00	05/05/18	11:09:22 PM	86.6	76.9	79.4	67.4	899	10,788	81.7
385	32.08	05/05/18	11:14:22 PM	86.4	76.9	79.3	67.3	898	10,776	81.7
386	32.17	05/05/18	11:19:22 PM	86.4	76.9	79.2	67.2	898	10,776	81.7

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
387	32.25	05/05/18	11:24:22 PM	86.3	77.0	79.1	67.2	898	10,776	81.6
388	32.33	05/05/18	11:29:22 PM	86.3	77.0	79.0	67.0	899	10,788	81.6
389	32.42	05/05/18	11:34:22 PM	86.8	77.0	78.9	66.7	898	10,776	81.9
390	32.50	05/05/18	11:39:22 PM	86.3	77.0	78.8	66.7	899	10,788	81.6
391	32.58	05/05/18	11:44:22 PM	86.0	77.0	78.6	66.6	898	10,776	81.5
392	32.67	05/05/18	11:49:22 PM	86.7	77.0	78.5	66.5	899	10,788	81.8
393	32.75	05/05/18	11:54:22 PM	86.5	77.0	78.4	66.4	899	10,788	81.8
394	32.83	05/05/18	11:59:22 PM	85.9	77.0	78.2	66.6	899	10,788	81.5
395	32.92	05/06/18	12:04:22 AM	86.1	77.0	78.0	66.9	898	10,776	81.6
396	33.00	05/06/18	12:09:22 AM	86.7	77.0	78.0	67.0	899	10,788	81.9
397	33.08	05/06/18	12:14:22 AM	86.1	77.0	77.9	67.2	899	10,788	81.6
398	33.17	05/06/18	12:19:22 AM	86.4	77.0	77.8	67.4	899	10,788	81.7
399	33.25	05/06/18	12:24:22 AM	86.3	77.0	77.8	67.2	899	10,788	81.7
400	33.33	05/06/18	12:29:22 AM	86.6	77.0	77.7	67.2	899	10,788	81.8
401	33.42	05/06/18	12:34:22 AM	86.3	77.0	77.6	67.2	899	10,788	81.6
402	33.50	05/06/18	12:39:22 AM	86.6	77.0	77.6	67.3	898	10,776	81.8
403	33.58	05/06/18	12:44:22 AM	86.2	77.1	77.5	66.9	899	10,788	81.6
404	33.67	05/06/18	12:49:22 AM	86.1	77.1	77.5	66.6	899	10,788	81.6
405	33.75	05/06/18	12:54:22 AM	86.5	77.1	77.4	66.7	899	10,788	81.8
406	33.83	05/06/18	12:59:22 AM	86.6	77.1	77.4	66.5	899	10,788	81.9
407	33.92	05/06/18	1:04:22 AM	86.4	77.1	77.3	66.2	899	10,788	81.8
408	34.00	05/06/18	1:09:22 AM	86.9	77.1	77.1	65.9	899	10,788	82.0
409	34.08	05/06/18	1:14:22 AM	86.4	77.2	77.0	65.0	899	10,788	81.8
410	34.17	05/06/18	1:19:22 AM	86.8	77.1	77.0	65.1	899	10,788	81.9
411	34.25	05/06/18	1:24:22 AM	86.3	77.1	76.9	65.6	899	10,788	81.7
412	34.33	05/06/18	1:29:22 AM	87.1	77.1	76.8	64.8	899	10,788	82.1
413	34.42	05/06/18	1:34:22 AM	86.3	77.2	76.8	65.1	899	10,788	81.8
414	34.50	05/06/18	1:39:22 AM	86.4	77.1	76.8	65.2	899	10,788	81.8
415	34.58	05/06/18	1:44:22 AM	86.2	77.2	76.7	64.6	899	10,788	81.7
416	34.67	05/06/18	1:49:22 AM	86.2	77.2	76.6	63.6	899	10,788	81.7
417	34.75	05/06/18	1:54:22 AM	86.6	77.1	76.5	63.3	900	10,800	81.9
418	34.83	05/06/18	1:59:22 AM	86.7	77.2	76.4	63.4	899	10,788	82.0
419	34.92	05/06/18	2:04:22 AM	86.7	77.2	76.3	63.4	899	10,788	81.9
420	35.00	05/06/18	2:09:22 AM	86.4	77.3	76.2	62.9	900	10,800	81.8
421	35.08	05/06/18	2:14:22 AM	86.6	77.3	76.1	62.9	899	10,788	81.9
422	35.17	05/06/18	2:19:22 AM	86.9	77.2	76.1	63.6	899	10,788	82.1
423	35.25	05/06/18	2:24:22 AM	86.6	77.2	76.0	63.6	900	10,800	81.9
424	35.33	05/06/18	2:29:22 AM	86.3	77.2	76.0	63.4	899	10,788	81.8
425	35.42	05/06/18	2:34:22 AM	86.8	77.3	76.0	63.5	900	10,800	82.0
426	35.50	05/06/18	2:39:22 AM	86.7	77.3	75.9	62.6	899	10,788	82.0
427	35.58	05/06/18	2:44:22 AM	86.5	77.3	75.7	62.5	899	10,788	81.9
428	35.67	05/06/18	2:49:22 AM	86.7	77.3	75.7	63.0	899	10,788	82.0
429	35.75	05/06/18	2:54:22 AM	86.8	77.3	75.6	63.3	900	10,800	82.0
430	35.83	05/06/18	2:59:22 AM	86.7	77.3	75.6	62.7	899	10,788	82.0
431	35.92	05/06/18	3:04:22 AM	86.5	77.3	75.5	62.2	899	10,788	81.9
432	36.00	05/06/18	3:09:22 AM	86.6	77.3	75.2	61.9	899	10,788	81.9
433	36.08	05/06/18	3:14:22 AM	86.6	77.3	75.1	61.9	899	10,788	81.9
434	36.17	05/06/18	3:19:22 AM	86.6	77.3	75.0	61.7	899	10,788	81.9
435	36.25	05/06/18	3:24:22 AM	86.5	77.3	74.9	61.4	899	10,788	81.9
436	36.33	05/06/18	3:29:22 AM	86.9	77.3	74.8	60.8	898	10,776	82.1
437	36.42	05/06/18	3:34:22 AM	86.4	77.3	74.7	60.9	899	10,788	81.9
438	36.50	05/06/18	3:39:22 AM	86.4	77.4	74.6	60.7	899	10,788	81.9
439	36.58	05/06/18	3:44:22 AM	86.6	77.4	74.5	60.6	899	10,788	82.0
440	36.67	05/06/18	3:49:22 AM	86.5	77.4	74.4	60.6	898	10,776	81.9
441	36.75	05/06/18	3:54:22 AM	86.8	77.3	74.3	60.6	899	10,788	82.1
442	36.83	05/06/18	3:59:22 AM	86.9	77.4	74.3	60.8	900	10,800	82.1
443	36.92	05/06/18	4:04:22 AM	86.6	77.3	74.2	60.8	899	10,788	81.9
444	37.00	05/06/18	4:09:22 AM	86.6	77.4	74.2	60.6	900	10,800	82.0
445	37.08	05/06/18	4:14:22 AM	86.8	77.4	74.1	60.6	899	10,788	82.1
446	37.17	05/06/18	4:19:22 AM	86.9	77.4	74.0	60.4	899	10,788	82.1
447	37.25	05/06/18	4:24:22 AM	86.7	77.4	73.9	60.3	900	10,800	82.1
448	37.33	05/06/18	4:29:22 AM	86.6	77.4	73.7	59.9	899	10,788	82.0
449	37.42	05/06/18	4:34:22 AM	86.6	77.4	73.7	59.8	899	10,788	82.0
450	37.50	05/06/18	4:39:22 AM	86.5	77.4	73.5	59.8	900	10,800	81.9
451	37.58	05/06/18	4:44:22 AM	86.3	77.4	73.5	59.8	899	10,788	81.8
452	37.67	05/06/18	4:49:22 AM	86.9	77.5	73.3	59.7	900	10,800	82.2

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
453	37.75	05/06/18	4:54:22 AM	87.0	77.4	73.2	59.3	899	10,788	82.2
454	37.83	05/06/18	4:59:22 AM	86.8	77.4	73.1	59.7	900	10,800	82.1
455	37.92	05/06/18	5:04:22 AM	86.8	77.5	73.1	59.5	900	10,800	82.1
456	38.00	05/06/18	5:09:22 AM	87.0	77.5	73.0	59.5	900	10,800	82.2
457	38.08	05/06/18	5:14:22 AM	87.1	77.5	73.0	59.6	900	10,800	82.3
458	38.17	05/06/18	5:19:22 AM	86.9	77.4	72.9	59.6	899	10,788	82.2
459	38.25	05/06/18	5:24:22 AM	87.2	77.5	72.9	59.6	900	10,800	82.3
460	38.33	05/06/18	5:29:22 AM	87.2	77.5	72.8	59.5	900	10,800	82.4
461	38.42	05/06/18	5:34:22 AM	86.6	77.5	72.6	58.8	899	10,788	82.1
462	38.50	05/06/18	5:39:22 AM	86.9	77.5	72.5	58.9	900	10,800	82.2
463	38.58	05/06/18	5:44:22 AM	86.8	77.5	72.4	58.7	900	10,800	82.2
464	38.67	05/06/18	5:49:22 AM	86.9	77.5	72.3	58.4	899	10,788	82.2
465	38.75	05/06/18	5:54:22 AM	86.7	77.5	72.2	58.0	900	10,800	82.1
466	38.83	05/06/18	5:59:22 AM	86.9	77.5	72.0	58.1	900	10,800	82.2
467	38.92	05/06/18	6:04:22 AM	86.9	77.5	71.8	58.0	899	10,788	82.2
468	39.00	05/06/18	6:09:22 AM	87.3	77.5	71.8	58.0	899	10,788	82.4
469	39.08	05/06/18	6:14:22 AM	87.0	77.5	71.7	57.8	900	10,800	82.3
470	39.17	05/06/18	6:19:22 AM	86.8	77.5	71.5	57.2	899	10,788	82.2
471	39.25	05/06/18	6:24:22 AM	86.3	77.5	71.4	57.5	900	10,800	81.9
472	39.33	05/06/18	6:29:22 AM	86.8	77.6	71.4	57.8	899	10,788	82.2
473	39.42	05/06/18	6:34:22 AM	86.9	77.5	71.4	57.5	900	10,800	82.2
474	39.50	05/06/18	6:39:22 AM	87.3	77.5	71.3	57.5	900	10,800	82.4
475	39.58	05/06/18	6:44:22 AM	87.0	77.6	71.2	57.5	899	10,788	82.3
476	39.67	05/06/18	6:49:22 AM	86.7	77.6	71.2	57.6	899	10,788	82.2
477	39.75	05/06/18	6:54:22 AM	86.8	77.6	71.2	58.0	900	10,800	82.2
478	39.83	05/06/18	6:59:22 AM	86.9	77.5	71.2	58.3	899	10,788	82.2
479	39.92	05/06/18	7:04:22 AM	86.9	77.6	71.2	58.4	899	10,788	82.3
480	40.00	05/06/18	7:09:22 AM	87.0	77.6	71.2	58.4	899	10,788	82.3
481	40.08	05/06/18	7:14:22 AM	87.2	77.6	71.2	58.8	900	10,800	82.4
482	40.17	05/06/18	7:19:22 AM	87.0	77.6	71.2	58.9	899	10,788	82.3
483	40.25	05/06/18	7:24:22 AM	87.2	77.7	71.2	59.0	900	10,800	82.4
484	40.33	05/06/18	7:29:22 AM	87.4	77.6	71.3	59.4	899	10,788	82.5
485	40.42	05/06/18	7:34:22 AM	87.0	77.6	71.4	59.4	899	10,788	82.3
486	40.50	05/06/18	7:39:22 AM	86.8	77.7	71.5	59.9	900	10,800	82.2
487	40.58	05/06/18	7:44:22 AM	86.9	77.6	71.7	60.1	899	10,788	82.3
488	40.67	05/06/18	7:49:22 AM	86.9	77.6	71.8	60.4	900	10,800	82.3
489	40.75	05/06/18	7:54:22 AM	86.9	77.6	72.0	60.9	899	10,788	82.3
490	40.83	05/06/18	7:59:22 AM	86.8	77.6	72.2	61.4	900	10,800	82.2
491	40.92	05/06/18	8:04:22 AM	87.0	77.7	72.4	62.0	900	10,800	82.3
492	41.00	05/06/18	8:09:22 AM	87.1	77.7	72.6	62.5	900	10,800	82.4
493	41.08	05/06/18	8:14:22 AM	87.2	77.7	72.9	63.2	900	10,800	82.5
494	41.17	05/06/18	8:19:22 AM	86.9	77.7	73.2	63.9	900	10,800	82.3
495	41.25	05/06/18	8:24:22 AM	87.1	77.7	73.5	64.2	901	10,812	82.4
496	41.33	05/06/18	8:29:22 AM	86.7	77.7	73.9	64.3	900	10,800	82.2
497	41.42	05/06/18	8:34:22 AM	87.0	77.7	74.2	64.7	900	10,800	82.4
498	41.50	05/06/18	8:39:22 AM	87.2	77.7	74.7	65.2	900	10,800	82.4
499	41.58	05/06/18	8:44:22 AM	87.4	77.7	75.2	65.7	901	10,812	82.6
500	41.67	05/06/18	8:49:22 AM	87.2	77.7	75.7	66.3	900	10,800	82.4
501	41.75	05/06/18	8:54:22 AM	87.2	77.8	76.2	66.8	900	10,800	82.5
502	41.83	05/06/18	8:59:22 AM	86.8	77.7	76.6	67.2	900	10,800	82.3
503	41.92	05/06/18	9:04:22 AM	86.8	77.8	77.1	67.6	900	10,800	82.3
504	42.00	05/06/18	9:09:22 AM	87.5	77.7	77.7	68.4	901	10,812	82.6
505	42.08	05/06/18	9:14:22 AM	86.9	77.8	78.2	68.9	900	10,800	82.4
506	42.17	05/06/18	9:19:22 AM	87.3	77.8	78.6	69.8	900	10,800	82.6
507	42.25	05/06/18	9:24:22 AM	87.5	77.7	79.2	70.5	901	10,812	82.6
508	42.33	05/06/18	9:29:22 AM	87.0	77.8	79.6	71.1	900	10,800	82.4
509	42.42	05/06/18	9:34:22 AM	87.2	77.8	80.1	71.9	900	10,800	82.5
510	42.50	05/06/18	9:39:22 AM	86.9	77.8	80.7	72.6	901	10,812	82.3
511	42.58	05/06/18	9:44:22 AM	87.5	77.8	81.2	73.5	900	10,800	82.6
512	42.67	05/06/18	9:49:22 AM	87.4	77.9	81.7	73.8	901	10,812	82.6
513	42.75	05/06/18	9:54:22 AM	87.4	77.9	82.3	74.1	900	10,800	82.6
514	42.83	05/06/18	9:59:22 AM	87.3	77.9	82.7	74.4	901	10,812	82.6
515	42.92	05/06/18	10:04:22 AM	87.3	77.9	83.0	74.7	901	10,812	82.6
516	43.00	05/06/18	10:09:22 AM	87.2	77.9	83.4	75.2	900	10,800	82.5
517	43.08	05/06/18	10:14:22 AM	87.5	77.9	83.8	75.6	901	10,812	82.7
518	43.17	05/06/18	10:19:22 AM	87.2	77.9	84.3	76.1	900	10,800	82.6

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
519	43.25	05/06/18	10:24:22 AM	87.3	77.9	84.8	76.2	901	10,812	82.6
520	43.33	05/06/18	10:29:22 AM	86.9	77.9	85.3	76.4	901	10,812	82.4
521	43.42	05/06/18	10:34:22 AM	87.3	77.9	85.7	76.6	901	10,812	82.6
522	43.50	05/06/18	10:39:22 AM	87.1	78.0	86.2	76.8	901	10,812	82.5
523	43.58	05/06/18	10:44:22 AM	87.3	77.9	86.6	77.3	900	10,800	82.6
524	43.67	05/06/18	10:49:22 AM	87.2	78.0	87.0	77.7	901	10,812	82.6
525	43.75	05/06/18	10:54:22 AM	87.5	78.0	87.4	78.0	901	10,812	82.7
526	43.83	05/06/18	10:59:22 AM	87.3	77.9	87.8	78.1	900	10,800	82.6
527	43.92	05/06/18	11:04:22 AM	87.5	78.0	88.3	78.4	901	10,812	82.7
528	44.00	05/06/18	11:09:22 AM	87.6	78.0	88.7	78.4	901	10,812	82.8
529	44.08	05/06/18	11:14:22 AM	87.3	78.0	89.1	79.0	900	10,800	82.6
530	44.17	05/06/18	11:19:22 AM	87.2	78.0	89.4	78.9	901	10,812	82.6
531	44.25	05/06/18	11:24:22 AM	86.8	78.0	89.6	79.5	900	10,800	82.4
532	44.33	05/06/18	11:29:22 AM	87.4	78.0	90.0	80.1	901	10,812	82.7
533	44.42	05/06/18	11:34:22 AM	87.5	78.0	90.4	80.0	900	10,800	82.7
534	44.50	05/06/18	11:39:22 AM	87.7	78.0	90.7	80.7	900	10,800	82.9
535	44.58	05/06/18	11:44:22 AM	87.6	78.0	91.0	81.3	901	10,812	82.8
536	44.67	05/06/18	11:49:22 AM	87.2	78.0	91.5	81.3	900	10,800	82.6
537	44.75	05/06/18	11:54:22 AM	87.1	78.0	92.0	81.3	900	10,800	82.6
538	44.83	05/06/18	11:59:22 AM	87.4	78.0	92.6	81.6	901	10,812	82.7
539	44.92	05/06/18	12:04:22 PM	87.5	78.0	92.9	81.8	900	10,800	82.7
540	45.00	05/06/18	12:09:22 PM	87.5	78.1	93.2	82.1	900	10,800	82.8
541	45.08	05/06/18	12:14:22 PM	87.6	78.0	93.6	82.5	900	10,800	82.8
542	45.17	05/06/18	12:19:22 PM	87.7	78.1	94.0	83.9	900	10,800	82.9
543	45.25	05/06/18	12:24:22 PM	86.9	78.1	94.4	83.6	899	10,788	82.5
544	45.33	05/06/18	12:29:22 PM	88.0	78.0	94.8	83.4	899	10,788	83.0
545	45.42	05/06/18	12:34:22 PM	87.5	78.1	95.1	83.7	900	10,800	82.8
546	45.50	05/06/18	12:39:22 PM	87.3	78.1	95.3	83.8	899	10,788	82.7
547	45.58	05/06/18	12:44:22 PM	87.7	78.1	95.7	84.5	900	10,800	82.9
548	45.67	05/06/18	12:49:22 PM	87.6	78.1	96.0	84.6	899	10,788	82.8
549	45.75	05/06/18	12:54:22 PM	87.5	78.1	96.4	84.6	899	10,788	82.8
550	45.83	05/06/18	12:59:22 PM	87.6	78.1	96.6	84.0	900	10,800	82.8
551	45.92	05/06/18	1:04:22 PM	87.3	78.1	96.6	84.0	899	10,788	82.7
552	46.00	05/06/18	1:09:22 PM	87.5	78.1	96.7	83.1	900	10,800	82.8
553	46.08	05/06/18	1:14:22 PM	87.2	78.1	96.4	83.9	899	10,788	82.7
554	46.17	05/06/18	1:19:22 PM	87.6	78.2	96.5	84.7	899	10,788	82.9
555	46.25	05/06/18	1:24:22 PM	87.5	78.1	96.7	85.2	899	10,788	82.8
556	46.33	05/06/18	1:29:22 PM	87.4	78.2	96.9	85.2	900	10,800	82.8
557	46.42	05/06/18	1:34:22 PM	87.6	78.2	97.0	86.0	899	10,788	82.9
558	46.50	05/06/18	1:39:22 PM	87.7	78.2	97.5	86.1	900	10,800	82.9
559	46.58	05/06/18	1:44:22 PM	87.9	78.2	97.9	86.1	899	10,788	83.1
560	46.67	05/06/18	1:49:22 PM	87.8	78.2	98.3	86.4	900	10,800	83.0
561	46.75	05/06/18	1:54:22 PM	87.7	78.2	98.9	85.7	899	10,788	82.9
562	46.83	05/06/18	1:59:22 PM	87.9	78.2	99.6	86.3	899	10,788	83.0
563	46.92	05/06/18	2:04:22 PM	87.5	78.2	100.0	86.9	900	10,800	82.8
564	47.00	05/06/18	2:09:22 PM	87.7	78.2	100.4	87.3	899	10,788	82.9
565	47.08	05/06/18	2:14:22 PM	87.5	78.2	100.9	87.7	899	10,788	82.9
566	47.17	05/06/18	2:19:22 PM	87.3	78.2	101.4	87.6	899	10,788	82.8
567	47.25	05/06/18	2:24:22 PM	87.5	78.2	101.7	88.0	898	10,776	82.8
568	47.33	05/06/18	2:29:22 PM	87.6	78.2	102.1	88.0	899	10,788	82.9
569	47.42	05/06/18	2:34:22 PM	87.7	78.2	102.7	87.5	899	10,788	83.0
570	47.50	05/06/18	2:39:22 PM	87.5	78.3	103.0	88.3	898	10,776	82.9
571	47.58	05/06/18	2:44:22 PM	87.7	78.3	103.4	88.2	899	10,788	83.0
572	47.67	05/06/18	2:49:22 PM	87.6	78.2	103.6	88.1	898	10,776	82.9
573	47.75	05/06/18	2:54:22 PM	87.6	78.3	103.8	88.2	898	10,776	82.9
574	47.83	05/06/18	2:59:22 PM	87.8	78.3	104.1	87.8	898	10,776	83.1
575	47.92	05/06/18	3:04:22 PM	87.4	78.3	104.1	87.9	898	10,776	82.8
576	48.00	05/06/18	3:09:22 PM	87.7	78.3	103.8	87.5	898	10,776	83.0
577	48.08	05/06/18	3:14:22 PM	87.8	78.3	103.9	88.4	898	10,776	83.0
578	48.17	05/06/18	3:19:22 PM	87.8	78.3	104.5	88.6	898	10,776	83.1
579	48.25	05/06/18	3:24:22 PM	88.1	78.3	104.7	88.7	899	10,788	83.2
580	48.33	05/06/18	3:29:22 PM	87.5	78.3	105.1	88.1	898	10,776	82.9
581	48.42	05/06/18	3:34:22 PM	87.9	78.3	104.9	89.6	898	10,776	83.1
582	48.50	05/06/18	3:39:22 PM	87.6	78.3	104.7	87.7	898	10,776	83.0
583	48.58	05/06/18	3:44:22 PM	87.7	78.3	104.9	89.1	898	10,776	83.0
584	48.67	05/06/18	3:49:22 PM	88.1	78.3	105.5	88.2	898	10,776	83.2

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
585	48.75	05/06/18	3:54:22 PM	88.1	78.3	105.6	89.0	898	10,776	83.2
586	48.83	05/06/18	3:59:22 PM	87.9	78.4	105.4	89.3	898	10,776	83.1
587	48.92	05/06/18	4:04:22 PM	87.7	78.4	105.1	87.1	899	10,788	83.1
588	49.00	05/06/18	4:09:22 PM	88.0	78.4	104.7	88.5	898	10,776	83.2
589	49.08	05/06/18	4:14:22 PM	88.0	78.3	105.3	88.7	898	10,776	83.2
590	49.17	05/06/18	4:19:22 PM	87.6	78.4	105.4	88.3	898	10,776	83.0
591	49.25	05/06/18	4:24:22 PM	88.1	78.4	105.2	89.7	898	10,776	83.2
592	49.33	05/06/18	4:29:22 PM	87.9	78.4	105.2	86.9	899	10,788	83.1
593	49.42	05/06/18	4:34:22 PM	87.5	78.4	104.4	87.9	898	10,776	82.9
594	49.50	05/06/18	4:39:22 PM	87.7	78.4	103.6	85.8	898	10,776	83.0
595	49.58	05/06/18	4:44:22 PM	87.6	78.4	102.6	85.7	898	10,776	83.0
596	49.67	05/06/18	4:49:22 PM	87.8	78.4	101.9	85.9	899	10,788	83.1
597	49.75	05/06/18	4:54:22 PM	87.7	78.4	101.6	86.9	898	10,776	83.0
598	49.83	05/06/18	4:59:22 PM	88.1	78.4	101.7	86.6	898	10,776	83.3
599	49.92	05/06/18	5:04:22 PM	88.0	78.4	102.0	86.7	898	10,776	83.2
600	50.00	05/06/18	5:09:22 PM	88.2	78.4	102.2	87.4	898	10,776	83.3
601	50.08	05/06/18	5:14:22 PM	87.8	78.4	102.0	87.1	898	10,776	83.1
602	50.17	05/06/18	5:19:22 PM	87.9	78.4	102.1	87.4	898	10,776	83.2
603	50.25	05/06/18	5:24:22 PM	87.9	78.4	102.1	86.8	898	10,776	83.2
604	50.33	05/06/18	5:29:22 PM	87.8	78.4	102.3	87.2	898	10,776	83.1
605	50.42	05/06/18	5:34:22 PM	87.8	78.4	102.0	86.7	899	10,788	83.1
606	50.50	05/06/18	5:39:22 PM	87.9	78.4	101.8	87.0	898	10,776	83.2
607	50.58	05/06/18	5:44:22 PM	87.7	78.5	102.1	86.8	898	10,776	83.1
608	50.67	05/06/18	5:49:22 PM	87.9	78.4	102.5	87.2	898	10,776	83.2
609	50.75	05/06/18	5:54:22 PM	88.2	78.5	102.1	86.4	898	10,776	83.3
610	50.83	05/06/18	5:59:22 PM	87.9	78.5	101.7	86.5	898	10,776	83.2
611	50.92	05/06/18	6:04:22 PM	87.9	78.4	101.4	86.1	898	10,776	83.2
612	51.00	05/06/18	6:09:22 PM	87.7	78.4	100.9	85.3	899	10,788	83.1
613	51.08	05/06/18	6:14:22 PM	87.8	78.5	100.8	85.5	898	10,776	83.2
614	51.17	05/06/18	6:19:22 PM	87.8	78.4	100.6	84.9	898	10,776	83.1
615	51.25	05/06/18	6:24:22 PM	87.7	78.5	100.5	84.7	898	10,776	83.1
616	51.33	05/06/18	6:29:22 PM	87.7	78.5	100.3	84.3	898	10,776	83.1
617	51.42	05/06/18	6:34:22 PM	87.9	78.5	99.7	83.8	899	10,788	83.2
618	51.50	05/06/18	6:39:22 PM	87.8	78.5	99.6	83.7	898	10,776	83.2
619	51.58	05/06/18	6:44:22 PM	87.9	78.5	98.9	83.6	898	10,776	83.2
620	51.67	05/06/18	6:49:22 PM	87.6	78.5	98.6	83.1	898	10,776	83.1
621	51.75	05/06/18	6:54:22 PM	88.0	78.5	97.9	82.6	899	10,788	83.3
622	51.83	05/06/18	6:59:22 PM	87.8	78.5	97.3	82.2	897	10,764	83.2
623	51.92	05/06/18	7:04:22 PM	87.9	78.5	97.0	82.0	899	10,788	83.2
624	52.00	05/06/18	7:09:22 PM	88.2	78.5	96.5	81.9	898	10,776	83.4
625	52.08	05/06/18	7:14:22 PM	88.0	78.5	96.0	81.5	898	10,776	83.2
626	52.17	05/06/18	7:19:22 PM	87.8	78.6	95.6	80.9	898	10,776	83.2
627	52.25	05/06/18	7:24:22 PM	88.1	78.6	95.2	80.7	898	10,776	83.3
628	52.33	05/06/18	7:29:22 PM	87.9	78.6	94.7	80.8	899	10,788	83.2
629	52.42	05/06/18	7:34:22 PM	87.7	78.5	94.5	80.3	898	10,776	83.1
630	52.50	05/06/18	7:39:22 PM	88.4	78.6	93.9	80.2	898	10,776	83.5
631	52.58	05/06/18	7:44:22 PM	87.7	78.5	93.5	80.2	898	10,776	83.1
632	52.67	05/06/18	7:49:22 PM	88.1	78.5	93.2	79.8	898	10,776	83.3
633	52.75	05/06/18	7:54:22 PM	88.5	78.6	92.8	79.6	898	10,776	83.5
634	52.83	05/06/18	7:59:22 PM	87.7	78.6	92.5	79.3	898	10,776	83.1
635	52.92	05/06/18	8:04:22 PM	87.8	78.6	92.1	78.9	898	10,776	83.2
636	53.00	05/06/18	8:09:22 PM	87.8	78.6	91.8	78.8	898	10,776	83.2
637	53.08	05/06/18	8:14:22 PM	87.9	78.6	91.4	78.5	899	10,788	83.3
638	53.17	05/06/18	8:19:22 PM	88.1	78.6	91.1	78.1	898	10,776	83.3
639	53.25	05/06/18	8:24:22 PM	88.0	78.6	90.7	77.9	898	10,776	83.3
640	53.33	05/06/18	8:29:22 PM	88.1	78.6	90.4	77.7	898	10,776	83.3
641	53.42	05/06/18	8:34:22 PM	88.4	78.6	90.2	77.3	898	10,776	83.5
642	53.50	05/06/18	8:39:22 PM	87.6	78.6	89.8	77.0	898	10,776	83.1
643	53.58	05/06/18	8:44:22 PM	88.0	78.6	89.4	76.7	898	10,776	83.3
644	53.67	05/06/18	8:49:22 PM	87.7	78.7	89.1	76.5	899	10,788	83.2
645	53.75	05/06/18	8:54:22 PM	88.4	78.6	88.8	76.2	898	10,776	83.5
646	53.83	05/06/18	8:59:22 PM	87.7	78.6	88.5	76.0	897	10,764	83.1
647	53.92	05/06/18	9:04:22 PM	87.8	78.6	88.3	75.8	898	10,776	83.2
648	54.00	05/06/18	9:09:22 PM	88.0	78.6	88.0	75.7	899	10,788	83.3
649	54.08	05/06/18	9:14:22 PM	88.2	78.6	87.7	75.5	898	10,776	83.4
650	54.17	05/06/18	9:19:22 PM	88.0	78.6	87.4	75.3	898	10,776	83.3

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
651	54.25	05/06/18	9:24:22 PM	87.7	78.6	87.2	75.1	898	10,776	83.2
652	54.33	05/06/18	9:29:22 PM	88.0	78.6	86.9	74.8	898	10,776	83.3
653	54.42	05/06/18	9:34:22 PM	87.9	78.6	86.8	74.6	899	10,788	83.3
654	54.50	05/06/18	9:39:22 PM	88.1	78.7	86.6	74.3	898	10,776	83.4
655	54.58	05/06/18	9:44:22 PM	87.8	78.6	86.4	74.2	898	10,776	83.2
656	54.67	05/06/18	9:49:22 PM	88.0	78.7	86.2	74.0	899	10,788	83.3
657	54.75	05/06/18	9:54:22 PM	88.2	78.6	86.0	73.6	898	10,776	83.4
658	54.83	05/06/18	9:59:22 PM	87.9	78.7	85.9	73.3	898	10,776	83.3
659	54.92	05/06/18	10:04:22 PM	88.1	78.7	85.7	73.3	898	10,776	83.4
660	55.00	05/06/18	10:09:22 PM	88.1	78.6	85.5	72.9	899	10,788	83.4
661	55.08	05/06/18	10:14:22 PM	88.1	78.7	85.3	72.7	898	10,776	83.4
662	55.17	05/06/18	10:19:22 PM	87.7	78.7	85.1	72.6	899	10,788	83.2
663	55.25	05/06/18	10:24:22 PM	87.8	78.7	84.9	72.3	898	10,776	83.3
664	55.33	05/06/18	10:29:22 PM	88.1	78.7	84.7	72.3	899	10,788	83.4
665	55.42	05/06/18	10:34:22 PM	88.9	78.7	84.5	72.0	898	10,776	83.8
666	55.50	05/06/18	10:39:22 PM	88.4	78.7	84.4	71.8	899	10,788	83.5
667	55.58	05/06/18	10:44:22 PM	88.3	78.7	84.2	71.8	899	10,788	83.5
668	55.67	05/06/18	10:49:22 PM	88.2	78.7	84.0	71.5	898	10,776	83.4
669	55.75	05/06/18	10:54:22 PM	87.6	78.7	83.8	71.4	899	10,788	83.1
670	55.83	05/06/18	10:59:22 PM	88.0	78.7	83.6	71.0	899	10,788	83.3
671	55.92	05/06/18	11:04:22 PM	88.3	78.7	83.4	70.9	898	10,776	83.5
672	56.00	05/06/18	11:09:22 PM	88.1	78.7	83.3	70.7	899	10,788	83.4
673	56.08	05/06/18	11:14:22 PM	88.1	78.7	83.1	70.5	899	10,788	83.4
674	56.17	05/06/18	11:19:22 PM	87.8	78.7	82.9	70.4	899	10,788	83.3
675	56.25	05/06/18	11:24:22 PM	88.1	78.7	82.8	70.1	899	10,788	83.4
676	56.33	05/06/18	11:29:22 PM	88.2	78.7	82.6	70.1	899	10,788	83.5
677	56.42	05/06/18	11:34:22 PM	88.0	78.7	82.4	69.7	899	10,788	83.3
678	56.50	05/06/18	11:39:22 PM	87.6	78.7	82.3	69.8	899	10,788	83.2
679	56.58	05/06/18	11:44:22 PM	88.6	78.8	82.0	69.7	899	10,788	83.7
680	56.67	05/06/18	11:49:22 PM	88.3	78.8	81.9	69.6	900	10,800	83.5
681	56.75	05/06/18	11:54:22 PM	87.9	78.8	81.7	69.6	899	10,788	83.3
682	56.83	05/06/18	11:59:22 PM	88.6	78.8	81.6	69.3	899	10,788	83.7
683	56.92	05/07/18	12:04:22 AM	87.8	78.8	81.4	69.2	900	10,800	83.3
684	57.00	05/07/18	12:09:22 AM	88.3	78.8	81.3	68.9	899	10,788	83.5
685	57.08	05/07/18	12:14:22 AM	88.3	78.8	81.1	68.9	899	10,788	83.5
686	57.17	05/07/18	12:19:22 AM	87.8	78.8	80.9	68.8	899	10,788	83.3
687	57.25	05/07/18	12:24:22 AM	88.4	78.8	80.7	68.6	900	10,800	83.6
688	57.33	05/07/18	12:29:22 AM	88.3	78.8	80.6	68.4	899	10,788	83.6
689	57.42	05/07/18	12:34:22 AM	88.1	78.8	80.4	68.4	899	10,788	83.5
690	57.50	05/07/18	12:39:22 AM	88.2	78.8	80.3	68.0	900	10,800	83.5
691	57.58	05/07/18	12:44:22 AM	87.9	78.8	80.2	67.8	899	10,788	83.4
692	57.67	05/07/18	12:49:22 AM	88.4	78.8	80.0	67.8	899	10,788	83.6
693	57.75	05/07/18	12:54:22 AM	88.2	78.8	79.8	67.5	900	10,800	83.5
694	57.83	05/07/18	12:59:22 AM	88.2	78.8	79.7	67.4	899	10,788	83.5
695	57.92	05/07/18	1:04:22 AM	88.1	78.8	79.6	67.1	900	10,800	83.4
696	58.00	05/07/18	1:09:22 AM	87.8	78.8	79.4	66.9	899	10,788	83.3
697	58.08	05/07/18	1:14:22 AM	88.7	78.8	79.3	66.9	900	10,800	83.8
698	58.17	05/07/18	1:19:22 AM	88.5	78.8	79.1	66.6	900	10,800	83.6
699	58.25	05/07/18	1:24:22 AM	88.1	78.8	79.0	67.0	900	10,800	83.5
700	58.33	05/07/18	1:29:22 AM	87.8	78.8	78.9	67.0	900	10,800	83.3
701	58.42	05/07/18	1:34:22 AM	88.0	78.8	78.8	66.8	901	10,812	83.4
702	58.50	05/07/18	1:39:22 AM	88.5	78.8	78.6	66.8	900	10,800	83.7
703	58.58	05/07/18	1:44:22 AM	88.1	78.8	78.5	67.2	900	10,800	83.4
704	58.67	05/07/18	1:49:22 AM	88.4	78.8	78.4	66.9	900	10,800	83.6
705	58.75	05/07/18	1:54:22 AM	88.1	78.8	78.3	66.8	900	10,800	83.5
706	58.83	05/07/18	1:59:22 AM	88.1	78.8	78.2	66.6	901	10,812	83.4
707	58.92	05/07/18	2:04:22 AM	88.4	78.8	78.0	66.4	900	10,800	83.6
708	59.00	05/07/18	2:09:22 AM	88.4	78.8	78.0	66.2	900	10,800	83.6
709	59.08	05/07/18	2:14:22 AM	88.2	78.8	77.9	66.1	900	10,800	83.5
710	59.17	05/07/18	2:19:22 AM	88.0	78.8	77.8	66.1	900	10,800	83.4
711	59.25	05/07/18	2:24:22 AM	88.5	78.8	77.6	66.2	900	10,800	83.7
712	59.33	05/07/18	2:29:22 AM	88.0	78.9	77.5	66.0	901	10,812	83.4
713	59.42	05/07/18	2:34:22 AM	88.3	78.9	77.5	65.9	900	10,800	83.6
714	59.50	05/07/18	2:39:22 AM	88.1	78.9	77.4	66.0	900	10,800	83.5
715	59.58	05/07/18	2:44:22 AM	88.5	78.9	77.3	66.0	900	10,800	83.7
716	59.67	05/07/18	2:49:22 AM	88.3	78.9	77.1	65.7	901	10,812	83.6

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
717	59.75	05/07/18	2:54:22 AM	88.3	78.9	77.1	65.6	900	10,800	83.6
718	59.83	05/07/18	2:59:22 AM	88.1	78.9	77.0	65.7	900	10,800	83.5
719	59.92	05/07/18	3:04:22 AM	88.4	78.9	76.9	65.8	900	10,800	83.6
720	60.00	05/07/18	3:09:22 AM	88.4	78.9	76.7	66.0	900	10,800	83.7
721	60.08	05/07/18	3:14:22 AM	88.1	78.9	76.5	66.2	900	10,800	83.5
722	60.17	05/07/18	3:19:22 AM	88.3	78.9	76.3	66.0	900	10,800	83.6
723	60.25	05/07/18	3:24:22 AM	88.4	78.9	76.2	65.9	901	10,812	83.7
724	60.33	05/07/18	3:29:22 AM	88.0	78.9	76.0	66.2	900	10,800	83.5
725	60.42	05/07/18	3:34:22 AM	88.5	78.9	75.8	65.4	900	10,800	83.7
726	60.50	05/07/18	3:39:22 AM	88.6	78.9	75.8	65.5	901	10,812	83.8
727	60.58	05/07/18	3:44:22 AM	88.4	78.9	75.6	65.0	900	10,800	83.7
728	60.67	05/07/18	3:49:22 AM	88.5	78.9	75.5	64.8	901	10,812	83.7
729	60.75	05/07/18	3:54:22 AM	88.4	78.9	75.2	64.8	900	10,800	83.7
730	60.83	05/07/18	3:59:22 AM	88.1	78.9	75.2	64.7	901	10,812	83.5
731	60.92	05/07/18	4:04:22 AM	88.2	78.9	75.1	64.7	900	10,800	83.6
732	61.00	05/07/18	4:09:22 AM	88.2	79.0	75.1	64.3	901	10,812	83.6
733	61.08	05/07/18	4:14:22 AM	88.4	79.0	75.0	63.9	900	10,800	83.7
734	61.17	05/07/18	4:19:22 AM	88.9	79.0	75.0	63.8	900	10,800	83.9
735	61.25	05/07/18	4:24:22 AM	88.7	79.0	75.0	63.8	900	10,800	83.8
736	61.33	05/07/18	4:29:22 AM	88.4	79.0	74.8	63.6	900	10,800	83.7
737	61.42	05/07/18	4:34:22 AM	88.4	79.0	74.7	63.1	900	10,800	83.7
738	61.50	05/07/18	4:39:22 AM	88.3	79.0	74.6	63.1	900	10,800	83.6
739	61.58	05/07/18	4:44:22 AM	88.4	79.0	74.6	62.9	900	10,800	83.7
740	61.67	05/07/18	4:49:22 AM	88.4	79.0	74.5	62.7	900	10,800	83.7
741	61.75	05/07/18	4:54:22 AM	88.3	79.0	74.5	62.4	899	10,788	83.7
742	61.83	05/07/18	4:59:22 AM	88.4	79.0	74.4	62.3	899	10,788	83.7
743	61.92	05/07/18	5:04:22 AM	88.6	79.0	74.3	62.3	899	10,788	83.8
744	62.00	05/07/18	5:09:22 AM	88.1	79.0	74.2	62.3	899	10,788	83.6
745	62.08	05/07/18	5:14:22 AM	88.5	79.0	74.2	62.1	899	10,788	83.8
746	62.17	05/07/18	5:19:22 AM	88.2	79.0	74.1	62.1	899	10,788	83.6
747	62.25	05/07/18	5:24:22 AM	88.2	79.0	74.0	62.0	899	10,788	83.6
748	62.33	05/07/18	5:29:22 AM	87.9	79.0	74.0	62.0	900	10,800	83.5
749	62.42	05/07/18	5:34:22 AM	88.7	79.0	73.8	61.9	899	10,788	83.9
750	62.50	05/07/18	5:39:22 AM	88.4	79.0	73.7	62.1	900	10,800	83.7
751	62.58	05/07/18	5:44:22 AM	88.5	79.0	73.6	61.8	899	10,788	83.7
752	62.67	05/07/18	5:49:22 AM	88.2	79.0	73.4	61.5	899	10,788	83.6
753	62.75	05/07/18	5:54:22 AM	88.6	79.0	73.2	61.6	900	10,800	83.8
754	62.83	05/07/18	5:59:22 AM	88.2	79.0	73.2	61.0	899	10,788	83.6
755	62.92	05/07/18	6:04:22 AM	88.3	79.1	73.1	60.4	900	10,800	83.7
756	63.00	05/07/18	6:09:22 AM	88.2	79.1	73.1	60.2	899	10,788	83.6
757	63.08	05/07/18	6:14:22 AM	88.5	79.0	73.0	60.1	899	10,788	83.8
758	63.17	05/07/18	6:19:22 AM	88.4	79.1	73.0	60.3	900	10,800	83.7
759	63.25	05/07/18	6:24:22 AM	88.3	79.0	72.7	59.8	899	10,788	83.6
760	63.33	05/07/18	6:29:22 AM	88.0	79.1	72.7	59.4	900	10,800	83.5
761	63.42	05/07/18	6:34:22 AM	88.5	79.1	72.7	59.3	899	10,788	83.8
762	63.50	05/07/18	6:39:22 AM	88.6	79.1	72.6	59.5	900	10,800	83.9
763	63.58	05/07/18	6:44:22 AM	88.3	79.0	72.4	59.1	899	10,788	83.6
764	63.67	05/07/18	6:49:22 AM	88.6	79.1	72.3	59.2	900	10,800	83.8
765	63.75	05/07/18	6:54:22 AM	88.2	79.1	72.2	58.8	900	10,800	83.6
766	63.83	05/07/18	6:59:22 AM	88.4	79.1	72.2	58.8	899	10,788	83.7
767	63.92	05/07/18	7:04:22 AM	88.4	79.1	72.1	58.9	899	10,788	83.7
768	64.00	05/07/18	7:09:22 AM	88.5	79.1	72.0	59.5	900	10,800	83.8
769	64.08	05/07/18	7:14:22 AM	88.5	79.1	72.0	59.6	899	10,788	83.8
770	64.17	05/07/18	7:19:22 AM	88.3	79.1	72.0	59.7	900	10,800	83.7
771	64.25	05/07/18	7:24:22 AM	88.4	79.1	72.0	58.9	899	10,788	83.8
772	64.33	05/07/18	7:29:22 AM	88.5	79.1	71.9	58.3	899	10,788	83.8
773	64.42	05/07/18	7:34:22 AM	88.1	79.1	71.9	58.7	900	10,800	83.6
774	64.50	05/07/18	7:39:22 AM	88.1	79.1	71.9	58.9	899	10,788	83.6
775	64.58	05/07/18	7:44:22 AM	88.6	79.1	71.9	59.3	900	10,800	83.9
776	64.67	05/07/18	7:49:22 AM	88.0	79.1	72.1	60.1	899	10,788	83.5
777	64.75	05/07/18	7:54:22 AM	88.5	79.1	72.3	60.2	900	10,800	83.8
778	64.83	05/07/18	7:59:22 AM	88.5	79.1	72.5	60.9	899	10,788	83.8
779	64.92	05/07/18	8:04:22 AM	88.4	79.1	72.6	61.7	900	10,800	83.8
780	65.00	05/07/18	8:09:22 AM	88.9	79.1	72.8	62.3	899	10,788	84.0
781	65.08	05/07/18	8:14:22 AM	88.1	79.1	73.1	62.1	900	10,800	83.6
782	65.17	05/07/18	8:19:22 AM	88.4	79.1	73.3	62.9	899	10,788	83.8

NE State Capital - NW Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Wc (Watts)	Average Loop Temp. Amb (ºF)
783	65.25	05/07/18	8:24:22 AM	88.4	79.1	73.5	63.7	900	10,800	83.7
784	65.33	05/07/18	8:29:22 AM	88.8	79.1	73.8	64.2	900	10,800	84.0
785	65.42	05/07/18	8:34:22 AM	88.1	79.1	74.2	64.6	900	10,800	83.6
786	65.50	05/07/18	8:39:22 AM	88.4	79.2	74.6	65.4	900	10,800	83.8
787	65.58	05/07/18	8:44:22 AM	88.8	79.2	74.9	65.8	900	10,800	84.0
788	65.67	05/07/18	8:49:22 AM	88.9	79.2	75.4	66.9	899	10,788	84.0
789	65.75	05/07/18	8:54:22 AM	88.0	79.2	76.0	67.5	900	10,800	83.6
790	65.83	05/07/18	8:59:22 AM	88.5	79.2	76.4	67.8	900	10,800	83.9
791	65.92	05/07/18	9:04:22 AM	88.5	79.2	76.9	68.5	900	10,800	83.9
792	66.00	05/07/18	9:09:22 AM	88.5	79.2	77.3	69.2	900	10,800	83.9
793	66.08	05/07/18	9:14:22 AM	88.5	79.2	77.9	69.1	900	10,800	83.8
794	66.17	05/07/18	9:19:22 AM	88.4	79.2	78.2	70.0	900	10,800	83.8
795	66.25	05/07/18	9:24:22 AM	88.9	79.2	79.0	71.4	899	10,788	84.0
796	66.33	05/07/18	9:29:22 AM	88.6	79.2	79.4	71.4	900	10,800	83.9
797	66.42	05/07/18	9:34:22 AM	88.7	79.2	79.9	71.9	900	10,800	84.0
798	66.50	05/07/18	9:39:22 AM	88.8	79.2	80.4	72.4	900	10,800	84.0
799	66.58	05/07/18	9:44:22 AM	88.5	79.3	81.0	73.3	900	10,800	83.9
800	66.67	05/07/18	9:49:22 AM	88.8	79.3	81.3	72.9	899	10,788	84.0
801	66.75	05/07/18	9:54:22 AM	88.5	79.3	82.0	73.8	900	10,800	83.9
802	66.83	05/07/18	9:59:22 AM	88.8	79.2	82.5	73.9	900	10,800	84.0
803	66.92	05/07/18	10:04:22 AM	88.6	79.3	82.9	73.3	900	10,800	83.9
804	67.00	05/07/18	10:09:22 AM	88.2	79.3	83.1	74.2	899	10,788	83.7
805	67.08	05/07/18	10:14:22 AM	88.6	79.2	83.6	75.7	900	10,800	83.9
806	67.17	05/07/18	10:19:22 AM	88.5	79.2	84.1	75.5	900	10,800	83.9
807	67.25	05/07/18	10:24:22 AM	88.9	79.3	84.6	75.7	900	10,800	84.1
808	67.33	05/07/18	10:29:22 AM	88.8	79.3	84.9	76.1	899	10,788	84.0
809	67.42	05/07/18	10:34:22 AM	88.5	79.3	85.2	76.6	900	10,800	83.9
810	67.50	05/07/18	10:39:22 AM	88.6	79.3	85.6	76.3	900	10,800	84.0
811	67.58	05/07/18	10:44:22 AM	88.7	79.3	86.0	76.2	899	10,788	84.0
812	67.67	05/07/18	10:49:22 AM	88.4	79.3	86.2	76.0	900	10,800	83.8
813	67.75	05/07/18	10:54:22 AM	88.8	79.3	86.6	77.1	900	10,800	84.1
814	67.83	05/07/18	10:59:22 AM	88.7	79.3	87.0	76.9	900	10,800	84.0
815	67.92	05/07/18	11:04:22 AM	89.0	79.3	87.2	77.9	899	10,788	84.2
816	68.00	05/07/18	11:09:22 AM	88.6	79.3	87.7	78.6	900	10,800	83.9
817	68.08	05/07/18	11:14:22 AM	88.6	79.3	88.1	78.4	900	10,800	83.9
818	68.17	05/07/18	11:19:22 AM	88.8	79.3	88.7	78.9	899	10,788	84.1
819	68.25	05/07/18	11:24:22 AM	88.8	79.3	89.1	79.0	900	10,800	84.1
820	68.33	05/07/18	11:29:22 AM	88.9	79.3	89.6	78.9	900	10,800	84.1
821	68.42	05/07/18	11:34:22 AM	88.8	79.3	89.8	78.6	900	10,800	84.1
822	68.50	05/07/18	11:39:22 AM	88.2	79.3	90.0	79.1	900	10,800	83.8
823	68.58	05/07/18	11:44:22 AM	88.6	79.3	90.3	80.0	900	10,800	84.0
824	68.67	05/07/18	11:49:22 AM	88.8	79.3	90.8	80.1	899	10,788	84.1
825	68.75	05/07/18	11:54:22 AM	88.9	79.3	91.2	80.5	900	10,800	84.1
826	68.83	05/07/18	11:59:22 AM	88.5	79.3	91.7	81.8	901	10,812	83.9
827	68.92	05/07/18	12:04:22 PM	88.7	79.4	92.0	80.9	900	10,800	84.1
828	69.00	05/07/18	12:09:22 PM	88.7	79.3	92.4	81.8	899	10,788	84.0
829	69.08	05/07/18	12:14:22 PM	88.5	79.3	92.8	81.1	900	10,800	83.9
830	69.17	05/07/18	12:19:22 PM	88.6	79.4	93.3	81.7	901	10,812	84.0
831	69.25	05/07/18	12:24:22 PM	89.0	79.4	93.9	81.9	900	10,800	84.2
832	69.33	05/07/18	12:29:22 PM	88.6	79.4	94.1	82.5	901	10,812	84.0
833	69.42	05/07/18	12:34:22 PM	88.7	79.4	94.4	81.4	900	10,800	84.0
834	69.50	05/07/18	12:39:22 PM	88.8	79.4	94.6	82.6	900	10,800	84.1
835	69.58	05/07/18	12:44:22 PM	88.6	79.4	94.6	82.6	900	10,800	84.0
836	69.67	05/07/18	12:49:22 PM	89.0	79.4	94.9	82.8	900	10,800	84.2
837	69.75	05/07/18	12:54:22 PM	88.5	79.4	95.4	84.1	900	10,800	83.9
838	69.83	05/07/18	12:59:22 PM	88.8	79.4	95.7	83.7	900	10,800	84.1
839	69.92	05/07/18	1:04:22 PM	88.7	79.4	96.1	84.3	900	10,800	84.0

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OPPD

Omaha Public Power District

May 7, 2018

Alvine Engineering
Mr. Paul Bauman, P.E.
1800 O Street, Suite 104
Lincoln, NE 68508

SUBJECT: Thermal Conductivity Test Results for State Capital Building Project – SE Test Loop

Dear Mr. Bauman,

The Commercial and Industrial Energy Solutions Department has completed the ground thermal conductivity test for the southeast test loop of the Nebraska State Capital Building project located northwest of South 18th Street and K Street in Lincoln, NE. The test results are essential design input to size the geothermal loop heat exchanger (GLHE) properly for this project. OPPD performed the test on a 670-feet long vertical test loop installed by K2 Geothermal. The attached well drilling log indicates the soil formations encountered. The on-site testing was performed for 68.58 hours from 05/01/18 until 05/04/18.

> **The calculated thermal conductivity of the ground (Kg) at this test bore location is 1.42 Btu/hr-ft-°F.**

The ground thermal diffusivity can be estimated from published data and the actual test well log report. For this test well, the thermal diffusivity is estimated to be **1.23 ft^2/day**.

The best approximation for an undisturbed soil temperature is 54-59° F based upon published annual earth temperatures and previous ground thermal conductivity testing in the area. The initial loop water temperature was approximately **59.0° F** during our test. I recommend consideration of a higher ground temperature for cooling design and a lower ground temperature for heating design due to potential ground water movement, which can create variations in deep-earth temperature throughout the year.

Attached is the raw data gathered from the 68.58-hour test. The data is provided in tabular and graphical formats for your review. Approximately 10,746 watts (36,701 Btu per hour) of heat was continuously added to the test loop during the test. At the end of the test, the water temperature was approximately 87.9°F going into the ground and 78.8°F coming out of the ground.

The results of this test must be properly used to size the GLHE. The following precautions (next page) should be considered before applying this data.

Design Precautions:

1. When designing the GLHE, the borehole backfill material becomes very important and affects the overall thermal conductivity, thus loop performance. The thermal conductivity determined by this test is for the **ground only** and does not include the effect of the borehole construction.

2. Bore hole construction (e.g. the diameter of the bore hole, diameter of the pipe loop, pipe loop material, and the type of backfill material) may impact the overall thermal conductivity of the heat exchanger and must be incorporated into the GLHE sizing calculations.

3. The calculated ground thermal conductivity is the average conductivity over the entire length of the single borehole tested. Significant changes between the depth of the borehole tested herein and any upcoming actual GLHE installation may result in change in thermal conductivity. Reference the attached test well log.

4. Changes in soil conditions may influence the overall thermal conductivity. Changes in soil conditions may be the result of variations in subsurface moisture content, change in pipe loop length from that used in the test loop, and/or changes in geological materials.

If you have any questions or need further information, please call me at (402) 636-3507.

Sincerely,

Timothy S. Rauscher, P.E., C.E.M.
C & I Energy Solutions Supervisor

Encl.

cc: OPPD Project File

THERMAL CONDUCTIVITY TEST - SUMMARY

Project Name: **NE State Capital - SE Test Loop**

Thermal Conductivity Test Date (Start): 5/1/2018

1. TEST WELL DESIGN

Well Length (L_c) =	670	ft
Nominal Pipe Size =	1 1/4	in
Diameter Ratio (DR) =	11	
Average Test Flow Rate =	8.2	gpm
Borehole Size (dia.) =	8.0	in
Loop Configuration =	One Bore Per Parallel Loop	
Backfill Material =	Hole Plug (top) and Sand	
Backfill Material Thermal Conductivity (K_{bf}) =	0.90	Btu/hr*ft*ºF

2. DATA LOGGED

Time to Circulate Non-Heated Water in Loop =	11.0	min.
Average Water Temp. From Ground during Initial Test =	59.1	ºF
Undisturbed Ground Temp (T_g) =	59.0	ºF
Duration of Test =	68.58	hours
Final Water Temp. Into Ground =	87.9	ºF
Final Water Temp. Out of Ground =	78.8	ºF
Maximum Average Loop Temperature =	83.6	ºF
Average Loop Delta-T =	9.2	ºF

3. POWER INPUT QUALITY

Average Heat Input into Loop =	10,746	Watts
Average Heat Input into Loop =	36,701	Btu/hr
Standard Deviation (σ) =	35.2	Watts
Standard Deviation Limit* =	161.0	Watts
% Standard Deviation =	0.33%	
% Standard Deviation Limit* =	1.5%	
Minimum Power Input =	10,572	Watts
Minimum Power Input Limit* =	9,660	Watts
Peak Power Input =	10,788	Watts
Peak Power Input Limit* =	11,807	Watts
Power Input Meets ASHRAE 1118 TRP Guidelines?	Yes	

4. TEST RESULTS

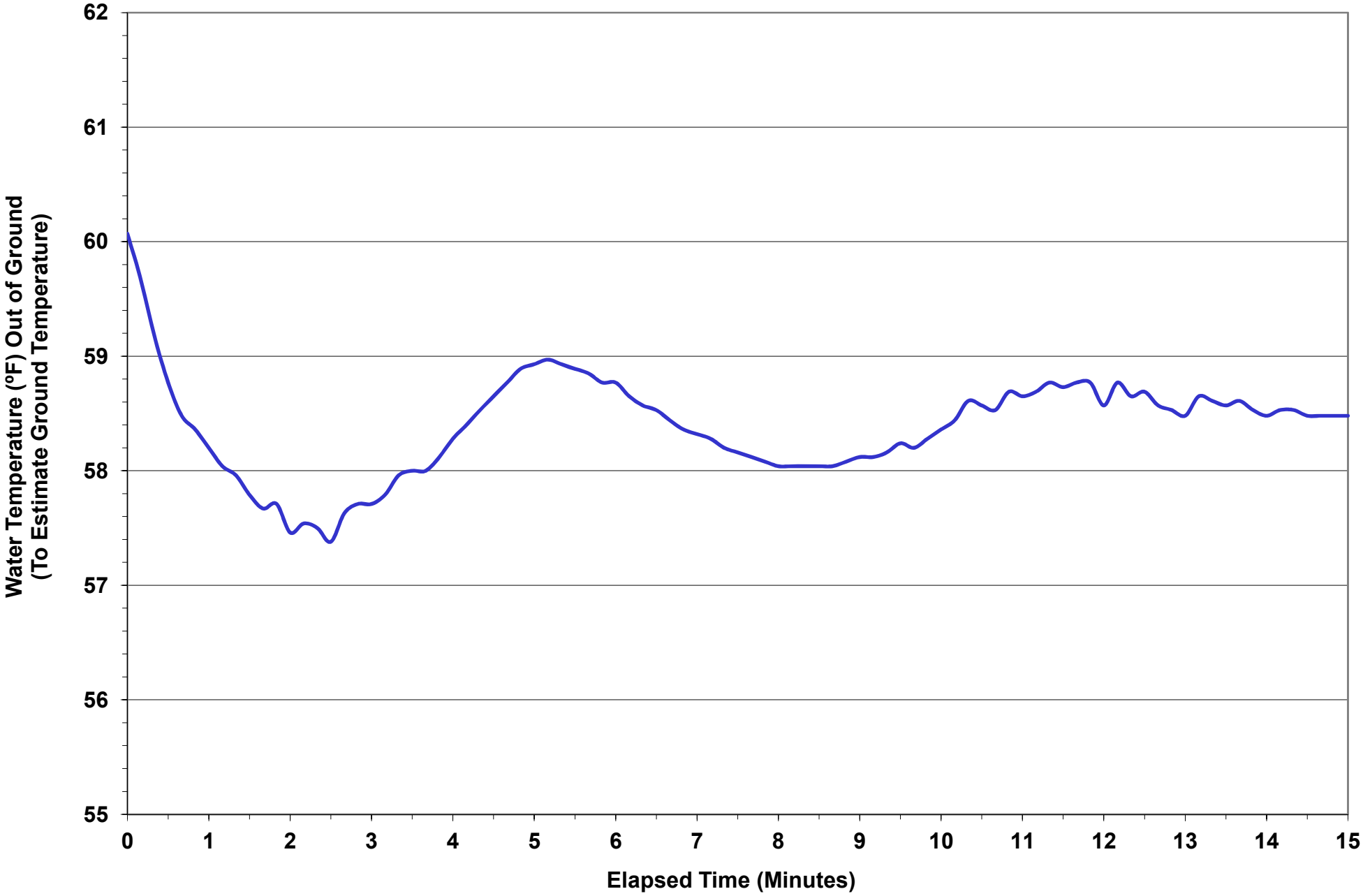
Calculated Ground Thermal Conductivity (K_g) =	1.42	Btu/hr*ft*ºF
Estimated Ground Thermal Diffusivity (α_g) =	1.23	ft^2/day

Notes:

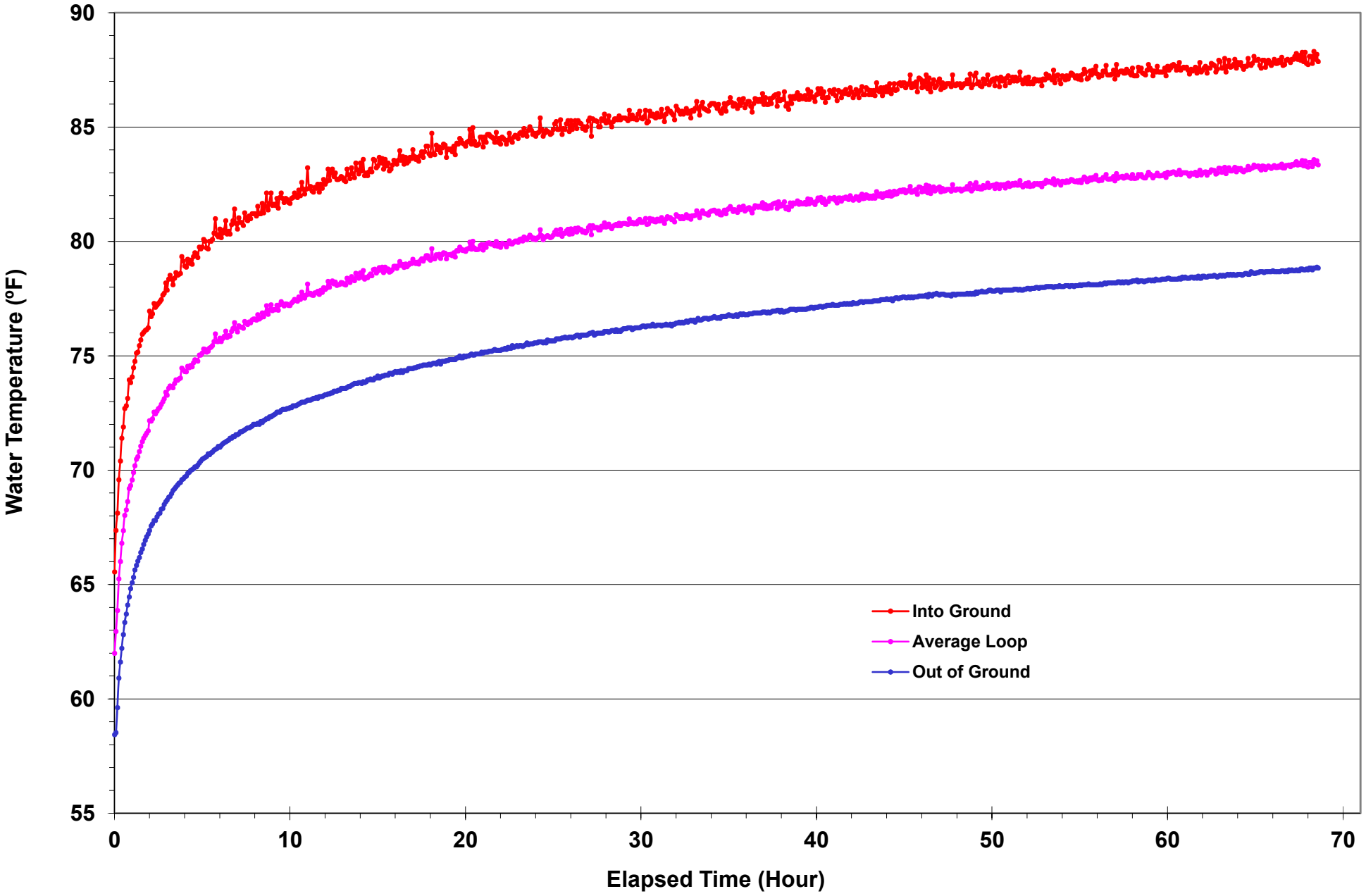
*Per ASHRAE 1118-TRP

K2 Geothermal		
NE State Capital		
Well Drilling Log		
Hole Number:	**SE Corner Well**	
Material	**From**	**To**
Brown Silty Clay	0	10
Course Yellow Sand	10	20
Medium Sand w/ layers of sandstone	20	45
Soft Gray Clay	45	65
Medium Sand w/ dark chips	65	80
Soft Orange Clay	80	90
Sandstone/Sand	90	100
Soft Orange Clay/Sand	100	110
Medium Sand	110	125
Sandstone	125	135
Sand	135	150
Sandstone	150	160
Soft Red Shale	160	165
Red/Gray Clay	165	170
White/Gray Clay	170	200
Gray Clay	200	260
Gray Shale	260	270
Maroon Clay	270	280
Gray Clay w/ shale	280	350
Limestone	350	385
Hard Gray Shale	385	395
Limestone	395	420
Black Shale	420	435
Red Shale	435	445
Clay	445	450
White Shale w/ limestone layers	450	455
Black Shale	455	465
Soft Gray Clay	465	485
Brown Shale	485	495
Soft Red Clay	495	515
Limestone	515	520
Gray Shale	520	535
Limestone	535	550
Soft Red Clay	550	625
Limestone	625	635
Gray Clay	635	660
Shale	660	675

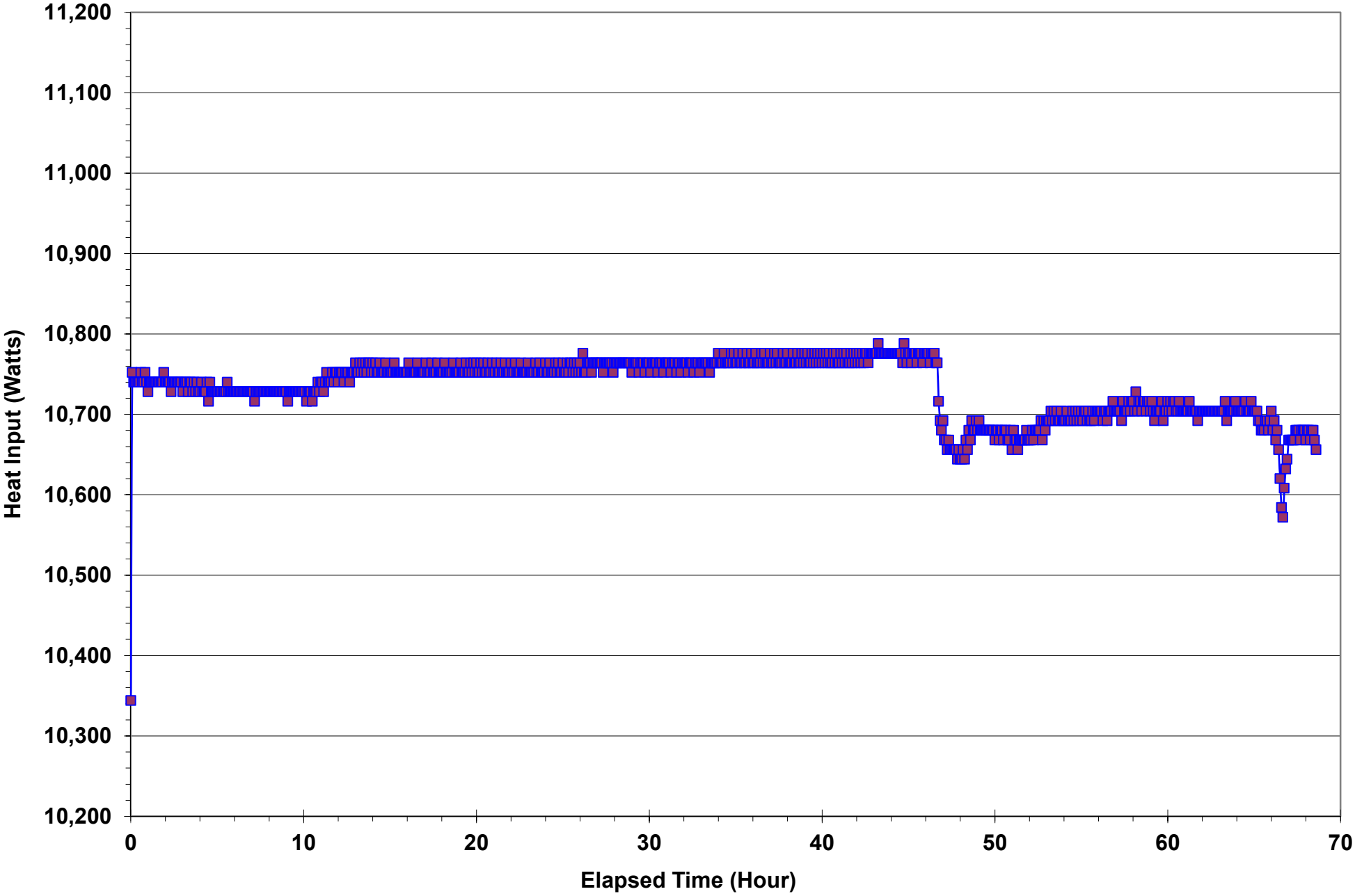
NE State Capital - SE Test Loop
Ground Thermal Conductivity Test
Initial Water (Deep Earth) Temperature



NE State Capital - SE Test Loop
Ground Thermal Conductivity Test
Test Loop Water Temperatures



NE State Capital - SE Test Loop
Ground Thermal Conductivity Test
Test Loop Heat Input



NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

LOGGED DATA INITIALLY TO DETERMINE UNDISTURBED SOIL TEMPERATURE

Approximate Flow Rate: 9.0 gpm Frequency of Samples: 10.0 sec.

Rdg. No.	Hour Min.	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
0	0.0	05/01/18	3:53:01 PM	60.1	60.1	83.7	84.6	0	0	60.1
1	0.2	05/01/18	3:53:11 PM	60.0	59.7	83.8	84.7	1	12	59.7
2	0.3	05/01/18	3:53:21 PM	60.0	59.2	83.8	84.6	0	0	59.2
3	0.5	05/01/18	3:53:31 PM	60.0	58.8	83.8	84.7	1	12	58.8
4	0.7	05/01/18	3:53:41 PM	59.9	58.5	83.8	84.4	0	0	58.5
5	0.8	05/01/18	3:53:51 PM	59.8	58.4	83.7	84.3	1	12	58.4
6	1.0	05/01/18	3:54:01 PM	59.8	58.2	83.6	84.0	0	0	58.2
7	1.2	05/01/18	3:54:11 PM	59.7	58.0	83.5	83.9	1	12	58.0
8	1.3	05/01/18	3:54:21 PM	59.6	58.0	83.4	83.8	0	0	58.0
9	1.5	05/01/18	3:54:31 PM	59.6	57.8	83.5	83.8	1	12	57.8
10	1.7	05/01/18	3:54:41 PM	59.4	57.7	83.5	84.0	0	0	57.7
11	1.8	05/01/18	3:54:51 PM	59.3	57.7	83.5	84.1	1	12	57.7
12	2.0	05/01/18	3:55:01 PM	59.5	57.5	83.5	84.3	0	0	57.5
13	2.2	05/01/18	3:55:11 PM	59.3	57.5	83.5	84.2	1	12	57.5
14	2.3	05/01/18	3:55:21 PM	59.3	57.5	83.5	84.2	1	12	57.5
15	2.5	05/01/18	3:55:31 PM	59.3	57.4	83.6	84.4	0	0	57.4
16	2.7	05/01/18	3:55:41 PM	59.1	57.6	83.6	84.4	1	12	57.6
17	2.8	05/01/18	3:55:51 PM	59.0	57.7	83.7	84.6	0	0	57.7
18	3.0	05/01/18	3:56:01 PM	59.0	57.7	83.7	84.5	1	12	57.7
19	3.2	05/01/18	3:56:11 PM	59.1	57.8	83.7	84.6	0	0	57.8
20	3.3	05/01/18	3:56:21 PM	59.0	58.0	83.7	84.5	1	12	58.0
21	3.5	05/01/18	3:56:31 PM	59.0	58.0	83.7	84.5	0	0	58.0
22	3.7	05/01/18	3:56:41 PM	58.9	58.0	83.7	84.5	1	12	58.0
23	3.8	05/01/18	3:56:51 PM	58.9	58.1	83.7	84.6	0	0	58.1
24	4.0	05/01/18	3:57:01 PM	58.9	58.3	83.7	84.7	1	12	58.3
25	4.2	05/01/18	3:57:11 PM	58.9	58.4	83.7	84.7	0	0	58.4
26	4.3	05/01/18	3:57:21 PM	58.8	58.5	83.7	84.8	1	12	58.5
27	4.5	05/01/18	3:57:31 PM	58.9	58.7	83.7	84.9	0	0	58.7
28	4.7	05/01/18	3:57:41 PM	58.9	58.8	83.7	85.0	1	12	58.8
29	4.8	05/01/18	3:57:51 PM	58.9	58.9	83.7	85.2	0	0	58.9
30	5.0	05/01/18	3:58:01 PM	58.9	58.9	83.7	85.1	1	12	58.9
31	5.2	05/01/18	3:58:11 PM	59.0	59.0	83.7	85.1	0	0	59.0
32	5.3	05/01/18	3:58:21 PM	59.0	58.9	83.8	85.0	1	12	58.9
33	5.5	05/01/18	3:58:31 PM	59.0	58.9	83.8	84.9	1	12	58.9
34	5.7	05/01/18	3:58:41 PM	59.0	58.9	83.8	84.9	0	0	58.9
35	5.8	05/01/18	3:58:51 PM	59.0	58.8	83.9	84.9	1	12	58.8
36	6.0	05/01/18	3:59:01 PM	59.0	58.8	83.9	84.8	0	0	58.8
37	6.2	05/01/18	3:59:11 PM	59.0	58.7	83.9	84.7	1	12	58.7
38	6.3	05/01/18	3:59:21 PM	59.0	58.6	84.0	84.6	0	0	58.6
39	6.5	05/01/18	3:59:31 PM	59.0	58.5	84.0	84.5	1	12	58.5
40	6.7	05/01/18	3:59:41 PM	59.0	58.4	84.0	84.2	0	0	58.4
41	6.8	05/01/18	3:59:51 PM	59.0	58.4	84.0	84.1	1	12	58.4
42	7.0	05/01/18	4:00:01 PM	59.0	58.3	84.0	84.1	0	0	58.3
43	7.2	05/01/18	4:00:11 PM	59.0	58.3	84.0	84.1	1	12	58.3
44	7.3	05/01/18	4:00:21 PM	59.0	58.2	84.0	83.9	0	0	58.2
45	7.5	05/01/18	4:00:31 PM	59.0	58.2	84.0	83.8	1	12	58.2
46	7.7	05/01/18	4:00:41 PM	58.9	58.1	84.0	83.9	0	0	58.1
47	7.8	05/01/18	4:00:51 PM	58.9	58.1	84.1	83.8	1	12	58.1
48	8.0	05/01/18	4:01:01 PM	58.9	58.0	84.1	83.7	0	0	58.0
49	8.2	05/01/18	4:01:11 PM	58.9	58.0	84.1	83.6	1	12	58.0
50	8.3	05/01/18	4:01:21 PM	58.9	58.0	84.1	83.5	1	12	58.0
51	8.5	05/01/18	4:01:31 PM	58.9	58.0	84.0	83.5	0	0	58.0
52	8.7	05/01/18	4:01:41 PM	58.8	58.0	84.0	83.4	1	12	58.0
53	8.8	05/01/18	4:01:51 PM	58.8	58.1	84.0	83.3	0	0	58.1
54	9.0	05/01/18	4:02:01 PM	58.8	58.1	84.0	83.2	1	12	58.1
55	9.2	05/01/18	4:02:11 PM	58.8	58.1	83.9	83.1	0	0	58.1
56	9.3	05/01/18	4:02:21 PM	58.8	58.2	83.9	82.9	1	12	58.2
57	9.5	05/01/18	4:02:31 PM	58.8	58.2	83.8	82.7	0	0	58.2
58	9.7	05/01/18	4:02:41 PM	58.8	58.2	83.8	82.7	1	12	58.2
59	9.8	05/01/18	4:02:51 PM	58.7	58.3	83.7	82.7	0	0	58.3
60	10.0	05/01/18	4:03:01 PM	58.9	58.4	83.7	82.7	1	12	58.4

NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
61	10.2	05/01/18	4:03:11 PM	58.9	58.4	83.7	82.5	0	0	58.4
62	10.3	05/01/18	4:03:21 PM	58.8	58.6	83.6	82.5	1	12	58.6
63	10.5	05/01/18	4:03:31 PM	58.8	58.6	83.6	82.6	0	0	58.6
64	10.7	05/01/18	4:03:41 PM	58.7	58.5	83.6	82.7	1	12	58.5
65	10.8	05/01/18	4:03:51 PM	58.9	58.7	83.5	82.8	0	0	58.7
66	11.0	05/01/18	4:04:01 PM	58.8	58.7	83.6	82.9	1	12	58.7
67	11.2	05/01/18	4:04:11 PM	58.9	58.7	83.6	83.0	0	0	58.7
68	11.3	05/01/18	4:04:21 PM	58.9	58.8	83.6	83.1	1	12	58.8
69	11.5	05/01/18	4:04:31 PM	58.8	58.7	83.6	83.1	1	12	58.7
70	11.7	05/01/18	4:04:41 PM	59.0	58.8	83.6	83.2	0	0	58.8
71	11.8	05/01/18	4:04:51 PM	58.9	58.8	83.6	83.2	1	12	58.8
72	12.0	05/01/18	4:05:01 PM	58.9	58.6	83.6	83.3	0	0	58.6
73	12.2	05/01/18	4:05:11 PM	59.0	58.8	83.6	83.3	1	12	58.8
74	12.3	05/01/18	4:05:21 PM	58.9	58.7	83.6	83.4	0	0	58.7
75	12.5	05/01/18	4:05:31 PM	58.8	58.7	83.7	83.4	1	12	58.7
76	12.7	05/01/18	4:05:41 PM	59.0	58.6	83.7	83.5	0	0	58.6
77	12.8	05/01/18	4:05:51 PM	59.0	58.5	83.7	83.6	1	12	58.5
78	13.0	05/01/18	4:06:01 PM	58.9	58.5	83.8	83.7	0	0	58.5
79	13.2	05/01/18	4:06:11 PM	59.1	58.7	83.8	83.8	1	12	58.7
80	13.3	05/01/18	4:06:21 PM	59.0	58.6	83.8	83.7	0	0	58.6
81	13.5	05/01/18	4:06:31 PM	58.9	58.6	83.8	83.8	1	12	58.6
82	13.7	05/01/18	4:06:41 PM	59.0	58.6	83.8	83.9	0	0	58.6
83	13.8	05/01/18	4:06:51 PM	59.0	58.5	83.8	84.1	1	12	58.5
84	14.0	05/01/18	4:07:01 PM	58.9	58.5	83.8	84.2	0	0	58.5
85	14.2	05/01/18	4:07:11 PM	58.9	58.5	83.8	84.3	1	12	58.5
86	14.3	05/01/18	4:07:21 PM	59.0	58.5	83.8	84.3	1	12	58.5
87	14.5	05/01/18	4:07:31 PM	59.0	58.5	83.8	84.3	0	0	58.5
88	14.7	05/01/18	4:07:41 PM	59.0	58.5	83.8	84.2	1	12	58.5
89	14.8	05/01/18	4:07:51 PM	59.0	58.5	83.8	84.0	0	0	58.5
90	15.0	05/01/18	4:08:01 PM	59.0	58.5	83.8	84.0	1	12	58.5

Water Volume of Loop in Ground = 13.48 ft^3, or = 100.82 gallons

NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)

LOGGED DATA TO CALCULATE SOIL THERMAL CONDUCTIVITY

Number of Hours:	68.58 hours	Total Accumulative Pulses Read:	737,025 Pulses
Calculated Meter Reading:	737,025 Watt*hrs	Average Pulses/Hour:	10,746 Pulses/hr
Multiplier:	1.0 Watt*hrs/pulse	Average Heat Input:	10,746 Watts
Approximate Flow Rate	8.2 gpm	Frequency of Samples:	5.0 minutes

0	0.00	05/01/18	4:17:46 PM	65.6	58.4	83.0	83.2	862	10,344	62.0
1	0.08	05/01/18	4:22:46 PM	67.4	58.5	84.3	84.0	896	10,752	63.0
2	0.17	05/01/18	4:27:46 PM	68.1	59.6	85.0	83.7	895	10,740	63.9
3	0.25	05/01/18	4:32:46 PM	69.6	60.9	85.5	82.8	895	10,740	65.3
4	0.33	05/01/18	4:37:46 PM	70.4	61.6	85.9	83.8	895	10,740	66.0
5	0.42	05/01/18	4:42:46 PM	71.4	62.2	86.2	83.1	895	10,740	66.8
6	0.50	05/01/18	4:47:46 PM	71.9	62.8	86.2	82.2	895	10,740	67.4
7	0.58	05/01/18	4:52:46 PM	72.7	63.4	85.9	80.8	896	10,752	68.0
8	0.67	05/01/18	4:57:46 PM	72.8	63.7	85.5	80.5	895	10,740	68.3
9	0.75	05/01/18	5:02:46 PM	73.1	64.1	85.5	80.0	895	10,740	68.6
10	0.83	05/01/18	5:07:46 PM	74.0	64.5	84.8	79.1	896	10,752	69.2
11	0.92	05/01/18	5:12:46 PM	73.8	64.8	84.3	78.8	895	10,740	69.3
12	1.00	05/01/18	5:17:46 PM	74.1	65.1	84.3	78.5	894	10,728	69.6
13	1.08	05/01/18	5:22:46 PM	74.5	65.3	84.2	78.2	895	10,740	69.9
14	1.17	05/01/18	5:27:46 PM	74.8	65.6	83.6	77.7	895	10,740	70.2
15	1.25	05/01/18	5:32:46 PM	75.1	65.8	83.6	77.7	895	10,740	70.5
16	1.33	05/01/18	5:37:46 PM	75.2	66.0	83.4	77.3	895	10,740	70.6
17	1.42	05/01/18	5:42:46 PM	75.5	66.2	83.2	77.1	895	10,740	70.8
18	1.50	05/01/18	5:47:46 PM	75.7	66.4	83.1	77.0	895	10,740	71.1
19	1.58	05/01/18	5:52:46 PM	76.0	66.6	82.8	76.2	895	10,740	71.3
20	1.67	05/01/18	5:57:46 PM	76.0	66.8	82.2	75.3	895	10,740	71.4
21	1.75	05/01/18	6:02:46 PM	76.1	66.9	81.7	74.1	895	10,740	71.5
22	1.83	05/01/18	6:07:46 PM	76.2	67.1	80.5	73.5	895	10,740	71.6
23	1.92	05/01/18	6:12:46 PM	76.2	67.2	79.9	73.5	896	10,752	71.7
24	2.00	05/01/18	6:17:46 PM	77.0	67.4	80.1	73.4	895	10,740	72.2
25	2.08	05/01/18	6:22:46 PM	76.7	67.6	79.4	73.0	895	10,740	72.1
26	2.17	05/01/18	6:27:46 PM	76.8	67.7	78.4	72.4	895	10,740	72.2
27	2.25	05/01/18	6:32:46 PM	77.3	67.8	77.9	72.3	895	10,740	72.5
28	2.33	05/01/18	6:37:46 PM	77.1	67.8	77.4	70.0	894	10,728	72.5
29	2.42	05/01/18	6:42:46 PM	77.2	68.0	76.9	71.0	895	10,740	72.6
30	2.50	05/01/18	6:47:46 PM	77.3	68.1	76.4	70.7	895	10,740	72.7
31	2.58	05/01/18	6:52:46 PM	77.4	68.1	76.1	70.1	895	10,740	72.8
32	2.67	05/01/18	6:57:46 PM	77.5	68.3	75.6	69.3	895	10,740	72.9
33	2.75	05/01/18	7:02:46 PM	77.7	68.3	75.3	69.6	895	10,740	73.0
34	2.83	05/01/18	7:07:46 PM	77.7	68.5	75.1	69.7	895	10,740	73.1
35	2.92	05/01/18	7:12:46 PM	78.2	68.6	75.5	69.7	895	10,740	73.4
36	3.00	05/01/18	7:17:46 PM	77.9	68.7	75.6	69.6	894	10,728	73.3
37	3.08	05/01/18	7:22:46 PM	78.4	68.8	75.6	69.6	895	10,740	73.6
38	3.17	05/01/18	7:27:46 PM	78.5	68.9	75.3	69.7	895	10,740	73.7
39	3.25	05/01/18	7:32:46 PM	78.4	69.0	75.4	69.7	895	10,740	73.7
40	3.33	05/01/18	7:37:46 PM	78.1	69.1	75.3	69.8	894	10,728	73.6
41	3.42	05/01/18	7:42:46 PM	78.4	69.2	75.3	69.9	895	10,740	73.8
42	3.50	05/01/18	7:47:46 PM	78.6	69.3	75.4	69.8	895	10,740	74.0
43	3.58	05/01/18	7:52:46 PM	78.5	69.4	75.5	70.0	894	10,728	73.9
44	3.67	05/01/18	7:57:46 PM	78.6	69.4	75.5	70.2	895	10,740	74.0
45	3.75	05/01/18	8:02:46 PM	78.6	69.5	75.3	70.3	894	10,728	74.0
46	3.83	05/01/18	8:07:46 PM	79.3	69.6	75.3	70.4	895	10,740	74.5
47	3.92	05/01/18	8:12:46 PM	79.1	69.6	75.5	70.4	894	10,728	74.4
48	4.00	05/01/18	8:17:46 PM	78.9	69.7	75.6	70.4	894	10,728	74.3
49	4.08	05/01/18	8:22:46 PM	78.9	69.7	75.7	70.2	895	10,740	74.3
50	4.17	05/01/18	8:27:46 PM	79.2	69.9	75.7	70.1	894	10,728	74.5
51	4.25	05/01/18	8:32:46 PM	79.1	69.9	75.7	70.0	894	10,728	74.5
52	4.33	05/01/18	8:37:46 PM	79.2	70.0	75.7	70.0	894	10,728	74.6
53	4.42	05/01/18	8:42:46 PM	79.0	70.0	75.7	69.9	895	10,740	74.5
54	4.50	05/01/18	8:47:46 PM	79.3	70.1	75.6	69.8	893	10,716	74.7
55	4.58	05/01/18	8:52:46 PM	79.5	70.2	75.6	69.9	895	10,740	74.8
56	4.67	05/01/18	8:57:46 PM	79.5	70.2	75.7	70.0	894	10,728	74.8

NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Wc (Watts)	Average Loop Temp. Amb (ºF)
57	4.75	05/01/18	9:02:46 PM	79.3	70.2	75.7	69.9	894	10,728	74.8
58	4.83	05/01/18	9:07:46 PM	79.8	70.3	75.7	69.7	894	10,728	75.0
59	4.92	05/01/18	9:12:46 PM	79.7	70.4	75.6	69.8	894	10,728	75.0
60	5.00	05/01/18	9:17:46 PM	79.8	70.5	75.7	69.7	894	10,728	75.1
61	5.08	05/01/18	9:22:46 PM	80.1	70.5	75.6	69.7	894	10,728	75.3
62	5.17	05/01/18	9:27:46 PM	80.0	70.6	75.6	69.7	894	10,728	75.3
63	5.25	05/01/18	9:32:46 PM	79.7	70.6	75.7	69.7	894	10,728	75.2
64	5.33	05/01/18	9:37:46 PM	79.7	70.7	75.7	69.9	894	10,728	75.2
65	5.42	05/01/18	9:42:46 PM	80.0	70.7	75.7	69.9	894	10,728	75.3
66	5.50	05/01/18	9:47:46 PM	80.0	70.8	75.7	70.1	894	10,728	75.4
67	5.58	05/01/18	9:52:46 PM	80.1	70.8	75.8	70.1	895	10,740	75.4
68	5.67	05/01/18	9:57:46 PM	80.4	70.9	75.7	70.3	894	10,728	75.6
69	5.75	05/01/18	10:02:46 PM	81.0	70.9	75.8	70.3	894	10,728	76.0
70	5.83	05/01/18	10:07:46 PM	80.3	71.0	75.9	70.2	894	10,728	75.6
71	5.92	05/01/18	10:12:46 PM	80.2	71.0	76.0	70.3	894	10,728	75.6
72	6.00	05/01/18	10:17:46 PM	80.5	71.0	76.0	70.3	894	10,728	75.8
73	6.08	05/01/18	10:22:46 PM	80.2	71.1	76.0	70.2	894	10,728	75.6
74	6.17	05/01/18	10:27:46 PM	80.4	71.2	76.2	70.2	894	10,728	75.8
75	6.25	05/01/18	10:32:46 PM	80.5	71.2	76.2	70.1	894	10,728	75.9
76	6.33	05/01/18	10:37:46 PM	80.9	71.2	76.3	70.1	894	10,728	76.1
77	6.42	05/01/18	10:42:46 PM	80.3	71.3	76.4	70.1	894	10,728	75.8
78	6.50	05/01/18	10:47:46 PM	80.5	71.3	76.4	70.0	894	10,728	75.9
79	6.58	05/01/18	10:52:46 PM	80.3	71.4	76.5	70.0	894	10,728	75.9
80	6.67	05/01/18	10:57:46 PM	80.7	71.4	76.5	70.1	894	10,728	76.1
81	6.75	05/01/18	11:02:46 PM	80.9	71.5	76.7	70.2	894	10,728	76.2
82	6.83	05/01/18	11:07:46 PM	81.4	71.5	76.7	70.1	894	10,728	76.5
83	6.92	05/01/18	11:12:46 PM	80.8	71.6	76.8	70.0	894	10,728	76.2
84	7.00	05/01/18	11:17:46 PM	80.5	71.6	76.8	69.6	894	10,728	76.1
85	7.08	05/01/18	11:22:46 PM	81.0	71.6	76.8	69.6	894	10,728	76.3
86	7.17	05/01/18	11:27:46 PM	80.8	71.7	76.8	69.8	893	10,716	76.3
87	7.25	05/01/18	11:32:46 PM	80.8	71.7	76.8	69.7	894	10,728	76.3
88	7.33	05/01/18	11:37:46 PM	80.7	71.7	76.9	70.2	894	10,728	76.2
89	7.42	05/01/18	11:42:46 PM	81.3	71.8	76.9	69.5	894	10,728	76.5
90	7.50	05/01/18	11:47:46 PM	81.0	71.8	76.9	69.3	894	10,728	76.4
91	7.58	05/01/18	11:52:46 PM	80.9	71.9	76.9	69.4	894	10,728	76.4
92	7.67	05/01/18	11:57:46 PM	81.1	71.9	76.9	69.2	894	10,728	76.5
93	7.75	05/02/18	12:02:46 AM	81.0	71.9	76.9	69.0	894	10,728	76.4
94	7.83	05/02/18	12:07:46 AM	81.2	71.9	76.9	69.0	894	10,728	76.6
95	7.92	05/02/18	12:12:46 AM	81.2	72.0	76.9	69.2	894	10,728	76.6
96	8.00	05/02/18	12:17:46 AM	81.2	72.0	76.9	68.7	894	10,728	76.6
97	8.08	05/02/18	12:22:46 AM	81.1	72.0	76.8	68.3	894	10,728	76.6
98	8.17	05/02/18	12:27:46 AM	81.5	72.1	76.8	68.1	894	10,728	76.8
99	8.25	05/02/18	12:32:46 AM	81.2	72.0	76.8	67.7	894	10,728	76.6
100	8.33	05/02/18	12:37:46 AM	81.2	72.1	76.7	67.6	894	10,728	76.7
101	8.42	05/02/18	12:42:46 AM	81.7	72.1	76.6	67.5	894	10,728	76.9
102	8.50	05/02/18	12:47:46 AM	81.3	72.2	76.6	67.3	894	10,728	76.7
103	8.58	05/02/18	12:52:46 AM	81.5	72.2	76.6	67.3	894	10,728	76.9
104	8.67	05/02/18	12:57:46 AM	82.1	72.3	76.6	67.2	894	10,728	77.2
105	8.75	05/02/18	1:02:46 AM	81.4	72.3	76.5	67.2	894	10,728	76.8
106	8.83	05/02/18	1:07:46 AM	81.7	72.3	76.5	67.2	894	10,728	77.0
107	8.92	05/02/18	1:12:46 AM	82.1	72.3	76.4	67.2	894	10,728	77.2
108	9.00	05/02/18	1:17:46 AM	81.6	72.4	76.4	67.2	894	10,728	77.0
109	9.08	05/02/18	1:22:46 AM	81.6	72.4	76.3	67.3	893	10,716	77.0
110	9.17	05/02/18	1:27:46 AM	81.6	72.5	76.3	67.0	894	10,728	77.0
111	9.25	05/02/18	1:32:46 AM	81.9	72.5	76.3	66.7	894	10,728	77.2
112	9.33	05/02/18	1:37:46 AM	81.5	72.5	76.2	66.7	894	10,728	77.0
113	9.42	05/02/18	1:42:46 AM	81.9	72.5	76.3	66.8	894	10,728	77.2
114	9.50	05/02/18	1:47:46 AM	82.1	72.6	76.3	67.0	894	10,728	77.4
115	9.58	05/02/18	1:52:46 AM	81.9	72.7	76.3	67.0	894	10,728	77.3
116	9.67	05/02/18	1:57:46 AM	81.7	72.7	76.3	67.0	894	10,728	77.2
117	9.75	05/02/18	2:02:46 AM	81.9	72.7	76.4	67.1	894	10,728	77.3
118	9.83	05/02/18	2:07:46 AM	81.8	72.7	76.4	67.0	894	10,728	77.3
119	9.92	05/02/18	2:12:46 AM	81.7	72.7	76.4	67.0	894	10,728	77.2
120	10.00	05/02/18	2:17:46 AM	81.7	72.7	76.4	66.8	894	10,728	77.2
121	10.08	05/02/18	2:22:46 AM	81.9	72.7	76.4	66.7	894	10,728	77.3
122	10.17	05/02/18	2:27:46 AM	81.9	72.8	76.4	66.5	893	10,716	77.4

NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
123	10.25	05/02/18	2:32:46 AM	82.1	72.8	76.3	66.2	894	10,728	77.5
124	10.33	05/02/18	2:37:46 AM	82.0	72.8	76.3	66.1	894	10,728	77.4
125	10.42	05/02/18	2:42:46 AM	81.9	72.9	76.3	66.0	894	10,728	77.4
126	10.50	05/02/18	2:47:46 AM	82.3	72.9	76.2	65.1	893	10,716	77.6
127	10.58	05/02/18	2:52:46 AM	82.0	72.9	76.0	64.1	894	10,728	77.5
128	10.67	05/02/18	2:57:46 AM	82.6	73.0	75.8	63.7	894	10,728	77.8
129	10.75	05/02/18	3:02:46 AM	82.3	73.0	75.6	63.3	894	10,728	77.6
130	10.83	05/02/18	3:07:46 AM	82.1	73.0	75.4	63.3	895	10,740	77.5
131	10.92	05/02/18	3:12:46 AM	82.3	73.0	75.2	63.2	894	10,728	77.7
132	11.00	05/02/18	3:17:46 AM	83.2	73.1	75.1	63.0	895	10,740	78.1
133	11.08	05/02/18	3:22:46 AM	82.3	73.1	74.8	62.7	895	10,740	77.7
134	11.17	05/02/18	3:27:46 AM	82.4	73.1	74.7	62.6	894	10,728	77.7
135	11.25	05/02/18	3:32:46 AM	82.2	73.1	74.4	62.4	895	10,740	77.7
136	11.33	05/02/18	3:37:46 AM	82.2	73.1	74.3	62.5	896	10,752	77.7
137	11.42	05/02/18	3:42:46 AM	82.4	73.1	74.2	62.4	895	10,740	77.8
138	11.50	05/02/18	3:47:46 AM	82.3	73.2	74.2	62.3	895	10,740	77.8
139	11.58	05/02/18	3:52:46 AM	82.5	73.1	74.0	61.9	895	10,740	77.8
140	11.67	05/02/18	3:57:46 AM	82.2	73.2	73.8	61.6	896	10,752	77.7
141	11.75	05/02/18	4:02:46 AM	82.5	73.2	73.7	61.7	895	10,740	77.9
142	11.83	05/02/18	4:07:46 AM	82.3	73.2	73.6	61.7	896	10,752	77.8
143	11.92	05/02/18	4:12:46 AM	82.7	73.3	73.4	61.4	896	10,752	78.0
144	12.00	05/02/18	4:17:46 AM	82.5	73.3	73.2	61.2	895	10,740	77.9
145	12.08	05/02/18	4:22:46 AM	82.6	73.3	73.0	61.2	896	10,752	78.0
146	12.17	05/02/18	4:27:46 AM	83.2	73.3	72.9	61.0	896	10,752	78.3
147	12.25	05/02/18	4:32:46 AM	82.7	73.3	72.5	60.9	896	10,752	78.0
148	12.33	05/02/18	4:37:46 AM	83.0	73.4	72.6	61.1	895	10,740	78.2
149	12.42	05/02/18	4:42:46 AM	83.2	73.4	72.5	61.0	896	10,752	78.3
150	12.50	05/02/18	4:47:46 AM	82.8	73.5	72.4	60.7	896	10,752	78.2
151	12.58	05/02/18	4:52:46 AM	83.0	73.5	72.1	60.5	896	10,752	78.2
152	12.67	05/02/18	4:57:46 AM	82.7	73.5	72.0	60.4	895	10,740	78.1
153	12.75	05/02/18	5:02:46 AM	82.7	73.5	71.8	60.2	896	10,752	78.1
154	12.83	05/02/18	5:07:46 AM	82.8	73.5	71.9	60.4	896	10,752	78.1
155	12.92	05/02/18	5:12:46 AM	82.8	73.6	71.7	60.2	896	10,752	78.2
156	13.00	05/02/18	5:17:46 AM	82.8	73.6	71.5	60.0	897	10,764	78.2
157	13.08	05/02/18	5:22:46 AM	82.7	73.6	71.3	59.9	896	10,752	78.1
158	13.17	05/02/18	5:27:46 AM	82.6	73.6	71.4	60.0	896	10,752	78.1
159	13.25	05/02/18	5:32:46 AM	83.2	73.6	71.4	60.0	897	10,764	78.4
160	13.33	05/02/18	5:37:46 AM	82.9	73.7	71.4	60.0	896	10,752	78.3
161	13.42	05/02/18	5:42:46 AM	82.8	73.7	71.4	60.1	897	10,764	78.2
162	13.50	05/02/18	5:47:46 AM	83.2	73.7	71.4	60.2	896	10,752	78.5
163	13.58	05/02/18	5:52:46 AM	83.0	73.8	71.2	59.8	897	10,764	78.4
164	13.67	05/02/18	5:57:46 AM	82.8	73.8	71.1	59.4	896	10,752	78.3
165	13.75	05/02/18	6:02:46 AM	83.4	73.8	71.0	59.5	897	10,764	78.6
166	13.83	05/02/18	6:07:46 AM	83.1	73.8	70.9	59.2	897	10,764	78.5
167	13.92	05/02/18	6:12:46 AM	83.0	73.8	70.9	59.2	896	10,752	78.4
168	14.00	05/02/18	6:17:46 AM	83.4	73.8	70.8	59.1	897	10,764	78.6
169	14.08	05/02/18	6:22:46 AM	83.1	73.8	70.6	58.8	896	10,752	78.4
170	14.17	05/02/18	6:27:46 AM	83.6	73.9	70.3	58.7	897	10,764	78.7
171	14.25	05/02/18	6:32:46 AM	82.9	73.8	70.1	58.8	896	10,752	78.4
172	14.33	05/02/18	6:37:46 AM	83.0	73.9	70.2	58.8	896	10,752	78.4
173	14.42	05/02/18	6:42:46 AM	82.9	74.0	70.1	58.6	897	10,764	78.4
174	14.50	05/02/18	6:47:46 AM	83.1	74.0	70.0	58.7	896	10,752	78.5
175	14.58	05/02/18	6:52:46 AM	83.2	74.0	69.7	58.3	896	10,752	78.6
176	14.67	05/02/18	6:57:46 AM	83.1	74.0	69.6	58.3	896	10,752	78.5
177	14.75	05/02/18	7:02:46 AM	83.6	74.0	69.7	58.2	897	10,764	78.8
178	14.83	05/02/18	7:07:46 AM	83.6	74.0	69.6	58.0	896	10,752	78.8
179	14.92	05/02/18	7:12:46 AM	83.2	74.0	69.5	58.0	896	10,752	78.6
180	15.00	05/02/18	7:17:46 AM	83.3	74.1	69.4	58.0	896	10,752	78.7
181	15.08	05/02/18	7:22:46 AM	83.7	74.0	69.3	58.0	896	10,752	78.9
182	15.17	05/02/18	7:27:46 AM	83.4	74.1	69.2	58.0	896	10,752	78.8
183	15.25	05/02/18	7:32:46 AM	83.6	74.1	69.2	58.0	897	10,764	78.9
184	15.33	05/02/18	7:37:46 AM	83.2	74.1	69.1	58.0	896	10,752	78.6
185	15.42	05/02/18	7:42:46 AM	83.6	74.2	68.9	58.0	896	10,752	78.9
186	15.50	05/02/18	7:47:46 AM	83.3	74.2	69.1	58.2	896	10,752	78.7
187	15.58	05/02/18	7:52:46 AM	83.4	74.2	69.0	57.9	896	10,752	78.8
188	15.67	05/02/18	7:57:46 AM	83.1	74.2	68.9	57.8	896	10,752	78.7

NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
189	15.75	05/02/18	8:02:46 AM	83.2	74.2	68.9	57.6	896	10,752	78.7
190	15.83	05/02/18	8:07:46 AM	83.3	74.2	68.8	57.5	896	10,752	78.8
191	15.92	05/02/18	8:12:46 AM	83.6	74.3	68.8	57.5	896	10,752	78.9
192	16.00	05/02/18	8:17:46 AM	83.5	74.3	68.7	57.5	896	10,752	78.9
193	16.08	05/02/18	8:22:46 AM	83.4	74.3	68.7	57.5	897	10,764	78.8
194	16.17	05/02/18	8:27:46 AM	83.6	74.3	68.7	57.5	896	10,752	78.9
195	16.25	05/02/18	8:32:46 AM	84.0	74.3	68.6	57.5	896	10,752	79.1
196	16.33	05/02/18	8:37:46 AM	83.6	74.4	68.5	57.4	896	10,752	79.0
197	16.42	05/02/18	8:42:46 AM	83.7	74.3	68.6	57.6	896	10,752	79.0
198	16.50	05/02/18	8:47:46 AM	83.4	74.4	68.7	57.5	896	10,752	78.9
199	16.58	05/02/18	8:52:46 AM	83.7	74.4	68.5	57.4	897	10,764	79.0
200	16.67	05/02/18	8:57:46 AM	83.4	74.4	68.5	57.4	896	10,752	78.9
201	16.75	05/02/18	9:02:46 AM	83.5	74.4	68.4	57.7	896	10,752	79.0
202	16.83	05/02/18	9:07:46 AM	83.7	74.4	68.4	57.5	896	10,752	79.1
203	16.92	05/02/18	9:12:46 AM	83.6	74.4	68.3	57.5	896	10,752	79.0
204	17.00	05/02/18	9:17:46 AM	84.0	74.4	68.5	57.7	896	10,752	79.2
205	17.08	05/02/18	9:22:46 AM	83.7	74.5	68.5	58.1	897	10,764	79.1
206	17.17	05/02/18	9:27:46 AM	83.6	74.5	68.6	58.4	896	10,752	79.0
207	17.25	05/02/18	9:32:46 AM	83.7	74.5	68.6	58.3	896	10,752	79.1
208	17.33	05/02/18	9:37:46 AM	83.5	74.5	68.5	58.4	896	10,752	79.0
209	17.42	05/02/18	9:42:46 AM	83.8	74.6	68.5	58.5	897	10,764	79.2
210	17.50	05/02/18	9:47:46 AM	83.9	74.6	68.5	58.4	896	10,752	79.2
211	17.58	05/02/18	9:52:46 AM	83.7	74.6	68.5	58.4	896	10,752	79.1
212	17.67	05/02/18	9:57:46 AM	83.9	74.6	68.5	58.4	896	10,752	79.3
213	17.75	05/02/18	10:02:46 AM	84.2	74.6	68.5	58.4	897	10,764	79.4
214	17.83	05/02/18	10:07:46 AM	84.2	74.6	68.5	58.4	896	10,752	79.4
215	17.92	05/02/18	10:12:46 AM	83.8	74.6	68.3	58.4	896	10,752	79.2
216	18.00	05/02/18	10:17:46 AM	83.8	74.6	68.3	58.3	896	10,752	79.2
217	18.08	05/02/18	10:22:46 AM	84.7	74.6	68.3	58.1	896	10,752	79.7
218	18.17	05/02/18	10:27:46 AM	83.8	74.7	68.3	58.1	897	10,764	79.3
219	18.25	05/02/18	10:32:46 AM	83.8	74.7	68.4	58.2	896	10,752	79.2
220	18.33	05/02/18	10:37:46 AM	84.2	74.6	68.3	57.7	896	10,752	79.4
221	18.42	05/02/18	10:42:46 AM	84.0	74.7	68.0	57.7	896	10,752	79.4
222	18.50	05/02/18	10:47:46 AM	84.1	74.8	68.1	57.6	896	10,752	79.4
223	18.58	05/02/18	10:52:46 AM	83.9	74.6	68.0	57.8	896	10,752	79.3
224	18.67	05/02/18	10:57:46 AM	84.1	74.8	68.1	57.5	897	10,764	79.4
225	18.75	05/02/18	11:02:46 AM	84.3	74.8	68.3	57.8	896	10,752	79.5
226	18.83	05/02/18	11:07:46 AM	84.2	74.8	68.3	57.2	896	10,752	79.5
227	18.92	05/02/18	11:12:46 AM	83.7	74.8	68.3	57.5	896	10,752	79.2
228	19.00	05/02/18	11:17:46 AM	84.1	74.8	68.2	57.0	896	10,752	79.4
229	19.08	05/02/18	11:22:46 AM	84.0	74.8	68.3	57.2	897	10,764	79.4
230	19.17	05/02/18	11:27:46 AM	84.1	74.8	68.4	57.1	896	10,752	79.4
231	19.25	05/02/18	11:32:46 AM	83.9	74.8	68.5	57.2	896	10,752	79.4
232	19.33	05/02/18	11:37:46 AM	84.2	74.8	68.5	57.4	896	10,752	79.5
233	19.42	05/02/18	11:42:46 AM	83.8	74.8	68.3	57.4	897	10,764	79.3
234	19.50	05/02/18	11:47:46 AM	84.3	74.9	68.5	57.8	896	10,752	79.6
235	19.58	05/02/18	11:52:46 AM	84.3	74.9	68.7	58.1	896	10,752	79.6
236	19.67	05/02/18	11:57:46 AM	84.5	75.0	68.7	57.7	897	10,764	79.8
237	19.75	05/02/18	12:02:46 PM	84.4	74.9	68.7	58.0	896	10,752	79.7
238	19.83	05/02/18	12:07:46 PM	84.3	74.9	68.8	57.9	897	10,764	79.6
239	19.92	05/02/18	12:12:46 PM	84.3	75.0	68.5	57.7	896	10,752	79.6
240	20.00	05/02/18	12:17:46 PM	84.2	75.0	68.4	57.7	897	10,764	79.6
241	20.08	05/02/18	12:22:46 PM	84.3	75.0	68.5	57.8	896	10,752	79.7
242	20.17	05/02/18	12:27:46 PM	84.4	75.0	68.6	57.6	896	10,752	79.7
243	20.25	05/02/18	12:32:46 PM	84.9	75.0	68.7	57.8	897	10,764	80.0
244	20.33	05/02/18	12:37:46 PM	84.3	75.1	68.8	58.3	896	10,752	79.7
245	20.42	05/02/18	12:42:46 PM	85.0	75.0	69.0	57.6	897	10,764	80.0
246	20.50	05/02/18	12:47:46 PM	84.4	75.0	68.8	57.4	896	10,752	79.7
247	20.58	05/02/18	12:52:46 PM	84.2	75.1	68.7	57.3	896	10,752	79.6
248	20.67	05/02/18	12:57:46 PM	84.2	75.1	68.7	57.8	897	10,764	79.6
249	20.75	05/02/18	1:02:46 PM	84.3	75.1	68.7	57.4	896	10,752	79.7
250	20.83	05/02/18	1:07:46 PM	84.6	75.1	68.7	57.9	896	10,752	79.8
251	20.92	05/02/18	1:12:46 PM	84.6	75.2	68.8	57.5	897	10,764	79.9
252	21.00	05/02/18	1:17:46 PM	84.1	75.1	68.9	58.1	896	10,752	79.6
253	21.08	05/02/18	1:22:46 PM	84.6	75.2	69.1	57.8	896	10,752	79.9
254	21.17	05/02/18	1:27:46 PM	84.3	75.2	69.1	57.8	897	10,764	79.8

NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
255	21.25	05/02/18	1:32:46 PM	84.7	75.2	68.9	57.4	896	10,752	79.9
256	21.33	05/02/18	1:37:46 PM	84.7	75.2	68.8	57.8	896	10,752	79.9
257	21.42	05/02/18	1:42:46 PM	84.6	75.2	68.9	57.8	897	10,764	79.9
258	21.50	05/02/18	1:47:46 PM	84.6	75.2	68.9	57.7	896	10,752	79.9
259	21.58	05/02/18	1:52:46 PM	84.5	75.2	69.0	58.3	896	10,752	79.9
260	21.67	05/02/18	1:57:46 PM	84.3	75.3	68.9	58.4	897	10,764	79.8
261	21.75	05/02/18	2:02:46 PM	84.8	75.2	68.9	58.3	896	10,752	80.0
262	21.83	05/02/18	2:07:46 PM	84.3	75.2	69.0	58.6	896	10,752	79.8
263	21.92	05/02/18	2:12:46 PM	84.5	75.2	68.9	59.0	896	10,752	79.9
264	22.00	05/02/18	2:17:46 PM	84.3	75.2	69.0	58.8	897	10,764	79.8
265	22.08	05/02/18	2:22:46 PM	84.6	75.3	69.3	59.0	896	10,752	79.9
266	22.17	05/02/18	2:27:46 PM	84.5	75.3	69.4	59.1	896	10,752	79.9
267	22.25	05/02/18	2:32:46 PM	84.4	75.3	69.6	59.3	897	10,764	79.9
268	22.33	05/02/18	2:37:46 PM	84.3	75.3	69.6	59.4	896	10,752	79.8
269	22.42	05/02/18	2:42:46 PM	84.4	75.4	69.7	59.3	896	10,752	79.9
270	22.50	05/02/18	2:47:46 PM	84.7	75.3	69.6	59.0	896	10,752	80.0
271	22.58	05/02/18	2:52:46 PM	84.5	75.3	69.5	58.9	897	10,764	79.9
272	22.67	05/02/18	2:57:46 PM	84.3	75.5	69.6	58.8	896	10,752	79.9
273	22.75	05/02/18	3:02:46 PM	84.6	75.4	69.4	59.2	896	10,752	80.0
274	22.83	05/02/18	3:07:46 PM	84.6	75.4	69.6	59.6	896	10,752	80.0
275	22.92	05/02/18	3:12:46 PM	84.6	75.5	69.8	59.8	896	10,752	80.0
276	23.00	05/02/18	3:17:46 PM	84.5	75.4	69.7	59.7	897	10,764	80.0
277	23.08	05/02/18	3:22:46 PM	84.7	75.5	69.7	59.8	896	10,752	80.1
278	23.17	05/02/18	3:27:46 PM	84.8	75.5	69.7	60.2	896	10,752	80.1
279	23.25	05/02/18	3:32:46 PM	84.6	75.4	69.8	60.0	896	10,752	80.0
280	23.33	05/02/18	3:37:46 PM	84.9	75.5	69.7	60.4	896	10,752	80.2
281	23.42	05/02/18	3:42:46 PM	84.7	75.5	69.9	59.9	897	10,764	80.1
282	23.50	05/02/18	3:47:46 PM	84.6	75.6	70.0	59.8	896	10,752	80.1
283	23.58	05/02/18	3:52:46 PM	84.9	75.5	70.0	59.7	896	10,752	80.2
284	23.67	05/02/18	3:57:46 PM	85.0	75.5	69.9	59.7	897	10,764	80.3
285	23.75	05/02/18	4:02:46 PM	84.9	75.5	69.7	59.7	896	10,752	80.2
286	23.83	05/02/18	4:07:46 PM	84.7	75.5	69.6	59.6	896	10,752	80.1
287	23.92	05/02/18	4:12:46 PM	84.7	75.6	69.6	59.5	896	10,752	80.2
288	24.00	05/02/18	4:17:46 PM	84.6	75.6	69.6	59.5	897	10,764	80.1
289	24.08	05/02/18	4:22:46 PM	84.7	75.6	69.7	59.5	896	10,752	80.2
290	24.17	05/02/18	4:27:46 PM	84.8	75.6	69.6	59.5	896	10,752	80.2
291	24.25	05/02/18	4:32:46 PM	85.4	75.6	69.7	59.5	897	10,764	80.5
292	24.33	05/02/18	4:37:46 PM	84.9	75.6	69.8	59.6	896	10,752	80.3
293	24.42	05/02/18	4:42:46 PM	84.6	75.6	69.8	59.3	896	10,752	80.1
294	24.50	05/02/18	4:47:46 PM	84.7	75.6	69.7	59.1	896	10,752	80.2
295	24.58	05/02/18	4:52:46 PM	84.9	75.6	69.5	59.1	897	10,764	80.2
296	24.67	05/02/18	4:57:46 PM	84.8	75.7	69.4	59.2	896	10,752	80.3
297	24.75	05/02/18	5:02:46 PM	84.8	75.7	69.2	59.2	897	10,764	80.2
298	24.83	05/02/18	5:07:46 PM	84.7	75.7	69.1	59.1	896	10,752	80.2
299	24.92	05/02/18	5:12:46 PM	84.7	75.7	69.0	58.9	896	10,752	80.2
300	25.00	05/02/18	5:17:46 PM	84.9	75.7	68.9	58.9	897	10,764	80.3
301	25.08	05/02/18	5:22:46 PM	85.2	75.7	68.9	58.8	896	10,752	80.4
302	25.17	05/02/18	5:27:46 PM	85.2	75.7	68.9	58.9	896	10,752	80.5
303	25.25	05/02/18	5:32:46 PM	84.9	75.7	68.9	58.9	897	10,764	80.3
304	25.33	05/02/18	5:37:46 PM	84.9	75.7	68.8	58.8	896	10,752	80.3
305	25.42	05/02/18	5:42:46 PM	85.3	75.7	68.7	58.6	897	10,764	80.5
306	25.50	05/02/18	5:47:46 PM	84.7	75.8	68.7	58.7	897	10,764	80.2
307	25.58	05/02/18	5:52:46 PM	84.9	75.8	68.5	58.7	896	10,752	80.4
308	25.67	05/02/18	5:57:46 PM	84.9	75.8	68.4	58.8	897	10,764	80.4
309	25.75	05/02/18	6:02:46 PM	85.2	75.8	68.3	58.4	896	10,752	80.5
310	25.83	05/02/18	6:07:46 PM	85.3	75.8	68.1	58.4	897	10,764	80.5
311	25.92	05/02/18	6:12:46 PM	84.8	75.8	68.2	58.4	896	10,752	80.3
312	26.00	05/02/18	6:17:46 PM	85.3	75.8	68.3	58.0	897	10,764	80.6
313	26.08	05/02/18	6:22:46 PM	84.9	75.8	68.3	58.0	896	10,752	80.3
314	26.17	05/02/18	6:27:46 PM	85.1	75.8	68.5	58.2	898	10,776	80.5
315	26.25	05/02/18	6:32:46 PM	85.3	75.9	68.3	58.0	896	10,752	80.6
316	26.33	05/02/18	6:37:46 PM	84.9	75.9	68.4	58.1	896	10,752	80.4
317	26.42	05/02/18	6:42:46 PM	85.3	75.9	68.4	57.8	897	10,764	80.6
318	26.50	05/02/18	6:47:46 PM	85.2	75.8	68.0	57.3	897	10,764	80.5
319	26.58	05/02/18	6:52:46 PM	85.2	75.9	67.8	57.1	897	10,764	80.5
320	26.67	05/02/18	6:57:46 PM	84.9	75.9	67.6	56.9	896	10,752	80.4

NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
321	26.75	05/02/18	7:02:46 PM	85.0	75.9	67.1	56.8	897	10,764	80.5
322	26.83	05/02/18	7:07:46 PM	84.9	75.9	66.4	56.7	897	10,764	80.4
323	26.92	05/02/18	7:12:46 PM	85.0	75.9	66.0	56.7	897	10,764	80.5
324	27.00	05/02/18	7:17:46 PM	85.3	76.0	65.7	57.0	897	10,764	80.6
325	27.08	05/02/18	7:22:46 PM	85.4	76.0	65.6	57.3	897	10,764	80.7
326	27.17	05/02/18	7:27:46 PM	84.6	76.0	65.4	57.3	897	10,764	80.3
327	27.25	05/02/18	7:32:46 PM	85.4	76.0	65.2	57.5	897	10,764	80.7
328	27.33	05/02/18	7:37:46 PM	85.3	75.9	65.0	57.6	896	10,752	80.6
329	27.42	05/02/18	7:42:46 PM	85.3	76.0	64.9	57.7	897	10,764	80.6
330	27.50	05/02/18	7:47:46 PM	85.2	76.0	64.8	57.9	897	10,764	80.6
331	27.58	05/02/18	7:52:46 PM	85.0	76.0	64.8	58.0	897	10,764	80.5
332	27.67	05/02/18	7:57:46 PM	85.0	76.0	65.0	58.1	897	10,764	80.5
333	27.75	05/02/18	8:02:46 PM	85.4	76.0	65.2	58.3	897	10,764	80.7
334	27.83	05/02/18	8:07:46 PM	85.3	76.0	65.7	59.6	897	10,764	80.6
335	27.92	05/02/18	8:12:46 PM	85.6	76.1	65.9	59.6	896	10,752	80.8
336	28.00	05/02/18	8:17:46 PM	85.2	76.1	66.0	59.7	897	10,764	80.6
337	28.08	05/02/18	8:22:46 PM	85.3	76.1	66.4	60.0	897	10,764	80.7
338	28.17	05/02/18	8:27:46 PM	85.5	76.0	66.6	59.9	897	10,764	80.8
339	28.25	05/02/18	8:32:46 PM	85.2	76.1	66.8	59.8	897	10,764	80.6
340	28.33	05/02/18	8:37:46 PM	85.0	76.1	67.1	59.7	897	10,764	80.6
341	28.42	05/02/18	8:42:46 PM	85.2	76.1	67.3	59.7	897	10,764	80.7
342	28.50	05/02/18	8:47:46 PM	85.4	76.1	67.5	59.1	897	10,764	80.7
343	28.58	05/02/18	8:52:46 PM	85.4	76.2	67.6	59.0	897	10,764	80.8
344	28.67	05/02/18	8:57:46 PM	85.3	76.1	67.7	59.0	897	10,764	80.7
345	28.75	05/02/18	9:02:46 PM	85.5	76.1	67.7	58.5	897	10,764	80.8
346	28.83	05/02/18	9:07:46 PM	85.3	76.1	67.7	58.4	897	10,764	80.7
347	28.92	05/02/18	9:12:46 PM	85.4	76.2	67.8	58.4	897	10,764	80.8
348	29.00	05/02/18	9:17:46 PM	85.4	76.2	67.9	58.4	896	10,752	80.8
349	29.08	05/02/18	9:22:46 PM	85.4	76.2	67.9	58.2	897	10,764	80.8
350	29.17	05/02/18	9:27:46 PM	85.4	76.2	67.9	58.0	897	10,764	80.8
351	29.25	05/02/18	9:32:46 PM	85.3	76.2	68.0	58.0	897	10,764	80.8
352	29.33	05/02/18	9:37:46 PM	85.7	76.2	67.8	57.8	897	10,764	81.0
353	29.42	05/02/18	9:42:46 PM	85.4	76.2	67.7	57.7	896	10,752	80.8
354	29.50	05/02/18	9:47:46 PM	85.5	76.2	67.6	57.6	897	10,764	80.8
355	29.58	05/02/18	9:52:46 PM	85.4	76.2	67.4	57.5	897	10,764	80.8
356	29.67	05/02/18	9:57:46 PM	85.4	76.2	67.4	57.3	897	10,764	80.8
357	29.75	05/02/18	10:02:46 PM	85.3	76.2	67.3	57.2	896	10,752	80.8
358	29.83	05/02/18	10:07:46 PM	85.6	76.2	67.5	57.1	897	10,764	80.9
359	29.92	05/02/18	10:12:46 PM	85.7	76.2	67.5	57.0	897	10,764	81.0
360	30.00	05/02/18	10:17:46 PM	85.4	76.3	67.5	57.0	897	10,764	80.8
361	30.08	05/02/18	10:22:46 PM	85.4	76.3	67.5	56.9	896	10,752	80.8
362	30.17	05/02/18	10:27:46 PM	85.5	76.3	67.6	56.8	897	10,764	80.9
363	30.25	05/02/18	10:32:46 PM	85.7	76.3	67.5	56.9	897	10,764	81.0
364	30.33	05/02/18	10:37:46 PM	85.2	76.3	67.5	56.8	897	10,764	80.8
365	30.42	05/02/18	10:42:46 PM	85.2	76.3	67.6	56.8	897	10,764	80.8
366	30.50	05/02/18	10:47:46 PM	85.7	76.3	67.5	56.7	896	10,752	81.0
367	30.58	05/02/18	10:52:46 PM	85.5	76.3	67.5	56.7	897	10,764	80.9
368	30.67	05/02/18	10:57:46 PM	85.6	76.4	67.5	56.7	897	10,764	81.0
369	30.75	05/02/18	11:02:46 PM	85.5	76.3	67.5	56.7	897	10,764	80.9
370	30.83	05/02/18	11:07:46 PM	85.4	76.3	67.5	56.6	896	10,752	80.9
371	30.92	05/02/18	11:12:46 PM	85.6	76.4	67.4	56.6	897	10,764	81.0
372	31.00	05/02/18	11:17:46 PM	85.5	76.4	67.5	56.5	897	10,764	80.9
373	31.08	05/02/18	11:22:46 PM	85.5	76.4	67.5	56.5	897	10,764	80.9
374	31.17	05/02/18	11:27:46 PM	85.8	76.3	67.6	56.5	897	10,764	81.0
375	31.25	05/02/18	11:32:46 PM	85.5	76.4	67.6	56.4	896	10,752	80.9
376	31.33	05/02/18	11:37:46 PM	85.2	76.4	67.5	56.3	897	10,764	80.8
377	31.42	05/02/18	11:42:46 PM	85.6	76.4	67.6	56.3	897	10,764	81.0
378	31.50	05/02/18	11:47:46 PM	85.8	76.4	67.6	56.1	897	10,764	81.1
379	31.58	05/02/18	11:52:46 PM	85.7	76.4	67.6	56.1	896	10,752	81.0
380	31.67	05/02/18	11:57:46 PM	85.7	76.4	67.6	56.2	897	10,764	81.0
381	31.75	05/03/18	12:02:46 AM	85.6	76.3	67.6	56.1	897	10,764	81.0
382	31.83	05/03/18	12:07:46 AM	85.5	76.4	67.6	56.2	896	10,752	81.0
383	31.92	05/03/18	12:12:46 AM	85.3	76.4	67.7	56.2	897	10,764	80.9
384	32.00	05/03/18	12:17:46 AM	85.9	76.4	67.7	56.3	897	10,764	81.2
385	32.08	05/03/18	12:22:46 AM	85.8	76.4	67.7	56.2	897	10,764	81.1
386	32.17	05/03/18	12:27:46 AM	85.7	76.5	67.7	56.2	897	10,764	81.1

NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
387	32.25	05/03/18	12:32:46 AM	85.6	76.4	67.7	56.0	896	10,752	81.0
388	32.33	05/03/18	12:37:46 AM	85.7	76.5	67.6	55.9	897	10,764	81.1
389	32.42	05/03/18	12:42:46 AM	85.6	76.4	67.6	55.9	897	10,764	81.0
390	32.50	05/03/18	12:47:46 AM	85.7	76.5	67.6	56.0	897	10,764	81.1
391	32.58	05/03/18	12:52:46 AM	85.8	76.5	67.6	55.9	896	10,752	81.2
392	32.67	05/03/18	12:57:46 AM	85.6	76.5	67.5	55.7	897	10,764	81.0
393	32.75	05/03/18	1:02:46 AM	85.7	76.5	67.5	55.5	897	10,764	81.1
394	32.83	05/03/18	1:07:46 AM	85.4	76.6	67.5	55.5	897	10,764	81.0
395	32.92	05/03/18	1:12:46 AM	85.7	76.5	67.5	55.3	896	10,752	81.1
396	33.00	05/03/18	1:17:46 AM	85.7	76.6	67.4	55.0	897	10,764	81.1
397	33.08	05/03/18	1:22:46 AM	85.8	76.5	67.4	54.8	897	10,764	81.1
398	33.17	05/03/18	1:27:46 AM	86.1	76.6	67.4	54.8	897	10,764	81.3
399	33.25	05/03/18	1:32:46 AM	85.8	76.6	67.4	54.6	897	10,764	81.2
400	33.33	05/03/18	1:37:46 AM	85.5	76.6	67.4	54.6	897	10,764	81.0
401	33.42	05/03/18	1:42:46 AM	85.9	76.6	67.4	54.5	897	10,764	81.2
402	33.50	05/03/18	1:47:46 AM	86.1	76.6	67.3	54.4	896	10,752	81.3
403	33.58	05/03/18	1:52:46 AM	85.8	76.6	67.3	54.4	897	10,764	81.2
404	33.67	05/03/18	1:57:46 AM	85.8	76.6	67.2	54.2	897	10,764	81.2
405	33.75	05/03/18	2:02:46 AM	85.7	76.6	67.1	54.2	897	10,764	81.2
406	33.83	05/03/18	2:07:46 AM	85.7	76.6	67.0	54.1	897	10,764	81.2
407	33.92	05/03/18	2:12:46 AM	86.0	76.6	67.0	54.1	897	10,764	81.3
408	34.00	05/03/18	2:17:46 AM	86.0	76.6	67.0	54.2	898	10,776	81.3
409	34.08	05/03/18	2:22:46 AM	86.0	76.7	67.0	54.0	897	10,764	81.4
410	34.17	05/03/18	2:27:46 AM	86.0	76.7	66.8	53.9	897	10,764	81.4
411	34.25	05/03/18	2:32:46 AM	86.0	76.7	66.7	53.9	897	10,764	81.3
412	34.33	05/03/18	2:37:46 AM	85.8	76.6	66.6	53.7	898	10,776	81.2
413	34.42	05/03/18	2:42:46 AM	86.0	76.7	66.4	53.5	897	10,764	81.3
414	34.50	05/03/18	2:47:46 AM	85.7	76.6	66.3	53.6	897	10,764	81.2
415	34.58	05/03/18	2:52:46 AM	85.6	76.7	66.1	53.4	897	10,764	81.2
416	34.67	05/03/18	2:57:46 AM	85.8	76.7	66.0	53.4	897	10,764	81.3
417	34.75	05/03/18	3:02:46 AM	86.0	76.7	65.9	53.2	898	10,776	81.4
418	34.83	05/03/18	3:07:46 AM	85.7	76.7	65.9	53.2	897	10,764	81.2
419	34.92	05/03/18	3:12:46 AM	86.0	76.8	65.9	53.1	898	10,776	81.4
420	35.00	05/03/18	3:17:46 AM	86.1	76.8	65.8	53.1	897	10,764	81.4
421	35.08	05/03/18	3:22:46 AM	86.3	76.8	65.8	53.1	897	10,764	81.5
422	35.17	05/03/18	3:27:46 AM	86.1	76.8	65.8	53.2	898	10,776	81.4
423	35.25	05/03/18	3:32:46 AM	85.9	76.7	65.7	53.3	897	10,764	81.3
424	35.33	05/03/18	3:37:46 AM	86.0	76.8	65.4	53.2	897	10,764	81.4
425	35.42	05/03/18	3:42:46 AM	86.0	76.8	65.4	53.4	898	10,776	81.4
426	35.50	05/03/18	3:47:46 AM	85.8	76.7	65.2	53.2	897	10,764	81.3
427	35.58	05/03/18	3:52:46 AM	86.2	76.8	65.2	53.3	897	10,764	81.5
428	35.67	05/03/18	3:57:46 AM	86.0	76.8	65.2	53.3	898	10,776	81.4
429	35.75	05/03/18	4:02:46 AM	86.1	76.8	65.0	53.1	897	10,764	81.4
430	35.83	05/03/18	4:07:46 AM	86.3	76.8	65.1	53.2	897	10,764	81.5
431	35.92	05/03/18	4:12:46 AM	85.9	76.8	65.2	53.2	898	10,776	81.3
432	36.00	05/03/18	4:17:46 AM	86.0	76.8	65.2	53.3	897	10,764	81.4
433	36.08	05/03/18	4:22:46 AM	86.1	76.8	65.1	53.4	897	10,764	81.5
434	36.17	05/03/18	4:27:46 AM	86.1	76.8	65.1	53.3	898	10,776	81.5
435	36.25	05/03/18	4:32:46 AM	85.9	76.8	65.1	53.4	897	10,764	81.4
436	36.33	05/03/18	4:37:46 AM	85.7	76.8	65.1	53.4	897	10,764	81.3
437	36.42	05/03/18	4:42:46 AM	86.0	76.9	65.0	53.3	897	10,764	81.5
438	36.50	05/03/18	4:47:46 AM	86.3	76.9	65.0	53.4	898	10,776	81.6
439	36.58	05/03/18	4:52:46 AM	86.2	76.9	65.1	53.4	897	10,764	81.5
440	36.67	05/03/18	4:57:46 AM	86.1	76.9	65.1	53.5	898	10,776	81.5
441	36.75	05/03/18	5:02:46 AM	86.2	76.9	65.1	53.4	897	10,764	81.5
442	36.83	05/03/18	5:07:46 AM	86.1	76.9	65.0	53.4	897	10,764	81.5
443	36.92	05/03/18	5:12:46 AM	86.5	76.9	65.0	53.3	897	10,764	81.7
444	37.00	05/03/18	5:17:46 AM	86.0	76.9	64.8	53.2	898	10,776	81.5
445	37.08	05/03/18	5:22:46 AM	86.3	76.9	64.9	53.2	897	10,764	81.6
446	37.17	05/03/18	5:27:46 AM	86.0	76.9	65.0	53.4	897	10,764	81.4
447	37.25	05/03/18	5:32:46 AM	86.0	76.9	65.0	53.4	898	10,776	81.5
448	37.33	05/03/18	5:37:46 AM	86.3	76.9	65.1	53.5	897	10,764	81.6
449	37.42	05/03/18	5:42:46 AM	86.0	76.9	65.2	53.4	898	10,776	81.5
450	37.50	05/03/18	5:47:46 AM	86.3	77.0	65.1	53.4	897	10,764	81.6
451	37.58	05/03/18	5:52:46 AM	86.4	77.0	65.3	53.7	897	10,764	81.7
452	37.67	05/03/18	5:57:46 AM	86.4	77.0	65.3	53.7	897	10,764	81.7

NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
453	37.75	05/03/18	6:02:46 AM	85.9	77.0	65.3	53.6	898	10,776	81.5
454	37.83	05/03/18	6:07:46 AM	86.5	77.0	65.3	53.4	897	10,764	81.7
455	37.92	05/03/18	6:12:46 AM	86.2	76.9	65.2	53.1	897	10,764	81.5
456	38.00	05/03/18	6:17:46 AM	86.2	77.0	65.1	53.1	898	10,776	81.6
457	38.08	05/03/18	6:22:46 AM	86.2	76.9	65.1	53.1	897	10,764	81.6
458	38.17	05/03/18	6:27:46 AM	86.6	76.9	65.0	53.2	897	10,764	81.7
459	38.25	05/03/18	6:32:46 AM	85.9	77.0	64.8	53.0	897	10,764	81.4
460	38.33	05/03/18	6:37:46 AM	86.0	77.0	64.7	53.0	898	10,776	81.5
461	38.42	05/03/18	6:42:46 AM	85.8	77.0	64.8	53.0	897	10,764	81.4
462	38.50	05/03/18	6:47:46 AM	86.3	77.0	64.9	53.2	897	10,764	81.7
463	38.58	05/03/18	6:52:46 AM	86.0	77.0	64.9	53.4	898	10,776	81.5
464	38.67	05/03/18	6:57:46 AM	86.3	77.0	64.9	53.4	897	10,764	81.7
465	38.75	05/03/18	7:02:46 AM	86.3	77.0	65.0	53.5	897	10,764	81.6
466	38.83	05/03/18	7:07:46 AM	86.4	77.0	65.1	53.8	898	10,776	81.7
467	38.92	05/03/18	7:12:46 AM	86.5	77.0	65.1	53.9	897	10,764	81.8
468	39.00	05/03/18	7:17:46 AM	86.2	77.0	65.0	53.8	898	10,776	81.6
469	39.08	05/03/18	7:22:46 AM	86.4	77.0	65.0	53.9	897	10,764	81.7
470	39.17	05/03/18	7:27:46 AM	86.3	77.0	64.9	53.9	898	10,776	81.6
471	39.25	05/03/18	7:32:46 AM	86.3	77.0	64.9	54.0	897	10,764	81.6
472	39.33	05/03/18	7:37:46 AM	86.4	77.0	65.0	53.9	897	10,764	81.7
473	39.42	05/03/18	7:42:46 AM	86.2	77.0	65.0	53.9	898	10,776	81.6
474	39.50	05/03/18	7:47:46 AM	86.6	77.1	65.0	54.0	897	10,764	81.9
475	39.58	05/03/18	7:52:46 AM	86.2	77.1	65.1	54.2	898	10,776	81.6
476	39.67	05/03/18	7:57:46 AM	86.6	77.1	65.2	54.3	897	10,764	81.8
477	39.75	05/03/18	8:02:46 AM	86.3	77.1	65.1	54.3	898	10,776	81.7
478	39.83	05/03/18	8:07:46 AM	86.3	77.1	65.2	54.4	897	10,764	81.7
479	39.92	05/03/18	8:12:46 AM	86.1	77.1	65.3	54.4	898	10,776	81.6
480	40.00	05/03/18	8:17:46 AM	86.4	77.1	65.2	54.4	897	10,764	81.8
481	40.08	05/03/18	8:22:46 AM	86.7	77.1	65.2	54.3	898	10,776	81.9
482	40.17	05/03/18	8:27:46 AM	86.5	77.2	65.3	54.7	897	10,764	81.8
483	40.25	05/03/18	8:32:46 AM	86.7	77.2	65.5	55.1	898	10,776	81.9
484	40.33	05/03/18	8:37:46 AM	86.3	77.1	65.5	54.9	897	10,764	81.7
485	40.42	05/03/18	8:42:46 AM	86.6	77.2	65.4	54.5	898	10,776	81.9
486	40.50	05/03/18	8:47:46 AM	86.1	77.2	65.4	54.4	897	10,764	81.6
487	40.58	05/03/18	8:52:46 AM	86.3	77.2	65.4	54.4	897	10,764	81.8
488	40.67	05/03/18	8:57:46 AM	86.3	77.2	65.4	54.2	898	10,776	81.8
489	40.75	05/03/18	9:02:46 AM	86.6	77.2	65.1	54.2	897	10,764	81.9
490	40.83	05/03/18	9:07:46 AM	86.6	77.2	64.6	54.0	898	10,776	81.9
491	40.92	05/03/18	9:12:46 AM	86.5	77.3	64.5	54.0	897	10,764	81.9
492	41.00	05/03/18	9:17:46 AM	86.6	77.2	64.3	54.1	897	10,764	81.9
493	41.08	05/03/18	9:22:46 AM	86.4	77.2	64.1	54.2	898	10,776	81.8
494	41.17	05/03/18	9:27:46 AM	86.2	77.2	64.0	54.3	897	10,764	81.7
495	41.25	05/03/18	9:32:46 AM	86.6	77.2	64.1	54.6	898	10,776	81.9
496	41.33	05/03/18	9:37:46 AM	86.6	77.3	64.2	54.5	897	10,764	81.9
497	41.42	05/03/18	9:42:46 AM	86.3	77.3	64.1	54.8	898	10,776	81.8
498	41.50	05/03/18	9:47:46 AM	86.6	77.3	64.1	54.8	897	10,764	81.9
499	41.58	05/03/18	9:52:46 AM	86.5	77.3	64.1	54.9	897	10,764	81.9
500	41.67	05/03/18	9:57:46 AM	86.6	77.3	64.1	55.2	898	10,776	81.9
501	41.75	05/03/18	10:02:46 AM	86.5	77.3	64.2	55.1	897	10,764	81.9
502	41.83	05/03/18	10:07:46 AM	86.4	77.3	64.2	55.3	898	10,776	81.8
503	41.92	05/03/18	10:12:46 AM	86.7	77.3	64.1	55.3	897	10,764	82.0
504	42.00	05/03/18	10:17:46 AM	86.6	77.3	64.2	55.5	898	10,776	81.9
505	42.08	05/03/18	10:22:46 AM	86.3	77.3	64.4	55.6	897	10,764	81.8
506	42.17	05/03/18	10:27:46 AM	86.4	77.3	64.5	55.5	898	10,776	81.9
507	42.25	05/03/18	10:32:46 AM	86.6	77.3	64.3	55.5	897	10,764	82.0
508	42.33	05/03/18	10:37:46 AM	86.5	77.3	64.4	55.7	898	10,776	81.9
509	42.42	05/03/18	10:42:46 AM	86.3	77.3	64.4	56.3	897	10,764	81.8
510	42.50	05/03/18	10:47:46 AM	86.6	77.4	64.7	56.6	898	10,776	82.0
511	42.58	05/03/18	10:52:46 AM	86.8	77.4	64.8	56.7	898	10,776	82.1
512	42.67	05/03/18	10:57:46 AM	86.4	77.3	65.0	57.0	897	10,764	81.9
513	42.75	05/03/18	11:02:46 AM	86.4	77.4	65.2	57.0	898	10,776	81.9
514	42.83	05/03/18	11:07:46 AM	86.7	77.4	65.4	57.5	898	10,776	82.0
515	42.92	05/03/18	11:12:46 AM	86.6	77.4	65.5	57.6	898	10,776	82.0
516	43.00	05/03/18	11:17:46 AM	86.4	77.4	65.6	58.1	898	10,776	81.9
517	43.08	05/03/18	11:22:46 AM	86.6	77.4	65.7	58.1	898	10,776	82.0
518	43.17	05/03/18	11:27:46 AM	86.4	77.4	65.9	58.3	898	10,776	81.9

NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
519	43.25	05/03/18	11:32:46 AM	86.6	77.4	66.0	58.4	899	10,788	82.0
520	43.33	05/03/18	11:37:46 AM	86.4	77.4	66.2	58.5	898	10,776	81.9
521	43.42	05/03/18	11:42:46 AM	86.9	77.4	66.3	58.7	898	10,776	82.2
522	43.50	05/03/18	11:47:46 AM	86.6	77.4	66.4	59.1	898	10,776	82.0
523	43.58	05/03/18	11:52:46 AM	86.6	77.4	66.8	59.9	898	10,776	82.0
524	43.67	05/03/18	11:57:46 AM	86.7	77.5	67.1	59.6	898	10,776	82.1
525	43.75	05/03/18	12:02:46 PM	86.4	77.5	67.3	60.2	898	10,776	81.9
526	43.83	05/03/18	12:07:46 PM	86.7	77.5	67.4	60.1	898	10,776	82.1
527	43.92	05/03/18	12:12:46 PM	86.6	77.5	67.6	60.1	898	10,776	82.0
528	44.00	05/03/18	12:17:46 PM	86.8	77.5	67.7	60.2	898	10,776	82.1
529	44.08	05/03/18	12:22:46 PM	86.6	77.5	67.8	60.4	898	10,776	82.0
530	44.17	05/03/18	12:27:46 PM	86.9	77.5	67.9	60.4	898	10,776	82.2
531	44.25	05/03/18	12:32:46 PM	86.5	77.5	68.2	60.8	898	10,776	82.0
532	44.33	05/03/18	12:37:46 PM	86.6	77.4	68.4	60.8	898	10,776	82.0
533	44.42	05/03/18	12:42:46 PM	86.9	77.5	68.6	61.2	898	10,776	82.2
534	44.50	05/03/18	12:47:46 PM	86.6	77.5	68.9	61.3	898	10,776	82.1
535	44.58	05/03/18	12:52:46 PM	86.6	77.5	69.2	61.4	898	10,776	82.1
536	44.67	05/03/18	12:57:46 PM	86.9	77.5	69.4	61.5	897	10,764	82.2
537	44.75	05/03/18	1:02:46 PM	86.9	77.5	69.5	61.7	899	10,788	82.2
538	44.83	05/03/18	1:07:46 PM	86.8	77.5	69.6	61.6	898	10,776	82.2
539	44.92	05/03/18	1:12:46 PM	86.9	77.6	69.6	61.6	897	10,764	82.3
540	45.00	05/03/18	1:17:46 PM	86.9	77.6	69.7	61.5	898	10,776	82.3
541	45.08	05/03/18	1:22:46 PM	86.7	77.5	70.1	61.7	898	10,776	82.1
542	45.17	05/03/18	1:27:46 PM	86.9	77.5	70.3	61.7	897	10,764	82.2
543	45.25	05/03/18	1:32:46 PM	86.9	77.6	70.4	61.9	898	10,776	82.2
544	45.33	05/03/18	1:37:46 PM	87.3	77.5	70.3	61.9	898	10,776	82.4
545	45.42	05/03/18	1:42:46 PM	86.7	77.6	70.5	61.9	898	10,776	82.2
546	45.50	05/03/18	1:47:46 PM	86.9	77.5	70.4	61.9	897	10,764	82.2
547	45.58	05/03/18	1:52:46 PM	86.8	77.6	70.4	61.8	898	10,776	82.2
548	45.67	05/03/18	1:57:46 PM	87.0	77.6	70.3	61.9	898	10,776	82.3
549	45.75	05/03/18	2:02:46 PM	86.6	77.6	70.4	61.9	898	10,776	82.1
550	45.83	05/03/18	2:07:46 PM	87.2	77.6	70.4	61.9	897	10,764	82.4
551	45.92	05/03/18	2:12:46 PM	87.1	77.6	70.7	62.2	898	10,776	82.4
552	46.00	05/03/18	2:17:46 PM	86.7	77.6	71.0	62.2	898	10,776	82.2
553	46.08	05/03/18	2:22:46 PM	87.0	77.6	71.3	62.3	898	10,776	82.3
554	46.17	05/03/18	2:27:46 PM	86.8	77.6	71.5	62.5	898	10,776	82.2
555	46.25	05/03/18	2:32:46 PM	87.3	77.7	71.7	62.7	897	10,764	82.5
556	46.33	05/03/18	2:37:46 PM	86.7	77.6	71.9	63.0	898	10,776	82.1
557	46.42	05/03/18	2:42:46 PM	87.2	77.7	72.2	63.4	898	10,776	82.4
558	46.50	05/03/18	2:47:46 PM	86.6	77.7	72.5	63.8	898	10,776	82.1
559	46.58	05/03/18	2:52:46 PM	86.9	77.6	72.9	64.1	897	10,764	82.3
560	46.67	05/03/18	2:57:46 PM	87.1	77.7	73.2	64.8	897	10,764	82.4
561	46.75	05/03/18	3:02:46 PM	86.7	77.7	73.8	65.4	893	10,716	82.2
562	46.83	05/03/18	3:07:46 PM	86.8	77.7	74.2	65.8	891	10,692	82.3
563	46.92	05/03/18	3:12:46 PM	87.0	77.7	74.8	65.8	890	10,680	82.3
564	47.00	05/03/18	3:17:46 PM	87.1	77.7	75.3	66.6	891	10,692	82.4
565	47.08	05/03/18	3:22:46 PM	86.6	77.7	75.7	65.6	889	10,668	82.2
566	47.17	05/03/18	3:27:46 PM	86.9	77.7	76.0	64.9	889	10,668	82.3
567	47.25	05/03/18	3:32:46 PM	86.7	77.7	76.1	65.4	888	10,656	82.2
568	47.33	05/03/18	3:37:46 PM	86.8	77.7	76.3	66.2	889	10,668	82.2
569	47.42	05/03/18	3:42:46 PM	86.9	77.7	76.6	66.4	888	10,656	82.3
570	47.50	05/03/18	3:47:46 PM	86.9	77.7	77.0	66.3	888	10,656	82.3
571	47.58	05/03/18	3:52:46 PM	86.9	77.7	77.3	66.9	888	10,656	82.3
572	47.67	05/03/18	3:57:46 PM	86.8	77.6	77.6	66.9	888	10,656	82.2
573	47.75	05/03/18	4:02:46 PM	87.3	77.7	77.8	66.9	888	10,656	82.5
574	47.83	05/03/18	4:07:46 PM	86.9	77.7	78.0	67.3	887	10,644	82.3
575	47.92	05/03/18	4:12:46 PM	86.8	77.7	78.3	66.9	888	10,656	82.2
576	48.00	05/03/18	4:17:46 PM	86.9	77.7	78.4	67.0	887	10,644	82.3
577	48.08	05/03/18	4:22:46 PM	86.9	77.7	78.4	66.7	887	10,644	82.3
578	48.17	05/03/18	4:27:46 PM	86.9	77.7	78.5	66.6	888	10,656	82.3
579	48.25	05/03/18	4:32:46 PM	86.7	77.7	78.5	66.5	887	10,644	82.2
580	48.33	05/03/18	4:37:46 PM	86.8	77.7	78.5	67.5	889	10,668	82.3
581	48.42	05/03/18	4:42:46 PM	86.9	77.7	78.6	68.9	888	10,656	82.3
582	48.50	05/03/18	4:47:46 PM	86.9	77.7	78.8	68.4	890	10,680	82.3
583	48.58	05/03/18	4:52:46 PM	87.1	77.7	79.0	68.3	889	10,668	82.4
584	48.67	05/03/18	4:57:46 PM	86.9	77.7	79.2	67.5	891	10,692	82.3

NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
585	48.75	05/03/18	5:02:46 PM	87.3	77.7	79.3	68.0	890	10,680	82.5
586	48.83	05/03/18	5:07:46 PM	86.7	77.7	79.3	68.3	890	10,680	82.2
587	48.92	05/03/18	5:12:46 PM	86.9	77.7	79.4	68.0	891	10,692	82.3
588	49.00	05/03/18	5:17:46 PM	87.2	77.7	79.4	67.5	890	10,680	82.5
589	49.08	05/03/18	5:22:46 PM	87.4	77.8	79.0	66.1	891	10,692	82.6
590	49.17	05/03/18	5:27:46 PM	86.9	77.7	78.6	65.8	890	10,680	82.3
591	49.25	05/03/18	5:32:46 PM	87.0	77.8	78.1	65.4	890	10,680	82.4
592	49.33	05/03/18	5:37:46 PM	86.8	77.8	77.7	65.8	890	10,680	82.3
593	49.42	05/03/18	5:42:46 PM	86.8	77.8	77.3	65.0	890	10,680	82.3
594	49.50	05/03/18	5:47:46 PM	87.1	77.8	77.0	64.4	890	10,680	82.5
595	49.58	05/03/18	5:52:46 PM	86.9	77.8	76.6	63.8	890	10,680	82.3
596	49.67	05/03/18	5:57:46 PM	87.1	77.8	76.1	63.4	890	10,680	82.4
597	49.75	05/03/18	6:02:46 PM	87.3	77.8	75.8	63.1	890	10,680	82.6
598	49.83	05/03/18	6:07:46 PM	86.9	77.9	75.5	62.6	890	10,680	82.4
599	49.92	05/03/18	6:12:46 PM	87.0	77.9	75.0	62.7	890	10,680	82.4
600	50.00	05/03/18	6:17:46 PM	87.1	77.8	74.9	62.8	889	10,668	82.5
601	50.08	05/03/18	6:22:46 PM	87.1	77.8	74.6	62.6	890	10,680	82.5
602	50.17	05/03/18	6:27:46 PM	86.8	77.8	74.3	62.5	890	10,680	82.3
603	50.25	05/03/18	6:32:46 PM	87.2	77.9	74.3	62.5	889	10,668	82.5
604	50.33	05/03/18	6:37:46 PM	87.1	77.9	74.0	62.5	890	10,680	82.5
605	50.42	05/03/18	6:42:46 PM	86.8	77.9	73.8	62.3	890	10,680	82.3
606	50.50	05/03/18	6:47:46 PM	87.2	77.8	73.5	62.5	889	10,668	82.5
607	50.58	05/03/18	6:52:46 PM	87.0	77.9	73.5	62.7	890	10,680	82.4
608	50.67	05/03/18	6:57:46 PM	87.1	77.9	73.4	62.7	890	10,680	82.5
609	50.75	05/03/18	7:02:46 PM	86.8	77.9	73.3	62.7	889	10,668	82.3
610	50.83	05/03/18	7:07:46 PM	87.2	77.9	73.2	62.5	889	10,668	82.5
611	50.92	05/03/18	7:12:46 PM	87.2	77.9	73.0	62.3	890	10,680	82.6
612	51.00	05/03/18	7:17:46 PM	86.9	77.9	73.0	62.3	888	10,656	82.4
613	51.08	05/03/18	7:22:46 PM	87.0	77.9	72.9	62.1	890	10,680	82.4
614	51.17	05/03/18	7:27:46 PM	87.2	77.9	72.9	62.1	889	10,668	82.5
615	51.25	05/03/18	7:32:46 PM	87.0	77.9	73.0	62.1	889	10,668	82.5
616	51.33	05/03/18	7:37:46 PM	87.2	77.9	72.9	62.0	888	10,656	82.6
617	51.42	05/03/18	7:42:46 PM	87.0	77.9	72.7	61.9	889	10,668	82.5
618	51.50	05/03/18	7:47:46 PM	87.1	77.9	72.6	61.6	889	10,668	82.5
619	51.58	05/03/18	7:52:46 PM	87.4	77.9	72.4	61.5	889	10,668	82.7
620	51.67	05/03/18	7:57:46 PM	87.1	77.9	72.4	61.5	889	10,668	82.5
621	51.75	05/03/18	8:02:46 PM	86.9	77.9	72.3	61.5	889	10,668	82.4
622	51.83	05/03/18	8:07:46 PM	87.0	77.9	72.1	61.2	890	10,680	82.5
623	51.92	05/03/18	8:12:46 PM	87.2	77.9	72.1	61.0	889	10,668	82.5
624	52.00	05/03/18	8:17:46 PM	86.9	78.0	71.9	60.4	889	10,668	82.4
625	52.08	05/03/18	8:22:46 PM	87.2	78.0	71.8	60.4	889	10,668	82.6
626	52.17	05/03/18	8:27:46 PM	86.9	77.9	71.5	59.8	890	10,680	82.4
627	52.25	05/03/18	8:32:46 PM	87.0	78.0	71.2	59.3	889	10,668	82.5
628	52.33	05/03/18	8:37:46 PM	86.9	78.0	70.9	59.2	890	10,680	82.4
629	52.42	05/03/18	8:42:46 PM	87.1	78.0	70.7	59.1	890	10,680	82.5
630	52.50	05/03/18	8:47:46 PM	87.0	78.0	70.6	59.0	890	10,680	82.5
631	52.58	05/03/18	8:52:46 PM	87.1	78.0	70.6	59.3	890	10,680	82.5
632	52.67	05/03/18	8:57:46 PM	87.0	78.0	70.5	59.1	891	10,692	82.5
633	52.75	05/03/18	9:02:46 PM	87.1	78.0	70.4	59.0	889	10,668	82.5
634	52.83	05/03/18	9:07:46 PM	86.8	78.0	70.2	58.9	891	10,692	82.4
635	52.92	05/03/18	9:12:46 PM	87.1	78.0	70.1	58.6	890	10,680	82.6
636	53.00	05/03/18	9:17:46 PM	87.1	78.0	70.1	58.7	891	10,692	82.5
637	53.08	05/03/18	9:22:46 PM	87.3	78.0	70.0	58.8	891	10,692	82.7
638	53.17	05/03/18	9:27:46 PM	87.2	78.0	69.7	58.7	891	10,692	82.6
639	53.25	05/03/18	9:32:46 PM	87.2	78.0	69.7	58.7	892	10,704	82.6
640	53.33	05/03/18	9:37:46 PM	87.2	78.0	69.7	58.7	891	10,692	82.6
641	53.42	05/03/18	9:42:46 PM	87.1	78.0	69.6	58.9	892	10,704	82.6
642	53.50	05/03/18	9:47:46 PM	87.5	78.0	69.5	58.4	891	10,692	82.7
643	53.58	05/03/18	9:52:46 PM	86.9	78.0	69.4	58.3	892	10,704	82.5
644	53.67	05/03/18	9:57:46 PM	87.2	78.0	69.2	57.9	891	10,692	82.6
645	53.75	05/03/18	10:02:46 PM	87.3	78.0	69.3	58.0	891	10,692	82.7
646	53.83	05/03/18	10:07:46 PM	87.1	78.1	69.2	57.9	892	10,704	82.6
647	53.92	05/03/18	10:12:46 PM	86.9	78.0	69.0	57.8	891	10,692	82.5
648	54.00	05/03/18	10:17:46 PM	87.2	78.0	68.8	57.7	891	10,692	82.6
649	54.08	05/03/18	10:22:46 PM	87.2	78.0	68.6	57.8	891	10,692	82.6
650	54.17	05/03/18	10:27:46 PM	87.1	78.1	68.6	58.0	892	10,704	82.6

NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
651	54.25	05/03/18	10:32:46 PM	87.2	78.1	68.7	57.8	891	10,692	82.7
652	54.33	05/03/18	10:37:46 PM	87.1	78.1	68.7	57.9	891	10,692	82.6
653	54.42	05/03/18	10:42:46 PM	87.2	78.0	68.7	57.7	891	10,692	82.6
654	54.50	05/03/18	10:47:46 PM	87.4	78.1	68.7	57.5	892	10,704	82.7
655	54.58	05/03/18	10:52:46 PM	87.3	78.1	68.5	57.5	891	10,692	82.7
656	54.67	05/03/18	10:57:46 PM	87.2	78.0	68.6	57.5	892	10,704	82.6
657	54.75	05/03/18	11:02:46 PM	87.2	78.1	68.5	57.2	891	10,692	82.6
658	54.83	05/03/18	11:07:46 PM	87.2	78.1	68.5	57.3	892	10,704	82.7
659	54.92	05/03/18	11:12:46 PM	87.1	78.1	68.5	57.8	891	10,692	82.6
660	55.00	05/03/18	11:17:46 PM	87.2	78.1	68.6	57.8	892	10,704	82.7
661	55.08	05/03/18	11:22:46 PM	87.1	78.1	68.6	57.6	891	10,692	82.6
662	55.17	05/03/18	11:27:46 PM	87.3	78.1	68.5	56.9	892	10,704	82.7
663	55.25	05/03/18	11:32:46 PM	87.5	78.1	68.5	56.9	892	10,704	82.8
664	55.33	05/03/18	11:37:46 PM	87.4	78.1	68.2	56.3	891	10,692	82.8
665	55.42	05/03/18	11:42:46 PM	87.1	78.1	68.0	56.1	892	10,704	82.6
666	55.50	05/03/18	11:47:46 PM	87.2	78.2	67.7	56.2	891	10,692	82.7
667	55.58	05/03/18	11:52:46 PM	87.5	78.1	67.9	56.5	891	10,692	82.8
668	55.67	05/03/18	11:57:46 PM	87.3	78.1	67.9	56.9	892	10,704	82.7
669	55.75	05/04/18	12:02:46 AM	87.5	78.1	67.8	57.0	891	10,692	82.8
670	55.83	05/04/18	12:07:46 AM	87.4	78.1	67.8	56.7	892	10,704	82.7
671	55.92	05/04/18	12:12:46 AM	87.7	78.1	67.8	56.7	892	10,704	82.9
672	56.00	05/04/18	12:17:46 AM	87.3	78.1	67.7	56.5	892	10,704	82.7
673	56.08	05/04/18	12:22:46 AM	87.2	78.1	67.7	56.7	892	10,704	82.7
674	56.17	05/04/18	12:27:46 AM	87.3	78.2	67.6	56.6	892	10,704	82.7
675	56.25	05/04/18	12:32:46 AM	87.2	78.1	67.5	56.7	891	10,692	82.7
676	56.33	05/04/18	12:37:46 AM	87.5	78.2	67.5	56.5	892	10,704	82.8
677	56.42	05/04/18	12:42:46 AM	87.4	78.2	67.4	56.4	892	10,704	82.8
678	56.50	05/04/18	12:47:46 AM	87.7	78.2	67.3	56.4	891	10,692	82.9
679	56.58	05/04/18	12:52:46 AM	87.3	78.2	67.2	55.7	892	10,704	82.7
680	56.67	05/04/18	12:57:46 AM	87.3	78.2	67.2	55.6	892	10,704	82.7
681	56.75	05/04/18	1:02:46 AM	87.3	78.2	67.1	55.7	892	10,704	82.7
682	56.83	05/04/18	1:07:46 AM	87.3	78.2	67.1	55.2	893	10,716	82.8
683	56.92	05/04/18	1:12:46 AM	87.5	78.2	67.0	55.4	892	10,704	82.8
684	57.00	05/04/18	1:17:46 AM	87.1	78.2	66.9	55.5	892	10,704	82.7
685	57.08	05/04/18	1:22:46 AM	87.7	78.2	66.8	55.3	892	10,704	83.0
686	57.17	05/04/18	1:27:46 AM	87.3	78.2	66.8	54.9	892	10,704	82.8
687	57.25	05/04/18	1:32:46 AM	87.4	78.2	66.8	55.1	892	10,704	82.8
688	57.33	05/04/18	1:37:46 AM	87.5	78.2	66.8	54.7	891	10,692	82.8
689	57.42	05/04/18	1:42:46 AM	87.5	78.2	66.8	54.7	893	10,716	82.8
690	57.50	05/04/18	1:47:46 AM	87.4	78.2	66.8	54.8	892	10,704	82.8
691	57.58	05/04/18	1:52:46 AM	87.4	78.2	66.7	55.0	892	10,704	82.8
692	57.67	05/04/18	1:57:46 AM	87.5	78.2	66.7	54.9	892	10,704	82.9
693	57.75	05/04/18	2:02:46 AM	87.5	78.2	66.6	55.0	893	10,716	82.8
694	57.83	05/04/18	2:07:46 AM	87.4	78.2	66.5	54.9	892	10,704	82.8
695	57.92	05/04/18	2:12:46 AM	87.3	78.2	66.4	54.8	893	10,716	82.8
696	58.00	05/04/18	2:17:46 AM	87.6	78.3	66.4	55.1	893	10,716	82.9
697	58.08	05/04/18	2:22:46 AM	87.2	78.3	66.4	54.7	892	10,704	82.8
698	58.17	05/04/18	2:27:46 AM	87.2	78.3	66.4	54.7	894	10,728	82.8
699	58.25	05/04/18	2:32:46 AM	87.2	78.3	66.4	55.2	892	10,704	82.8
700	58.33	05/04/18	2:37:46 AM	87.6	78.2	66.4	54.8	893	10,716	82.9
701	58.42	05/04/18	2:42:46 AM	87.5	78.3	66.4	55.4	893	10,716	82.9
702	58.50	05/04/18	2:47:46 AM	87.6	78.3	66.4	55.1	892	10,704	82.9
703	58.58	05/04/18	2:52:46 AM	87.4	78.3	66.3	55.3	893	10,716	82.8
704	58.67	05/04/18	2:57:46 AM	87.3	78.2	66.2	55.2	893	10,716	82.8
705	58.75	05/04/18	3:02:46 AM	87.3	78.3	66.1	55.5	892	10,704	82.8
706	58.83	05/04/18	3:07:46 AM	87.5	78.3	66.1	55.7	893	10,716	82.9
707	58.92	05/04/18	3:12:46 AM	87.7	78.3	66.0	56.0	893	10,716	83.0
708	59.00	05/04/18	3:17:46 AM	87.6	78.3	66.0	56.0	892	10,704	83.0
709	59.08	05/04/18	3:22:46 AM	87.5	78.3	66.1	56.5	893	10,716	82.9
710	59.17	05/04/18	3:27:46 AM	87.2	78.3	66.1	56.8	892	10,704	82.8
711	59.25	05/04/18	3:32:46 AM	87.5	78.3	66.2	57.5	891	10,692	82.9
712	59.33	05/04/18	3:37:46 AM	87.4	78.4	66.4	57.0	892	10,704	82.9
713	59.42	05/04/18	3:42:46 AM	87.7	78.3	66.4	56.5	892	10,704	83.0
714	59.50	05/04/18	3:47:46 AM	87.4	78.3	66.4	56.4	892	10,704	82.9
715	59.58	05/04/18	3:52:46 AM	87.4	78.3	66.6	56.4	892	10,704	82.9
716	59.67	05/04/18	3:57:46 AM	87.4	78.4	66.6	56.5	893	10,716	82.9

NE State Capital - SE Test Loop

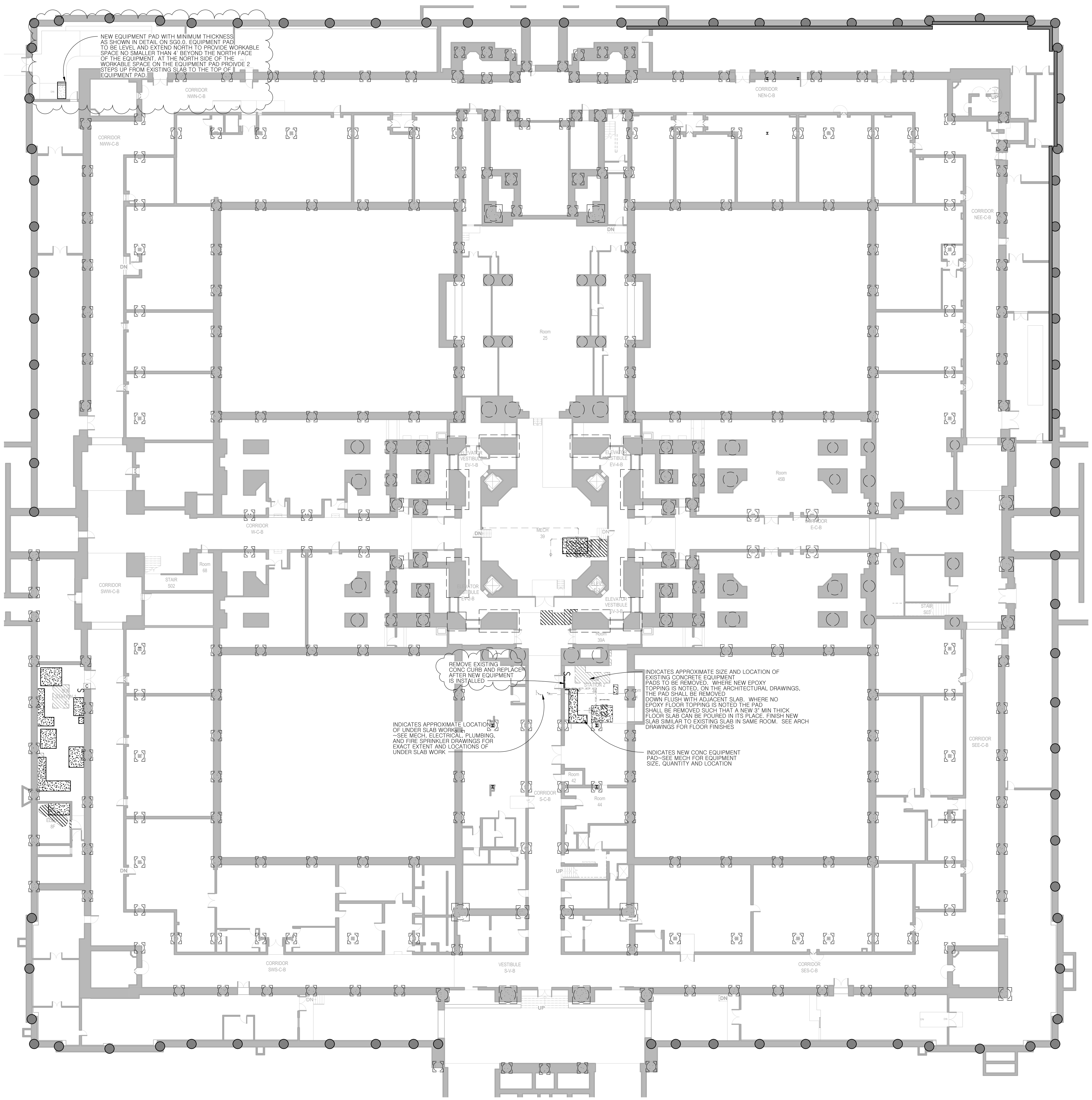
GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
717	59.75	05/04/18	4:02:46 AM	87.4	78.4	66.8	56.6	891	10,692	82.9
718	59.83	05/04/18	4:07:46 AM	87.6	78.4	66.9	56.5	892	10,704	83.0
719	59.92	05/04/18	4:12:46 AM	87.2	78.4	67.1	57.0	892	10,704	82.8
720	60.00	05/04/18	4:17:46 AM	87.7	78.4	67.2	57.8	893	10,716	83.0
721	60.08	05/04/18	4:22:46 AM	87.5	78.4	67.2	58.1	892	10,704	82.9
722	60.17	05/04/18	4:27:46 AM	87.6	78.4	67.3	58.2	893	10,716	83.0
723	60.25	05/04/18	4:32:46 AM	87.7	78.4	67.3	57.8	892	10,704	83.0
724	60.33	05/04/18	4:37:46 AM	87.7	78.4	67.4	57.8	893	10,716	83.1
725	60.42	05/04/18	4:42:46 AM	87.7	78.4	67.4	57.3	893	10,716	83.0
726	60.50	05/04/18	4:47:46 AM	87.5	78.4	67.5	57.2	892	10,704	82.9
727	60.58	05/04/18	4:52:46 AM	87.7	78.4	67.5	56.9	892	10,704	83.0
728	60.67	05/04/18	4:57:46 AM	87.8	78.4	67.5	56.7	893	10,716	83.1
729	60.75	05/04/18	5:02:46 AM	87.5	78.4	67.6	56.2	892	10,704	82.9
730	60.83	05/04/18	5:07:46 AM	87.6	78.4	67.6	55.7	892	10,704	83.0
731	60.92	05/04/18	5:12:46 AM	87.6	78.4	67.5	55.4	892	10,704	83.0
732	61.00	05/04/18	5:17:46 AM	87.6	78.4	67.5	55.2	892	10,704	83.0
733	61.08	05/04/18	5:22:46 AM	87.6	78.4	67.4	55.0	892	10,704	83.0
734	61.17	05/04/18	5:27:46 AM	87.5	78.4	67.3	54.7	892	10,704	82.9
735	61.25	05/04/18	5:32:46 AM	87.3	78.4	67.3	54.6	893	10,716	82.9
736	61.33	05/04/18	5:37:46 AM	87.5	78.4	67.2	54.4	892	10,704	83.0
737	61.42	05/04/18	5:42:46 AM	87.5	78.4	67.1	54.2	892	10,704	82.9
738	61.50	05/04/18	5:47:46 AM	87.5	78.4	67.1	54.1	892	10,704	82.9
739	61.58	05/04/18	5:52:46 AM	87.6	78.4	66.9	53.9	892	10,704	83.0
740	61.67	05/04/18	5:57:46 AM	87.4	78.4	66.8	53.9	892	10,704	82.9
741	61.75	05/04/18	6:02:46 AM	87.5	78.5	66.7	53.9	891	10,692	83.0
742	61.83	05/04/18	6:07:46 AM	87.8	78.4	66.7	53.8	892	10,704	83.1
743	61.92	05/04/18	6:12:46 AM	87.4	78.4	66.6	53.6	892	10,704	82.9
744	62.00	05/04/18	6:17:46 AM	87.5	78.5	66.5	53.5	892	10,704	83.0
745	62.08	05/04/18	6:22:46 AM	87.6	78.5	66.4	53.5	892	10,704	83.0
746	62.17	05/04/18	6:27:46 AM	87.7	78.4	66.4	53.4	892	10,704	83.1
747	62.25	05/04/18	6:32:46 AM	87.4	78.4	66.4	53.4	892	10,704	82.9
748	62.33	05/04/18	6:37:46 AM	87.6	78.5	66.4	53.2	892	10,704	83.0
749	62.42	05/04/18	6:42:46 AM	87.6	78.5	66.4	53.2	892	10,704	83.0
750	62.50	05/04/18	6:47:46 AM	87.8	78.5	66.4	53.1	892	10,704	83.1
751	62.58	05/04/18	6:52:46 AM	87.7	78.5	66.6	53.1	892	10,704	83.1
752	62.67	05/04/18	6:57:46 AM	87.7	78.5	66.8	53.0	892	10,704	83.1
753	62.75	05/04/18	7:02:46 AM	87.4	78.5	67.1	53.1	892	10,704	82.9
754	62.83	05/04/18	7:07:46 AM	87.5	78.4	67.5	53.6	892	10,704	83.0
755	62.92	05/04/18	7:12:46 AM	87.9	78.5	68.0	54.0	892	10,704	83.2
756	63.00	05/04/18	7:17:46 AM	87.9	78.5	68.7	54.4	892	10,704	83.2
757	63.08	05/04/18	7:22:46 AM	87.6	78.5	69.2	54.4	892	10,704	83.0
758	63.17	05/04/18	7:27:46 AM	87.6	78.5	69.8	54.7	892	10,704	83.1
759	63.25	05/04/18	7:32:46 AM	88.0	78.5	70.4	55.1	892	10,704	83.2
760	63.33	05/04/18	7:37:46 AM	87.4	78.5	70.9	55.4	893	10,716	83.0
761	63.42	05/04/18	7:42:46 AM	87.7	78.6	71.4	55.6	891	10,692	83.1
762	63.50	05/04/18	7:47:46 AM	87.9	78.5	71.9	55.9	892	10,704	83.2
763	63.58	05/04/18	7:52:46 AM	87.6	78.6	72.5	56.1	892	10,704	83.1
764	63.67	05/04/18	7:57:46 AM	87.7	78.5	73.2	56.6	892	10,704	83.1
765	63.75	05/04/18	8:02:46 AM	87.7	78.6	73.7	56.9	892	10,704	83.2
766	63.83	05/04/18	8:07:46 AM	88.0	78.5	74.3	57.1	892	10,704	83.2
767	63.92	05/04/18	8:12:46 AM	87.6	78.5	75.0	57.9	893	10,716	83.1
768	64.00	05/04/18	8:17:46 AM	87.8	78.6	75.6	57.7	892	10,704	83.2
769	64.08	05/04/18	8:22:46 AM	87.7	78.6	76.3	58.4	892	10,704	83.2
770	64.17	05/04/18	8:27:46 AM	87.8	78.6	76.9	58.5	892	10,704	83.2
771	64.25	05/04/18	8:32:46 AM	87.7	78.5	77.6	59.3	892	10,704	83.1
772	64.33	05/04/18	8:37:46 AM	87.5	78.6	78.4	59.9	892	10,704	83.0
773	64.42	05/04/18	8:42:46 AM	87.7	78.6	79.3	60.5	892	10,704	83.1
774	64.50	05/04/18	8:47:46 AM	87.7	78.6	80.1	60.6	893	10,716	83.1
775	64.58	05/04/18	8:52:46 AM	88.0	78.6	80.7	60.9	892	10,704	83.3
776	64.67	05/04/18	8:57:46 AM	87.7	78.6	81.3	61.7	892	10,704	83.2
777	64.75	05/04/18	9:02:46 AM	87.7	78.7	81.8	61.6	892	10,704	83.2
778	64.83	05/04/18	9:07:46 AM	87.8	78.6	82.5	61.5	893	10,716	83.2
779	64.92	05/04/18	9:12:46 AM	88.1	78.6	83.0	62.5	892	10,704	83.3
780	65.00	05/04/18	9:17:46 AM	87.9	78.6	83.6	63.1	892	10,704	83.3
781	65.08	05/04/18	9:22:46 AM	87.9	78.6	84.3	63.4	892	10,704	83.3
782	65.17	05/04/18	9:27:46 AM	88.0	78.6	84.8	63.9	892	10,704	83.3

NE State Capital - SE Test Loop

GROUND THERMAL CONDUCTIVITY TEST - LOGGED DATA

Rdg. No.	Hour	Date	Time	Water Temp. Into Ground Tgi (or two) (°F)	Water Temp. Out of Ground Tgo (or twi) (°F)	Trailer Air Temp Amb (°F)	Outside Air Temp Tavg (ºF)	Energy into the Loop System Pulses Read	Energy into the Loop System Wc (Watts)	Average Loop Temp. Amb (ºF)
783	65.25	05/04/18	9:32:46 AM	87.7	78.7	85.2	64.6	891	10,692	83.2
784	65.33	05/04/18	9:37:46 AM	87.6	78.7	85.7	64.6	891	10,692	83.1
785	65.42	05/04/18	9:42:46 AM	87.9	78.7	86.2	64.9	890	10,680	83.3
786	65.50	05/04/18	9:47:46 AM	87.9	78.6	86.8	65.8	890	10,680	83.3
787	65.58	05/04/18	9:52:46 AM	87.6	78.7	87.2	66.2	890	10,680	83.2
788	65.67	05/04/18	9:57:46 AM	87.8	78.7	87.7	67.3	891	10,692	83.2
789	65.75	05/04/18	10:02:46 AM	87.9	78.7	88.3	67.6	891	10,692	83.3
790	65.83	05/04/18	10:07:46 AM	87.8	78.7	88.8	67.8	890	10,680	83.3
791	65.92	05/04/18	10:12:46 AM	87.7	78.7	89.4	68.5	891	10,692	83.2
792	66.00	05/04/18	10:17:46 AM	87.8	78.7	89.9	69.7	892	10,704	83.3
793	66.08	05/04/18	10:22:46 AM	88.0	78.7	90.3	68.7	890	10,680	83.3
794	66.17	05/04/18	10:27:46 AM	87.8	78.7	90.7	70.0	891	10,692	83.2
795	66.25	05/04/18	10:32:46 AM	87.8	78.7	91.0	70.3	889	10,668	83.2
796	66.33	05/04/18	10:37:46 AM	87.9	78.7	91.4	71.2	890	10,680	83.3
797	66.42	05/04/18	10:42:46 AM	87.8	78.7	91.8	70.6	888	10,656	83.3
798	66.50	05/04/18	10:47:46 AM	88.1	78.7	92.2	72.4	885	10,620	83.4
799	66.58	05/04/18	10:52:46 AM	87.7	78.7	92.6	73.7	882	10,584	83.2
800	66.67	05/04/18	10:57:46 AM	87.7	78.7	93.0	73.8	881	10,572	83.2
801	66.75	05/04/18	11:02:46 AM	87.9	78.7	93.4	74.1	884	10,608	83.3
802	66.83	05/04/18	11:07:46 AM	88.0	78.7	93.7	74.8	886	10,632	83.3
803	66.92	05/04/18	11:12:46 AM	87.9	78.8	94.0	75.6	887	10,644	83.3
804	67.00	05/04/18	11:17:46 AM	87.8	78.7	94.3	76.2	889	10,668	83.3
805	67.08	05/04/18	11:22:46 AM	88.0	78.8	94.6	75.6	889	10,668	83.4
806	67.17	05/04/18	11:27:46 AM	88.0	78.7	94.9	77.7	889	10,668	83.3
807	67.25	05/04/18	11:32:46 AM	88.1	78.7	95.3	79.1	889	10,668	83.4
808	67.33	05/04/18	11:37:46 AM	88.2	78.8	95.7	78.2	889	10,668	83.5
809	67.42	05/04/18	11:42:46 AM	88.0	78.7	96.0	78.5	890	10,680	83.3
810	67.50	05/04/18	11:47:46 AM	88.1	78.7	96.2	79.3	890	10,680	83.4
811	67.58	05/04/18	11:52:46 AM	87.9	78.8	96.4	79.3	890	10,680	83.4
812	67.67	05/04/18	11:57:46 AM	88.3	78.8	96.5	80.3	889	10,668	83.5
813	67.75	05/04/18	12:02:46 PM	87.9	78.8	96.7	80.2	890	10,680	83.3
814	67.83	05/04/18	12:07:46 PM	88.3	78.8	96.9	79.6	890	10,680	83.5
815	67.92	05/04/18	12:12:46 PM	87.8	78.8	97.0	80.2	890	10,680	83.3
816	68.00	05/04/18	12:17:46 PM	87.7	78.8	97.0	81.1	889	10,668	83.3
817	68.08	05/04/18	12:22:46 PM	88.1	78.8	97.0	80.5	890	10,680	83.5
818	68.17	05/04/18	12:27:46 PM	88.1	78.8	97.0	80.4	890	10,680	83.5
819	68.25	05/04/18	12:32:46 PM	87.8	78.8	96.9	79.0	889	10,668	83.3
820	68.33	05/04/18	12:37:46 PM	88.3	78.8	96.5	82.0	890	10,680	83.6
821	68.42	05/04/18	12:42:46 PM	88.0	78.8	96.5	82.4	890	10,680	83.4
822	68.50	05/04/18	12:47:46 PM	88.2	78.9	96.6	81.4	889	10,668	83.5
823	68.58	05/04/18	12:52:46 PM	87.9	78.8	95.4	82.5	888	10,656	83.4



NEW EQUIPMENT PAD WITH MINIMUM THICKNESS AS SHOWN IN DETAIL ON SG0.0. EQUIPMENT PAD TO BE LEVEL AND EXTEND NORTH TO PROVIDE WORKABLE SPACE NO SMALLER THAN 4' BEYOND THE NORTH FACE OF THE EQUIPMENT. AT THE NORTH SIDE OF THE WORKABLE SPACE ON THE EQUIPMENT PAD PROIVDE 2 STEPS UP FROM EXISTING SLAB TO THE TOP OF EQUIPMENT PAD.
CORRIDOR NWN-C-B
CORRIDOR NWW-C-B
REMOVE EXISTING CONC CURB AND REPLACE AFTER NEW EQUIPMENT IS INSTALLED
INDICATES APPROXIMATE SIZE AND LOCATION OF EXISTING CONCRETE EQUIPMENT PADS TO BE REMOVED. WHERE NEW EPOXY TOPPING IS NOTED, ON THE ARCHITECTURAL DRAWINGS, THE PAD SHALL BE REMOVED DOWN FLUSH WITH ADJACENT SLAB. WHERE NO EPOXY FLOOR TOPPING IS NOTED THE PAD SHALL BE REMOVED SUCH THAT A NEW 3" MIN THICK FLOOR SLAB CAN BE POURED IN ITS PLACE. FINISH NEW SLAB SIMILAR TO EXISTING SLAB IN SAME ROOM. SEE ARCH DRAWINGS FOR FLOOR FINISHES
INDICATES APPROXIMATE LOCATION OF UNDER SLAB WORK ~SEE MECH, ELECTRICAL, PLUMBING, AND FIRE SPRINKLER DRAWINGS FOR EXACT EXTENT AND LOCATIONS OF UNDER SLAB WORK
INDICATES NEW CONC EQUIPMENT PAD~SEE MECH FOR EQUIPMENT SIZE, QUANTITY AND LOCATION
ELEVATOR VESTIBULE EV-2-B
ELEVATOR VESTIBULE EV-3-B
Room 39A
Room 42
Room 44
CORRIDOR S-C-B

A1 FOUNDATION PLAN PHASE A

SCALE: 1/16" = 1'-0"

BVH

ARCHITECT
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440 NORTH 8TH STREET, SUITE 100
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bvh.com

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RO YOUKER STRUCTURAL ENGINEERING

STRUCTURAL CONSULTANT
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benesch

CIVIL, SURVEY AND GEOTECHNICAL CONSULTANT
ALFRED BENESCH & COMPANY
825 M STREET, SUITE 100
LINCOLN NE 68508
V 402 479 2200
benesch.com

REVISIONS SCHEDULE		
MARK	DATE	DESCRIPTION
1	05/14/2018	ADDENDUM #4

NW NE TOWER SW SE

KEYPLAN

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100% CONSTRUCTION DOCUMENTS

NEBRASKA STATE CAPITOL HVAC REPLACEMENT AND WINDOW RESTORATION

PROJECT: OCC 201405
BVH L14077

DATE: APRIL 23 2018

PROFESSIONAL STRUCTURAL ENGINEER
JEFFREY W. PANKOKE
E-14785
04/23/2018
STATE OF NEBRASKA

FOUNDATION PLAN

NORTH

S1.0 PA