Appendix 13 – Soil Heat Transfer Study

Pipeline Influence on Soil Heat Transfer

Summit Carbon

RS2 Modeling Analysis

LSC Project #s 63524600703
Submittal Date 10/25/2024

LAKE SUPERIOR CONSULTING

Table of Contents

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EXECUTIVE SUMMARY

Lake Superior Consulting, LLC (LSC) has prepared a modeled analysis of the expected soil heat transfer influence from the Summit Carbon Solutions (SCS) transmission system. Utilizing Rocscience's geotechnical software RS2, the thermal module incorporated historical weather data and estimated low and high operating temperatures for both summer and winter conditions. Over a span of two years, the analysis covered five different pipelines to account for the cyclic heating and cooling processes between warmer and colder months. The pipelines analyzed include two 24-inch pipes, one 12-inch pipe, and two 6-inch pipes.

The study employed a variety of geotechnical references to establish conservative thermal property assumptions for different soil types and saturation conditions that may be encountered in the field. A key reference used in this analysis was "Thermal Properties of Soils" by Omar T. Farouki (1981). Extensive research was conducted to comprehend both the conductive nature of the soil and the mechanics utilized by the RS2 software to calculate results through finite element analysis (FEA).

Upon completing this iterative modeling process, several conclusions were drawn regarding the impact of SCS pipelines in surrounding soils. This report includes detailed information on the analysis conducted, outputs from the RS2 thermal analysis, and summarized conclusions based on the FEA modeling.

LSC’s findings are focused on the expected thermal influence above the pipeline. After the model was generated, interpretations were read from the soil heat maps produced. Thermal influence values were tabulated as horizontal feet away from the pipe, and where thermal equilibrium is expected to be reached at a depth of 6 inches below grade. As the main concern of the thermal influence from the pipeline is based on the environmental impact to the surrounding soil.

Based on the conclusions drawn from this report, the surface impact due to the pipeline has shown to be minimal. Especially, given the conservative conditions of the operating temperatures during the analysis.

BACKGROUND

Heat transfer in soils poses issues faced in several different fields, including engineering, geophysics, and agriculture. This report serves as the justification to the minimal impact the pipeline will have after construction and operation, and to analyze the expected surface conditions after the heat transfers through the soil above the pipe.

To achieve this, five different locations were identified, each selected to represent the system under distinct environmental and operational scenarios. This selection aimed to provide a holistic view of the soil heat transfer influences across the entire pipeline network.

SCOPE

SCS has requested that LSC provide support of the modeling through engineering and design. LSC’s comprehensive scope is identified in the following sections, along with physical deliverables anticipated for each scope item listed:

- RS2 Thermal Analysis Models
- Technical Report Summarizing Findings

OBJECTIVES AND APPROACH

The primary objective of this project is to model and analyze the thermal impact of SCS’ pipelines on surrounding soil conditions. LSC utilized RS2 software to create conservative geometric models of the pipelines buried with a standard 4-foot cover. Temperature boundaries were established for both the pipeline's operating temperature and the atmospheric temperature at grade. The analysis incorporated pipeline geometry and location from SCS, and historical weather data near the site locations were acquired from the National Weather Service (NWS). An initial ground temperature, sourced from the United States Department of Agriculture (USDA), was also included. Table 1 includes the information regarding the pipelines that were identified for this study. Figure 1 shows their geographic location. Based on the location of each pipe, a respective USDA and NWS station was selected to gather data for both weather and ground temperatures. See Appendix 1 and 2 to see this information in greater detail.

Table 1: Pipeline Information – Geometry, Operating Temperature, and Location

Pipe Diameter and ID	Summer Pipe Temp (°F)	Winter Pipe Temp (°F)	GPS Coordinates	USDA Station	NWS Station
24" Pipe (1)	85	44	47.011397, -100.793231	Mandan #1	Bismark Municipal, ND
24" Pipe (2)	85	44	45.968227, -99.4218183	Eros Data Center	Ashley, ND
12" Pipe	85	55	42.951329, -95.771627	Shagbark Hills	Sheldon, IA
6" Pipe (1)	120	80	40.754387, -95.399415	Roger Farms	Shenandoah, IA
6" Pipe (2)	120	80	42.053138, -94.237302	Ames	Jefferson, IA

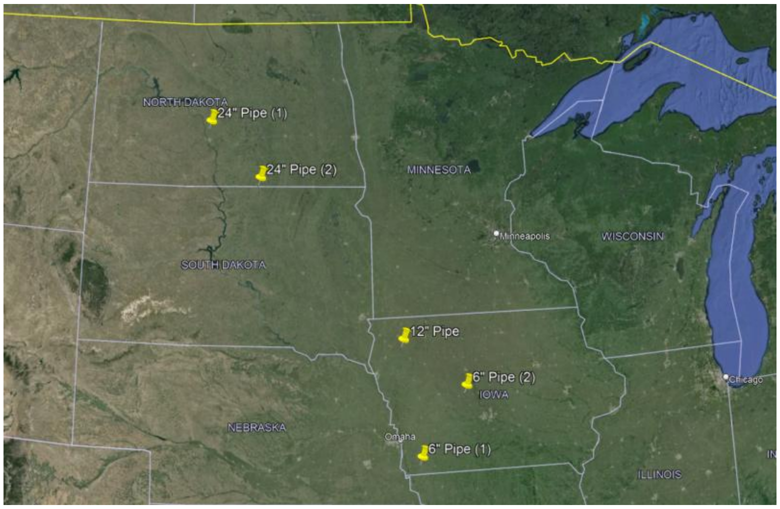

Figure 1: Pipeline Location Map

ASSUMPTIONS

Several key assumptions were made during the modeling process to ensure a conservative and consistent analysis.

- **Soil Characteristics**: The soil was categorized into two types: Fine Grained (clay) and Coarse Grained (sand).
- **Saturation Conditions**: The model included three saturation conditions: 15%, 35%, and 55%.
- **Thermal Properties**: Thermal properties, including Thermal Conductivity, Volumetric Specific Heat Capacity, and Latent Heat, were derived from Sanger (Figure 4) with units in BTU-ft-h-F.

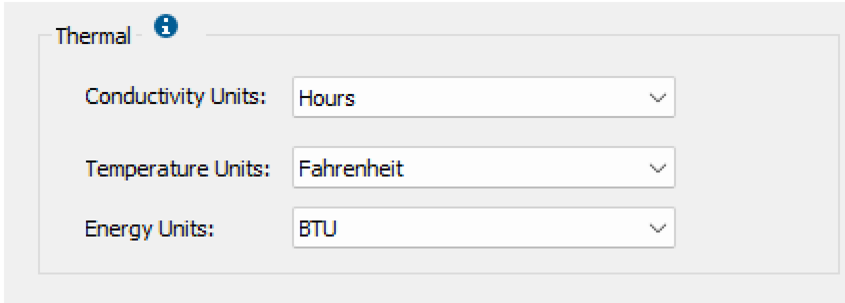

Figure 2: Thermal Unit Setup from Project Settings in RS2

- **Weather and Soil Temperature Data**: Information regarding monthly average temperatures and initial ground temperatures were from readings from the nearest proximity station, to given pipe locations.
- **Depth of Cover**: A standard 4-foot depth of cover was applied to the pipeline.
- **Surface Boundary Conditions**: Average monthly temperatures were applied at the surface boundary for the duration of each month.
- **Operating Temperature**: The pipe temperature boundary was set on the outer diameter of the pipe. The pipe having direct contact with the soil interface lets us assume that there is no heat loss from the operating temperature. Simplifying the model by not considering the thermal properties and wall thickness of the pipe, but to focus on the thermal influence of the soil due to the imposed temperature. The operating temperature is the temperature at the facility and does not account for dissipation of heat as the product travels along the pipeline and approaches a lower ambient temperature overtime.
- **Pipe Temperature Boundary**: Several different operating temperatures were analyzed. The operating temperature fluctuates with the hottest and coldest months. Six months of the hottest temperature, centered on July, and six months of the coldest temperature, centered on January. These operating temperatures were acquired from SCS. This interpretation of operating temperature was selected due to the conservative nature of furthest thermal influence away from the pipe.
- **Thermal Analysis Method**: Transient Thermal FEA was used as the method of thermal analysis in RS2.
- **Initial Ground Temperature**: The initial ground temperature was based on an average over the past five years on January 1st (01/01/2020 – 01/01/2024). A static temperature grid was implemented at timestep = 0 on January 1st, with temperature readings at depths of 2 inches, 4 inches, 8 inches, 20 inches, and 40 inches.
- **Snow Cover and Weather Conditions:** Snow and rain data cannot be accurately represented in RS2. Both the fluctuating saturation conditions of rain and insulating properties of snow cover are field conditions that could impact the soil heat transfer model. Precipitation cannot be represented like this in the model, so the saturation was fixed at a percentage for three different conditions: 15%, 35%, and 55%.

MODELING METHODS

RS2, a comprehensive FEA software by Rocscience, was used for this project to model and analyze the thermal interactions between the SCS pipeline and the surrounding soil. RS2 is particularly well-suited for this type of analysis due to its capabilities in simulating soil behavior, thermal conduction, and hydraulic properties under various conditions.

The workflow for this project involved several key steps. Initially, project settings were defined to establish the overall parameters and analysis type. Next, the geometry of the model was created, including the representation of the pipeline and surrounding soil environment. Material properties for both the pipeline and the soil were then specified, focusing on thermal and hydraulic characteristics. A mesh was generated to discretize the model for accurate FEA. Finally, the thermal module was utilized to set up temperature boundaries and initial conditions, allowing for the simulation of heat transfer processes over the specified time-period. Each of these steps is critical to ensuring the model accurately represents real-world conditions and provides reliable results for assessing the thermal impact of the pipeline.

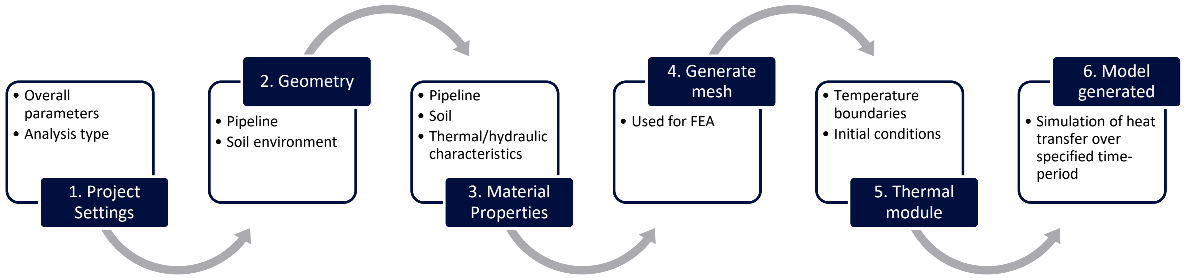

Figure 3: Summary of RS2 Modeling Workflow

PROJECT SETTINGS

The project settings in RS2 were configured during setup. Time units were set to days, conductivity units to hours, temperature units to Fahrenheit, and energy units to British thermal units (BTU). The analysis was divided into monthly stages over a two-year period, allowing for detailed tracking of temperature variations and an iteration factor of time in days. The thermal analysis feature was enabled in the project settings so that thermal module was included in the modeling process, and a thermal analysis could then be completed during the FEA.

GEOMETRY SETUP

The geometry setup in RS2 was designed to accurately represent a cross-section of a pipeline as it would exist in the field. The following steps were taken to create this model:

- **Cross-Section Dimensions**: A cross-section extending 90 feet in either direction from the pipe was created to ensure that the thermal influence would not be constrained by the external boundaries of the model. This setup provided ample space for the analysis to capture the full extent of thermal interactions between the pipeline and surrounding soil.
- **Pipeline Placement**: A pipe with the correct diameter was centered horizontally within the cross-section. The depth of the pipe was set to provide 4 feet of cover.

This geometric setup was critical for ensuring that the thermal analysis performed in RS2 accurately reflected the proposed post-installation conditions. With a large enough FEA area to create reliable results for the subsequent evaluation of thermal influences. This geometry allowed the modeled soil temperature to reach ambient temperature as it gets further away from the origin.

MATERIAL PROPERTIES

PIPELINE PROPERTIES

The pipeline was represented as a liner in the model to simulate the thermal boundary condition around the pipe. Typically, in RS2 a liner is converted to a structural interface that acts as a material component like the concrete of a foundation. Where conditions can be applied to the positive and negative side of a geometry. In this case, a circular geometry where the center of the geometry was excavated out and made into a structural interface. Instead of modeling the entire pipe structure, a simplified approach was used where the operating temperature of the pipeline was applied directly to the boundary representing the outer surface of the pipe. This assumption ensured that the heat transfer from the pipe to the surrounding soil was conservatively modeled, accounting for the maximum potential thermal impact.

To account for the maximum potential thermal impact, the operating temperature of the pipeline was applied directly to the outer surface of the pipe. This assumption simplified the approach for modeling a thermal boundary around the pipe.

SOIL PROPERTIES

The soil material properties were categorized into fine-grained (clay) and coarse-grained (sand) materials. Unit weight and stiffness values were based on realistic values for sand and clay.

- **Thermal Properties**: The thermal conductivity and volumetric heat capacity for both frozen and unfrozen states were critical factors. These values were derived from reputable sources, including Sanger's 1968 research, which provided a reliable basis for the thermal properties used in the model. Conservative values were applied, particularly for coarse material with high saturation, to model the fastest possible heat transfer through the soil. This conservative approach ensures that the model accounts for the highest potential thermal impact.

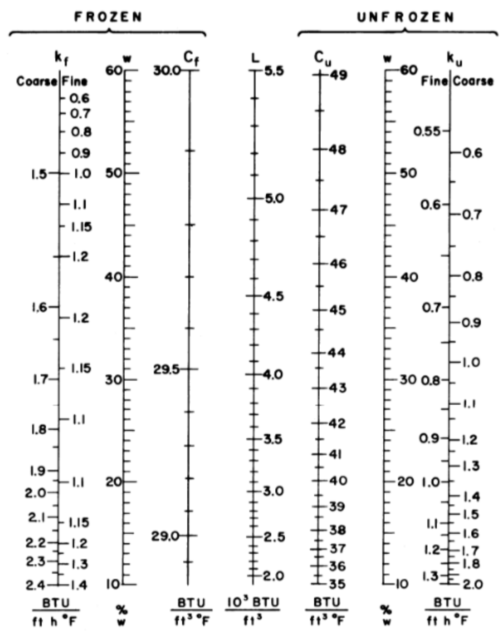

Figure 4: Thermal Properties of Soil (Sanger, 1968)

- **Hydraulic Properties**: The hydraulic properties, particularly soil saturation levels, were carefully considered. Three saturation conditions were modeled: 15%, 35%, and 55%. These conditions reflect the expected variations in soil saturation over the timeline of the model, providing a comprehensive analysis of the soil's thermal response.

By employing conservative assumptions and utilizing empirical data from reputable sources, the model accounts for the inherent uncertainties in geotechnical relationships. The calculations that are generated in the RS2 model are conservative in nature due to their empirical origins. The values offered to the analysis are set to constant thermal conductivity values and will remain the same throughout the timespan of the model. Having this conservative approach is important for providing a reliable analysis of the thermal impacts of the pipeline in the surrounding soil. The study incorporated research on soil thermal conductivity, particularly focusing on conditions in northern regions of the United States, to ensure the accuracy and relevance of the thermal properties used in the model.

FINITE ELEMENT MESH

In conducting thermal analysis using RS2 software, the mesh configuration is critical for accurately simulating heat transfer in soil around a warm or hot pipe. The mesh defines boundaries, ensuring comprehensive coverage of the computational domain, and is refined near the pipe to capture localized thermal effects effectively. This refinement involves decreasing element size to enhance mesh density, crucial for precise temperature gradient calculations. The mesh divides the area into smaller sections, or elements, to ensure thorough coverage of the entire model. Closer to the pipe, where more detailed temperature calculations are needed, the mesh is refined by using smaller elements to capture sharp temperature changes more precisely. This breakdown of the soil into smaller units helps the software simulate how heat moves through the soil, improving the accuracy of predictions, especially around the buried infrastructure.

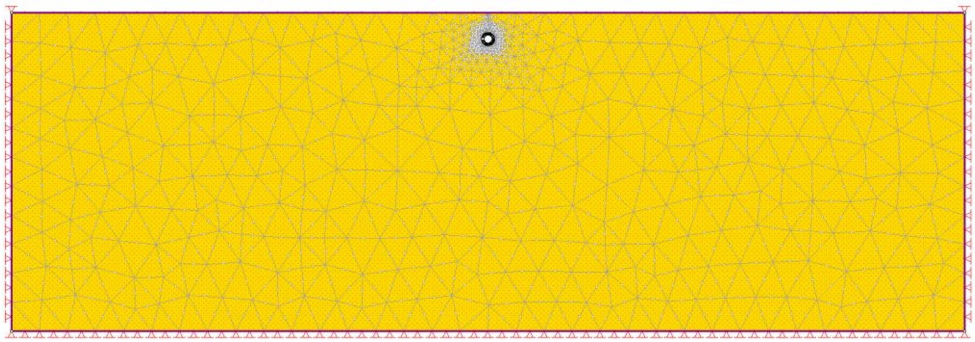

Figure 5: Finite Element Mesh Generation

THERMAL ANALYSIS

The thermal analysis process commenced with establishing thermal boundaries, representing both at-grade temperatures and the operating temperature surrounding the pipe's outer diameter. This step was crucial to simulate the heat transfer dynamics between the pipe and the surrounding soil accurately. Given the time-dependent thermal properties of soil, the transient FEA method was chosen. The transient method, unlike steady-state analysis, accounts for temperature variations over time, making it ideal for modeling dynamic thermal processes and evolving conditions.

Initial soil temperatures were determined using a static temperature grid derived from USDA ground temperature readings, interpolated using the Local Thin-Plate Spline method. This interpolation technique provides a smooth, continuous surface that accurately represents the spatial variation of ground temperatures based on scattered data points. It ensures a realistic representation of ground conditions as observed on January 1st, before the pipeline's influence.

Six different operating temperature conditions were analyzed during the modeling process specific to each pipe size and season. A step change operating temperature model, where only the hottest and coldest temperatures of the pipeline are applied over 6-month periods. The hottest temperature was relative to the summer months being centered on July, while the coldest was centered on January. A linear model was initially considered, using a constant interpolation between July and January. Incremental changes each day through the year, between the hottest and coldest temperatures. An alternative block-change model was also evaluated, where the operating temperature ramped up and down over a 2-month period leading into July and January. Ultimately, the drastic-change (6-month) model was selected due to its more conservative nature, as it projected a greater thermal influence extending away from the pipeline compared to the linear model and block-change models.

To simplify the model, thermal conductivity and heat capacity were set to constant values, reducing computational complexity while still offering a reasonable approximation of soil thermal behavior. Additionally, latent heat was enabled in the model to account for freeze-thaw conditions expected in the cold region of the study area. This consideration is essential for accurately simulating phase changes in soil moisture, which significantly impact soil thermal dynamics. Incorporating latent heat ensures that the model realistically represents the thermal behavior of soil subjected to freezing and thawing cycles, thereby enhancing the reliability of the analysis.

INTERPRETED RESULTS

Using the RS2 Interpret module, the thermal analysis revealed temperature variations in the soil surrounding the warm and hot pipe. The generated temperature outputs, visualized through graphical representations, showed pronounced thermal gradients near the pipe, diminishing with distance. Constant thermal conductivity and heat capacity simplified the model, while the inclusion of latent heat accurately depicted freeze-thaw cycles. A sensitivity analysis highlighted the importance of mesh density and initial conditions derived from USDA data for realistic simulations. The time set on the model revealed a cyclic repeating relationship of ground temperatures on the same months between year intervals. This is evidence that the time applied to the model was an appropriate length and allowed the model to develop fully and reveal characteristics of winter months more accurately. Although extreme conditions between winter and summer months were used, results were also interpreted from the fall and spring months as well to understand the model further. Overall, the inputs that were given to the software are justifiable and conservative, therefore the models produced are fair to analyze and draw conclusions from. The thermal interactions between the soil and the pipeline and the overall influence that pipeline had in the modeling is what can be expected in the field.

DESIGN CRITERIA

The nature of this project is to give RS2 the information needed to accurately depict existing conditions of thermal influence. Tables 2-4 characterize the overall inputs that were given to the model. These values were adjusted during the modeling process to both monitor change and understand the impact of each input.

Table 2: Soil Thermal Properties at 15% Saturation

Soil Type	Unfrozen Thermal Conductivity, ku	Frozen Thermal Conductivity, kf	Unfrozen Volumetric Heat Capacity, Cu	Frozen Volumetric Heat Capacity, Cf
Fine	1.15	1.175	38	29
Coarse	1.6	2.15	38	29

Table 3: Soil Thermal Properties at 35% Saturation

Soil Type	Unfrozen Thermal Conductivity, ku	Frozen Thermal Conductivity, kf	Unfrozen Volumetric Heat Capacity, Cu	Frozen Volumetric Heat Capacity, Cf
Fine	0.725	1.2	44.5	29.6
Coarse	0.9	1.625	44.5	29.6

Table 4: Soil Thermal Properties at 55% Saturation

Soil Type	Unfrozen Thermal Conductivity, ku	Frozen Thermal Conductivity, kf	Unfrozen Volumetric Heat Capacity, Cu	Frozen Volumetric Heat Capacity, Cf
Fine	.55	0.75	48.25	29.95
Coarse	.575	1.475	48.25	29.95

MODEL CHARACTERIZATION

There are several characteristics that should be considered fair expectations from the results. The first expectation is that the fluctuation of temperature boundaries should carry the largest influential factor onto the model. With operating temperatures varying significantly between the summer and winter months. With a difference of 30°F for the 12-inch pipe, 40°F for the two 6-inch pipes, and 41°F for the two 24-inch pipes. In addition, the temperature data collected from the NWS being applied to the model also shares a large variance depending on the season. With the largest variance being the 24-inch pipe 2 model, with 13°F average in the month of January and 71.7°F average in month of July, a total variance of 58.7°F. This environmental difference on the thermal boundary at grade will define the nature of the model. Therefore, the thermal influence due to each pipeline will be characterized by these inputs and the outputs will vary the most between seasons.

Other characteristic expectations are due to the material property inputs of thermal conductivity of the soil. The trends should reveal that coarse grained soils (i.e., sand) have a larger thermal influence due to the increase in thermal conductivity. From a soil heat transfer perspective this is because of two key factors. Coarse grained material has larger particles, with more direct contact points between particles. This allows for the facilitation of conductive heat transfer. Additionally, the pores between particles are better connected allowing for heat transfer through the interconnected air or water filled voids. Although the impact may not be as prominent as the changes of temperature due to thermal boundaries, there may not be a large variance when it comes to the grain of the material.

TEMPERATURE GRADIENTS INTERPRETATIONS

This report placed emphasis on the thermal influence at the surface due to the conditions that may happen after the pipeline is buried. 120 models were generated in RS2, 24 different conditions for 6 different pipes. RS2 interpret rendered a heat map for each of these different scenarios over a 2-year sample size. To determine the expected impact due to the pipeline, interpretation readings were estimated to develop a clear picture of the pipeline systems thermal impact.

These interpretations measure several distances, as the thermal influence from the pipe becomes weaker as distance from the centerline increases. A horizontal bar datum has been placed at 6-inches below grade, 3.5 feet above the top of the pipe. Based on this 6-inch marker, four vertical lines were drafted to represent an upper and a lower bound. The lower bound consists of the two vertical lines closest to the pipeline, and the area between the two represents the moderate influence zone. The upper bound consists of the two vertical lines furthest from the pipe. These vertical lines are representative of where ambient temperatures are expected to be reached. This is determined based on where the gradients begin to level off and return to ambient temperature.

The area between the upper and lower bound is considered a transitional area that is expected to have a low impact on the surface temperature. In this area, heat dissipates and the thermal influence at the surface gets lower as distance away from the pipe approaches the upper bound limit. After the upper bound threshold is crossed, that is where ambient soil temperatures near the surface are expected to have negligible influence due to the pipeline.

Each season over the course of the study revealed to have its own unique temperature gradient pattern, which transposed the three pipe sizes and locations. Although there were variations between the observed patterns, the same set of principles were applied as a means of consistent interpretation. See Figures 9-12 for example interpretations of thermal influence. These readings are detailed out in Appendix 3, interpretations can be observed for all 120 scenarios, and results are summarized in Tables 6-10.

Interpretations are given for every season given the “6-inch pipeline (2)”. The coarse-grained material at 55% saturation conditions is used for this example. USDA soil temperature readings were obtained for monthly averages in January, April, July, and October since 2020. The soil temperature readings were obtained from USDA station in Ames, IA. This location is near the “6-inch pipeline (2)” and serves as a comparable existing condition of soil temperature. Temperatures are recorded at several depths including the 4-inch, and 8-inch mark, which are the closest readings to the interpretation mark at 6-inches expanded upon in appendix 2. Table 5 provides comparable soil temperatures to the temperature gradients temperatures as it approaches no pipeline influence at 6-inch depth of cover.

Table 5: Average Soil Temperatures, USDA, Ames IA

Month	Average Temperature - 4in (°F)	Average Temperature – 8in (°F)	Average Temperature (°F)
January	34	35	34.5
April	44.75	43.75	44.25
July	66.25	64.75	65.5
October	54	55	54.5

Three influence zones were generated for each of the 120 variations. The zones are defined by an upper and a lower bound vertical line, as temperature variations dissipate further away from the centerline. The exact metric of each of these different zones varies, depending on the season, interpretation of the temperature gradient, and temperature incrementation generated by the legend. Figures 6-8 are a detailed example of the “6-inch pipeline (2)”, for the coarse-grained material, 55% saturation condition, and the detailed influence zones for the month of April.

As the temperature gradients vary depending on the scenario, and the temperature difference between the boundaries can change, it can be difficult to assign definite degree changes to represent each zone. Therefore, interpretation principles were used to draft the zone boundaries, based on temperature fluctuations within the zone. The best way to analyze each zone is to directly read the temperature boundaries from the legend and apply them to the gradient, and the slopes within each zone are implicative of the pipeline’s thermal influence. Steeper slopes, indicate a larger change in temperature over a shorter distance.

Figure 6 represents an example of a moderate influence zone. The temperature changes happening within the zone are dictated by the apparent influence of the pipe. Closer to the pipe, the distance between each color or temperature change is smaller, and vice versa as the distance from the pipe increases. Another defining characteristic of the moderate influence zone, are the slopes of each temperature change, which are steep. See the vertical slope interfaces of each temperature boundary between the 64-52 (°F) range. The lower bound vertical line in this scenario was drafted because the temperature boundary of 52°F passed through the 6-inch depth horizontal datum. This is also where the temperature changes start to become more gradual, and the thermal influence is expected to dissipate in the low influence zone.

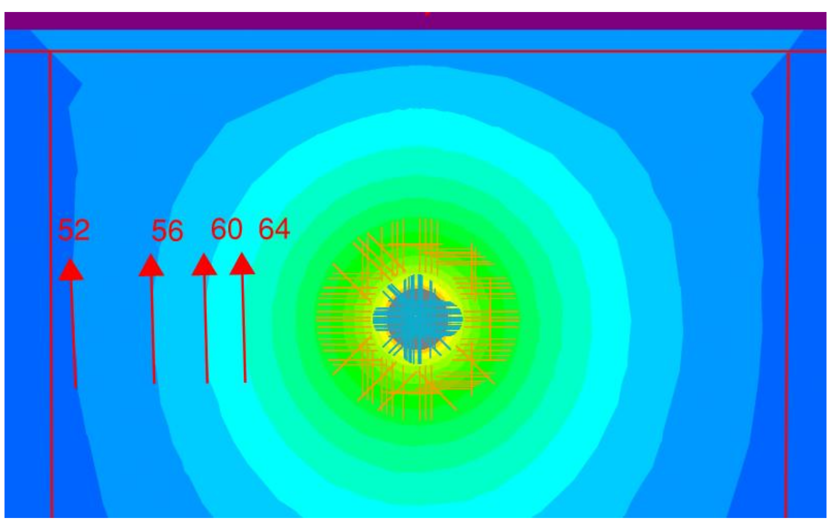

Figure 6: Moderate Influence Zone, Pipe 2 (6 inches) - Spring Interpretation

The low influence zone is the area between the upper and lower boundaries. This zone is where temperature influence is trending towards ambient. The principals that were employed to determine where the upper boundary would be drafted, are elaborated upon in Figure 7. In this zone, the slope of each temperature change in the gradient start to be more gradual, as well as the distance between each temperature change becomes further apart. The slopes will generally change from steep to less steep;

this is indicative of the temperature influence dissipating with distance. The low influence is characterized as a transitional zone headed toward ambient temperatures.

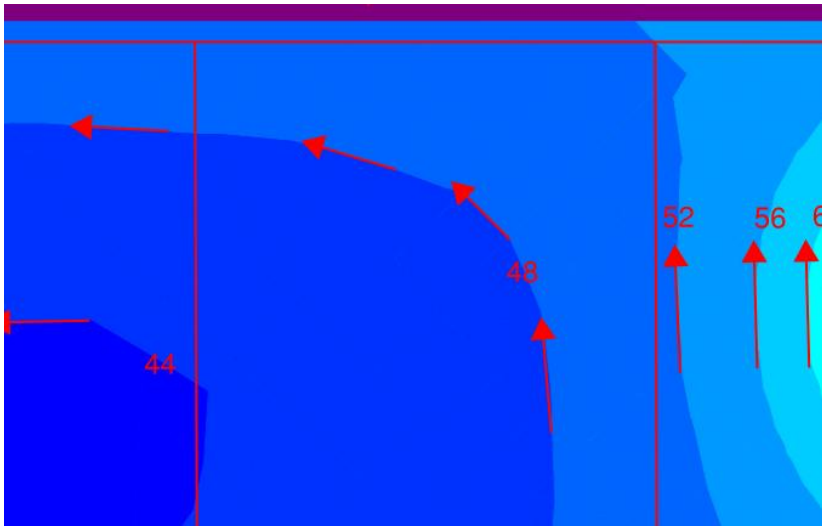

Figure 7: Low Influence Zone, Pipe 2 (6 inches) - Spring Interpretation

The last zone identified is where ambient temperatures are expected to be reached at the 6-inch mark. The no influence zone is the area outside of the upper vertical boundary and is where temperature influence is expected to be negligible. This is defined by the beginning of a consistent temperature gradient, where temperature change patterns hit a level of consistency. Even though small changes can be observed at long distances, the no influence zone is typically where the temperature change boundaries begin to level off, and the slopes get close to zero. See in Figure 8 as temperature changes become more horizontal and the temperature gradient exhibits less differences with distance.

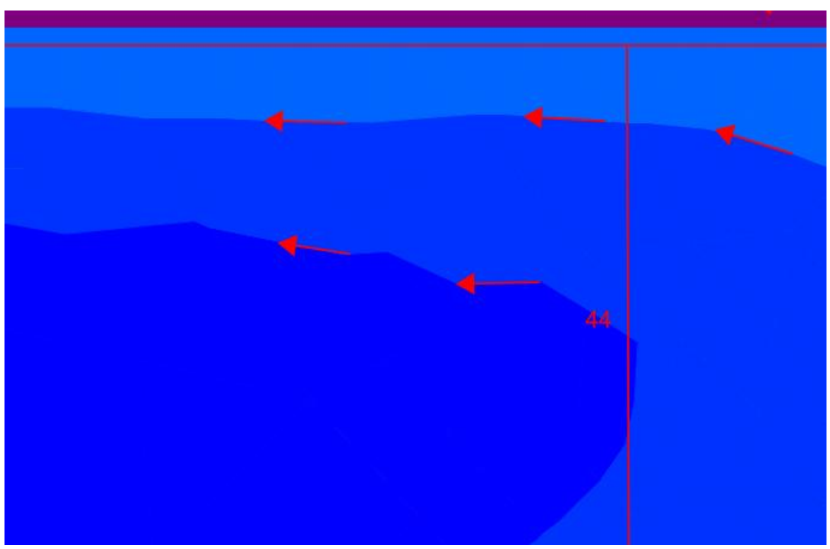

Figure 8: No Influence Zone, Pipe 2 (6in) - Spring Interpretation

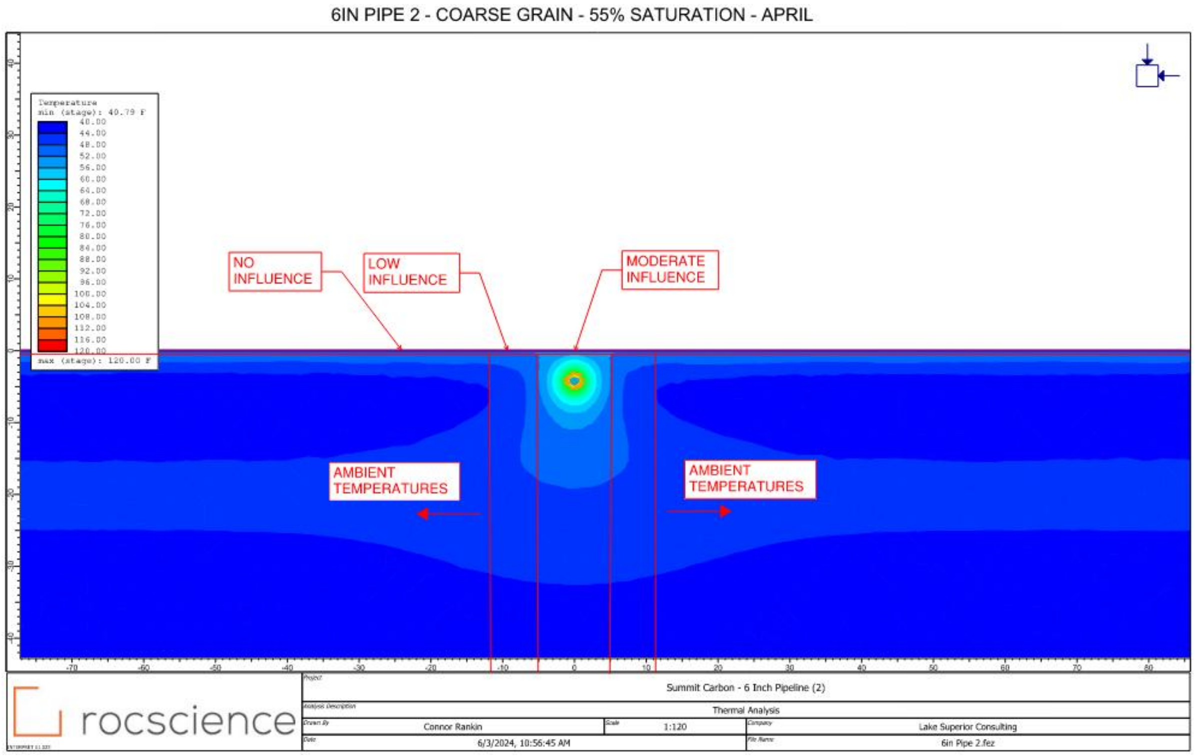

Figure 9: Pipe 2 (6 inches) - Spring Interpretation

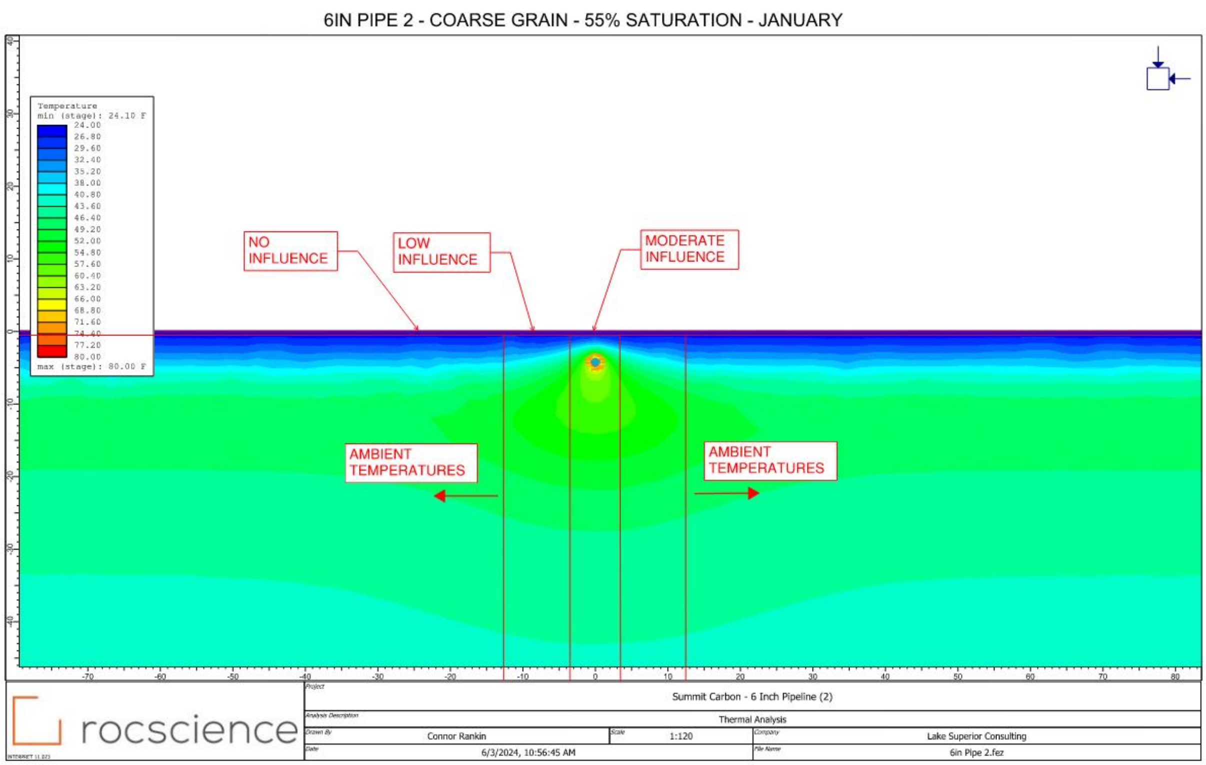

Figure 10: Pipe 2 (6 inches) – Winter Interpretation

6IN PIPE 2 - COARSE GRAIN - 55% SATURATION - JULY

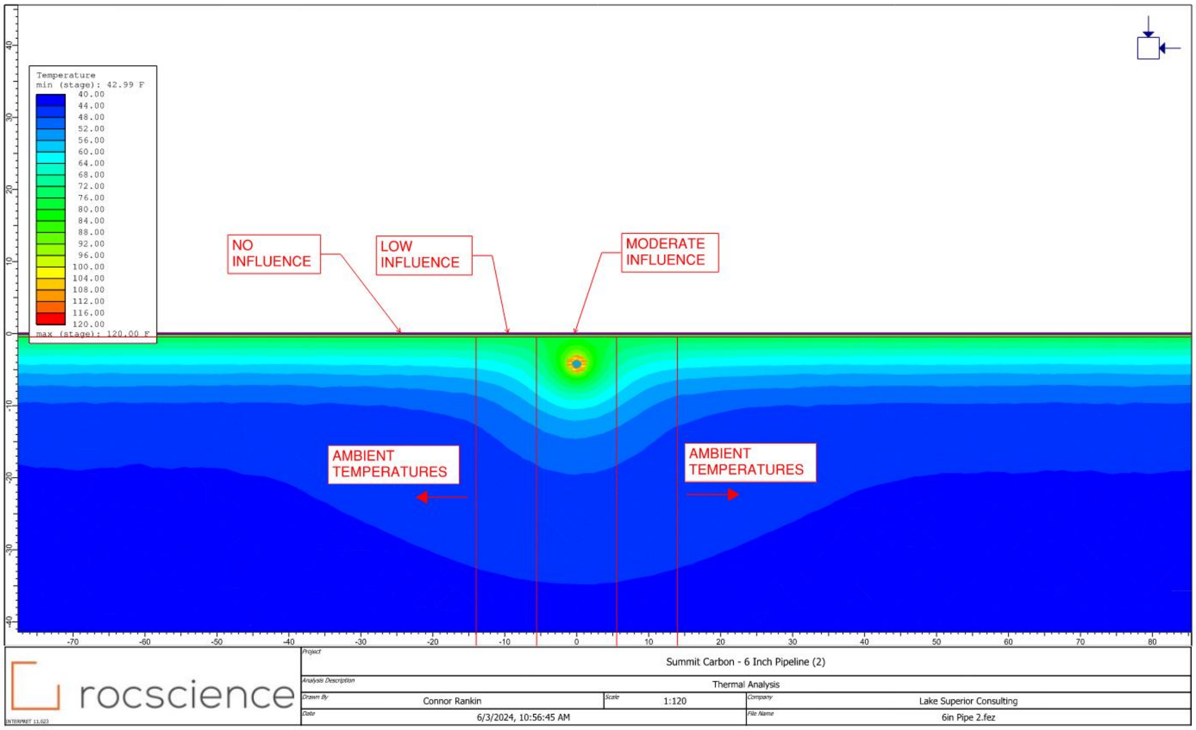

Figure 11: Pipe 2 (6 inches) – Summer Interpretation

6IN PIPE 2 - COARSE GRAIN - 55% SATURATION - OCTOBER

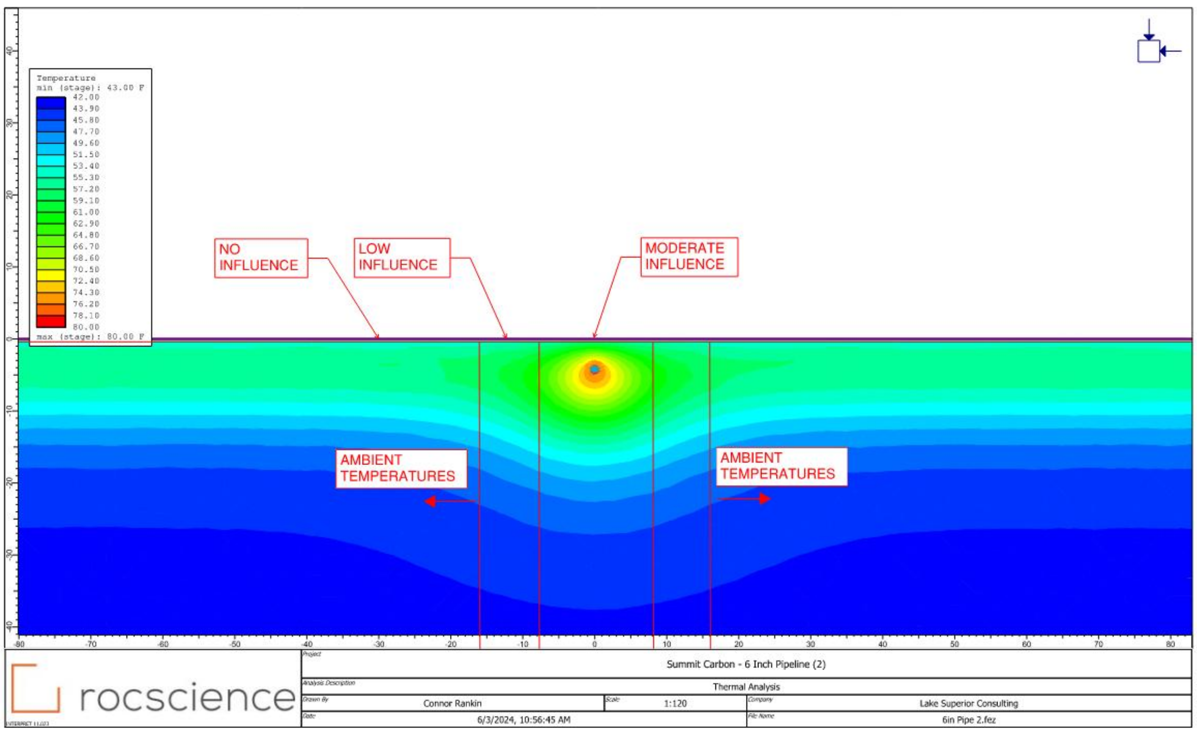

Figure 12: Pipe 2 (6 inches) – Fall Interpretation

TEMPERATURE DATA

Tables 6-10 summarize the results from the modeled simulations, the values reported are the interpreted thermal influence lengths in feet. The distance is measured from the centerline of pipe to the distance away from the pipe where ground temperature above the pipe approaches equilibrium. Therefore, the total thermal influence will be double the range values provided in the tables. The thermal influence lengths are a function of pipeline diameter, soil grain size, season, and saturation percentage. The range of values for each pipe condition is based on the impact that can be expected at the surface above the pipe, as the readings are taken from a depth of 6 inches.

From the centerline of pipe at zero feet, to the lower value of the range, the expected thermal impact at the surface is moderate. This is because the interpretation readings within this range exhibit temperature fluctuations at the 6-inch mark, indicative of thermal influence due to the proximity of the pipe.

The range between the two numbers reported on the tables, has a low impact at the surface. This range is where the temperature at the 6-inch mark dissipates as it gets further away from the centerline above the pipe.

The high value on the range, represents the upper bound. Observations made at these distances reveal where the temperature variations begin to round off returning to ambient ground temperatures. Any distance beyond this higher value is expected to have no thermal impact at the surface.

Table 6: 24 Inch Pipeline (1)

	Fine	**Coarse**	**Fine**	**Coarse**	**Fine**	**Coarse**
	High Saturation - 55%		**Medium Saturation – 35%**		**Low Saturation – 15%**	
Winter	8.5 – 13.5ft	9 – 15.5ft	11.5 – 19ft	10.5 – 15.5ft	7 - 15.5ft	7.5 - 18ft
Spring	5 – 11ft	5 – 16ft	3 – 15.5ft	3.5 – 16ft	3 – 13ft	3 – 16ft
Summer	2.5 – 12.5ft	5.5 – 14ft	7.5 - 14.5ft	8 – 17.5ft	7.5 – 13.5ft	5 – 13ft
Fall	10 – 18ft	8 – 16ft	9.5 – 15.5ft	6.5 – 16ft	6.5 – 16ft	9 – 16ft

Table 7: 24 Inch Pipeline (2)

	Fine	**Coarse**	**Fine**	**Coarse**	**Fine**	**Coarse**
	High Saturation - 55%		**Medium Saturation – 35%**		**Low Saturation – 15%**	
Winter	7.5 – 14.5ft	11 - 21ft	4.5 - 16ft	3 - 13ft	8.5 – 17.5ft	3 – 10.5ft
Spring	5 - 16ft	4 – 19ft	3 - 16ft	3.5 – 13.5ft	3 – 10.5ft	5 – 11.5ft
Summer	3 - 15ft	5.5 - 14ft	6 – 15.5ft	7.5 - 15ft	7.5 – 16.5ft	3.5 - 10ft
Fall	10 - 16ft	10.5 – 13.5ft	7 – 15.5ft	8.5 - 21ft	7 – 16.5ft	8 – 16.5ft

Table 8: 12 Inch Pipeline

	Fine	**Coarse**	**Fine**	**Coarse**	**Fine**	**Coarse**
	High Saturation - 55%		**Medium Saturation – 35%**		**Low Saturation – 15%**	
Winter	7 - 16ft	5 - 11ft	3 - 11ft	8 – 15.5ft	2 – 10.5ft	6 – 13.5ft
Spring	5.5 – 15.5ft	3.5 - 8ft	2.5 - 10ft	5.5 - 13ft	5.5 - 13ft	2.5 – 13.5ft
Summer	5 – 12.5ft	3.5 - 10ft	3 - 11ft	4 - 11ft	3.5 - 13ft	5 – 12ft
Fall	6.5 - 16ft	9.5 – 15.5ft	5.5 – 15.5ft	8.5 - 16ft	7.5 - 16ft	4 – 17.5ft

Table 9: 6 Inch Pipeline (1)

	Fine	Coarse	Fine	Coarse	Fine	Coarse
	High Saturation - 55%		**Medium Saturation – 35%**		**Low Saturation – 15%**	
Winter	4.5 – 10.5ft	3.5 – 12.5ft	3 – 10.5ft	2.5 – 12.5ft	5 – 12.5ft	2.5 - 11ft
Spring	3.5 - 10ft	5 – 11.5ft	6 - 12ft	7.5 – 14.5ft	8 - 16ft	4.5 – 13.5 ft
Summer	5 - 12ft	5.5 - 14ft	2.5 - 9ft	3 – 10.5ft	2 - 12ft	4 - 14ft
Fall	7.5 - 16ft	8 - 16ft	4.5 - 16ft	6 – 13.5ft	3 – 13.5ft	3.5 - 15ft

Table 10: 6 Inch Pipeline (2)

	Fine	Coarse	Fine	Coarse	Fine	Coarse
	High Saturation - 55%		**Medium Saturation – 35%**		**Low Saturation – 15%**	
Winter	5 – 15.5ft	2 - 12ft	5 – 11.5ft	3 - 12ft	5 - 13ft	3 - 11ft
Spring	5.5 - 16ft	8.5 - 15ft	2.5 – 13.5ft	2 – 13.5ft	3.5 - 13ft	2 – 13.5ft
Summer	3 - 11ft	3 - 10ft	3.5 - 12ft	4 - 14ft	2 - 14ft	2 - 12ft
Fall	7.5 - 16ft	5.5 - 16ft	6 -16ft	5 – 17.5ft	4.5 - 15ft	2.5 - 13ft

LIMITATIONS

ASSUMPTIONS AND EMPIRICAL FORMULAS

An important consideration to make when interpreting the results of this report is that they are all based on theoretical models and assumptions of how the soil will react given the boundary conditions and thermal properties. No existing model can exactly replicate the conditions in the field without extensive lab testing and/or field temperature readings at the site locations. This is due to the empirical nature of soil mechanics and the geotechnical models that were used during this study. The finite element mesh will produce a temperature gradient based on the thermal formulas imposed on the model. These formulas originate from geotechnical study, as an observational science of geophysics and thermodynamics.

However, conservative values have been assumed. The primary method of heat transfer of soil is conductive, the soil thermal conductivity values were adjusted to overcompensate against their intrinsic inaccuracies. Extreme conditions were applied to the thermal boundaries of the pipe as the main influential heat source. It is fair to say that given the approach to the modeling process, although not actual existing conditions of temperature, the models allow for justifiable results regarding influence from SCS' pipeline.

MODEL OF SIMPLICITY

One limitation to the model is that of the inaccuracy of temperature at the surface. Due to simplicity of the model, a constant boundary was applied to the grade and therefore there is never a time in which the temperature at that plane will be anything else besides the temperature being applied at the current time step. This would not be an accurate depiction of what would happen in the field because, especially directly over the pipe, heat would transfer upwards towards the surface. Due to this limitation of the model, most interpretations shall be taken from the influence relationship on the X axis of the model, and at a depth of 6-inches below the surface. This interpretation is more accurate representation of the influence of temperature due to the pipeline acting on the soil.

Another example of simplicity being a constraining limitation, is the modeling of heat transfer. The thermal conductivity between soil particles is set to constant, thermal soil unfrozen water content is set to simple, and it doesn't include the modeling of dispersity. Although, the modeling process was set to have general parameters, the results are still conclusive and allow for a conservative approach.

INTERPRETATION

One limitation to this model is the interpretation of where ambient temperature is reached. Although small differences can be observed at long distances, it is most likely that ambient temperature is reached closer to where the temperature difference begins to level off in the model. This is an assumption but also exists as a limitation of the study because where the influence line is drawn is more alike to an approximation than an exact.

CONCLUSIONS

THERMAL INFLUENCE

The analysis of thermal influence revealed notable differences between coarse-grained and fine-grained materials. Coarse-grained materials exhibited a larger thermal influence compared to fine-grained materials. This discrepancy is attributed to the higher thermal conductivity of coarse-grained soils, which enables more efficient heat transfer. The results indicate an upper and lower range of thermal influence for each saturation condition, as correlated to the coarse and fine-grained material respectively.

The largest thermal influence was often observed in the fall. This anomaly is likely due to the operating temperature of the pipeline dramatically increasing during this season, skewing the results. However, the winter scenario, particularly for coarse-grained soils with 15% saturation, is more realistic for representing a worst-case scenario. In winter, the thermal influence is amplified due to the higher thermal conductivity of frozen soils. Thus, the presence of freezing temperatures during winter months can lead to an increased thermal influence from the pipeline.

The operating temperatures used in the thermal analysis of the pipeline were based on the initial product temperature as it exits the facility. As the product travels over several miles along the transmission line, its temperature will gradually decrease to an ambient temperature. This lower temperature would result in less heat transfer to the soil. However, for this analysis, a higher initial operating temperature was used as a conservative measure. Additionally, the model assumed no heat loss through the pipe walls, further emphasizing the conservative nature of the approach. **In practice, the thermal impact at the ground surface would likely be smaller than the results predicted in this report, due to the lower temperatures present over the majority of the pipeline.**

CONCLUSIONS

The study conducted using RS2 incorporated conservative assumptions and inputs to analyze the thermal influence of a pipeline. Key inputs included thermal boundaries and the thermal properties of various soil conditions. A total of 120 thermal gradient models were generated to simulate conservative field scenarios. Interpretations were performed using a principled approach, ensuring repeatable and reliable results. The findings consistently aligned with the expected principles of thermal heat transfer in soils.

There were consistent results when analyzing the thermal influence above the pipe, at a 6-inch depth. Based on the methodology implemented, three different zones are defined. A moderate influence zone, a low influence zone, and a no influence zone. **Overall, the pipeline network projects to have minimal thermal influence at the surface based on the findings of this report.**

The zones are defined by an upper and lower range, measured as distance away from the centerline of pipe. The total influence would effectively be double that range, as the influence is symmetrical to the centerline. The lower range of values indicates where the heat begins to dissipate towards ambient temperatures. The average lower range value, indicative of all 120 scenarios was approximately 5.3 feet away from the centerline. While the higher range value represents where ambient temperatures are beginning to happen. The average value for this characterization was approximately 14.0 feet away from the centerline of the pipe. In between the upper and lower bounds, the heat dissipates with distance and is expected to have a low level of influence at the surface.

This conclusion is exemplified by the conservative nature in which operating temperatures were implemented into RS2. It is important to note that the modeled operating temperature was held constant at the highest expected product temperature for each line size. In operation, product temperature will decrease significantly as the product moves through the pipeline and away from the capture facility compression. This conservative approach led to exaggerated temperature models that still depict minimal thermal influence of the pipeline on the soils near the ground surface.

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APPENDIX 1 – NATIONAL WEATHER SERVICE DATA

Monthly Mean Avg Temperature for JEFFERSON, IA

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	22.6	32.6	42.9	49.8	63.5	68.5	73.2	73.6	66.0	55.5	32.8	9.4	49.2
2001	21.4	17.2	30.4	52.2	60.8	68.7	76.0	73.9	61.9	50.8	48.9	31.5	49.5
2002	28.6	29.5	30.0	48.7	57.4	73.0	77.3	71.3	65.5	46.2	34.8	29.9	49.4
2003	19.0	19.8	34.5	50.8	58.2	67.6	73.3	75.0	61.7	53.5	35.8	28.4	48.1
2004	17.7	21.1	40.8	51.4	60.5	67.3	71.5	67.1	67.2	52.8	40.4	26.7	48.7
2005	18.3	31.1	35.9	53.7	58.0	72.7	75.8	72.0	67.9	52.9	40.1	20.4	49.9
2006	32.7	25.3	36.0	53.5	61.3	71.2	75.8	72.6	60.3	48.7	38.9	31.5	50.7
2007	21.3	16.0	41.0	46.7	64.9	71.2	75.2	75.4	64.9	56.1	37.2	20.4	49.2
2008	16.5	16.7	32.7	44.8	58.2	70.4	73.3	69.2	62.7	50.9	36.2	17.1	45.7
2009	12.4	26.6	36.7	46.1	60.2	68.7	67.6	67.8	62.7	44.2	43.0	17.9	46.2
2010	12.0	15.0	35.3	54.4	59.8	70.3	73.2	74.1	62.8	54.0	37.3	19.2	47.3
2011	13.6	21.8	34.3	46.9	59.2	69.8	76.7	70.9	59.2	53.4	38.3	28.0	47.7
2012	26.7	27.8	50.7	52.9	65.7	71.5	78.7	70.7	61.7	48.7	38.8	25.6	51.6
2013	20.5	23.5	28.5	42.9	58.2	69.3	72.0	71.1	67.3	50.5	33.5	17.1	46.2
2014	15.5	15.8	29.4	47.3	60.4	69.7	67.9	70.4	61.7	51.9	28.6	28.0	45.5
2015	21.4	13.8	37.7	50.8	59.4	69.3	71.5	68.5	67.6	53.0	42.1	31.1	48.9
2016	17.7	27.1	M	M	M	M	M	M	M	M	M	M	22.4
2017	M	M	M	M	M	M	M	M	M	M	M	M	M
2018	M	M	M	M	M	M	M	M	M	M	M	M	M
2019	M	M	M	M	M	M	M	69.0	68.0	47.6	31.9	29.4	49.2
2020	22.0	24.6	39.6	46.6	57.6	73.2	75.1	71.7	61.6	45.8	41.4	27.3	48.9
2021	24.4	11.8	42.0	49.1	58.7	73.5	73.0	73.0	66.7	54.9	39.5	32.5	49.9
2022	14.4	20.7	36.4	43.0	60.8	71.4	74.2	71.6	64.6	50.7	36.7	20.1	47.1
2023	23.1	25.0	32.5	48.5	62.5	70.7	71.1	72.0	66.5	53.2	39.0	34.3	49.9
2024	M	36.5	39.1	50.4	60.7	M	M	M	M	M	M	M	46.7
Mean	20.1	22.7	36.5	49.1	60.3	70.4	73.6	71.5	64.2	51.2	37.9	25.0	47.3
Max	32.7 2006	36.5 2024	50.7 2012	54.4 2010	65.7 2012	73.5 2021	78.7 2012	75.4 2007	68.0 2019	56.1 2007	48.9 2001	34.3 2023	51.6
Min	12.0 2010	11.8 2021	28.5 2013	42.9 2013	57.4 2002	67.3 2004	67.6 2009	67.1 2004	59.2 2011	44.2 2009	28.6 2014	9.4 2000	22.4

Monthly Mean Avg Temperature for SHENANDOAH, IA

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	27.7	36.1	44.7	51.8	66.6	71.7	75.7	77.6	68.3	58.0	33.7	14.5	52.2
2001	24.0	21.1	34.5	56.0	64.5	70.0	78.5	75.3	64.8	53.2	49.5	33.7	52.1
2002	29.2	31.2	34.5	52.2	60.1	76.9	80.2	75.9	68.3	48.6	37.2	31.9	52.2
2003	22.9	24.9	39.8	54.5	61.0	70.2	78.7	78.6	63.1	56.2	38.4	32.2	51.7
2004	21.6	25.3	44.7	54.4	65.3	69.8	73.4	70.6	70.1	56.2	43.8	30.9	52.2
2005	22.2	34.7	40.9	54.9	62.9	75.8	78.0	75.4	71.5	54.7	43.3	24.6	53.2
2006	36.6	29.9	41.1	57.6	64.0	74.2	79.3	75.7	62.4	51.9	41.8	33.5	54.0
2007	24.3	20.8	47.2	49.4	67.9	73.8	78.2	79.3	67.0	58.2	40.6	23.5	52.5
2008	20.2	22.9	36.9	47.2	61.5	73.9	77.3	74.3	65.9	54.3	40.6	22.9	49.8
2009	20.5	31.3	40.3	49.1	63.7	72.9	71.8	71.7	64.9	47.3	45.3	21.2	50.0
2010	16.3	20.6	39.2	57.7	62.2	75.5	78.0	78.6	66.8	56.6	41.0	24.7	51.4
2011	18.4	26.1	39.5	51.7	62.7	73.8	82.0	75.6	62.8	55.4	41.8	31.0	51.7
2012	30.1	31.8	55.1	57.1	68.8	74.7	83.0	74.6	64.2	51.2	42.6	31.0	55.4
2013	26.6	28.0	34.0	46.4	61.6	71.6	75.2	75.3	70.0	52.4	37.4	21.2	50.0
2014	20.4	20.2	35.2	51.2	63.9	72.6	72.3	74.4	64.7	55.1	33.5	31.3	49.6
2015	26.4	19.8	41.1	53.0	61.3	73.1	75.6	72.0	71.0	56.4	46.7	34.2	52.6
2016	23.4	34.3	47.5	54.3	62.2	77.2	75.8	75.0	70.8	58.0	47.4	25.6	54.3
2017	26.8	38.2	42.7	54.5	62.2	73.9	77.8	70.6	70.1	55.6	40.8	28.2	53.5
2018	20.4	24.8	39.3	43.1	70.0	76.2	75.2	74.3	69.2	50.4	31.9	29.8	50.4
2019	23.2	17.1	33.1	53.6	59.8	72.2	77.5	73.5	71.6	48.9	36.1	32.1	49.9
2020	26.2	30.2	43.6	49.7	60.0	76.6	77.1	73.9	64.0	48.8	45.8	29.3	52.1
2021	27.2	15.5	45.7	50.8	61.6	75.2	75.3	75.9	69.7	56.4	42.8	36.2	52.7
2022	20.5	27.1	39.8	47.4	63.4	74.4	76.9	75.1	67.8	52.8	39.0	24.0	50.7
2023	27.7	29.6	37.0	52.9	65.2	73.3	74.1	74.5	69.6	55.5	40.4	36.3	53.0
2024	20.9	40.1	42.8	54.4	64.1	M	M	M	M	M	M	M	44.5
Mean	24.1	27.3	40.8	52.2	63.5	73.7	77.0	74.9	67.4	53.8	40.9	28.5	51.7
Max	36.6 2006	40.1 2024	55.1 2012	57.7 2010	70.0 2018	77.2 2016	83.0 2012	79.3 2007	71.6 2019	58.2 2007	49.5 2001	36.3 2023	55.4
Min	16.3 2010	15.5 2021	33.1 2019	43.1 2018	59.8 2019	69.8 2004	71.8 2009	70.6 2004	62.4 2006	47.3 2009	31.9 2018	14.5 2000	44.5

Monthly Mean Avg Temperature for SHELDON, IA

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	15.9	27.2	39.2	46.0	60.5	65.3	73.0	72.6	60.3	50.9	26.7	6.0	45.3
2001	17.2	10.5	24.7	48.0	58.4	66.9	73.9	70.7	59.2	47.4	44.0	26.4	45.6
2002	23.4	24.9	24.1	46.2	53.5	72.1	76.6	69.8	63.1	42.4	32.6	25.8	46.2
2003	16.1	17.1	31.7	47.4	55.7	66.6	71.4	72.3	58.2	49.5	31.6	23.7	45.1
2004	14.0	17.3	38.5	48.5	58.1	64.9	70.4	65.5	64.8	49.7	38.3	24.3	46.2
2005	14.8	29.4	32.2	50.9	56.6	70.7	73.1	70.6	65.8	50.8	37.1	19.3	47.6
2006	30.7	23.6	32.7	50.6	58.8	69.0	74.6	69.8	56.8	46.7	34.8	27.3	47.9
2007	17.3	11.8	37.7	45.2	64.0	70.5	73.0	70.4	61.2	54.0	34.0	17.5	46.4
2008	14.6	14.3	29.1	43.3	57.2	67.4	70.4	65.0	58.6	47.2	33.4	13.2	42.8
2009	8.6	22.3	31.5	41.6	55.3	63.6	65.1	66.0	61.8	40.5	37.8	14.9	42.4
2010	8.0	12.4	35.5	51.4	56.5	69.6	72.2	72.4	59.5	50.6	34.0	14.8	44.7
2011	8.7	17.9	29.6	43.5	56.5	66.2	75.5	69.2	57.7	50.8	34.2	23.7	44.5
2012	22.3	24.2	47.9	50.3	62.7	70.4	77.5	69.3	60.2	44.2	35.5	22.9	48.9
2013	17.3	21.2	27.0	38.0	55.2	66.2	70.4	68.5	63.8	48.3	30.0	12.0	43.2
2014	12.7	10.6	26.5	44.1	57.5	67.9	66.6	67.3	60.1	49.5	25.4	24.1	42.7
2015	18.8	13.4	35.4	48.3	56.6	67.5	70.2	66.2	65.8	51.6	37.3	26.2	46.4
2016	15.3	24.6	39.0	46.9	58.0	71.5	70.7	69.0	63.6	51.3	42.0	19.1	47.6
2017	20.5	30.1	33.1	47.1	55.5	68.6	72.5	64.9	63.6	48.6	32.7	21.0	46.5
2018	13.4	12.7	32.5	34.6	63.1	72.0	70.7	68.2	64.1	43.7	27.5	23.4	43.8
2019	15.5	9.3	27.3	45.0	53.2	68.9	M	M	M	M	M	M	36.5
2020	M	M	M	M	M	M	M	M	M	M	M	M	M
2021	M	M	M	M	M	M	M	M	M	M	M	M	M
2022	M	M	M	M	M	M	M	M	M	M	M	M	M
2023	M	M	M	M	M	M	M	M	M	M	M	M	M
2024	M	M	M	M	M	M	M	M	M	M	M	M	M
Mean	16.3	18.7	32.8	45.8	57.6	68.3	72.0	68.8	61.5	48.3	34.1	20.3	45.0
Max	30.7 2006	30.1 2017	47.9 2012	51.4 2010	64.0 2007	72.1 2002	77.5 2012	72.6 2000	65.8 2015	54.0 2007	44.0 2001	27.3 2006	48.9
Min	8.0 2010	9.3 2019	24.1 2002	34.6 2018	53.2 2019	63.6 2009	65.1 2009	64.9 2017	56.8 2006	40.5 2009	25.4 2014	6.0 2000	36.5

Monthly Mean Avg Temperature for BISMARCK MUNICIPAL AP, ND

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	15.1	22.6	35.7	43.6	56.6	62.7	72.0	70.8	59.7	48.8	24.1	6.8	43.2
2001	18.7	7.5	29.9	44.7	57.8	64.3	72.5	72.5	61.0	44.1	38.0	20.8	44.3
2002	19.4	25.7	18.8	40.8	50.3	68.1	74.8	69.2	61.4	36.4	32.6	22.8	43.4
2003	14.4	11.8	25.0	47.0	54.0	63.6	72.5	75.6	60.1	49.4	22.2	23.9	43.3
2004	7.7	17.4	35.2	45.9	53.6	61.6	70.1	64.4	61.1	46.0	35.1	22.0	43.3
2005	9.5	24.0	32.5	48.7	53.7	67.6	72.2	68.1	61.3	46.9	33.7	19.5	44.8
2006	26.8	20.1	31.4	49.8	57.5	67.8	77.2	71.5	57.0	41.5	29.8	23.4	46.2
2007	14.6	8.9	36.6	42.1	57.4	67.0	75.5	67.1	59.5	47.0	31.1	15.0	43.5
2008	11.7	14.4	30.6	41.8	53.0	62.0	72.2	71.5	59.0	45.7	31.2	6.8	41.7
2009	8.7	13.5	21.5	41.2	54.3	61.4	66.9	66.8	65.0	39.5	38.1	10.5	40.6
2010	9.3	10.5	33.7	47.8	54.2	65.3	70.7	71.1	56.2	48.7	28.4	11.6	42.3
2011	8.7	12.1	21.2	40.1	52.4	62.7	71.6	69.2	57.7	48.9	31.4	25.1	41.8
2012	22.7	22.2	43.2	47.1	55.2	67.2	75.7	67.7	59.0	42.7	28.6	14.9	45.5
2013	13.9	21.9	22.7	34.5	54.7	64.7	70.0	71.0	63.8	42.0	27.6	7.4	41.2
2014	13.8	9.6	27.2	41.1	55.8	63.4	68.5	68.7	60.2	47.8	21.5	19.8	41.4
2015	19.1	12.0	36.1	45.4	53.9	66.4	71.8	70.2	64.4	48.9	33.3	22.1	45.3
2016	17.1	32.5	39.0	45.0	57.2	68.0	71.8	68.9	60.0	48.1	39.6	10.5	46.5
2017	11.1	22.6	31.0	45.3	56.9	67.9	75.9	67.1	60.4	46.8	31.7	19.6	44.7
2018	13.0	8.6	26.5	36.2	61.4	70.0	71.6	70.7	57.9	42.2	25.5	23.6	42.3
2019	13.0	-0.4	22.7	44.2	52.2	67.2	72.6	67.5	60.4	39.2	29.1	17.5	40.4
2020	15.5	22.4	34.2	40.9	55.0	71.1	74.0	73.1	60.0	40.3	35.2	25.8	45.6
2021	25.8	10.5	38.6	43.1	55.6	72.9	78.8	73.1	65.1	50.7	35.3	17.3	47.2
2022	13.1	15.6	31.7	37.0	55.0	67.0	73.9	73.6	63.5	47.8	23.4	8.2	42.5
2023	13.6	16.8	14.7	37.0	61.3	70.7	70.1	70.6	63.6	45.3	33.2	28.4	43.8
2024	15.5	29.2	28.5	45.5	55.7	M	M	M	M	M	M	M	34.9
Mean	14.9	16.5	29.9	43.0	55.4	66.3	72.6	70.0	60.7	45.2	30.8	17.6	43.2
Max	26.8 2006	32.5 2016	43.2 2012	49.8 2006	61.4 2018	72.9 2021	78.8 2021	75.6 2003	65.1 2021	50.7 2021	39.6 2016	28.4 2023	47.2
Min	7.7 2004	-0.4 2019	14.7 2023	34.5 2013	50.3 2002	61.4 2009	66.9 2009	64.4 2004	56.2 2010	36.4 2002	21.5 2014	6.8 2000	34.9

Monthly Mean Avg Temperature for ASHLEY, ND

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2000	14.8	25.2	36.0	42.9	57.3	62.8	70.9	69.9	57.8	48.6	25.5	6.1	43.2
2001	M	5.4	25.4	M	57.3	64.7	72.5	72.1	59.5	43.1	40.6	20.8	46.1
2002	M	24.3	M	40.6	M	M	74.6	M	61.3	M	M	M	50.2
2003	M	M	M	43.7	M	62.6	70.9	73.3	M	M	M	M	62.6
2004	M	M	33.9	44.8	M	58.7	M	62.8	60.5	M	34.6	21.1	45.2
2005	M	22.2	30.2	46.4	M	66.7	72.8	67.2	61.7	49.1	35.0	18.9	47.0
2006	M	M	M	M	M	66.4	77.5	M	56.0	40.1	M	M	60.0
2007	12.3	7.3	M	M	M	M	74.2	67.1	M	48.0	M	M	41.8
2008	11.4	M	M	M	M	62.3	70.9	70.5	58.6	M	M	9.3	47.2
2009	M	13.0	M	M	M	61.4	65.9	M	63.2	M	37.9	11.8	42.2
2010	M	M	M	M	M	65.2	70.1	70.6	56.6	49.0	30.3	11.7	50.5
2011	M	M	17.6	38.2	49.5	61.0	73.1	68.6	57.9	48.2	31.2	22.7	46.8
2012	19.1	20.4	41.6	45.7	55.9	67.4	76.3	67.8	58.7	42.0	28.1	15.2	44.9
2013	12.2	15.7	17.1	32.1	53.5	64.0	69.8	70.3	63.1	40.9	27.0	7.5	39.4
2014	7.2	6.8	21.8	38.3	53.3	63.2	67.6	67.3	58.6	47.1	20.0	16.9	39.0
2015	16.7	7.0	31.6	44.8	53.2	65.6	70.5	69.5	63.7	48.4	34.2	22.2	43.9
2016	13.7	25.6	36.3	41.3	55.8	66.8	70.5	69.2	59.0	46.5	40.9	10.9	44.7
2017	12.1	20.8	26.6	42.3	55.7	65.9	72.8	65.7	59.7	44.9	28.7	16.4	42.6
2018	11.1	6.7	23.9	29.8	60.9	68.6	69.9	69.2	57.7	36.0	21.7	19.7	39.6
2019	8.3	-3.2	17.0	38.6	47.4	64.3	70.6	65.7	59.5	37.2	26.7	16.5	37.4
2020	12.2	16.0	29.7	38.7	52.1	68.8	71.0	71.1	55.2	37.0	34.2	22.9	42.4
2021	20.8	7.7	36.8	39.9	54.6	71.1	77.0	72.5	64.2	49.9	35.0	M	48.1
2022	M	9.8	27.7	35.3	53.3	66.1	71.4	70.2	62.3	45.2	24.2	6.5	42.9
2023	11.7	13.9	12.9	33.6	60.0	70.4	68.5	68.3	62.2	44.8	31.9	26.9	42.1
2024	12.0	28.4	26.3	43.3	54.9	M	M	M	M	M	M	M	33.0
Mean	13.0	14.4	27.4	40.0	54.7	65.2	71.7	69.0	59.9	44.5	30.9	16.0	44.9
Max	20.8 2021	28.4 2024	41.6 2012	46.4 2005	60.9 2018	71.1 2021	77.5 2006	73.3 2003	64.2 2021	49.9 2021	40.9 2016	26.9 2023	62.6
Min	7.2 2014	-3.2 2019	12.9 2023	29.8 2018	47.4 2019	58.7 2004	65.9 2009	62.8 2004	55.2 2020	36.0 2018	20.0 2014	6.1 2000	33.0

APPENDIX 2 – USDA SOIL DATA

Report Generator | Air & Water Database Report Generator

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Rogers Farm #1 (2001)
Nebraska SCAN Site - 1215 ft
Reporting Frequency: Daily; Date Range: 2020-01-01 to 2024-06-24

(As of: Thu Aug 01 08:56:29 GMT-08:00 2024)
Provisional data, subject to revision

Date	Rogers Farm #1 (2001) Soil Temperature Average -2in (degF)	Rogers Farm #1 (2001) Soil Temperature Average -4in (degF)	Rogers Farm #1 (2001) Soil Temperature Average -8in (degF)	Rogers Farm #1 (2001) Soil Temperature Average -20in (degF)	Rogers Farm #1 (2001) Soil Temperature Average -40in (degF)
2020-01-01	35	36	38	43	46
2021-01-01	35	36	38	43	46
2022-01-01					
2023-01-01	32	31	31	34	41
2024-01-01	33	34	36	40	46

Natural Resources Conservation Service National Water and Climate Center

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Interactive Map	Report Generator	Update Reports
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View Station Information

Create/Modify Report View Report Report Details

Output Format Layout Time Period Fit Table To Screen

Ames (2031)
Iowa SCAN Site - 1073 ft
Reporting Frequency: Daily; Date Range: 2020-01-01 to 2024-06-24

(As of: Thu Aug 01 08:45:25 GMT-08:00 2024)
Provisional data, subject to revision

Date	Ames (2031) Soil Temperature Average -2in (degF)	Ames (2031) Soil Temperature Average -4in (degF)	Ames (2031) Soil Temperature Average -8in (degF)	Ames (2031) Soil Temperature Average -20in (degF)	Ames (2031) Soil Temperature Average -40in (degF)
2020-01-01	35	36	38	40	43
2021-01-01	33	34	36	39	42
2022-01-01	33	35	37	41	44
2023-01-01	34	35	36	38	41
2024-01-01	37	38	40	43	45

Report Generator | Air & Water Database Report Generator

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Shagbark Hills (2068)
Iowa SCAN Site - 1400 ft
Reporting Frequency: Daily; Date Range: 2020-01-01 to 2024-06-24

(As of: Thu Aug 01 08:42:43 GMT-08:00 2024)
Provisional data, subject to revision

Date	Shagbark Hills (2068) Soil Temperature Average -2in (degF)	Shagbark Hills (2068) Soil Temperature Average -4in (degF)	Shagbark Hills (2068) Soil Temperature Average -8in (degF)	Shagbark Hills (2068) Soil Temperature Average -20in (degF)	Shagbark Hills (2068) Soil Temperature Average -40in (degF)
2020-01-01	32	33	34	36	41
2021-01-01	32	33	34	36	42
2022-01-01	28	30	33	37	42
2023-01-01	31	31	32	34	40
2024-01-01	32	33	35	38	43

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View Station Information

Create/Modify Report View Report Report Details

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Mandan #1 (2020)
North Dakota SCAN Site - 1930 ft
Reporting Frequency: Daily; Date Range: 2020-01-01 to 2024-06-24

(As of: Thu Aug 01 08:53:14 GMT-08:00 2024)
Provisional data, subject to revision

Date	Mandan #1 (2020) Soil Temperature Average -2in (degF)	Mandan #1 (2020) Soil Temperature Average -4in (degF)	Mandan #1 (2020) Soil Temperature Average -8in (degF)	Mandan #1 (2020) Soil Temperature Average -20in (degF)	Mandan #1 (2020) Soil Temperature Average -40in (degF)
2020-01-01	32	33	35	37	39
2021-01-01	30	30	32	35	40
2022-01-01	30	31	33	35	40
2023-01-01	30	31	32	35	40
2024-01-01	32	33	34	37	40

Natural Resources Conservation Service National Water and Climate Center

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Output Format | Layout | Time Period | Fit Table To Screen

Eros Data Center (2072)
South Dakota SCAN Site - 1602 ft
Reporting Frequency: Daily; Date Range: 2020-01-01 to 2024-06-24

(As of: Thu Aug 01 08:49:02 GMT-08:00 2024)
Provisional data, subject to revision

Date	Eros Data Center (2072) Soil Temperature Average -2in (degF)	Eros Data Center (2072) Soil Temperature Average -4in (degF)	Eros Data Center (2072) Soil Temperature Average -8in (degF)	Eros Data Center (2072) Soil Temperature Average -20in (degF)	Eros Data Center (2072) Soil Temperature Average -40in (degF)
2020-01-01	30	32	32	35	39
2021-01-01	30	31	32	36	39
2022-01-01	25	27	29	35	39
2023-01-01	30	32	32	35	38
2024-01-01	32	33	34	37	41

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Forecast Plots	**Webservices**	**Contact Us**

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Create/Modify Report | View Report | Report Details

Output Format | Layout | Time Period | Fit Table To Screen

Ames (2031)
Iowa SCAN Site - 1073 ft
Reporting Frequency: Monthly; Date Range: Jun 2020 to Oct 2024

(As of: Fri Oct 18 08:58:41 GMT-08:00 2024)
Provisional data, subject to revision

Date	Ames (2031) Soil Temperature Average -2in (degF)	Ames (2031) Soil Temperature Average -4in (degF)	Ames (2031) Soil Temperature Average -8in (degF)	Ames (2031) Soil Temperature Average -20in (degF)	Ames (2031) Soil Temperature Average -40in (degF)
Jan 2021	34	35	36	39	41
Jan 2022	30	32	34	38	41
Jan 2023	34	35	35	38	40

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View Station Information

Create/Modify Report | View Report | Report Details

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Ames (2031)
Iowa SCAN Site - 1073 ft
Reporting Frequency: Monthly; Date Range: Jun 2020 to Oct 2024

(As of: Fri Oct 18 08:57:44 GMT-08:00 2024)
Provisional data, subject to revision

Date	Ames (2031) Soil Temperature Average -2in (degF)	Ames (2031) Soil Temperature Average -4in (degF)	Ames (2031) Soil Temperature Average -8in (degF)	Ames (2031) Soil Temperature Average -20in (degF)	Ames (2031) Soil Temperature Average -40in (degF)
Apr 2021	45	46	45	44	43
Apr 2022	41	41	40	40	40
Apr 2023	45	45	44	42	41
Apr 2024	47	47	46	45	44

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Ames (2031)
Iowa SCAN Site - 1073 ft
Reporting Frequency: Monthly; Date Range: Jun 2020 to Oct 2024

(As of: Fri Oct 18 08:54:33 GMT-08:00 2024)
Provisional data, subject to revision

Date	Ames (2031) Soil Temperature Average -2in (degF)	Ames (2031) Soil Temperature Average -4in (degF)	Ames (2031) Soil Temperature Average -8in (degF)	Ames (2031) Soil Temperature Average -20in (degF)	Ames (2031) Soil Temperature Average -40in (degF)
Jul 2021	66	66	64	61	58
Jul 2022	67	66	65	61	58
Jul 2023	67	66	64	60	57
Jul 2024	68	67	66	62	59

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Forecast Plots	Webservices	Contact Us

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Ames (2031)
Iowa SCAN Site - 1073 ft
Reporting Frequency: Monthly; Date Range: Jun 2020 to Oct 2024

(As of: Fri Oct 18 08:56:26 GMT-08:00 2024)
Provisional data, subject to revision

Date	Ames (2031) Soil Temperature Average -2in (degF)	Ames (2031) Soil Temperature Average -4in (degF)	Ames (2031) Soil Temperature Average -8in (degF)	Ames (2031) Soil Temperature Average -20in (degF)	Ames (2031) Soil Temperature Average -40in (degF)
Oct 2020	50	51	52	54	55
Oct 2021	56	56	57	58	58
Oct 2022	52	53	54	55	55
Oct 2023	55	56	57	58	57

APPENDIX 3 – RS2 THERMAL MODELS

APPENDIX 3 - RS2 THERMAL MODELS

Table of Content:

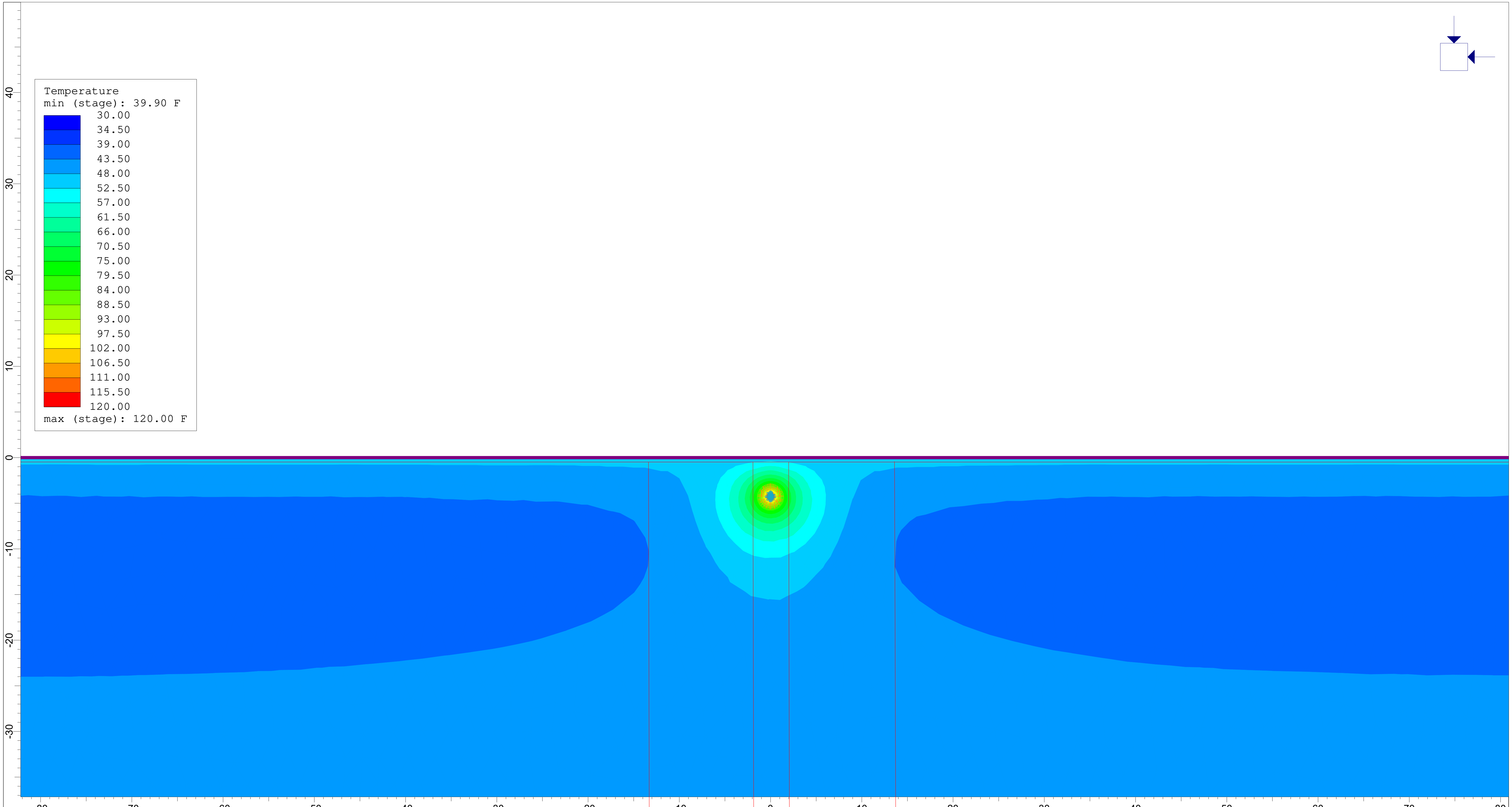
Soil Conditions:

Coarse Grain: 15% Sat, 35% Sat, 55% Sat
Fine Grain: 15% Sat, 35% Sat, 55% Sat

Seasonal Outputs:

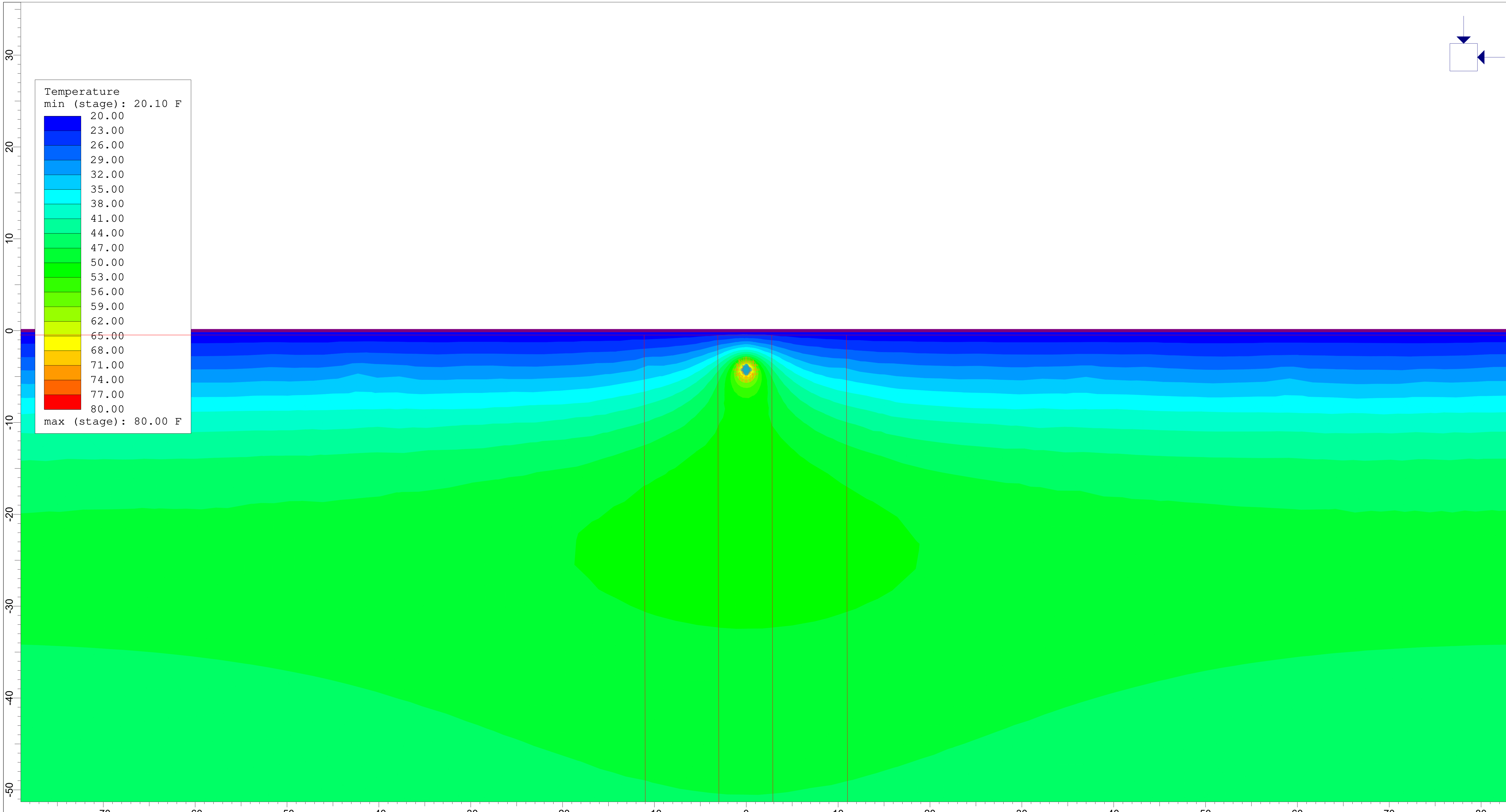
Spring: April
Winter: January
Summer: July
Fall: October

6IN PIPE 1 - COARSE GRAIN - 15% SATURATION - APRIL



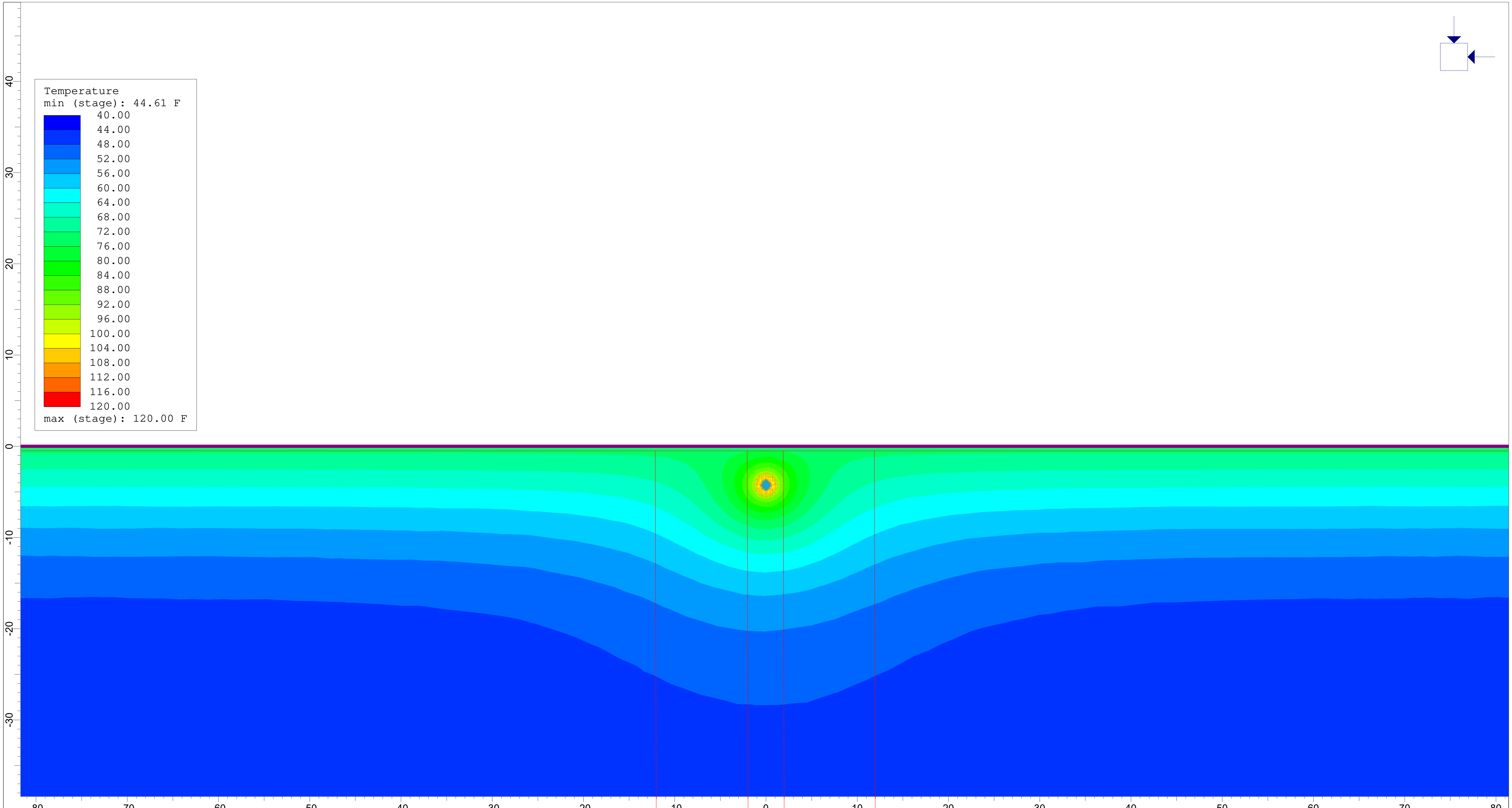
rocscience	Project	Summit Carbon - 6 Inch Pipeline (1)	
	Analysis Description	Thermal Influence	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 1.fez

6IN PIPE 1 - COARSE GRAIN - 15% SATURATION - JANUARY



rocscience	Project: Summit Carbon - 6 Inch Pipeline (1)		
	Analysis Description: Thermal Influence		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 1.fez

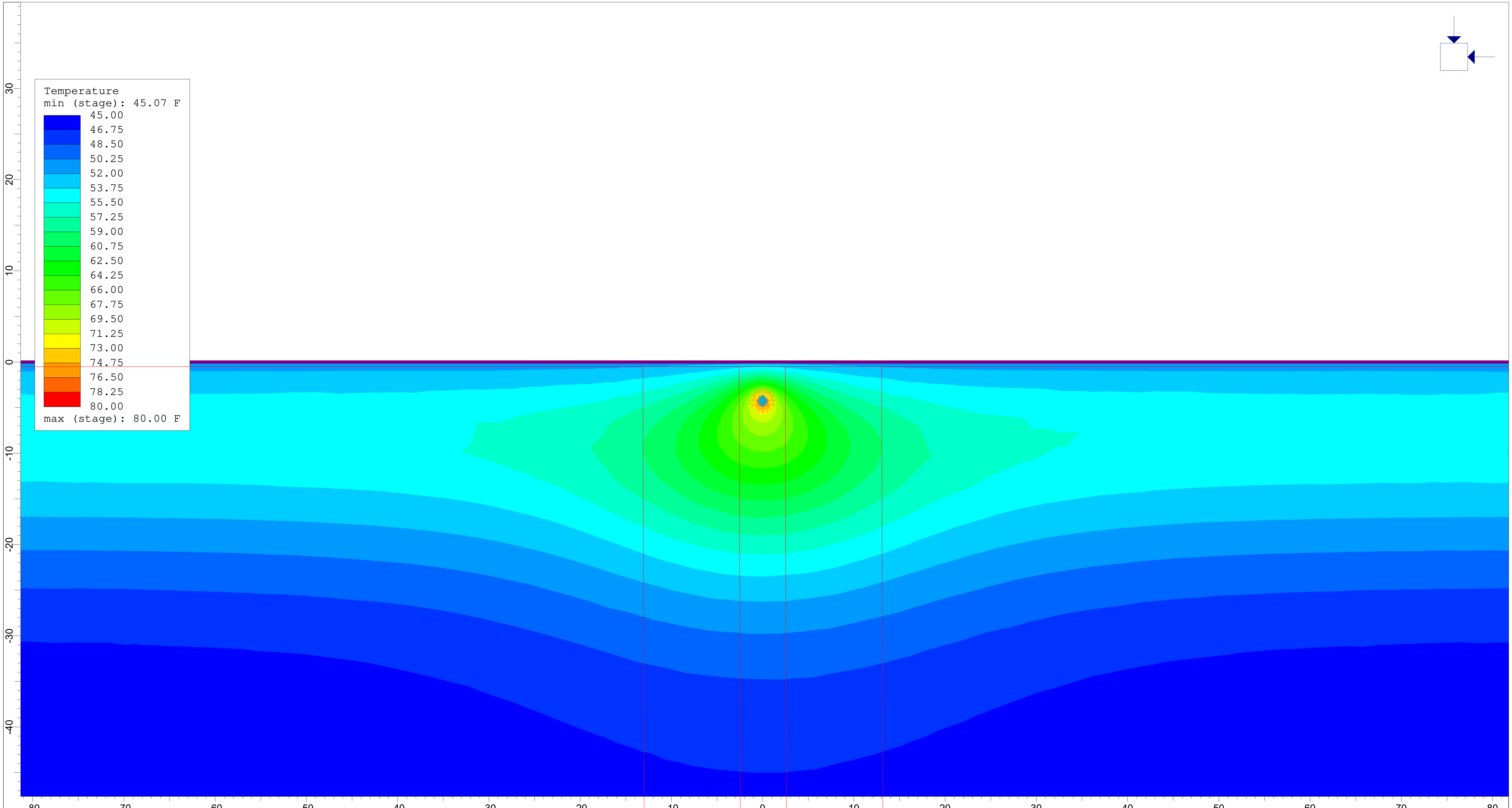
6IN PIPE 1 - COARSE GRAIN - 15% SATURATION - JULY



Project	Summit Carbon - 6 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	6in Pipe 1.fez

INTERPRET 11.023

6IN PIPE 1 - COARSE GRAIN - 15% SATURATION - OCTOBER

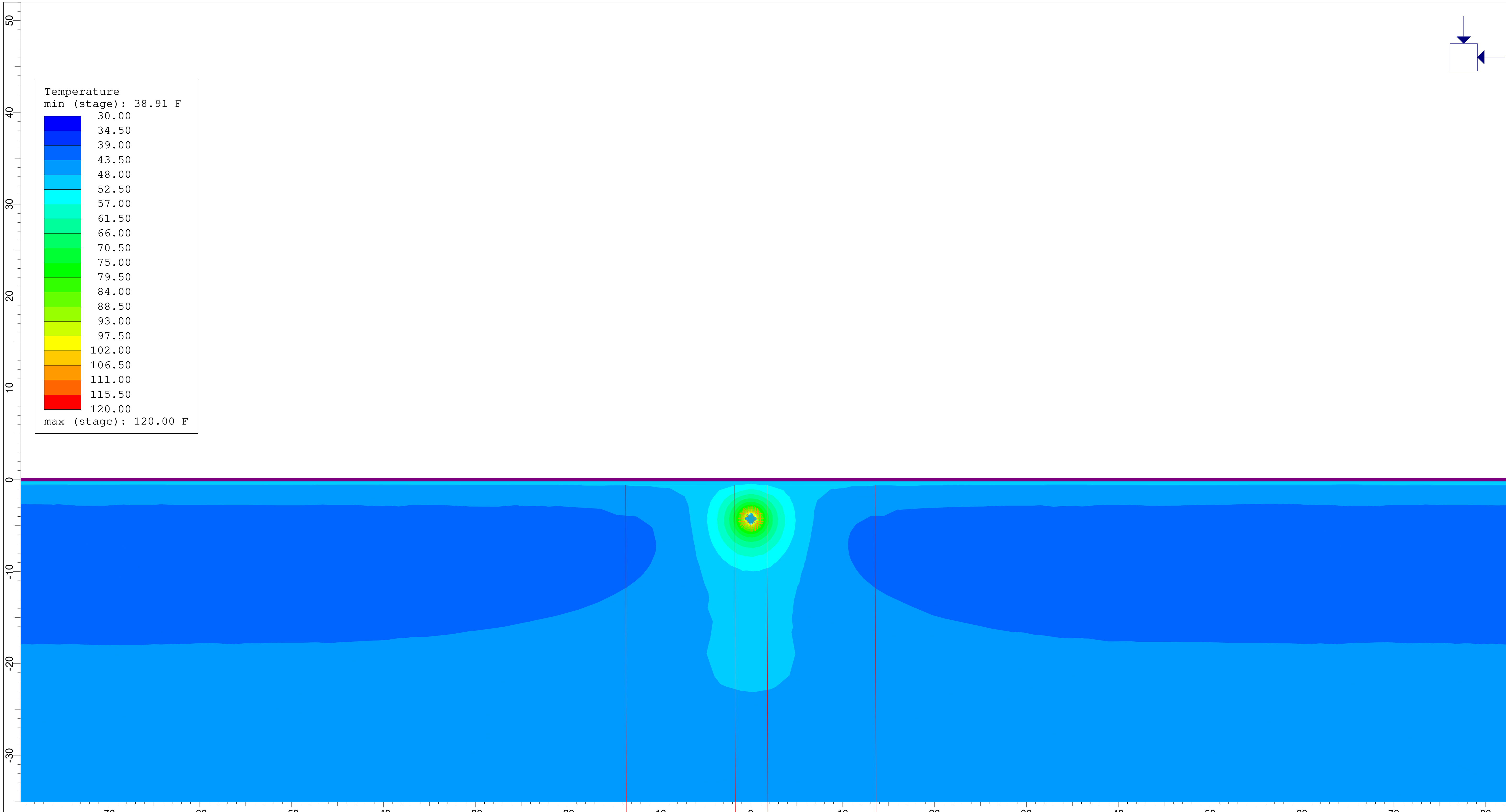


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (1)
Analysis Description	Thermal Influence
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	6in Pipe 1.fez

6IN PIPE 1 - COARSE GRAIN - 35% SATURATION - APRIL

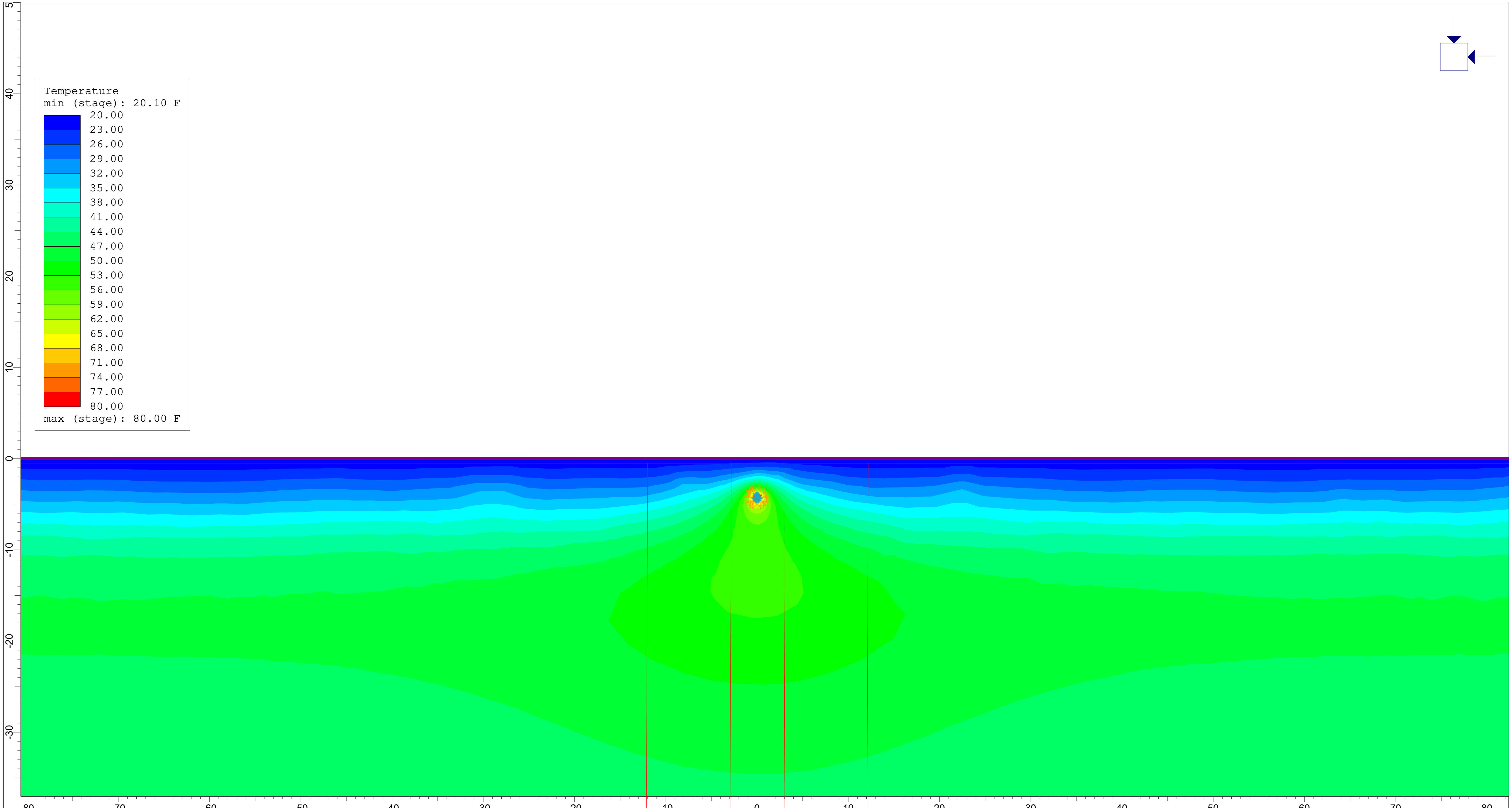


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 1.fez

6IN PIPE 1 - COARSE GRAIN - 35% SATURATION - JANUARY

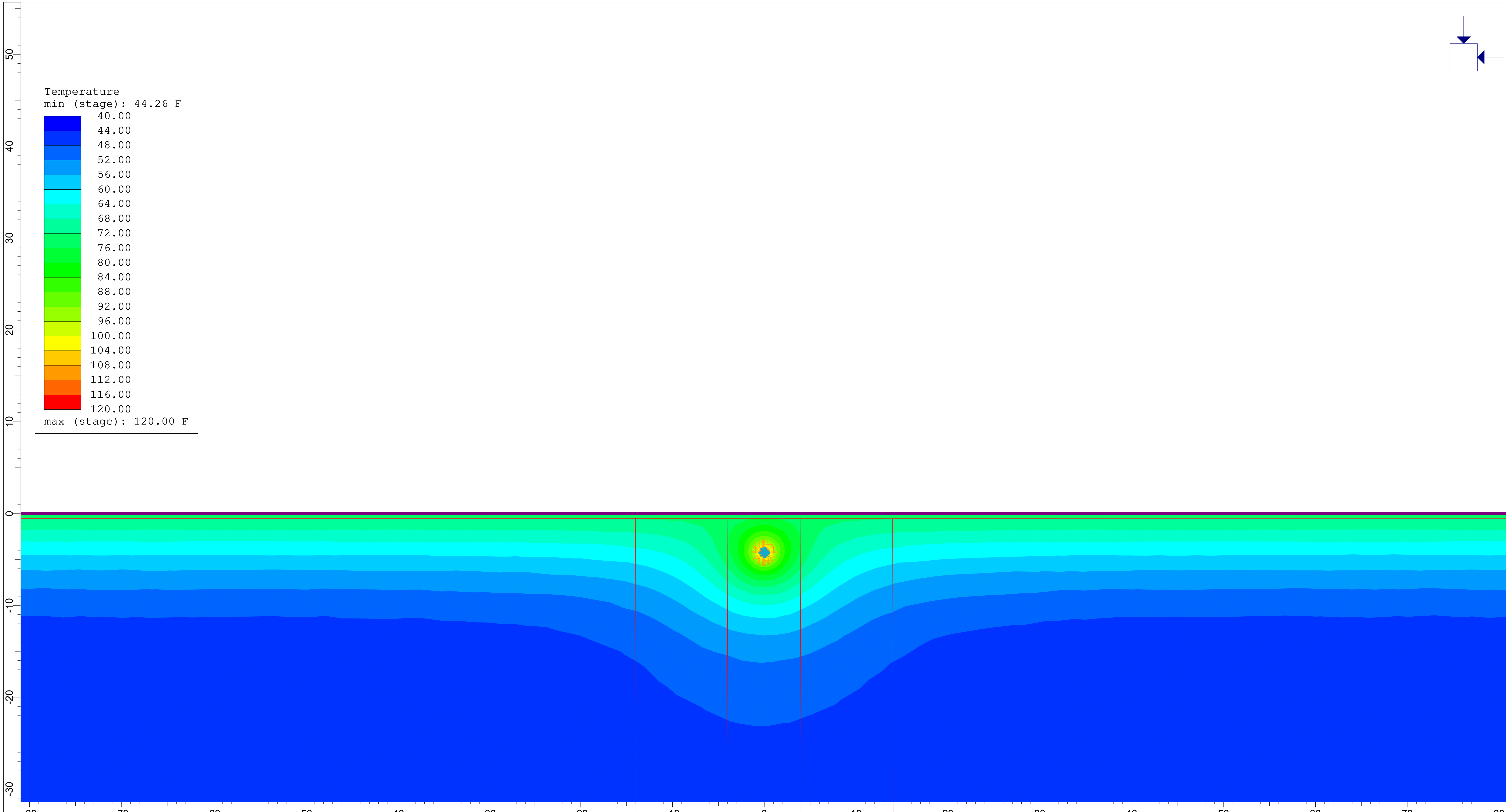


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 1.fez

6IN PIPE 1 - COARSE GRAIN - 35% SATURATION - JULY

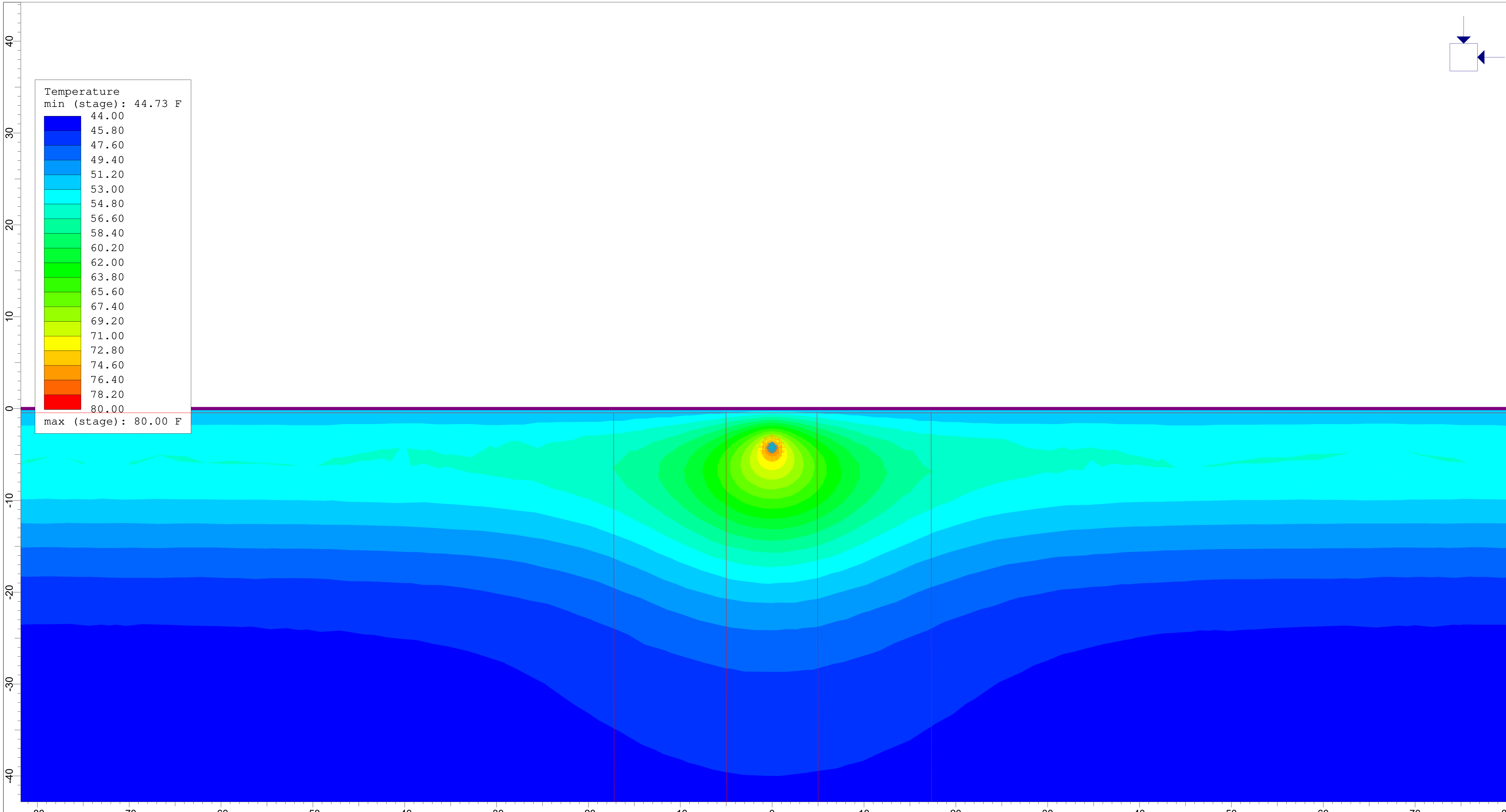


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (1)
Analysis Description	Thermal Influence
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	6in Pipe 1.fez

6IN PIPE 1 - COARSE GRAIN - 35% SATURATION - OCTOBER

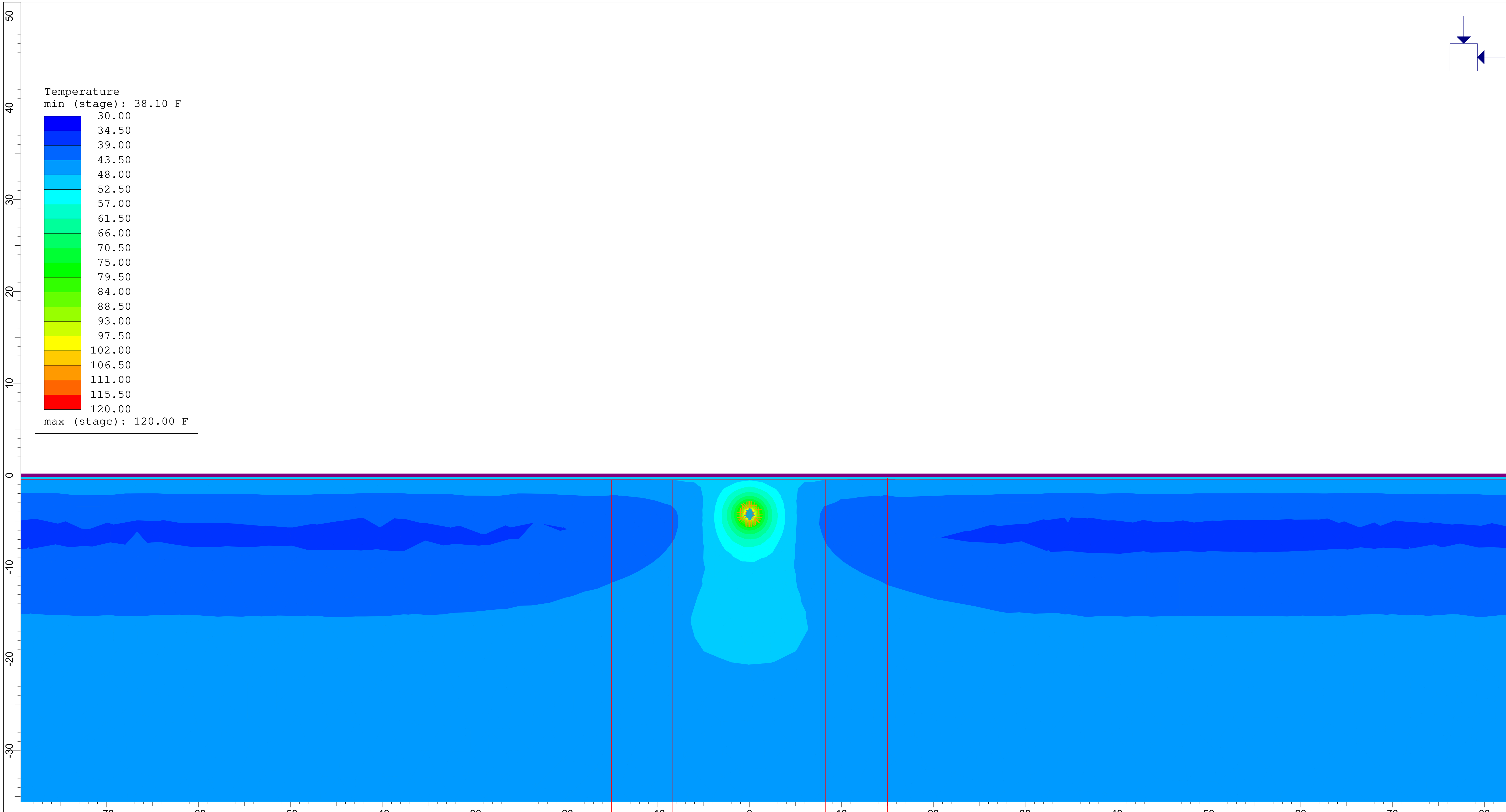


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 1.fez

6IN PIPE 1 - COARSE GRAIN - 55% SATURATION - APRIL

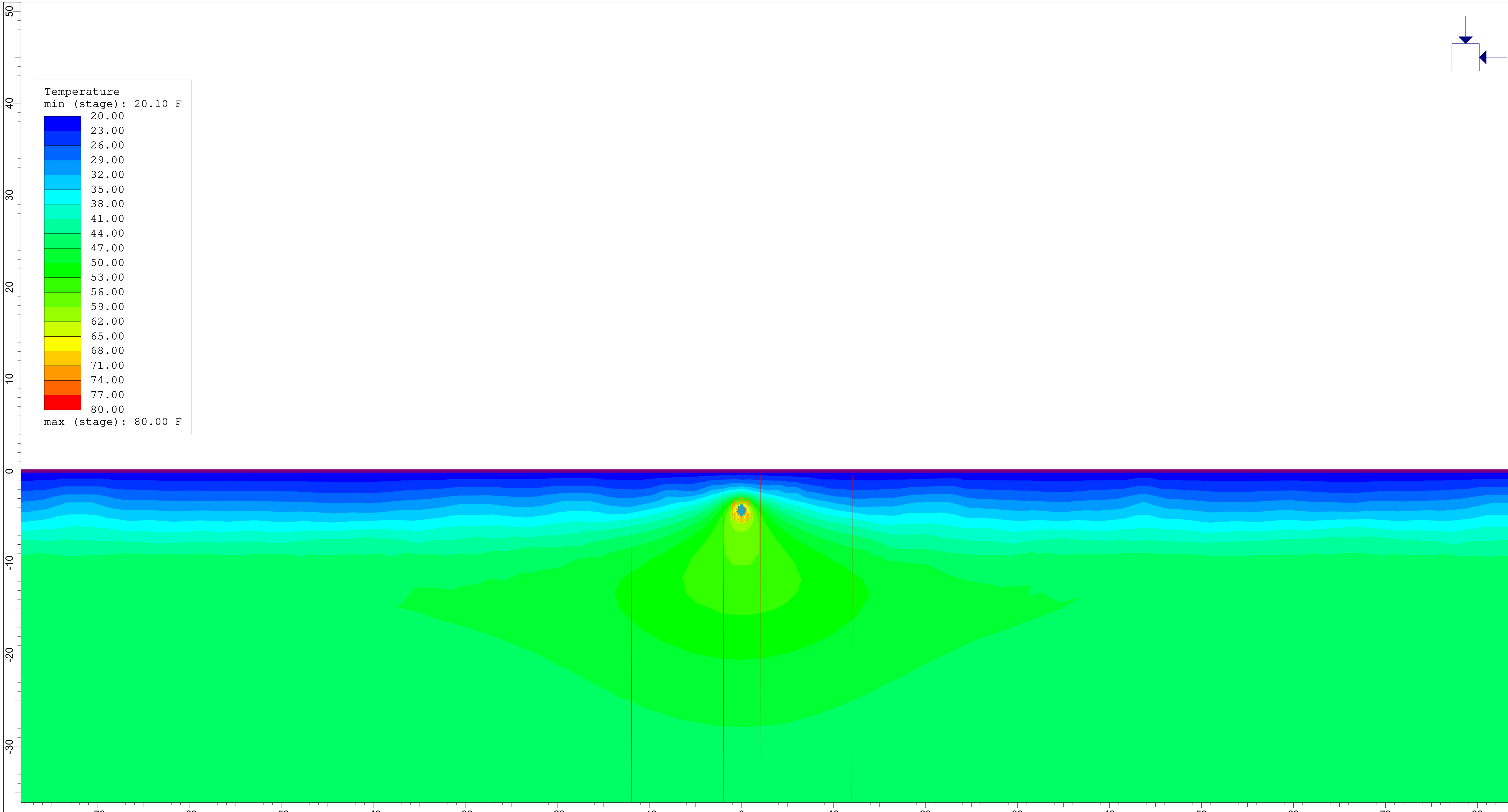


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (1)
Analysis Description	Thermal Influence
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	6in Pipe 1.fez

6IN PIPE 1 - COARSE GRAIN - 55% SATURATION - JANUARY

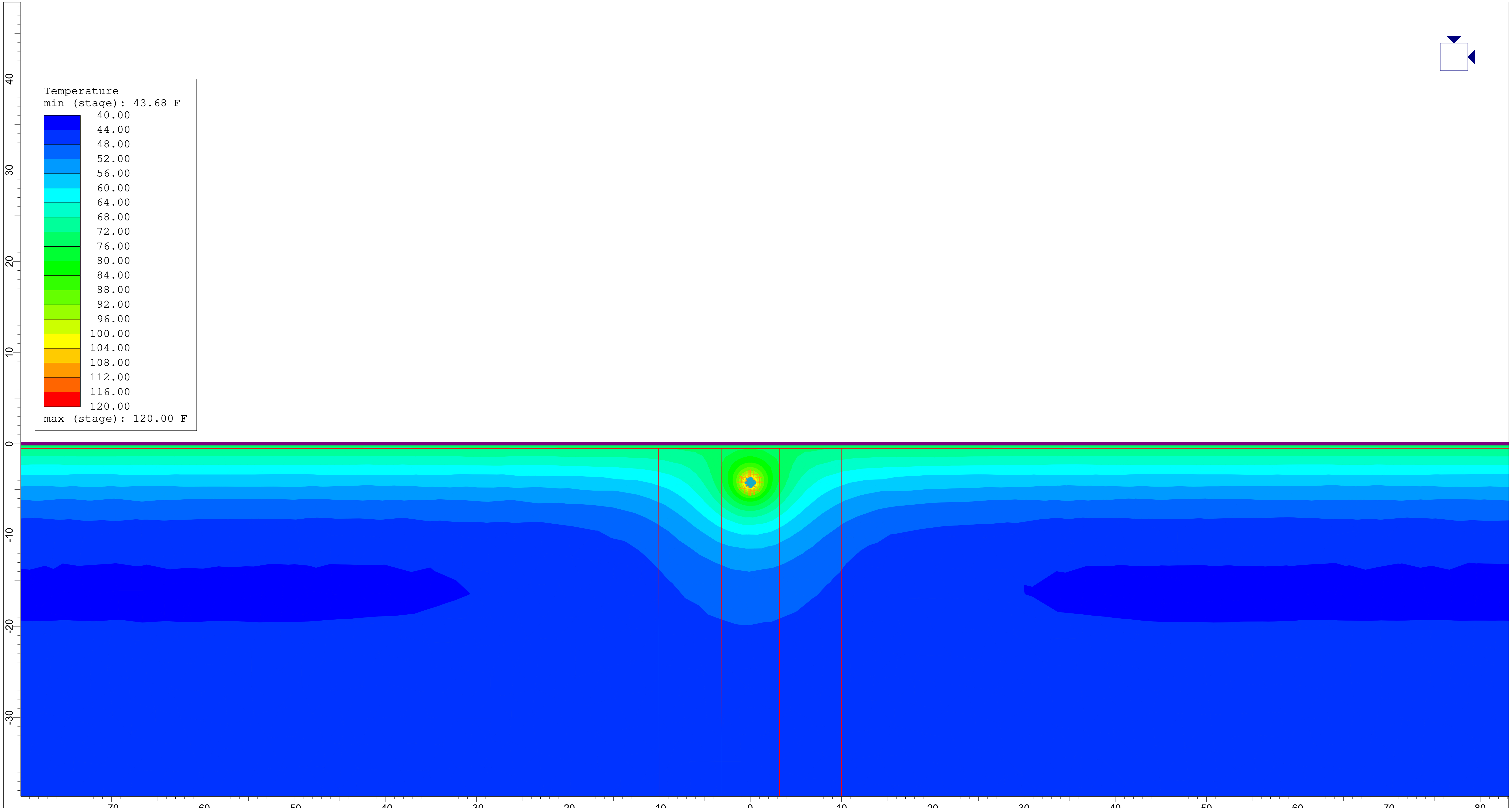


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (1)
Analysis Description	Thermal Influence
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	6in Pipe 1.fez

6IN PIPE 1 - COARSE GRAIN - 55% SATURATION - JULY

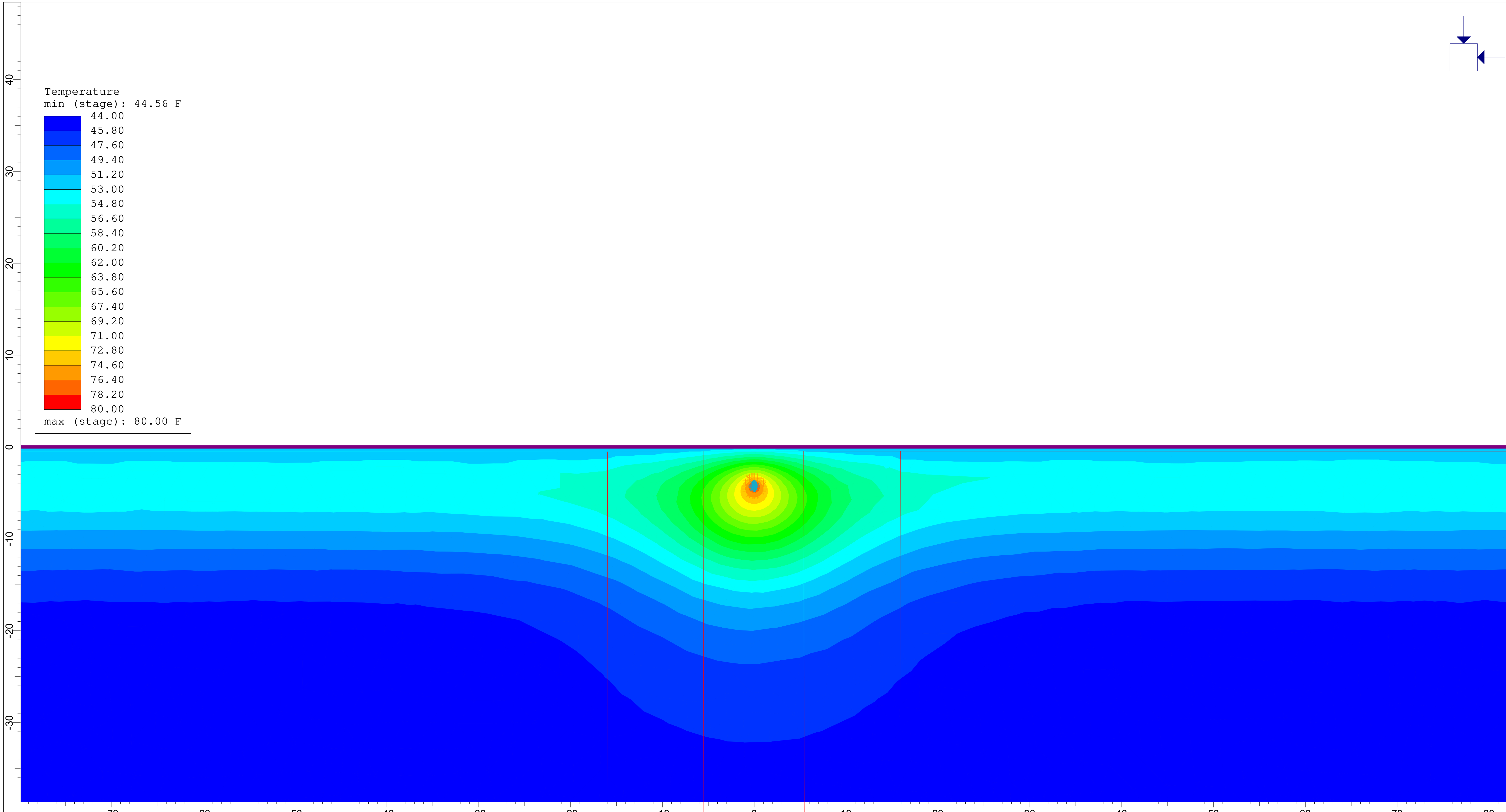


rocscience

INTERPRET 11.023

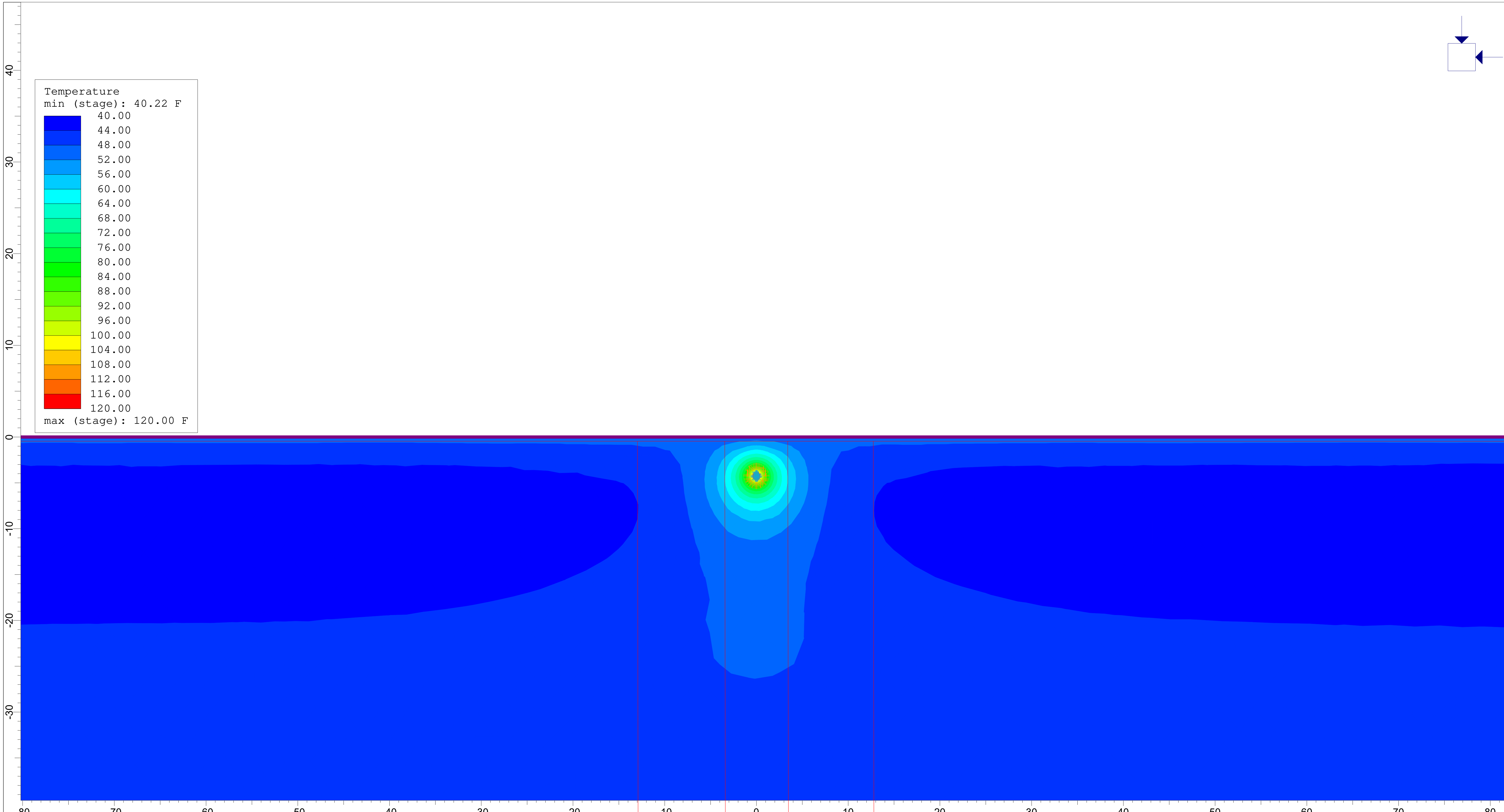
Project	Summit Carbon - 6 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 1.fez

6IN PIPE 1 - COARSE GRAIN - 55% SATURATION - OCTOBER



rocscience	Project	Summit Carbon - 6 Inch Pipeline (1)	
	Analysis Description	Thermal Influence	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 1.fez

6IN PIPE 1 - FINE GRAIN - 15% SATURATION - APRIL

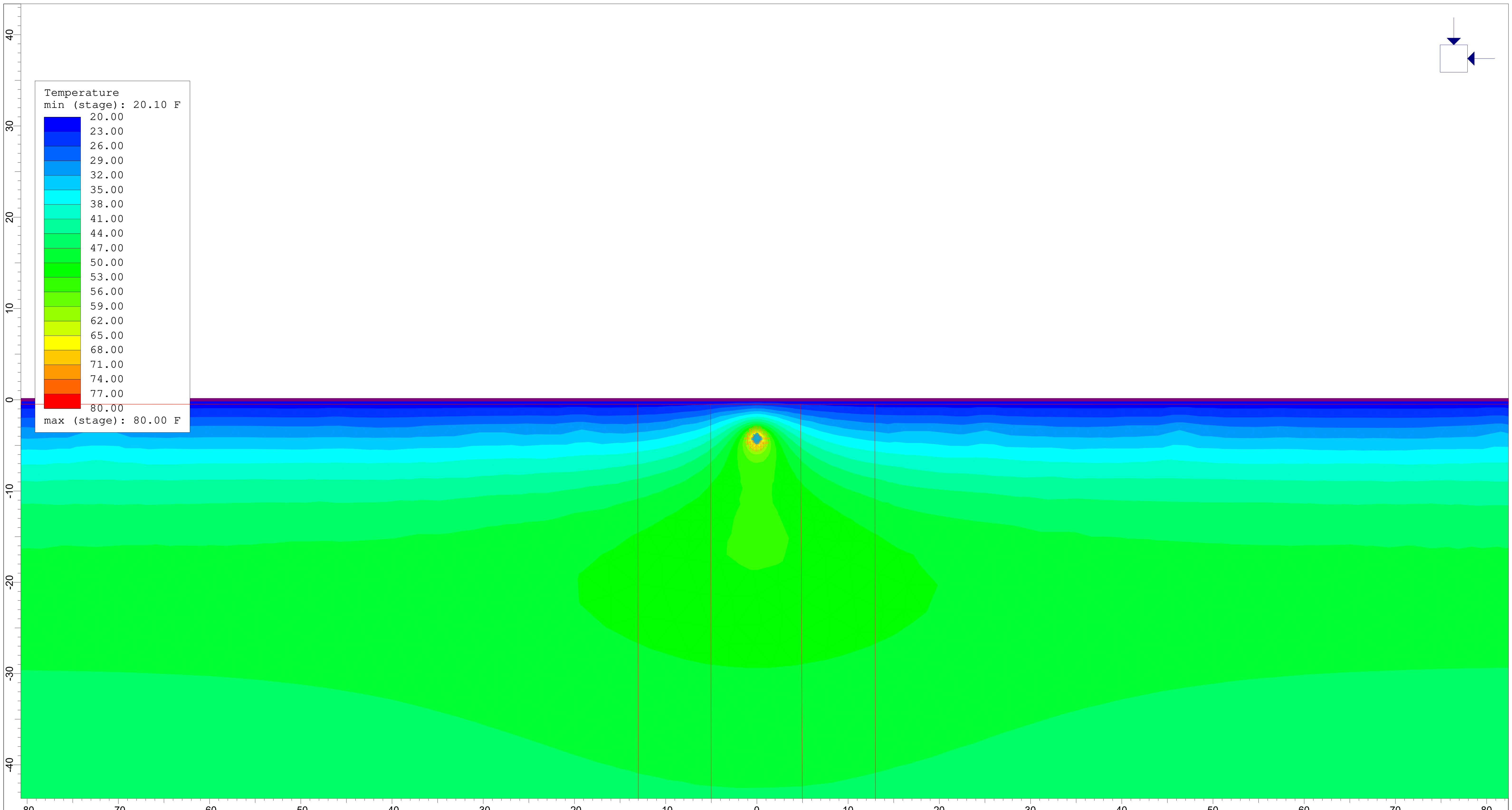


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 1.fez

6IN PIPE 1 - FINE GRAIN - 15% SATURATION - JANUARY

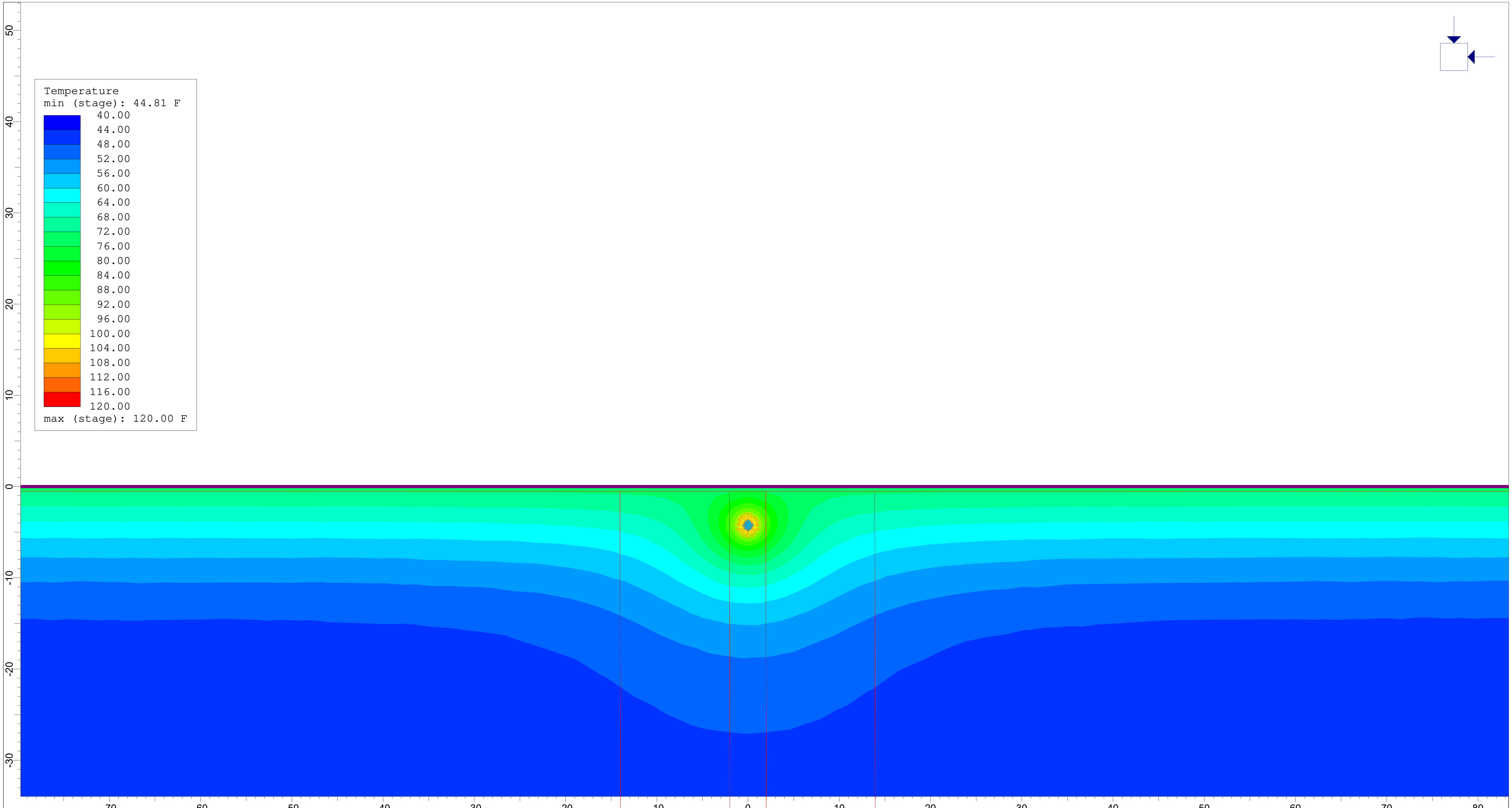


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 1.fez

6IN PIPE 1 - FINE GRAIN - 15% SATURATION - JULY

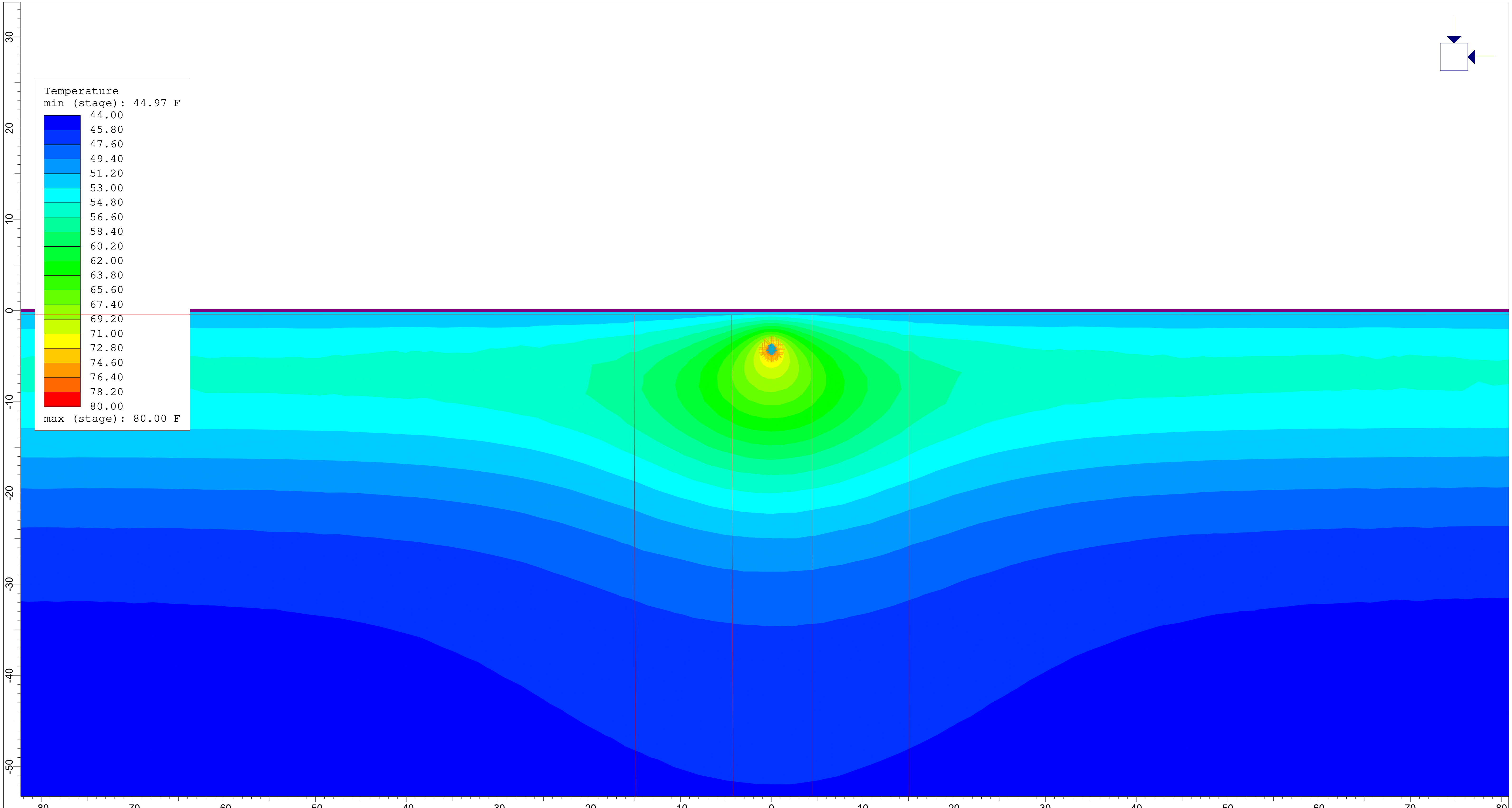


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 1.fez

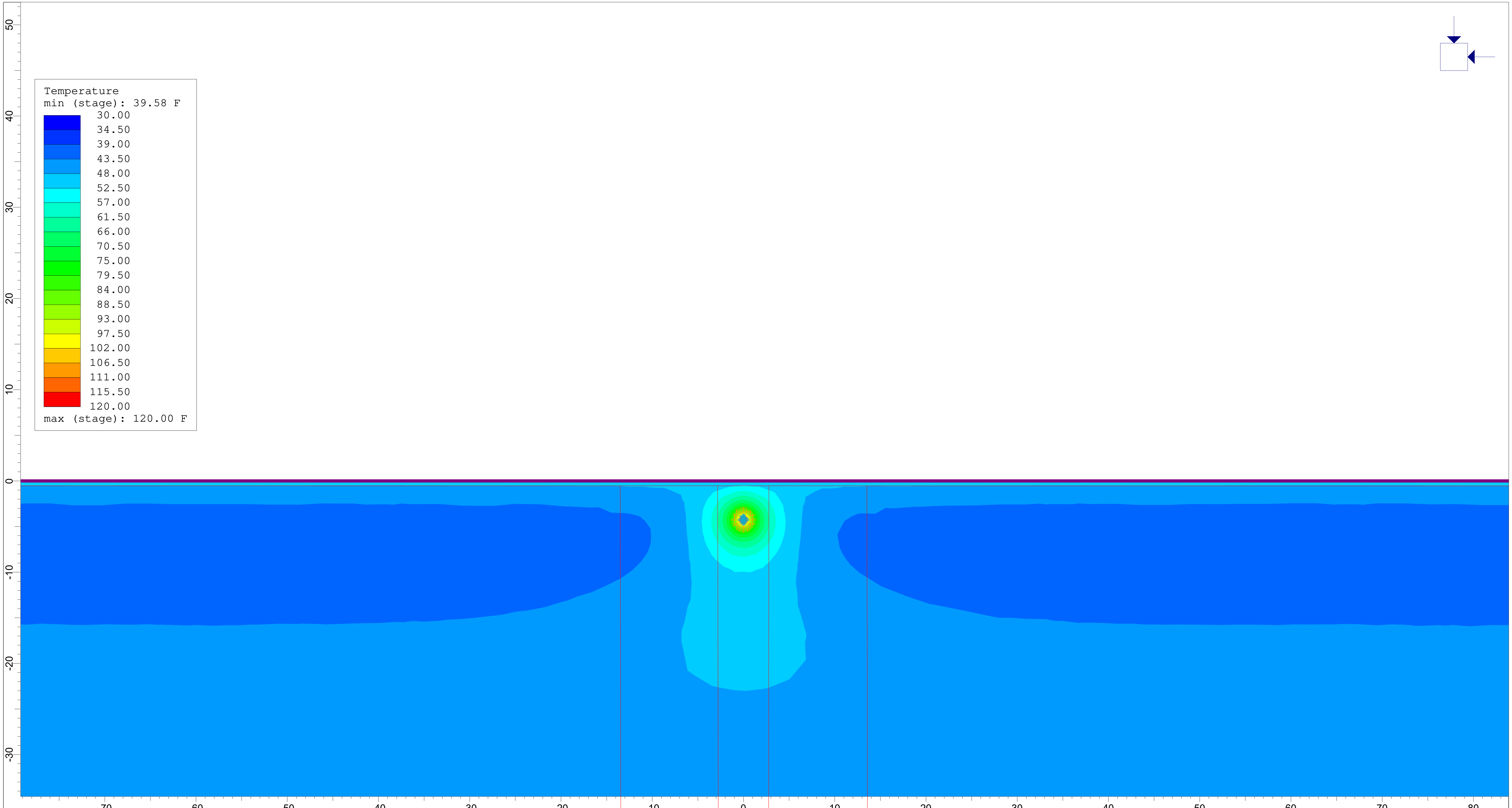
6IN PIPE 1 - FINE GRAIN - 15% SATURATION - OCTOBER



rocscience
INTERPRET 11.023

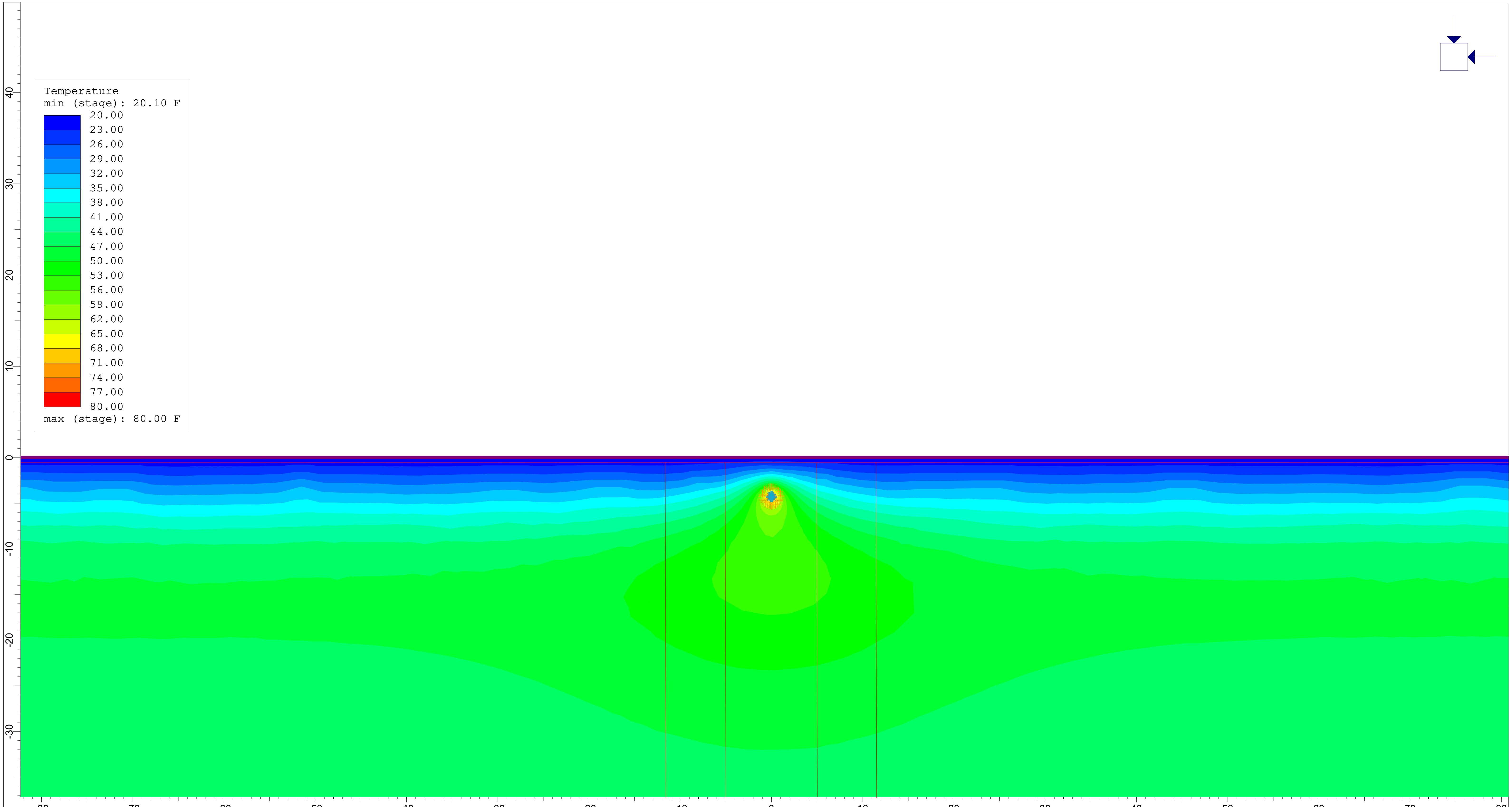
Project	Summit Carbon - 6 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 1.fez

6IN PIPE 1 - FINE GRAIN - 35% SATURATION - APRIL



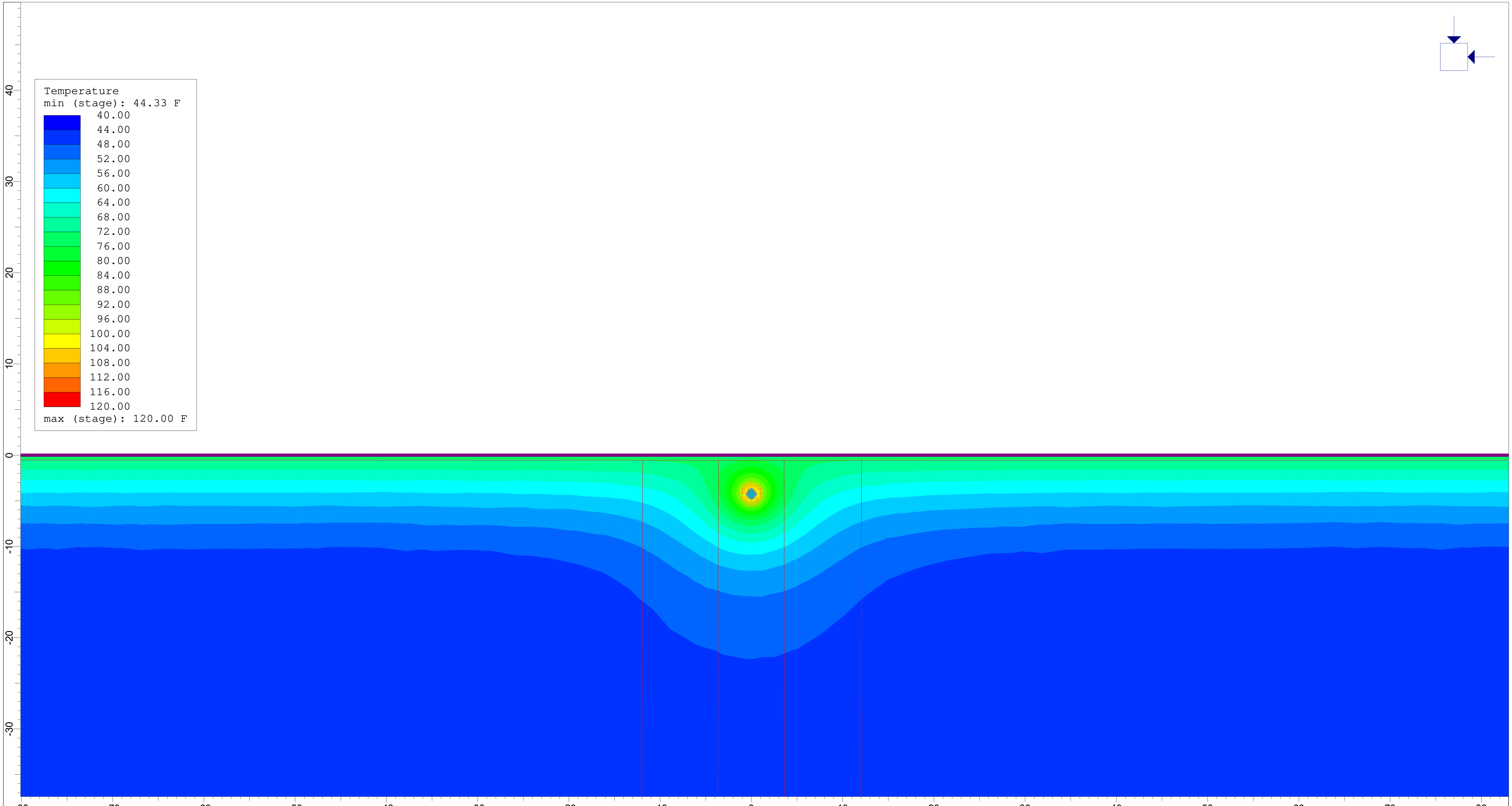
rocscience	Project	Summit Carbon - 6 Inch Pipeline (1)	
	Analysis Description	Thermal Influence	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 1.fez

6IN PIPE 1 - FINE GRAIN - 35% SATURATION - JANUARY



rocscience	Project: Summit Carbon - 6 Inch Pipeline (1)		
	Analysis Description: Thermal Influence		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 1.fez

6IN PIPE 1 - FINE GRAIN - 35% SATURATION - JULY

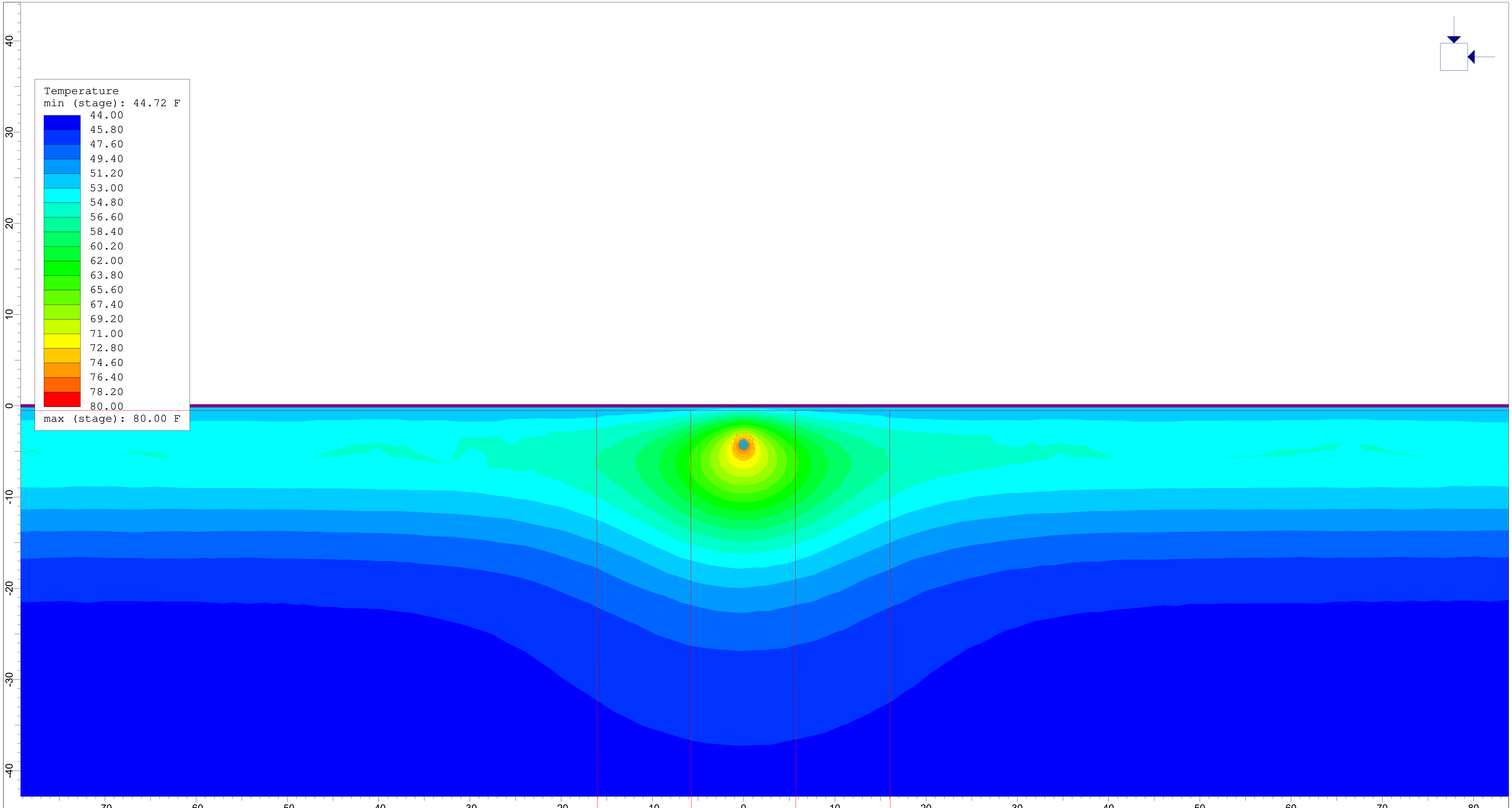


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 1.fez

6IN PIPE 1 - FINE GRAIN - 35% SATURATION - OCTOBER

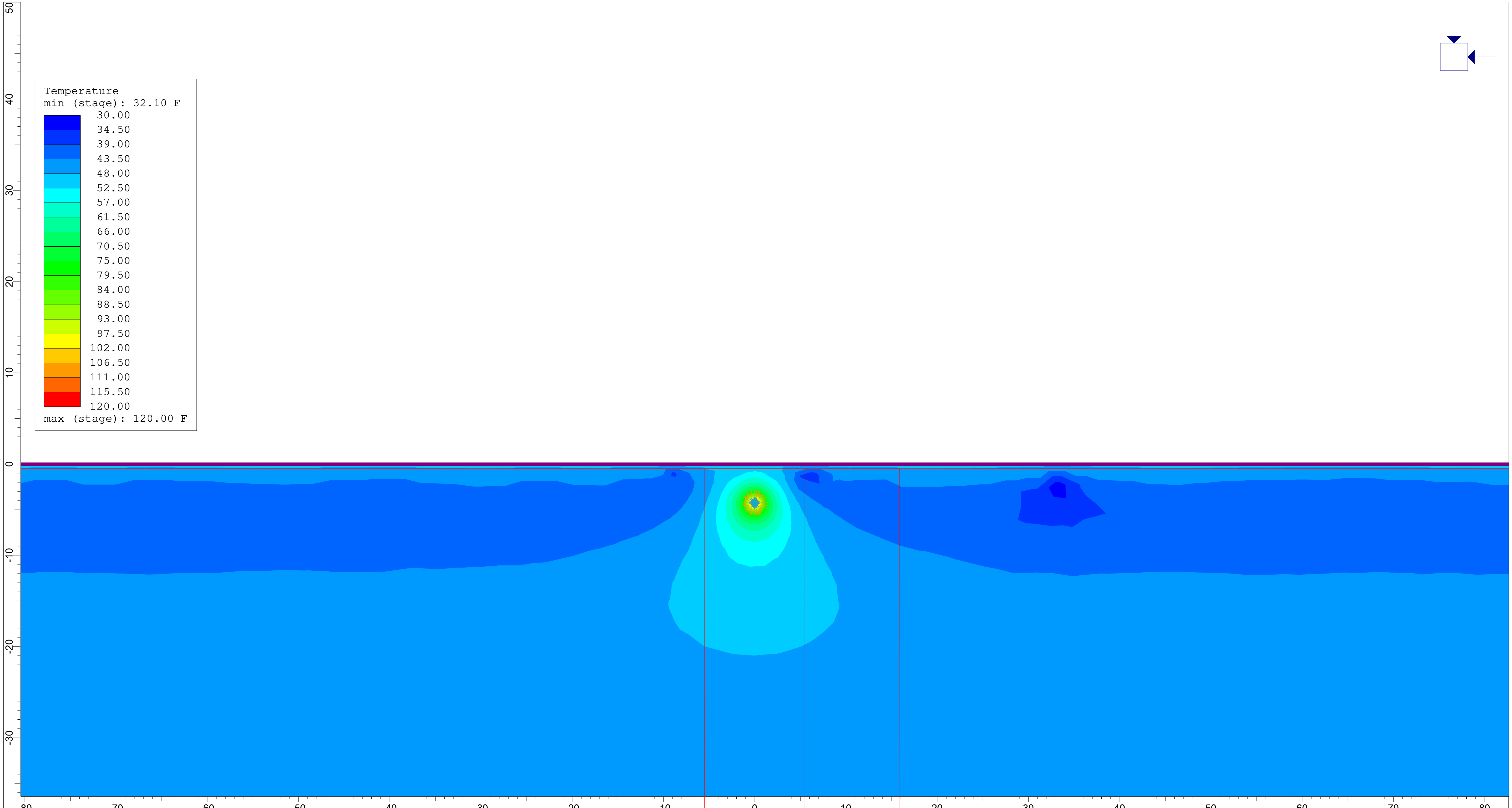


rocscience

INTERPRET 11.023

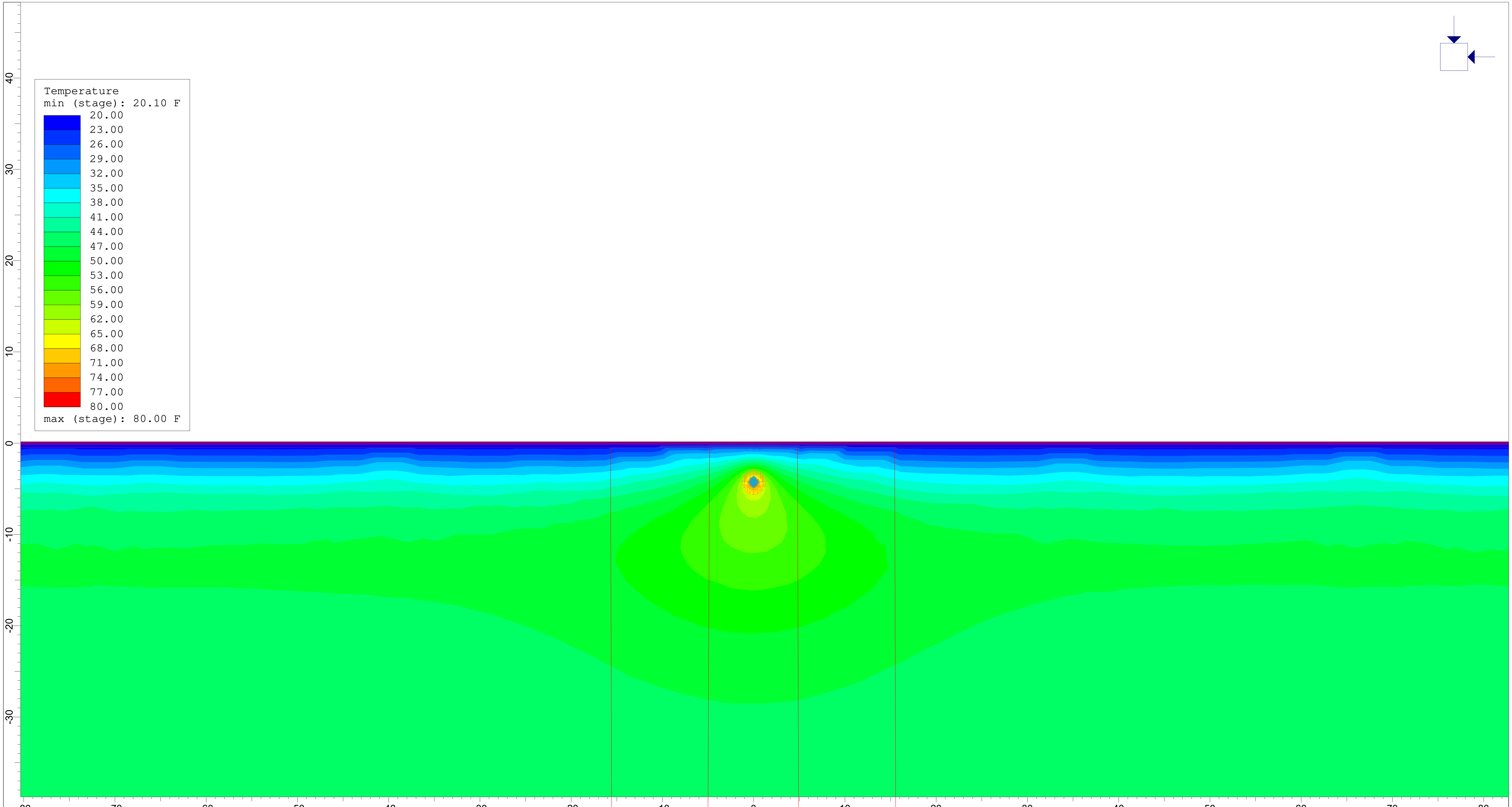
Project	Summit Carbon - 6 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	6in Pipe 1.fez

6IN PIPE 1 - FINE GRAIN - 55% SATURATION - APRIL



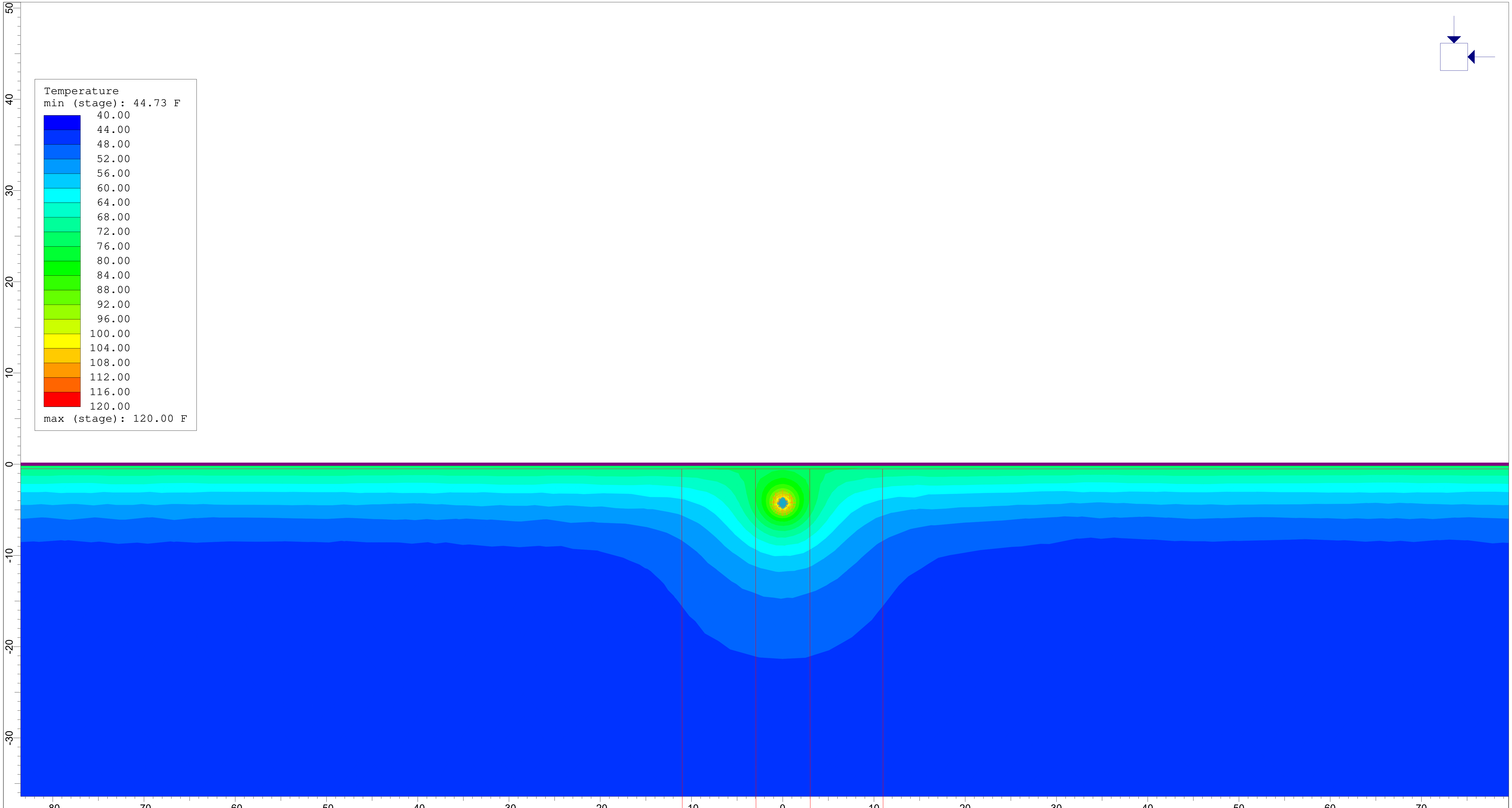
rocscience	Project: Summit Carbon - 6 Inch Pipeline (1)		
	Analysis Description: Thermal Influence		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 1.fez

6IN PIPE 1 - FINE GRAIN - 55% SATURATION - JANUARY



rocscience	Project	Summit Carbon - 6 Inch Pipeline (1)	
	Analysis Description	Thermal Influence	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 1.fez

6IN PIPE 1 - FINE GRAIN - 55% SATURATION - JULY

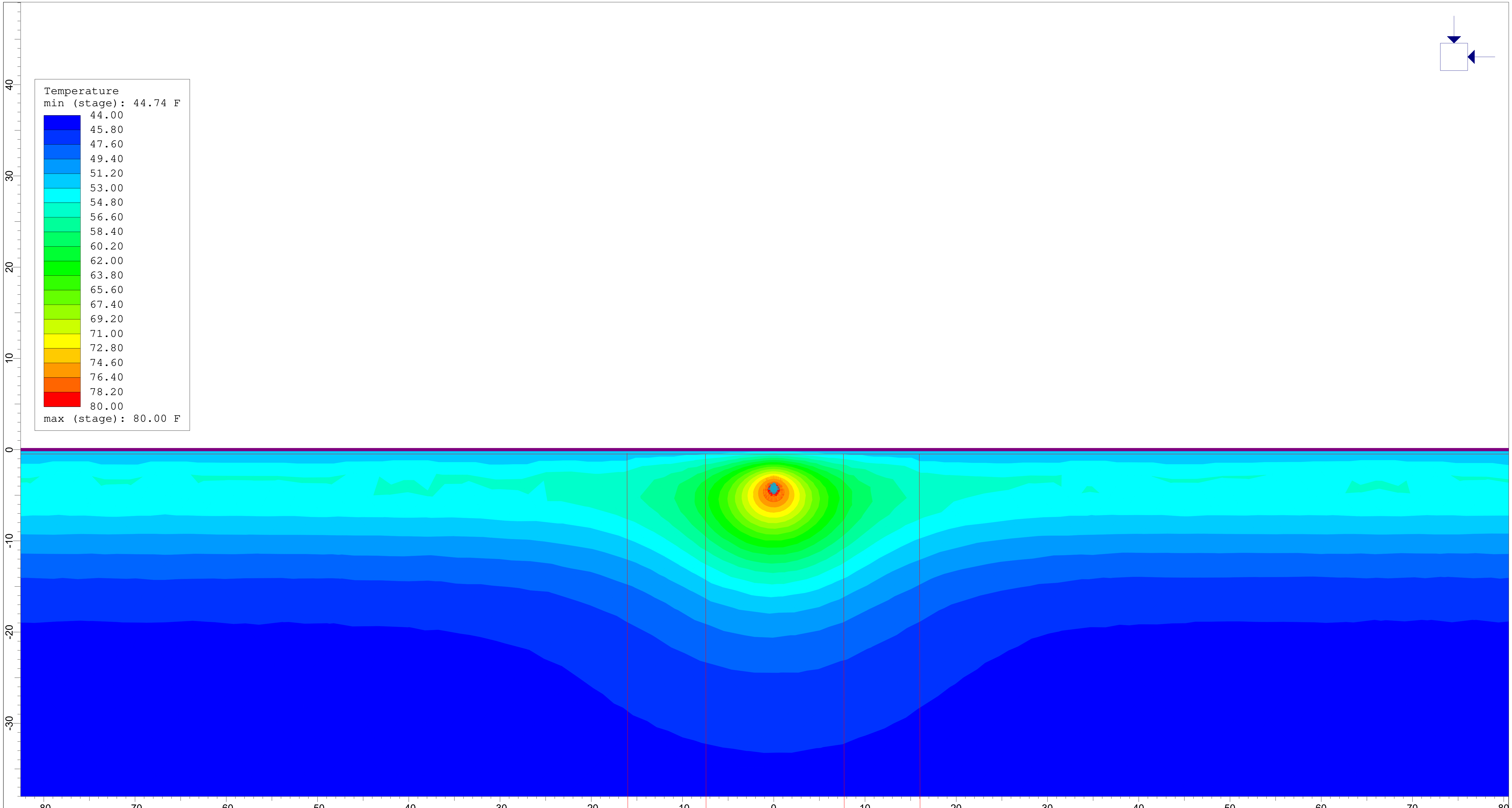


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 1.fez

6IN PIPE 1 - FINE GRAIN - 55% SATURATION - OCTOBER

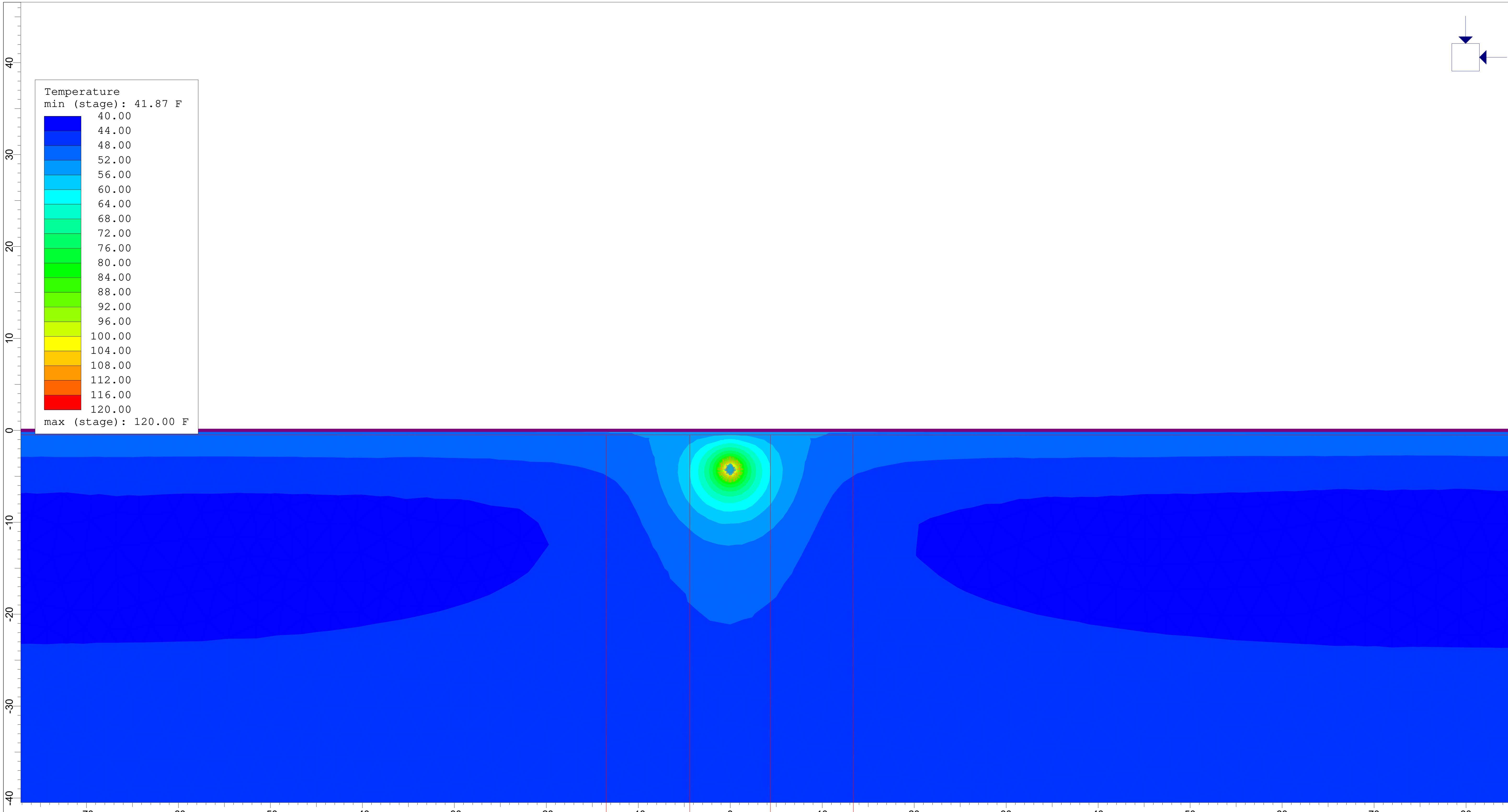


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 1.fez

6IN PIPE 2 - COARSE GRAIN - 15% SATURATION - APRIL

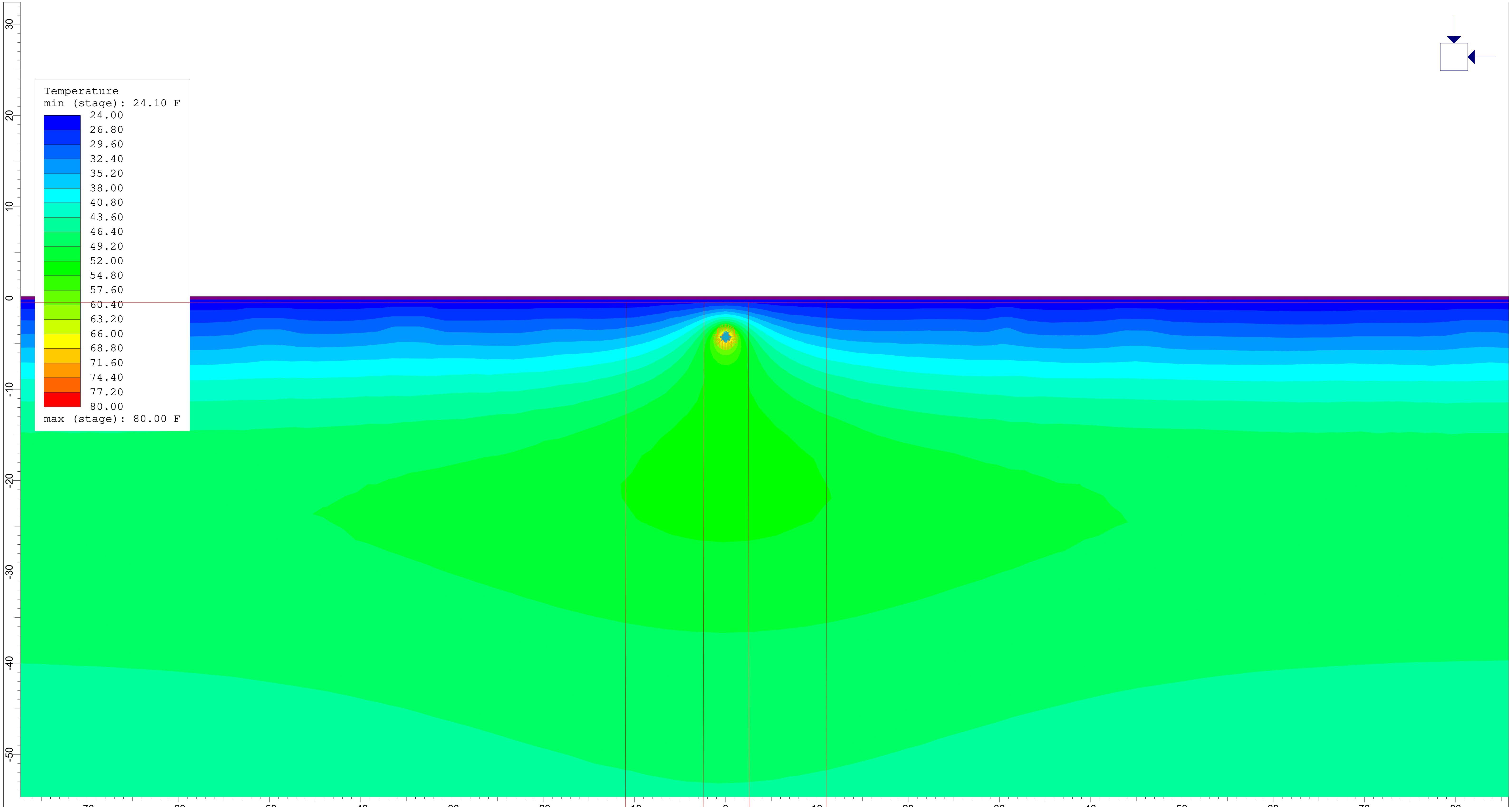


Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	6in Pipe 2.fez

rocscience

INTERPRET 11.023

6IN PIPE 2 - COARSE GRAIN - 15% SATURATION - JANUARY

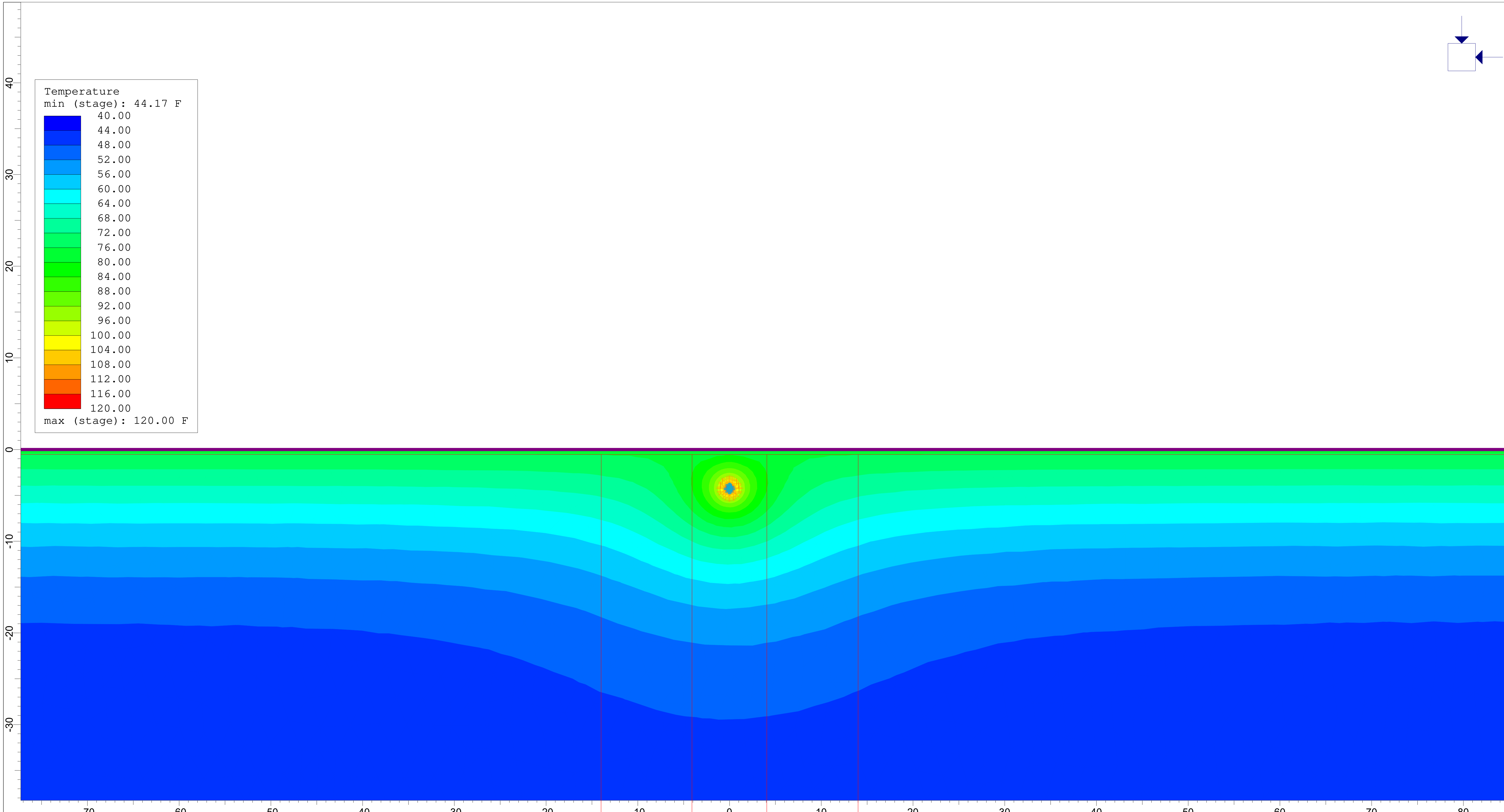


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 2.fez

6IN PIPE 2 - COARSE GRAIN - 15% SATURATION - JULY

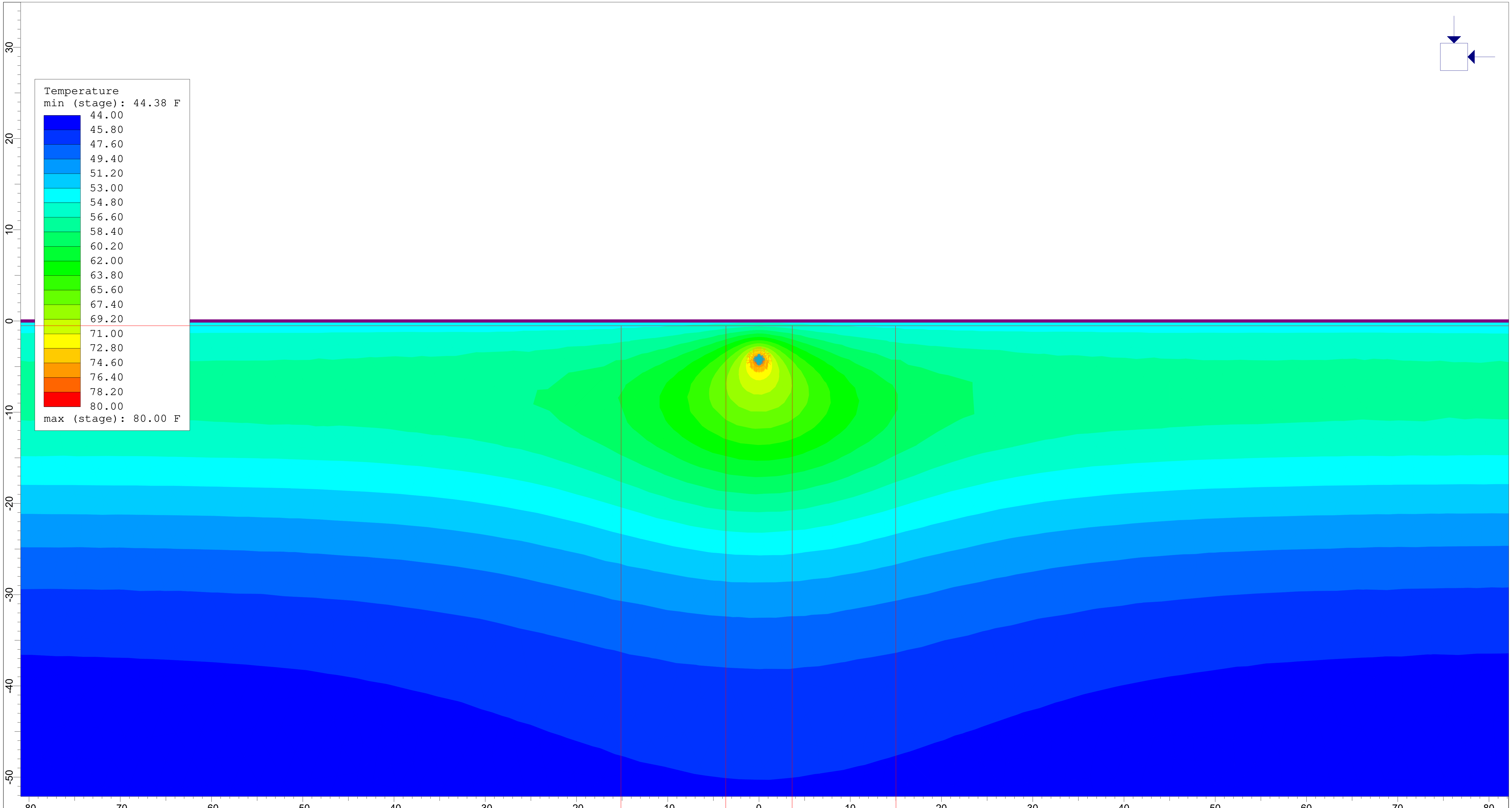


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By Connor Rankin	*Scale* 1:120	*Company*	Lake Superior Consulting
Date 6/3/2024, 10:56:45 AM		*File Name*	6in Pipe 2.fez

6IN PIPE 2 - COARSE GRAIN - 15% SATURATION - OCTOBER

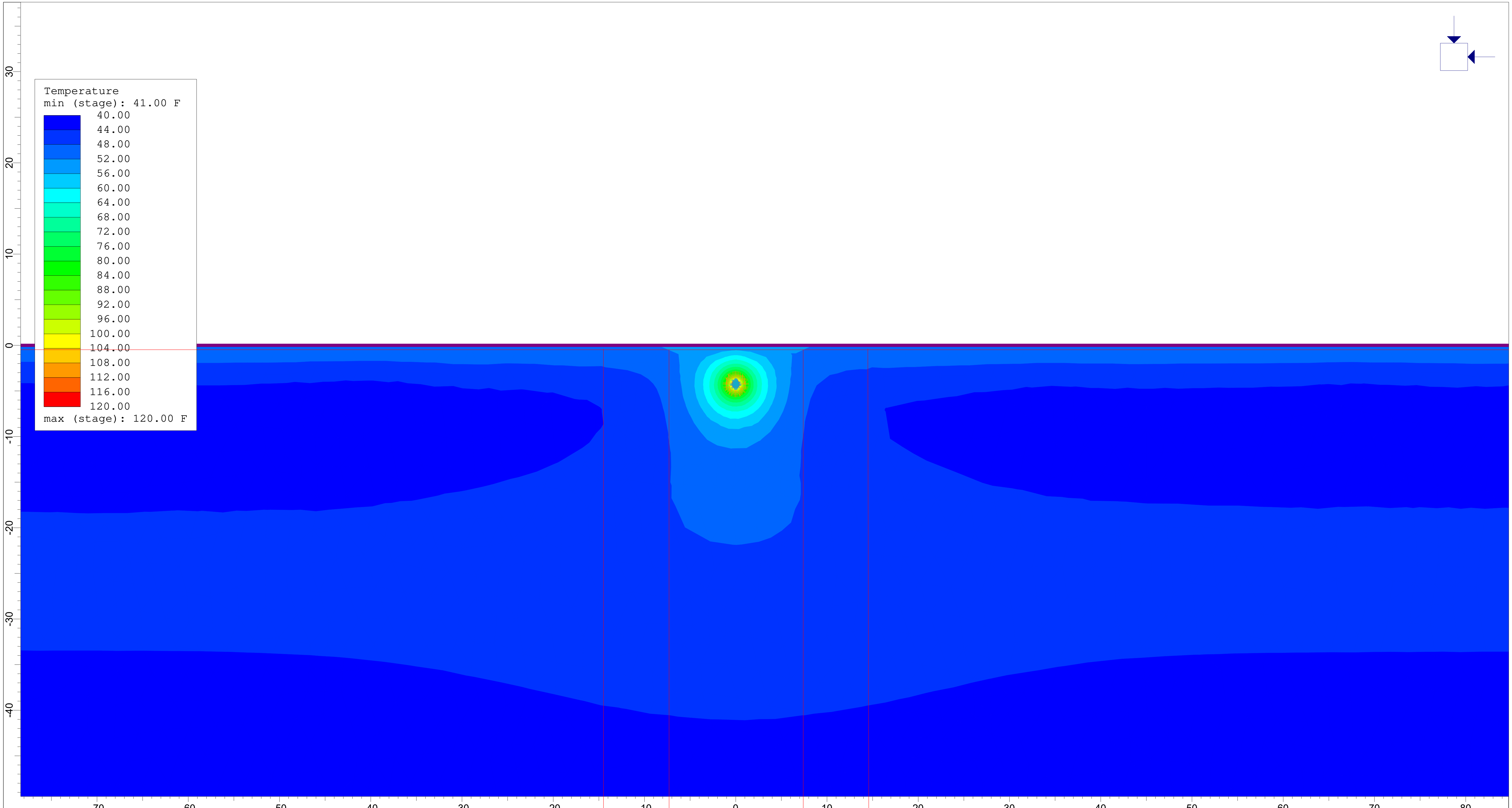


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (2)
Analysis Description	Thermal Analysis
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	6in Pipe 2.fez

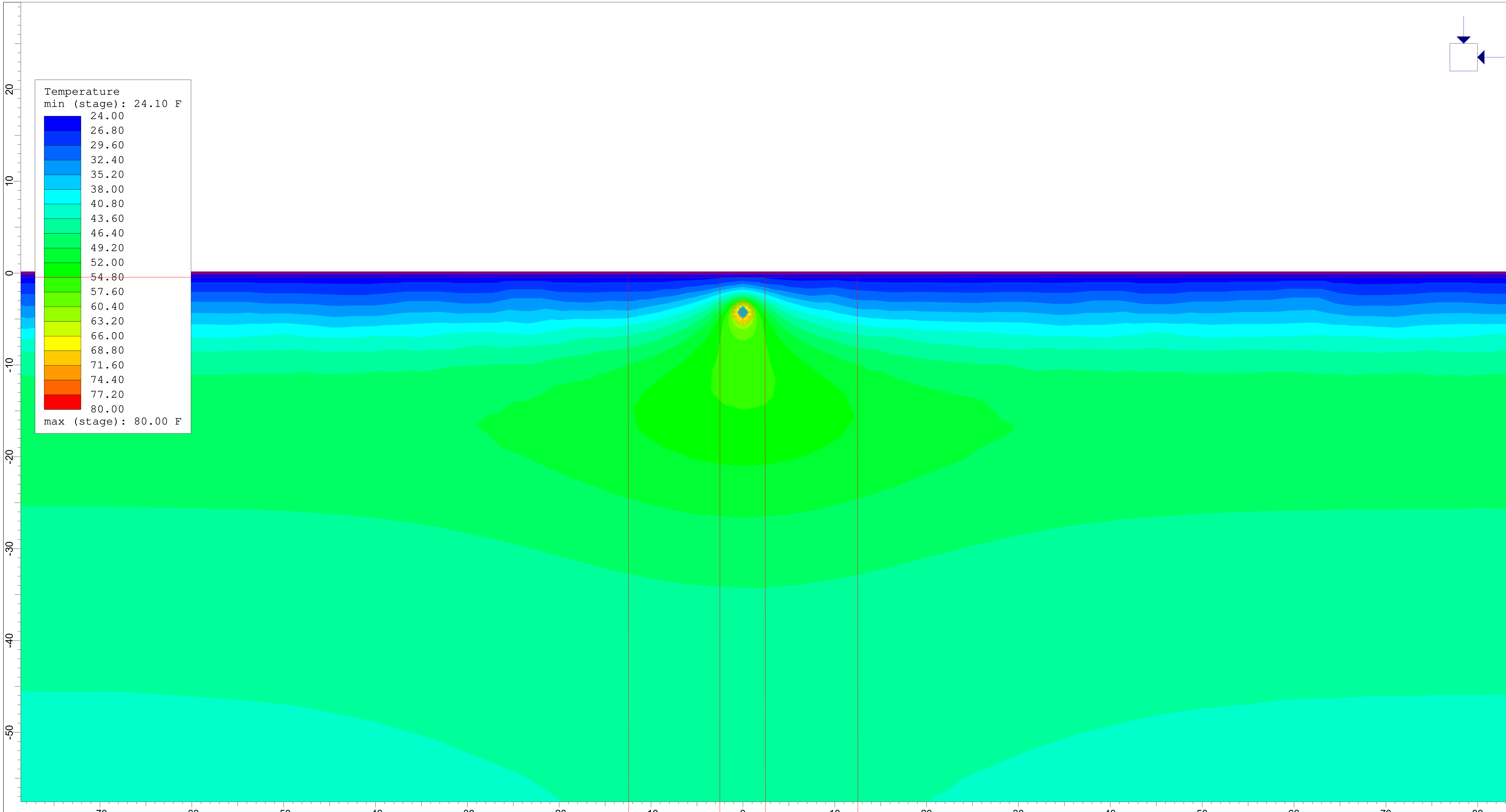
6IN PIPE 2 - COARSE GRAIN - 35% SATURATION - APRIL



Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By	Connor Rankin	Scale 1:120	Company Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM		File Name 6in Pipe 2.fez

INTERPRET 11.023

6IN PIPE 2 - COARSE GRAIN - 35% SATURATION - JANUARY

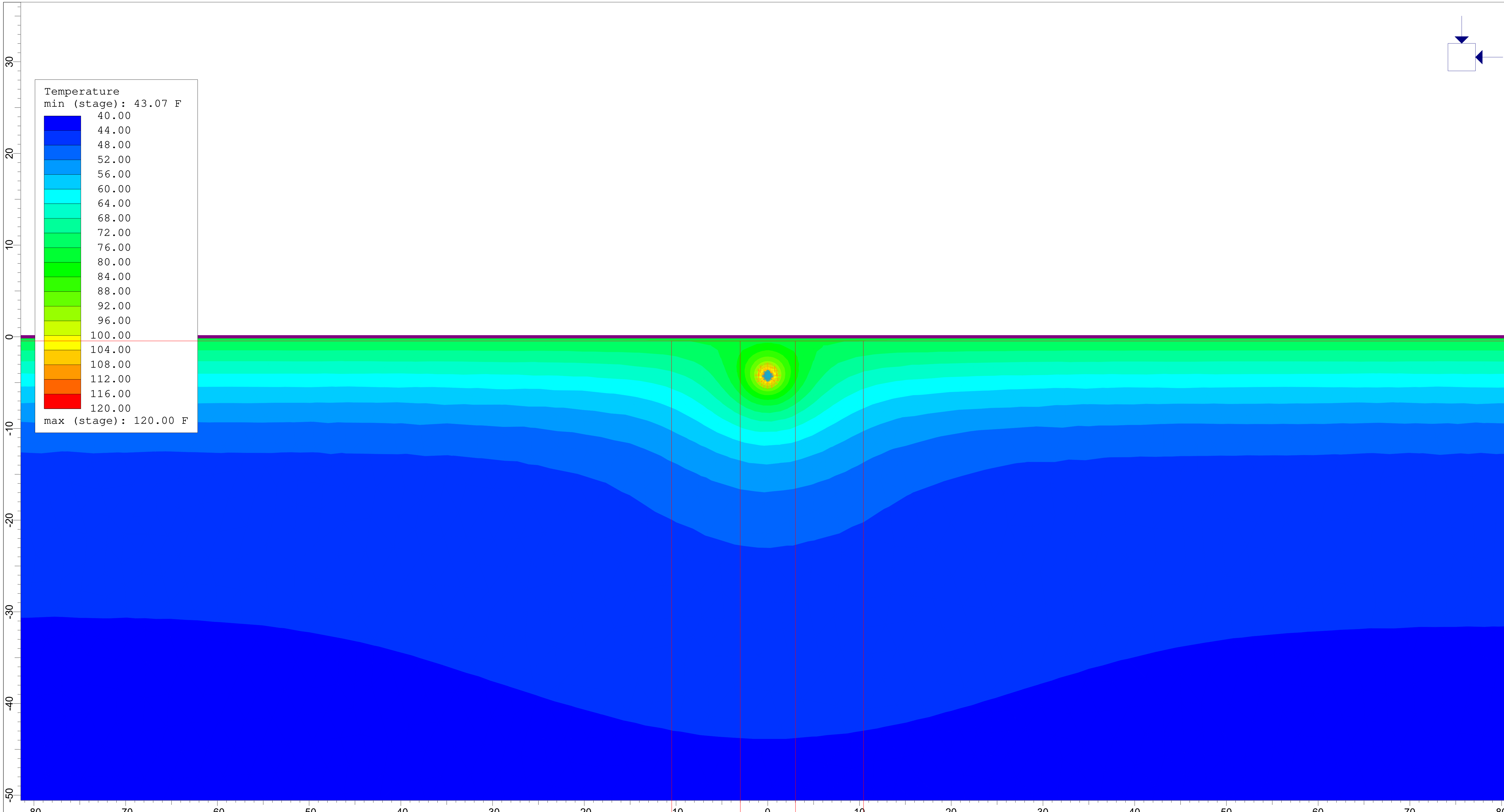


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 2.fez

6IN PIPE 2 - COARSE GRAIN - 35% SATURATION - JULY

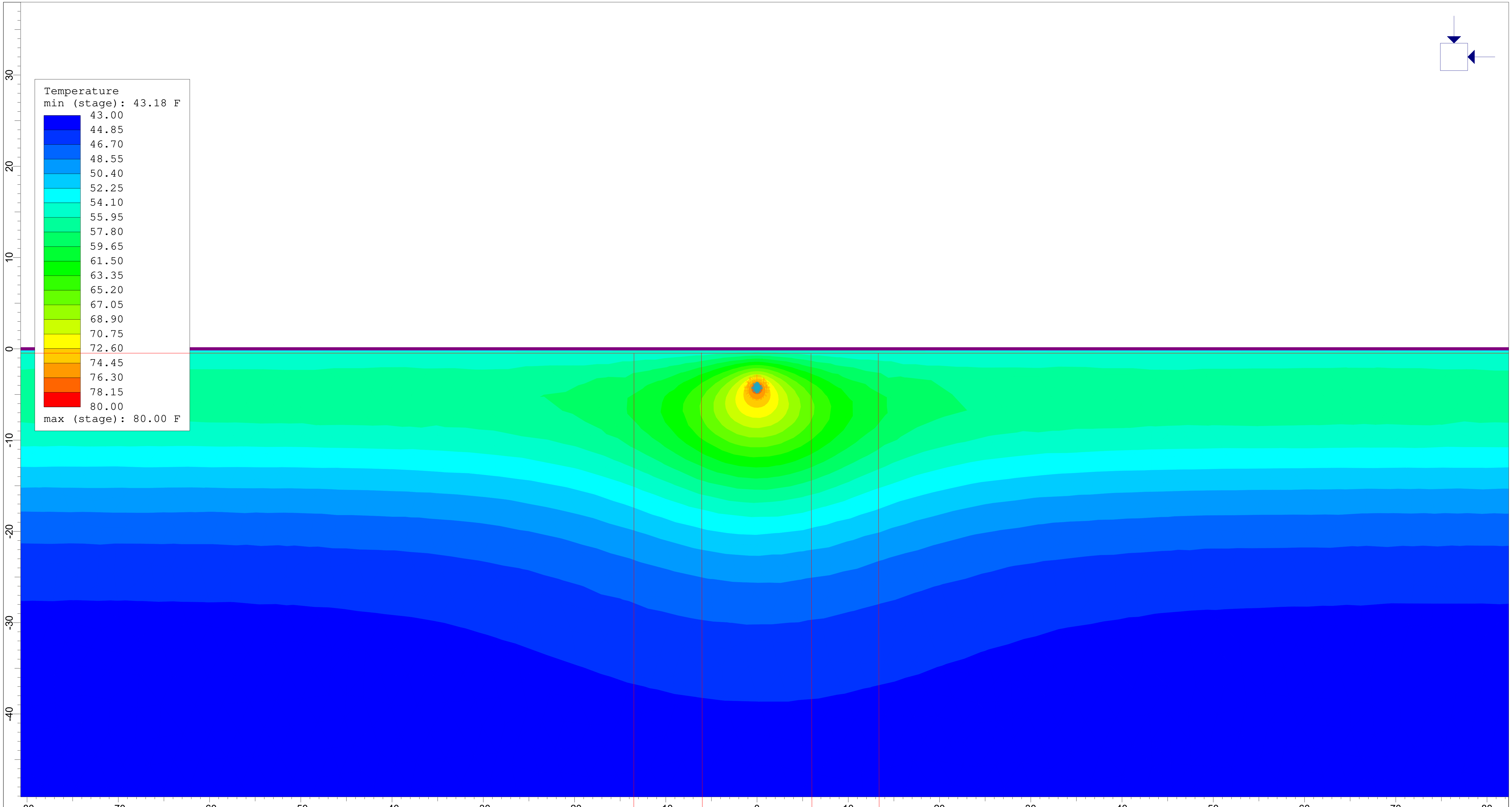


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	6in Pipe 2.fez

6IN PIPE 2 - COARSE GRAIN - 35% SATURATION - OCTOBER

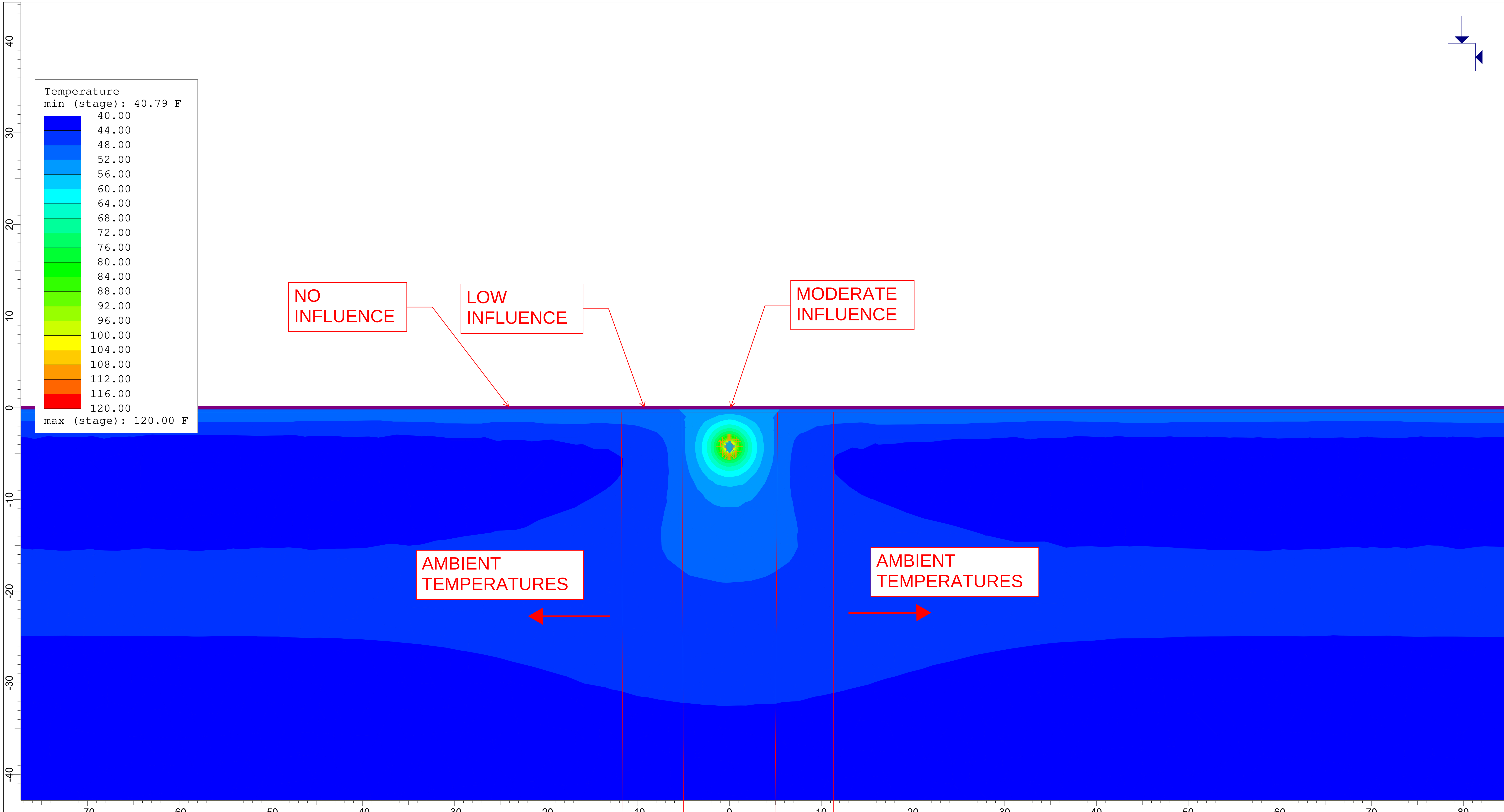


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	6in Pipe 2.fez

6IN PIPE 2 - COARSE GRAIN - 55% SATURATION - APRIL

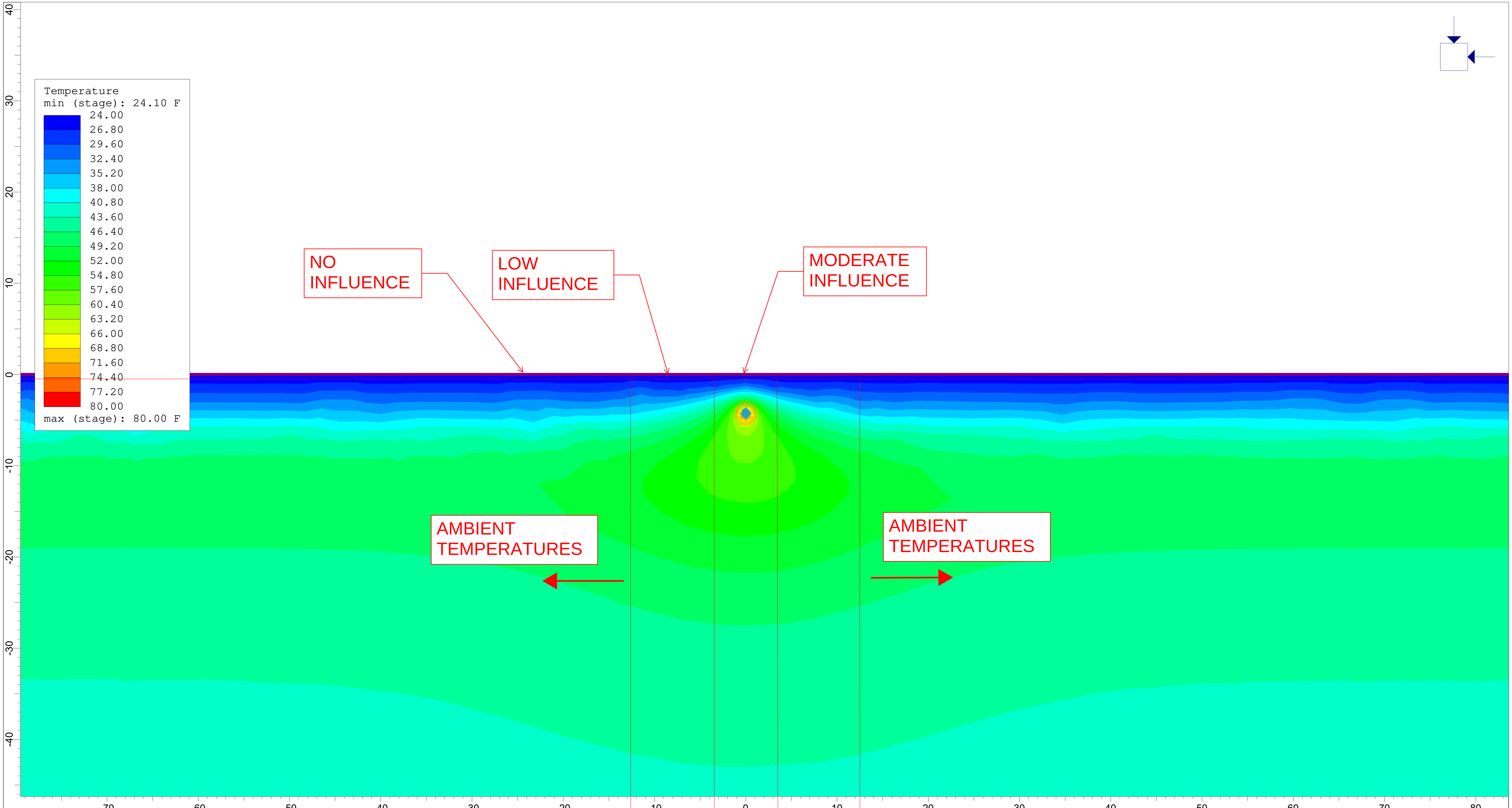


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	6in Pipe 2.fez

6IN PIPE 2 - COARSE GRAIN - 55% SATURATION - JANUARY

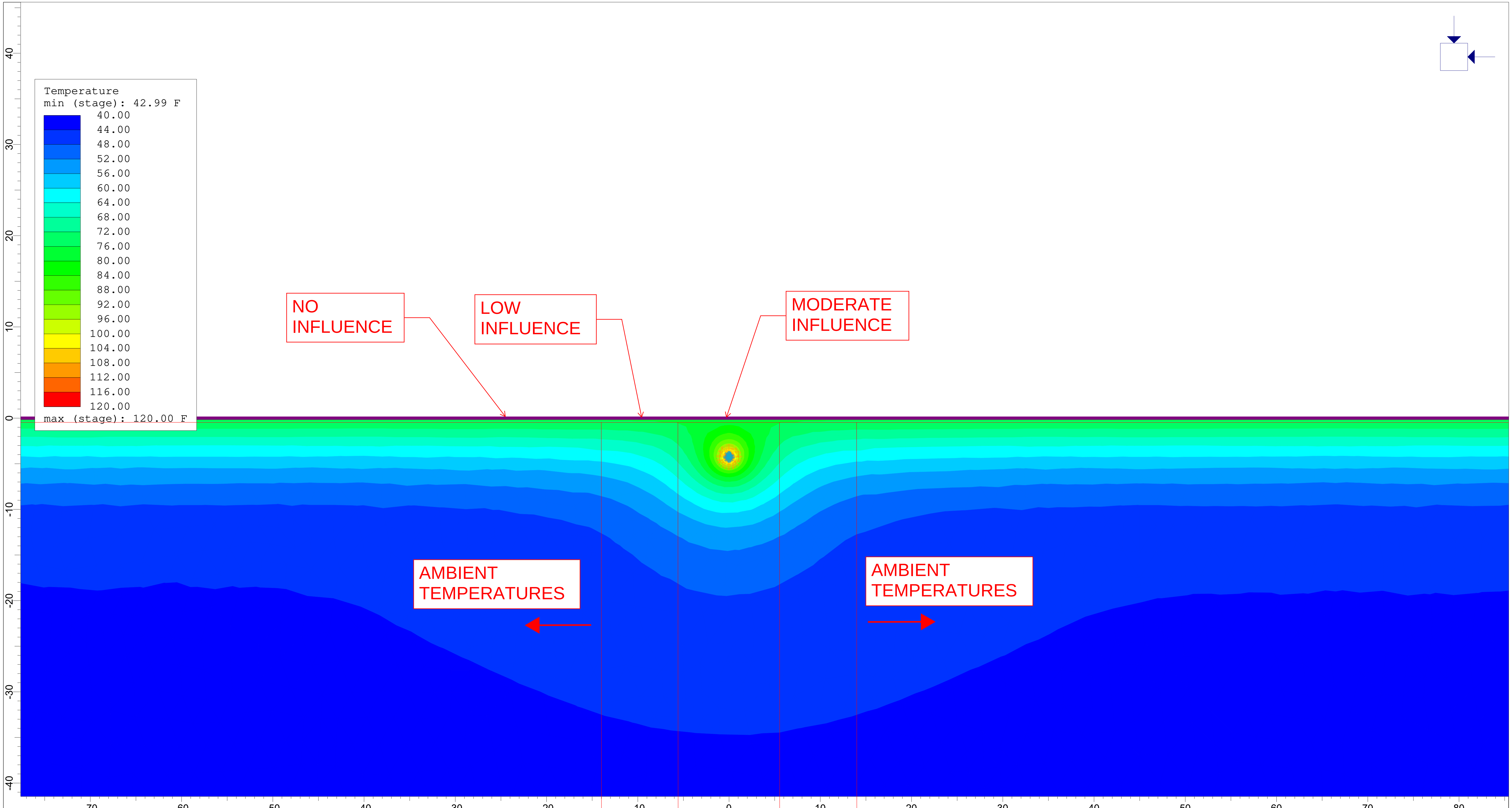


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 2.fez

6IN PIPE 2 - COARSE GRAIN - 55% SATURATION - JULY

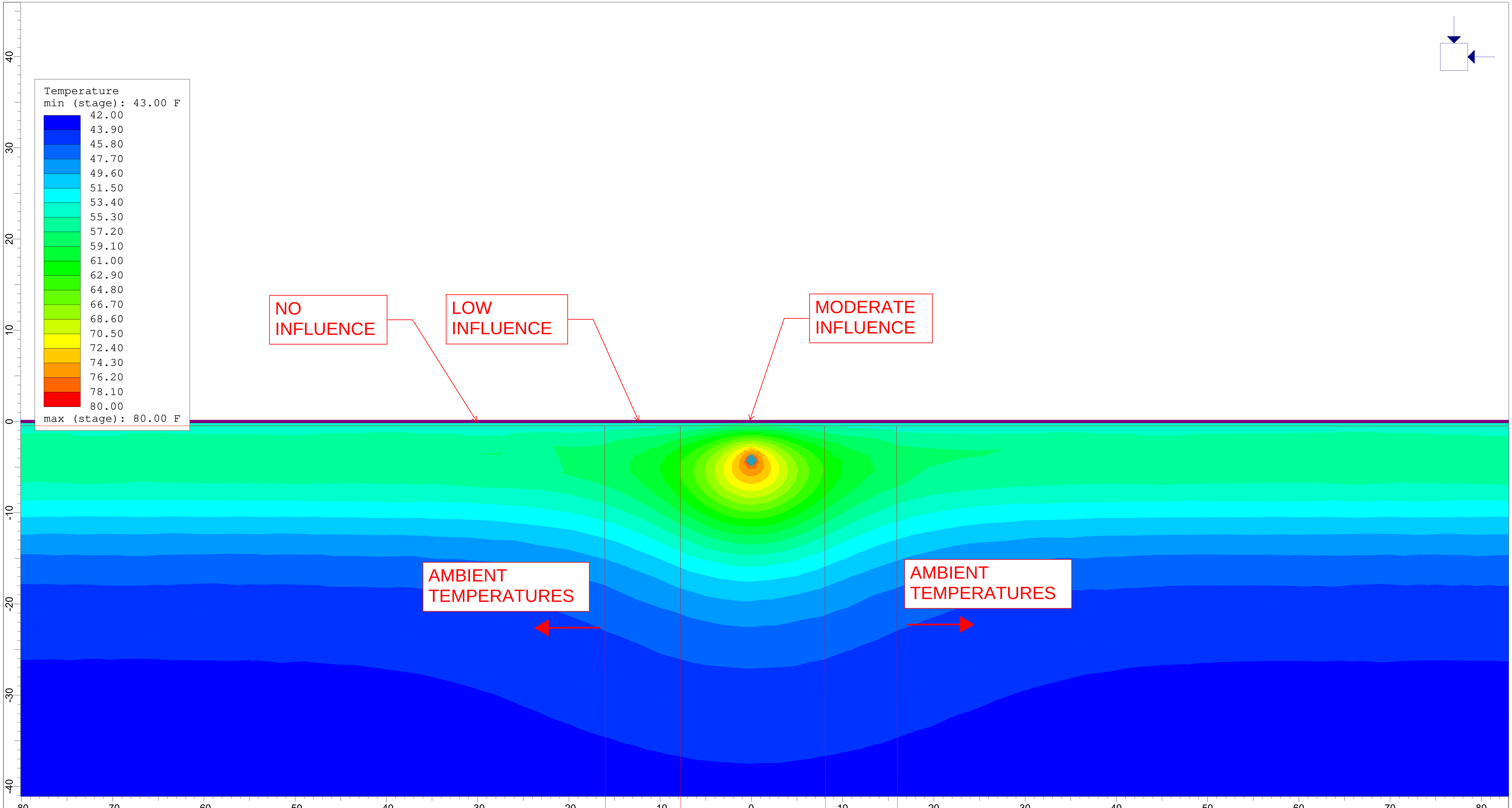


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (2)
Analysis Description	Thermal Analysis
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	6in Pipe 2.fez

6IN PIPE 2 - COARSE GRAIN - 55% SATURATION - OCTOBER

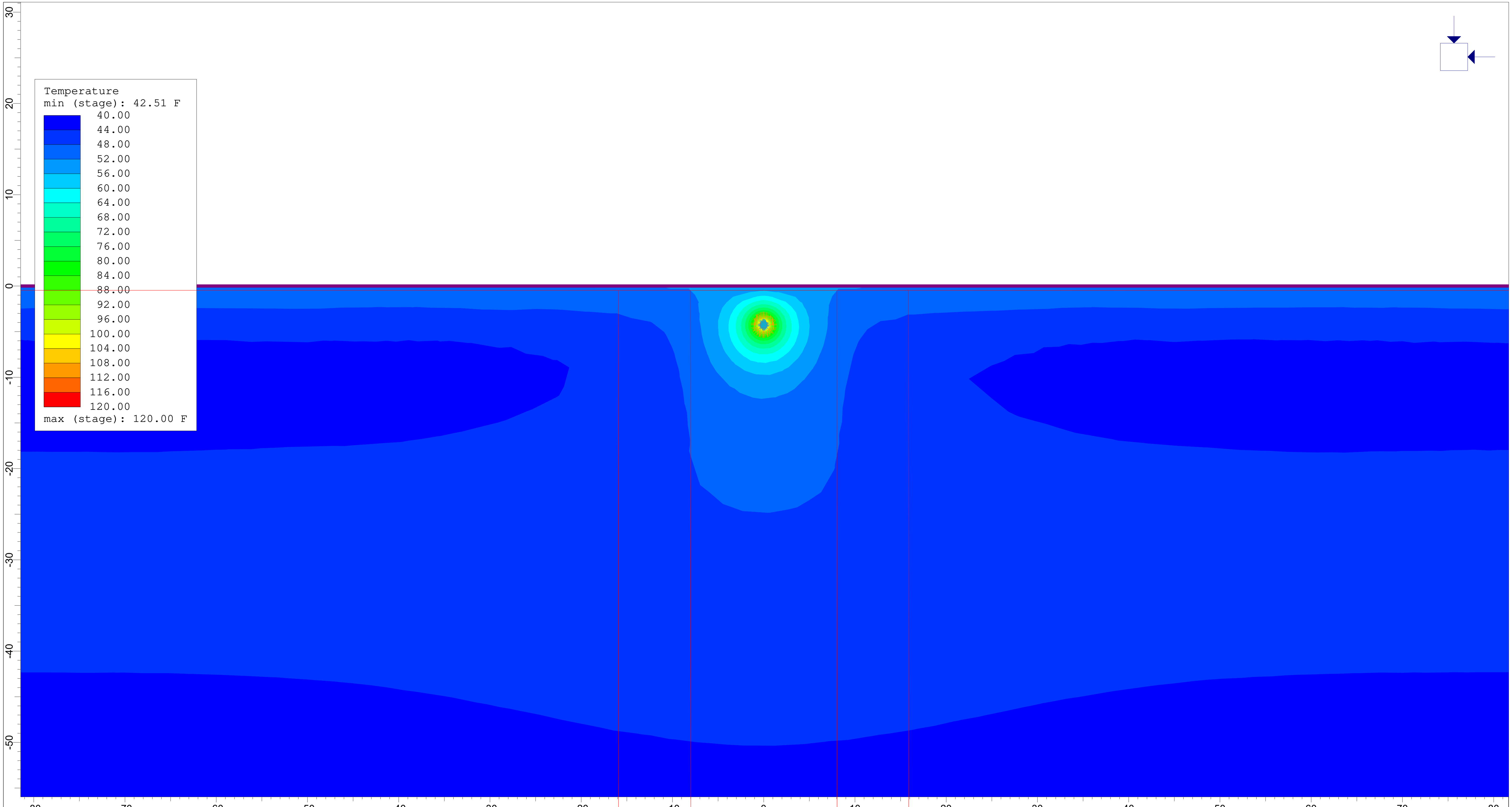


rocscience

INTERPRET 11.023

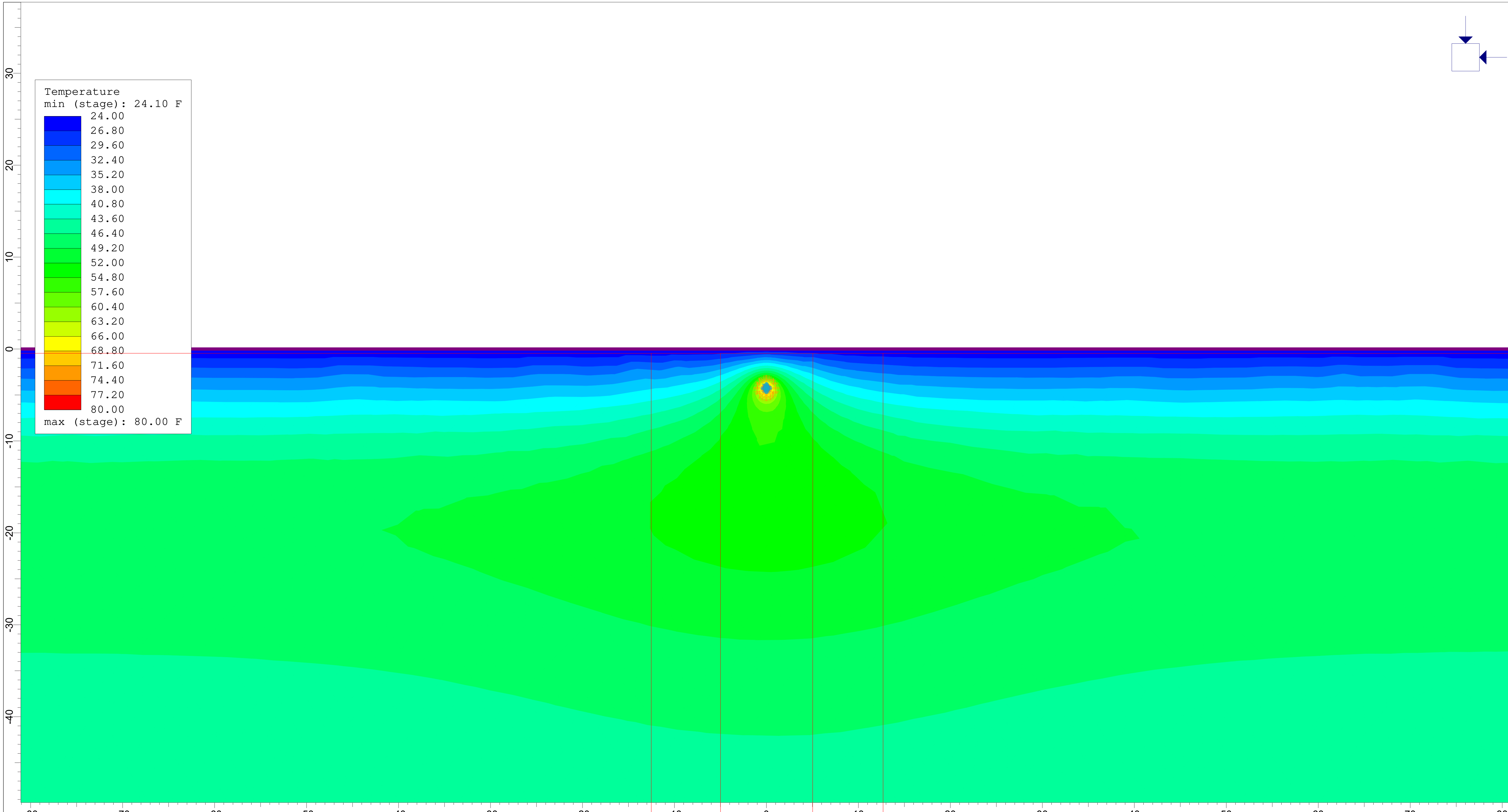
Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 2.fez

6IN PIPE 2 - FINE GRAIN - 15% SATURATION - APRIL



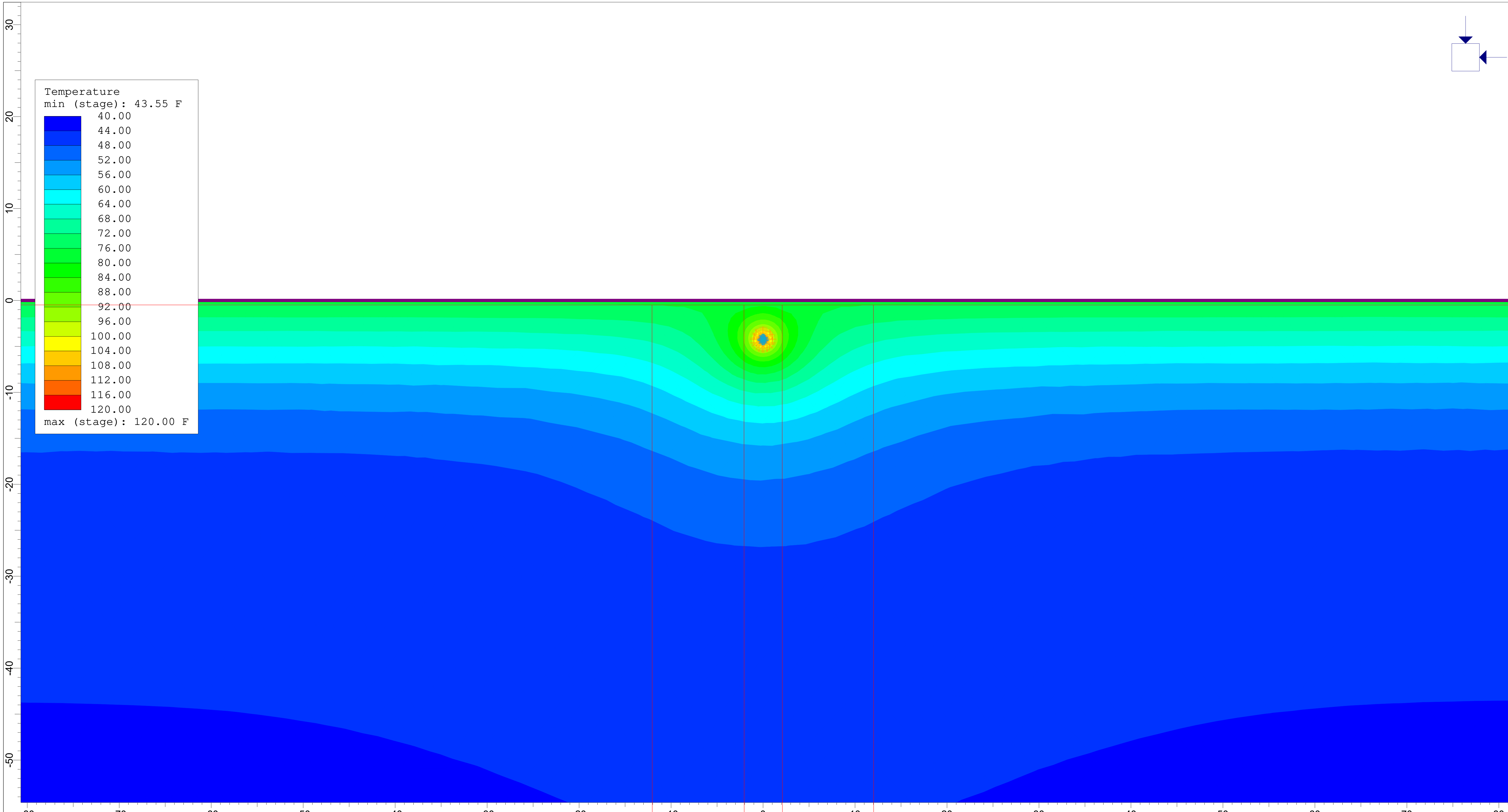
rocscience	Project: Summit Carbon - 6 Inch Pipeline (2)		
	Analysis Description: Thermal Analysis		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 2.fez

6IN PIPE 2 - FINE GRAIN - 15% SATURATION - JANUARY



rocscience	Project	Summit Carbon - 6 Inch Pipeline (2)	
	Analysis Description	Thermal Analysis	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 2.fez

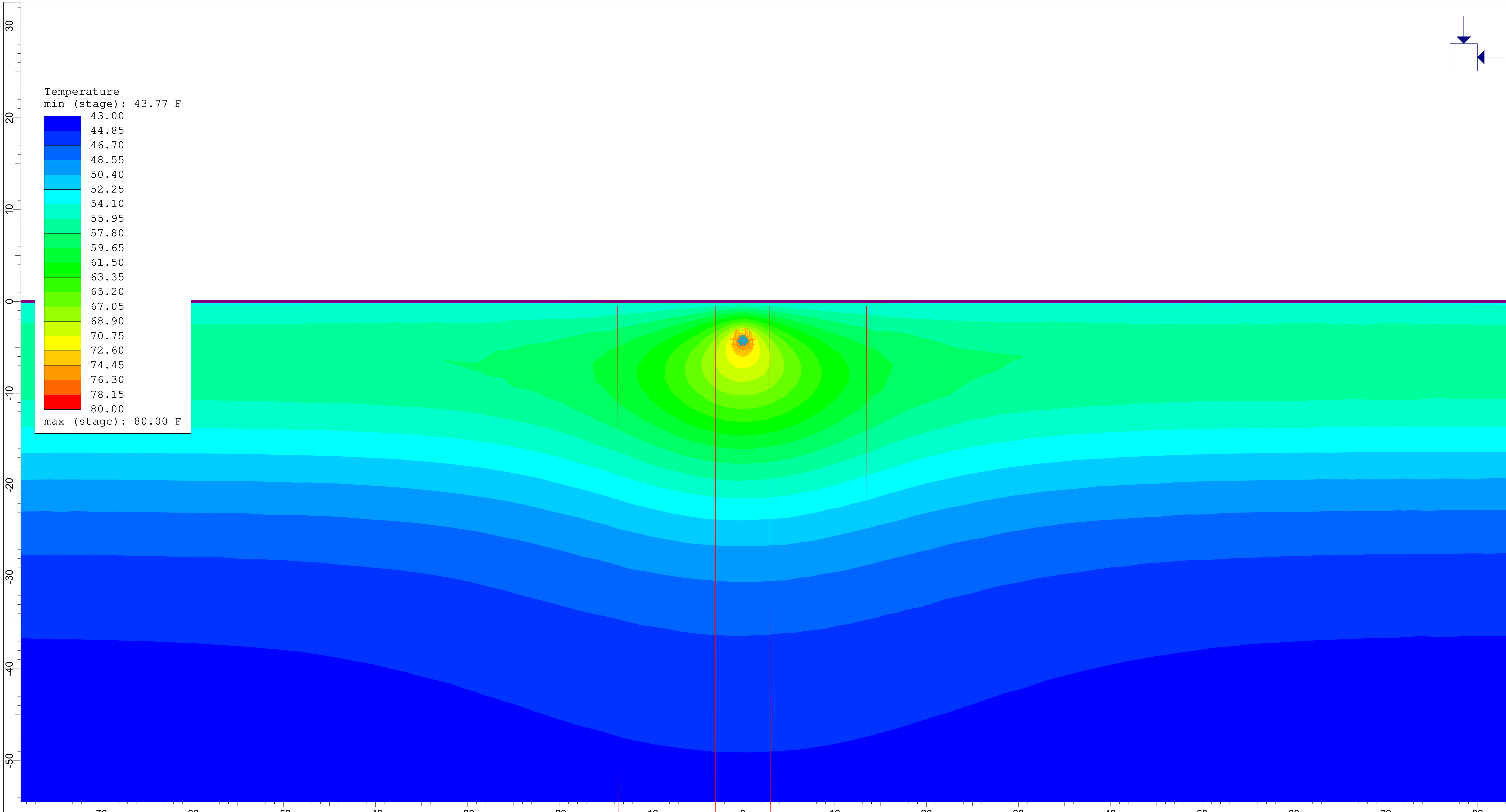
6IN PIPE 2 - FINE GRAIN - 15% SATURATION - JULY



Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 2.fez

INTERPRET 11.023

6IN PIPE 2 - FINE GRAIN - 15% SATURATION - OCTOBER

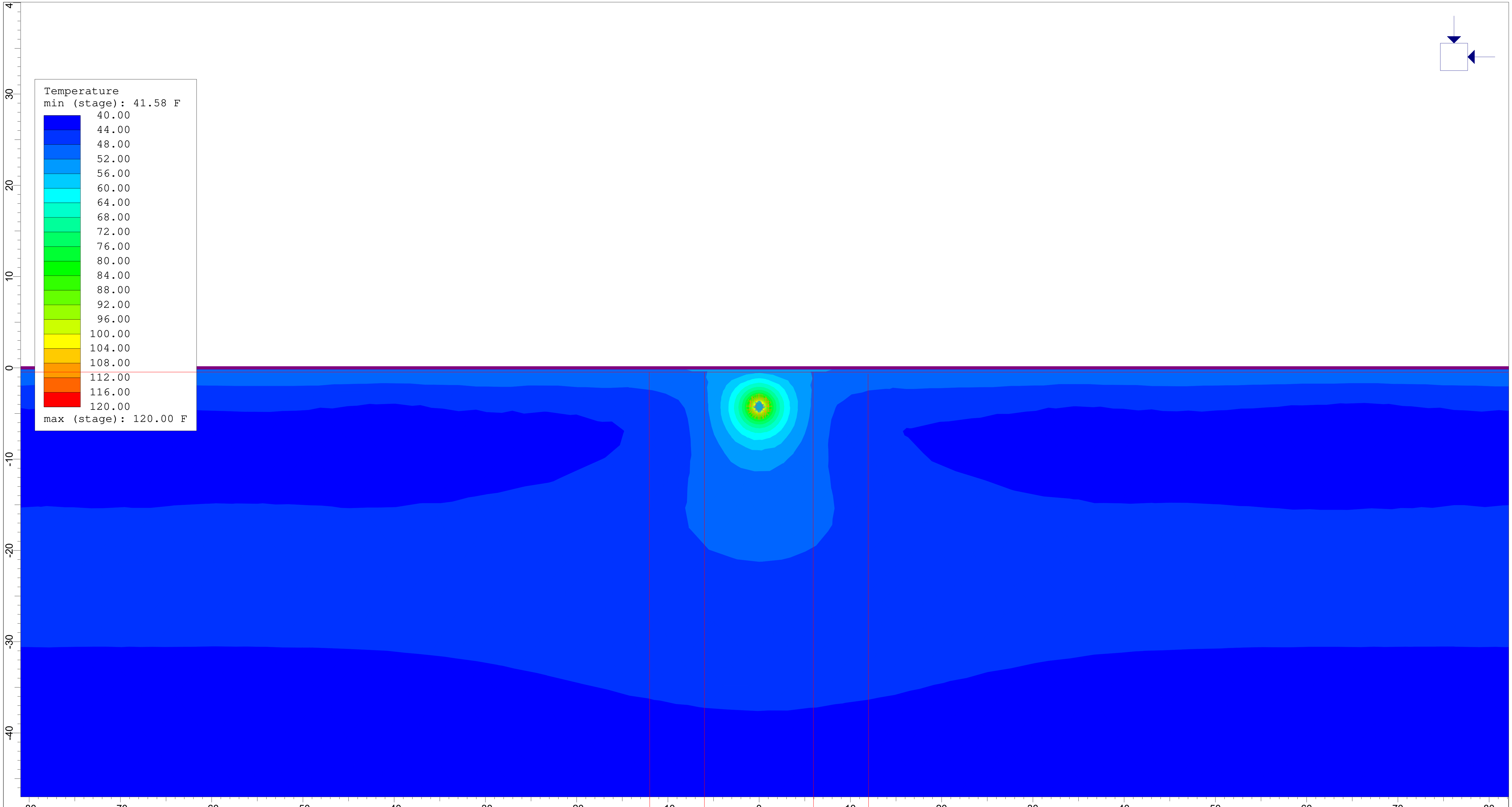


rocscience

INTERPRET 11.023

Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	6in Pipe 2.fez

6IN PIPE 2 - FINE GRAIN - 35% SATURATION - APRIL

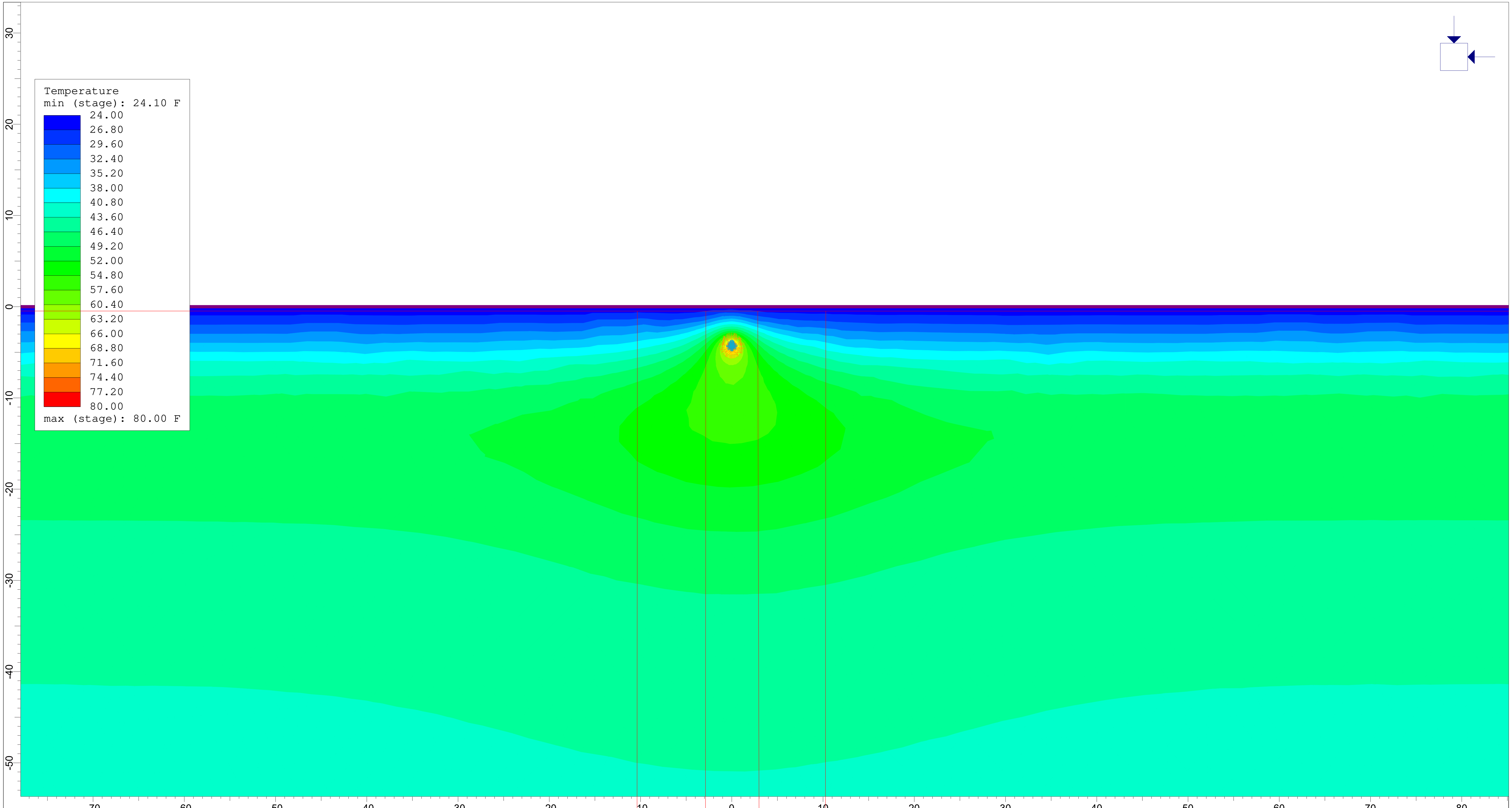


rocscience

INTERPRET 11.023

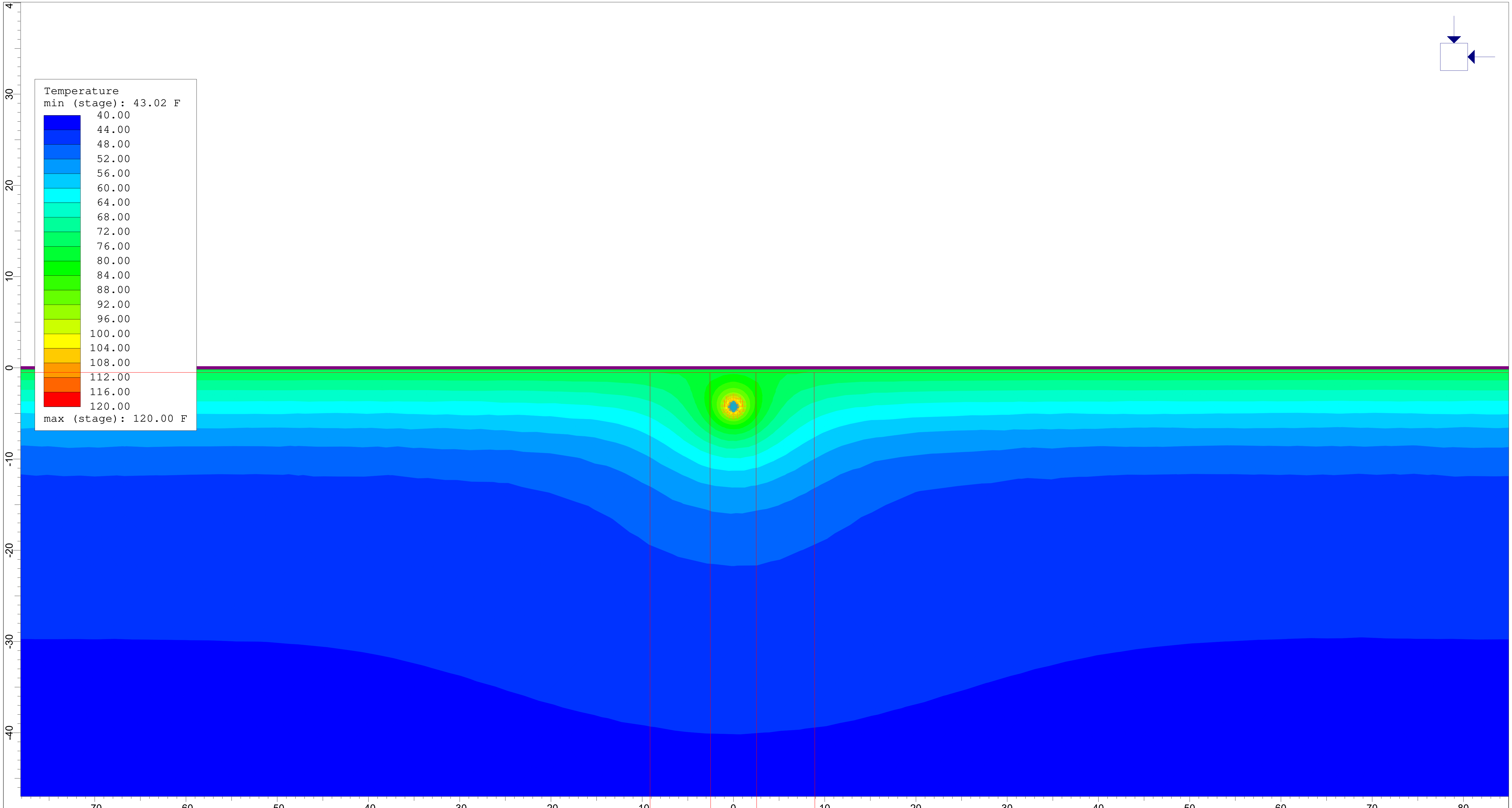
Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	6in Pipe 2.fez

6IN PIPE 2 - FINE GRAIN - 35% SATURATION - JANUARY



rocscience	Project: Summit Carbon - 6 Inch Pipeline (2)		
	Analysis Description: Thermal Analysis		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 2.fez

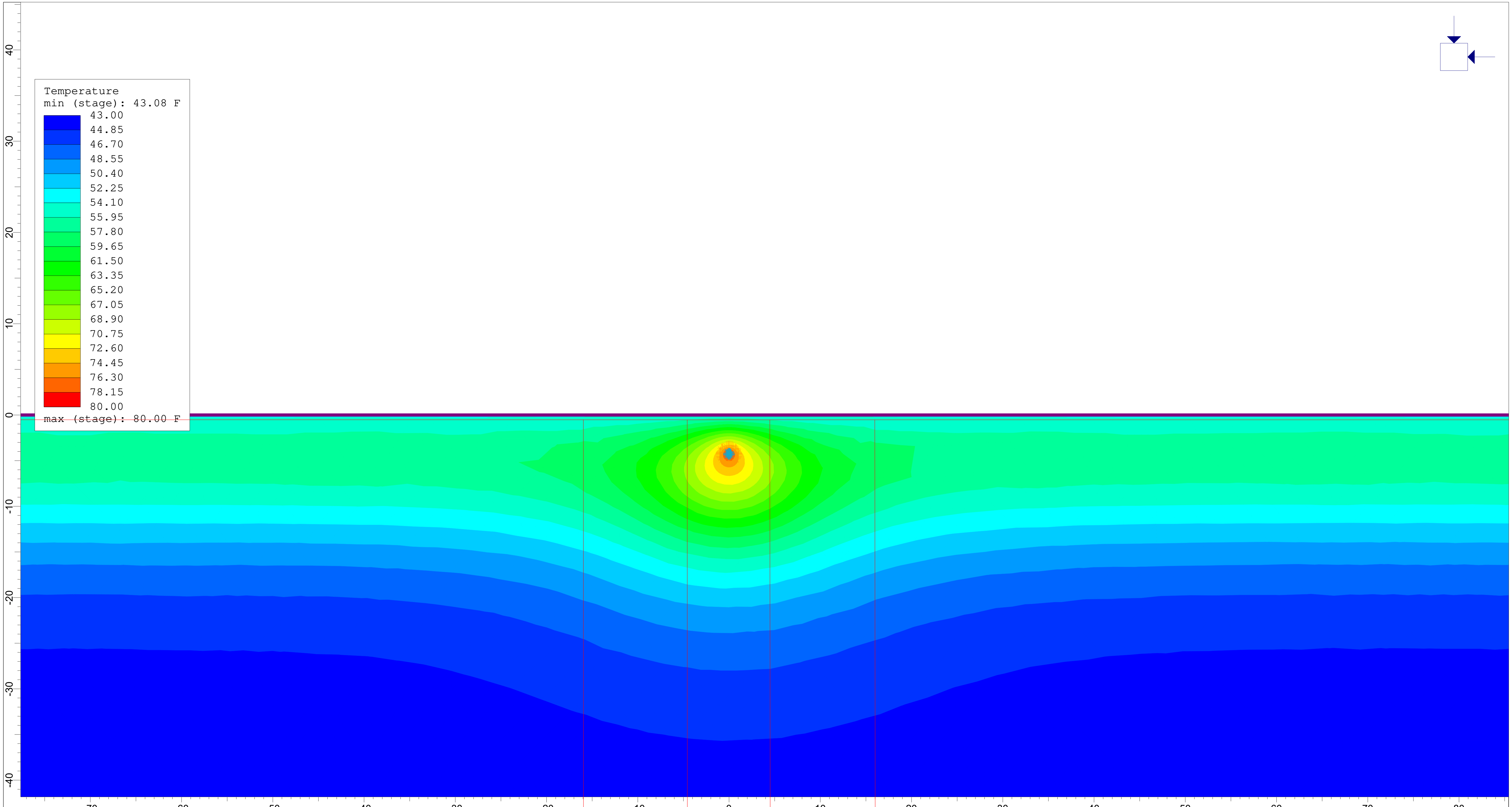
6IN PIPE 2 - FINE GRAIN - 35% SATURATION - JULY



rocscience
INTERPRET 11.023

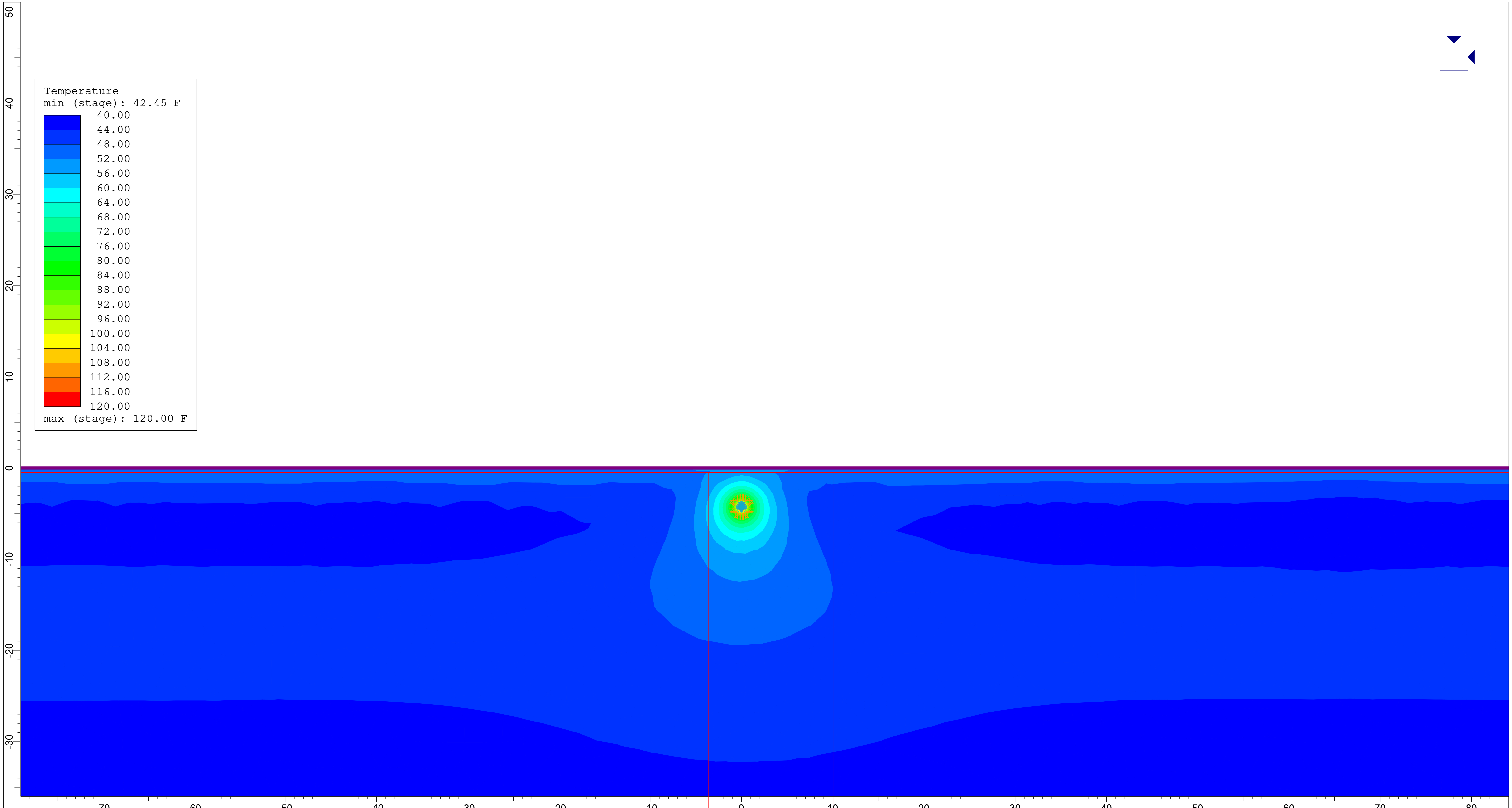
Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	6in Pipe 2.fez

6IN PIPE 2 - FINE GRAIN - 35% SATURATION - OCTOBER



rocscience	Project: Summit Carbon - 6 Inch Pipeline (2)		
	Analysis Description: Thermal Analysis		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 2.fez

6IN PIPE 2 - FINE GRAIN - 55% SATURATION - APRIL

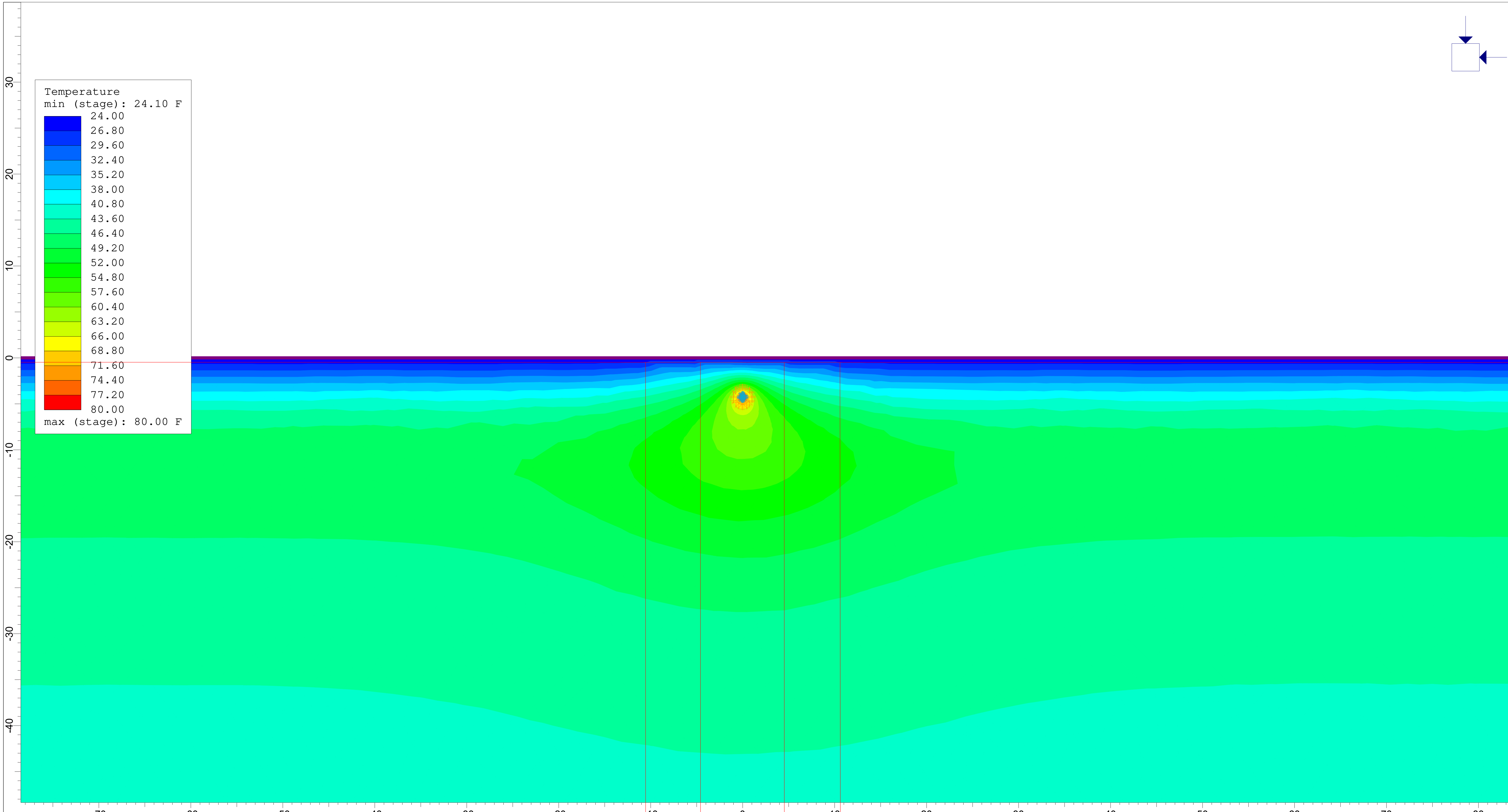


rocscience

INTERPRET 11.023

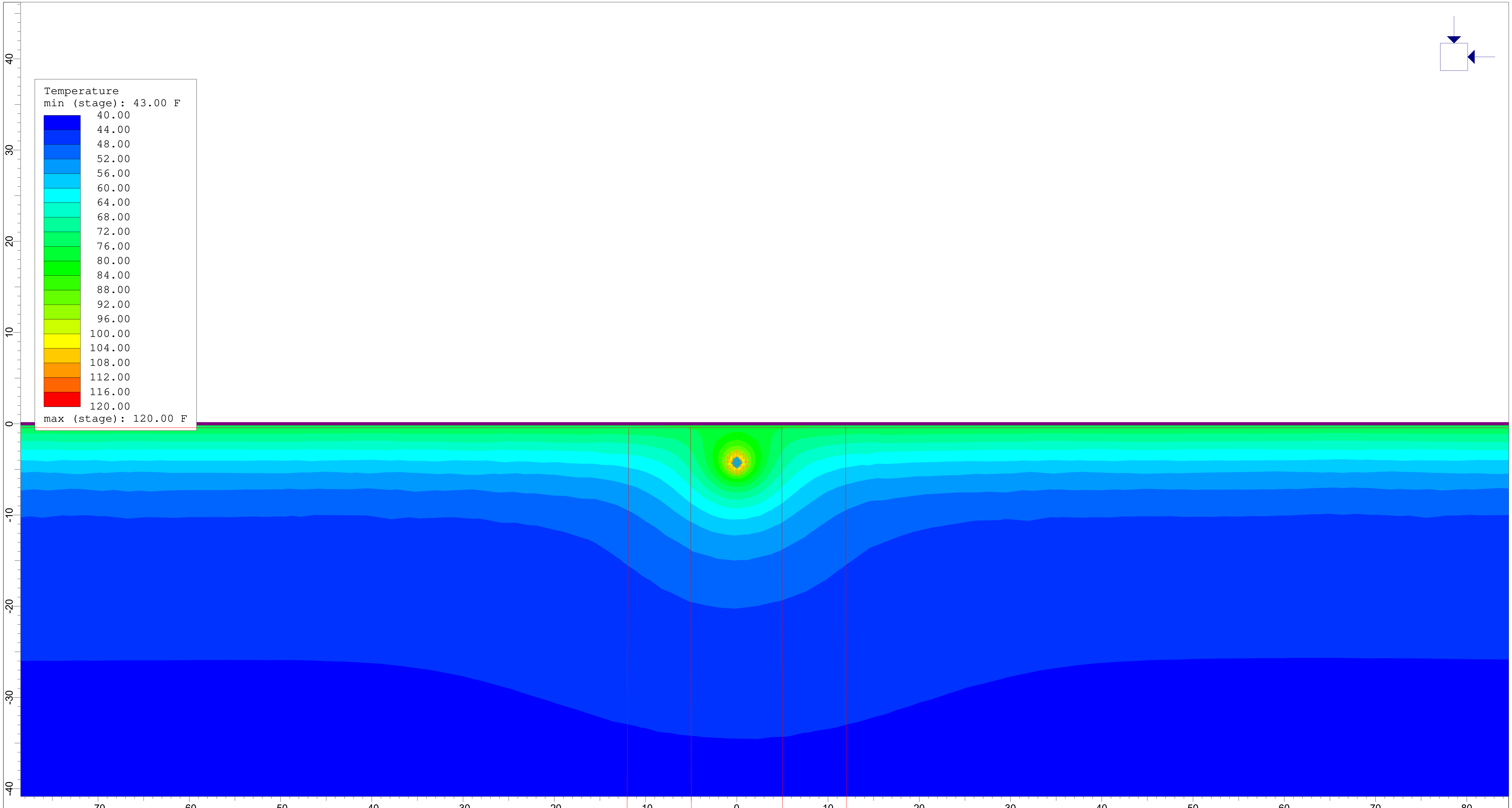
Project	Summit Carbon - 6 Inch Pipeline (2)		
Analysis Description	Thermal Analysis		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	6in Pipe 2.fez

6IN PIPE 2 - FINE GRAIN - 55% SATURATION - JANUARY



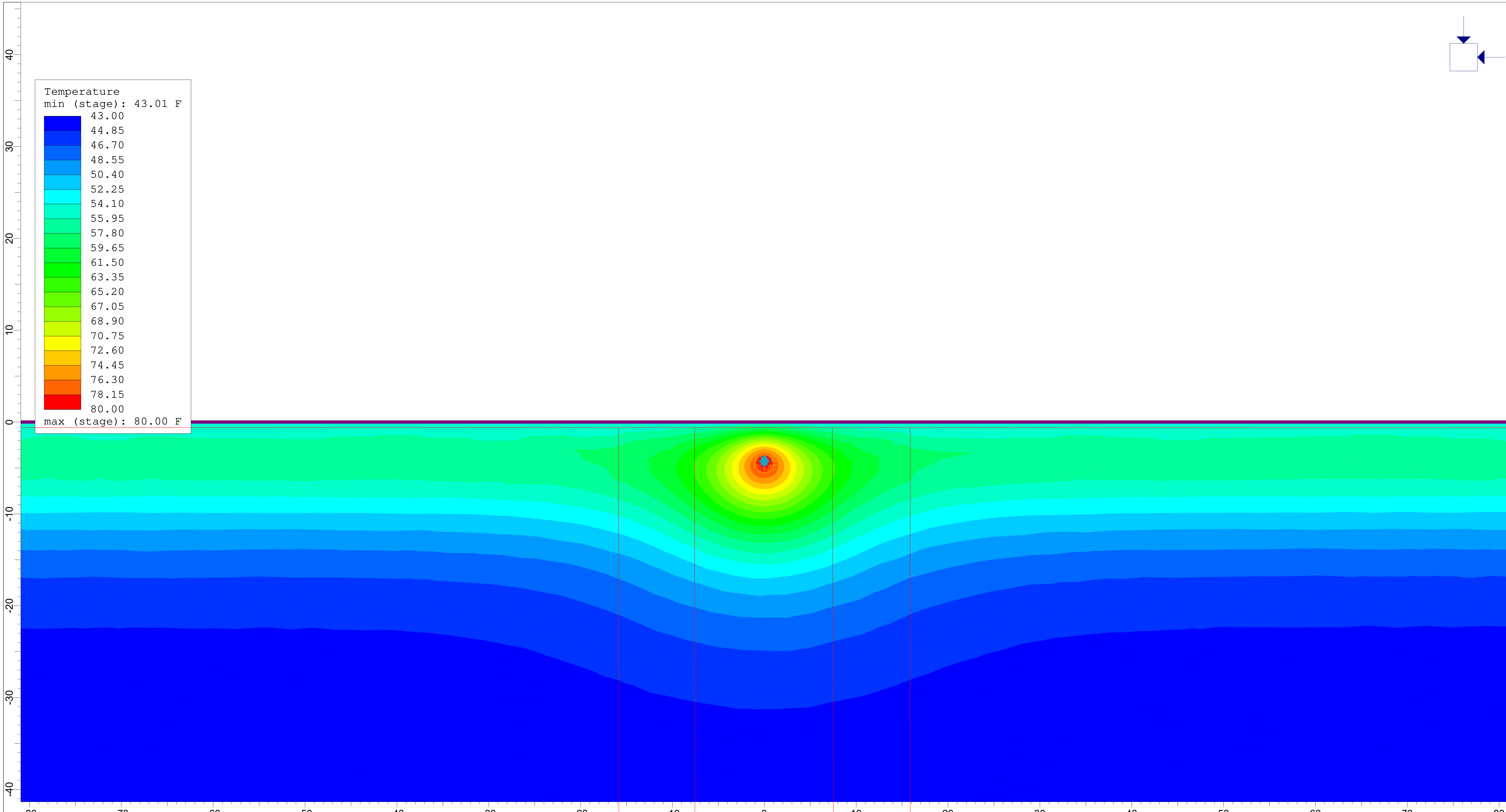
rocscience	Project	Summit Carbon - 6 Inch Pipeline (2)	
	Analysis Description	Thermal Analysis	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 2.fez

6IN PIPE 2 - FINE GRAIN - 55% SATURATION - JULY



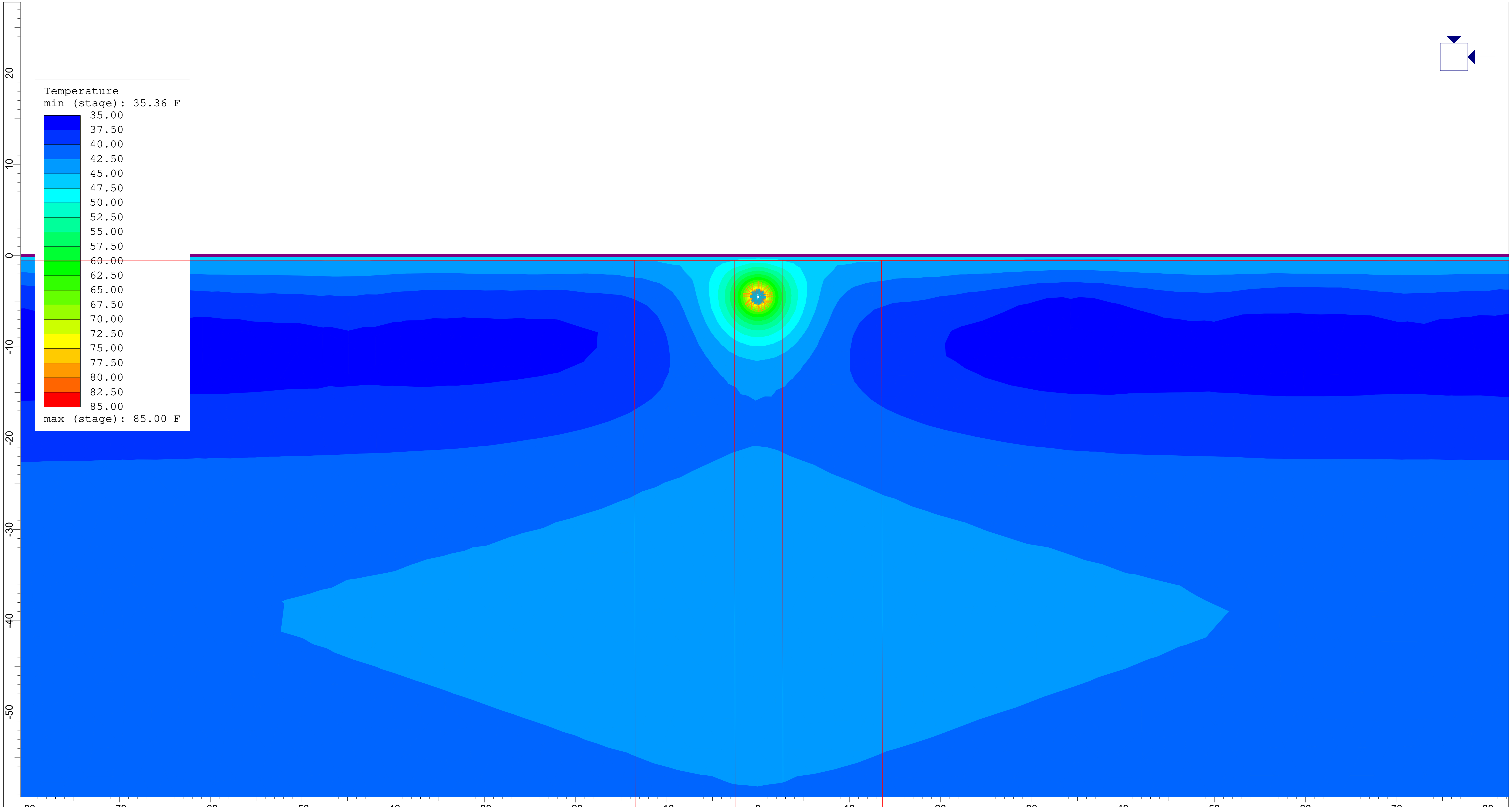
rocscience	Project: Summit Carbon - 6 Inch Pipeline (2)		
	Analysis Description: Thermal Analysis		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 2.fez

6IN PIPE 2 - FINE GRAIN - 55% SATURATION - OCTOBER



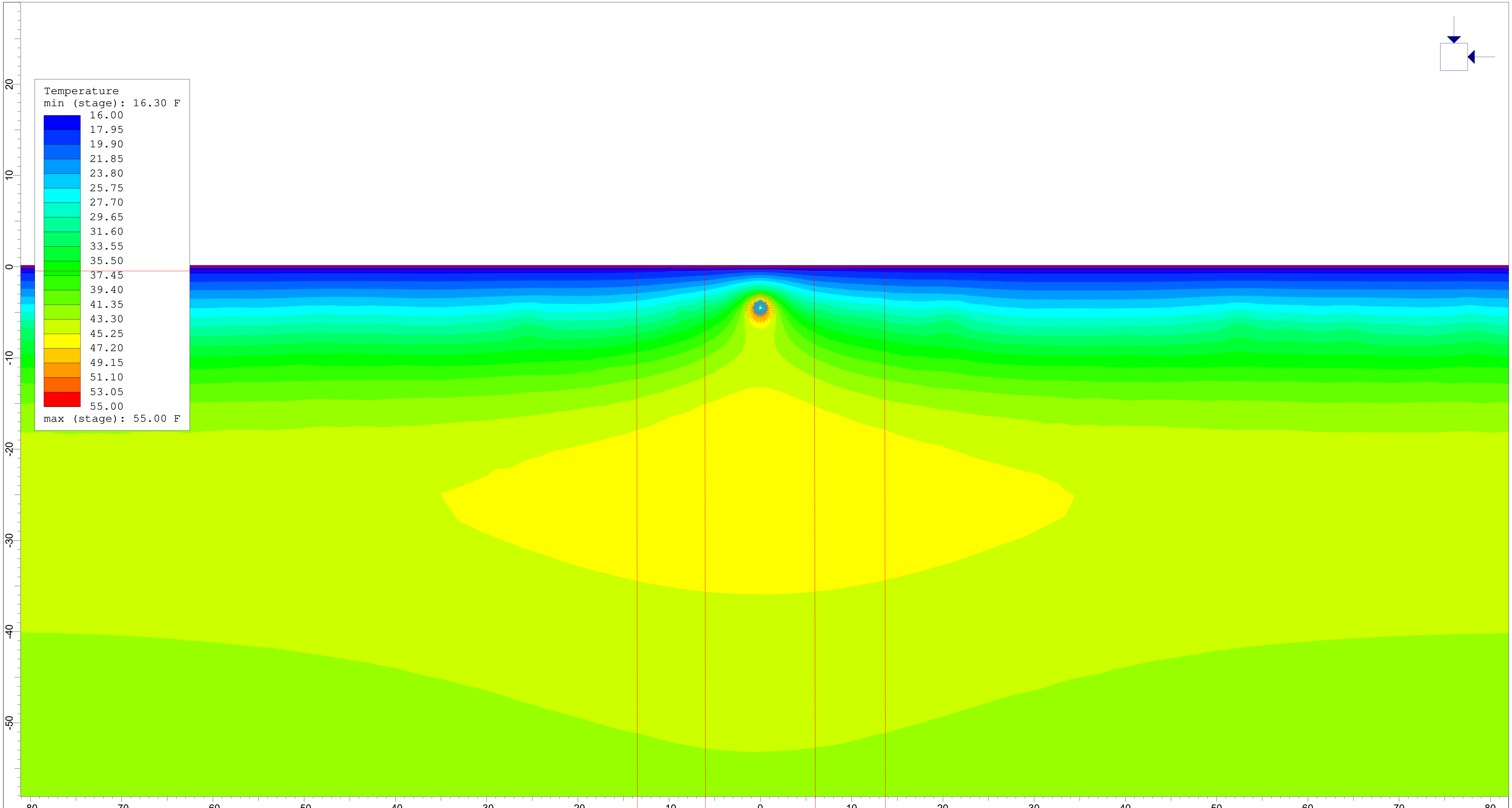
rocscience	Project: Summit Carbon - 6 Inch Pipeline (2)		
	Analysis Description: Thermal Analysis		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 6in Pipe 2.fez

12IN PIPE - COARSE GRAIN - 15% SATURATION - APRIL



rocscience	Project	Summit Carbon - 12 Inch Pipeline	
	Analysis Description	Thermal Analysis	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 12in Pipe.fez

12IN PIPE - COARSE GRAIN - 15% SATURATION - JANUARY

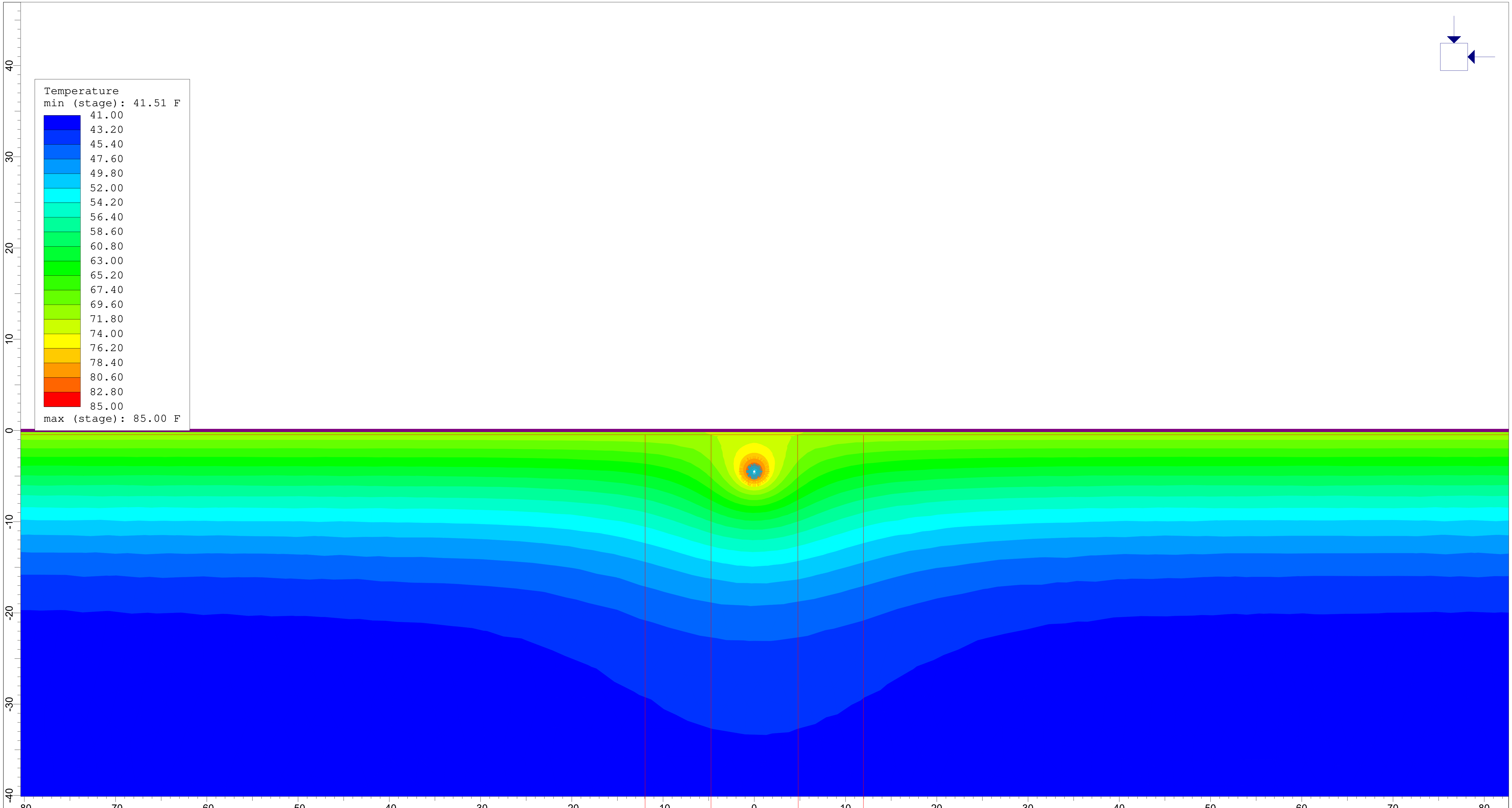


rocscience

INTERPRET 11.023

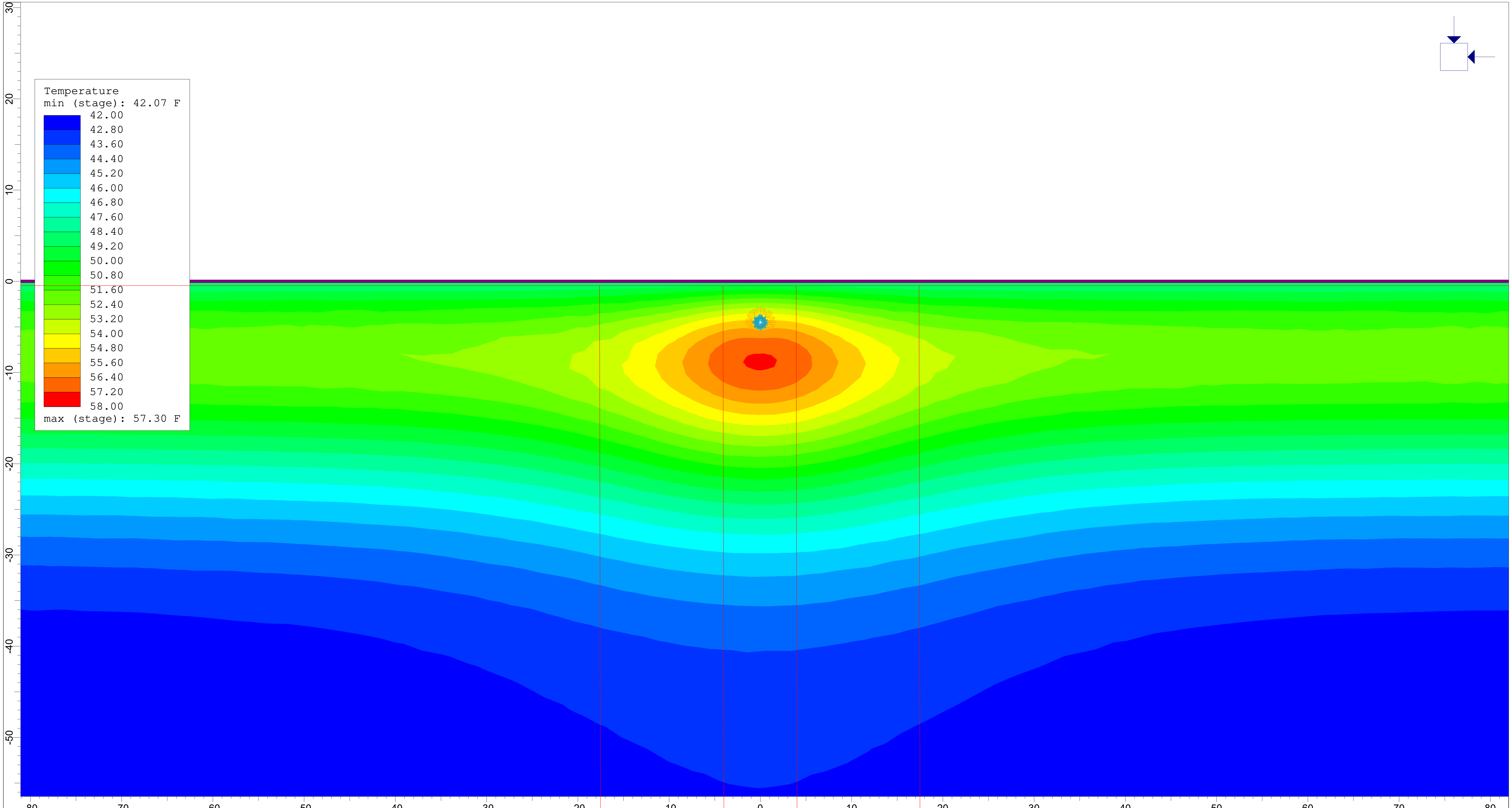
Project	Summit Carbon - 12 Inch Pipeline
Analysis Description	Thermal Analysis
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	12in Pipe.fez

12IN PIPE - COARSE GRAIN - 15% SATURATION - JULY



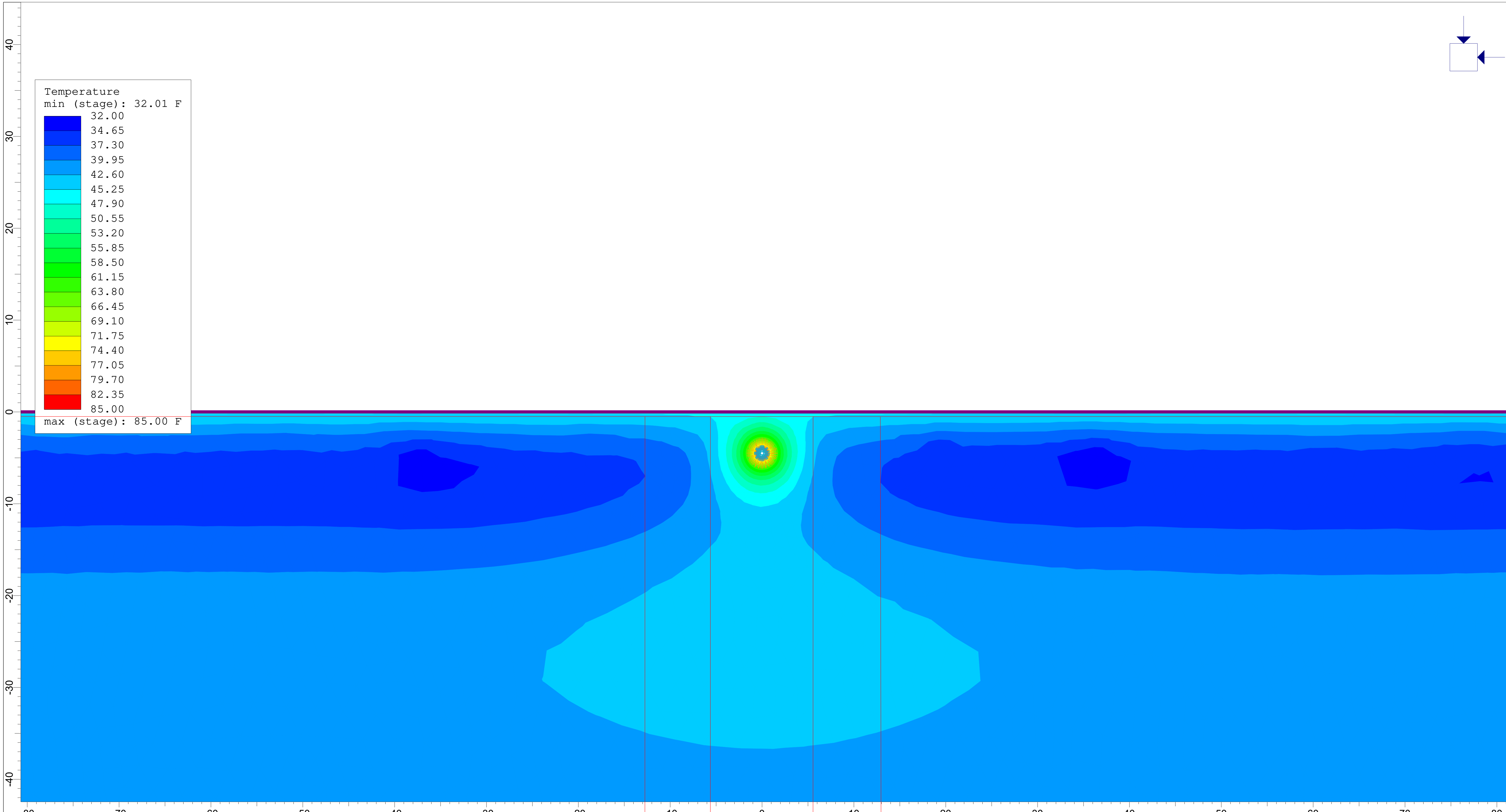
rocscience	Project	Summit Carbon - 12 Inch Pipeline	
	Analysis Description	Thermal Analysis	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 12in Pipe.fez

12IN PIPE - COARSE GRAIN - 15% SATURATION - OCTOBER



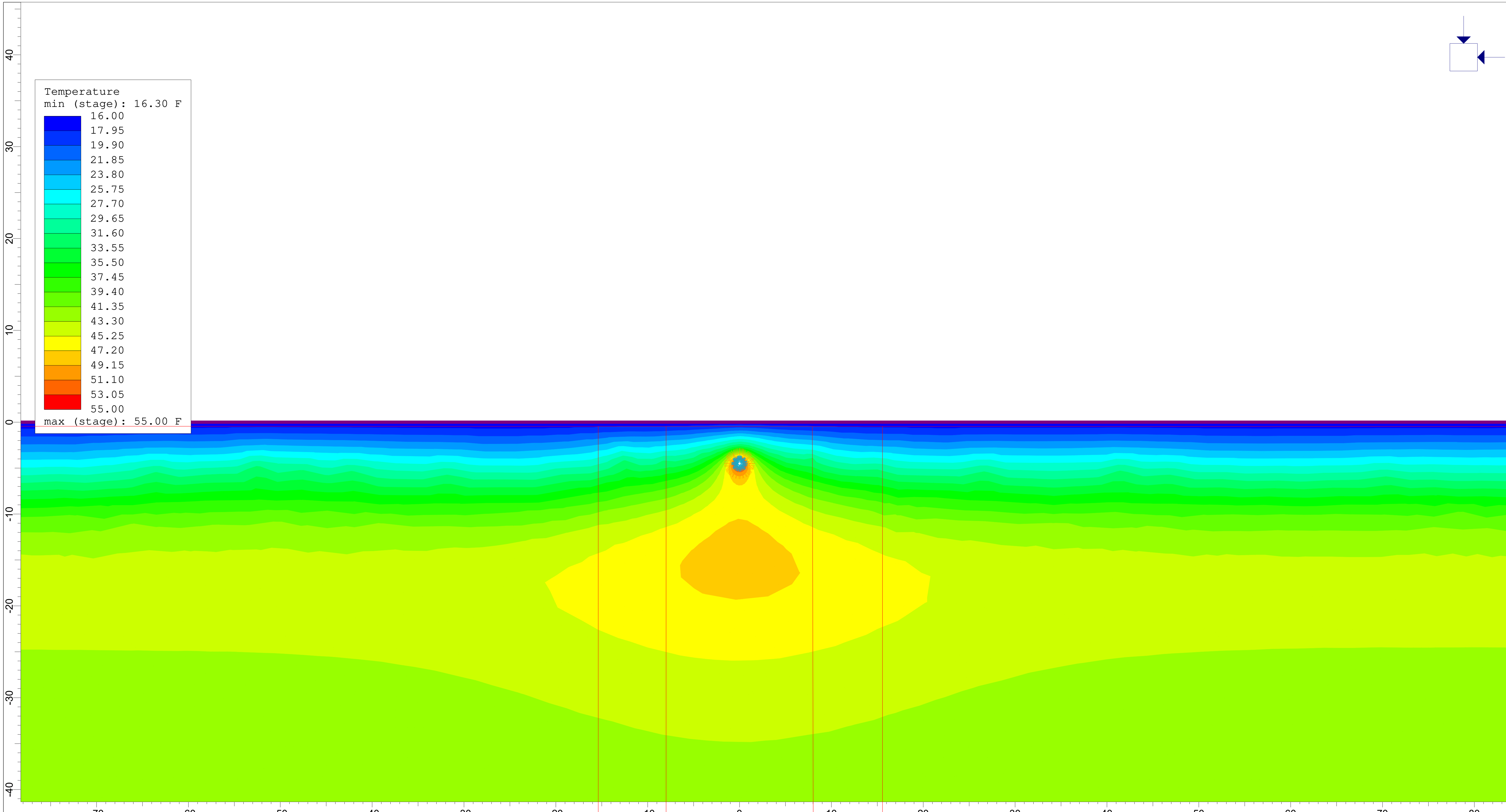
rocscience	Project	Summit Carbon - 12 Inch Pipeline		
	Analysis Description	Thermal Analysis		
	Drawn By	Connor Rankin	Scale 1:120	Company Lake Superior Consulting
INTERPRET 11.023	Date	6/3/2024, 10:56:45 AM		File Name 12in Pipe.fez

12IN PIPE - COARSE GRAIN - 35% SATURATION - APRIL



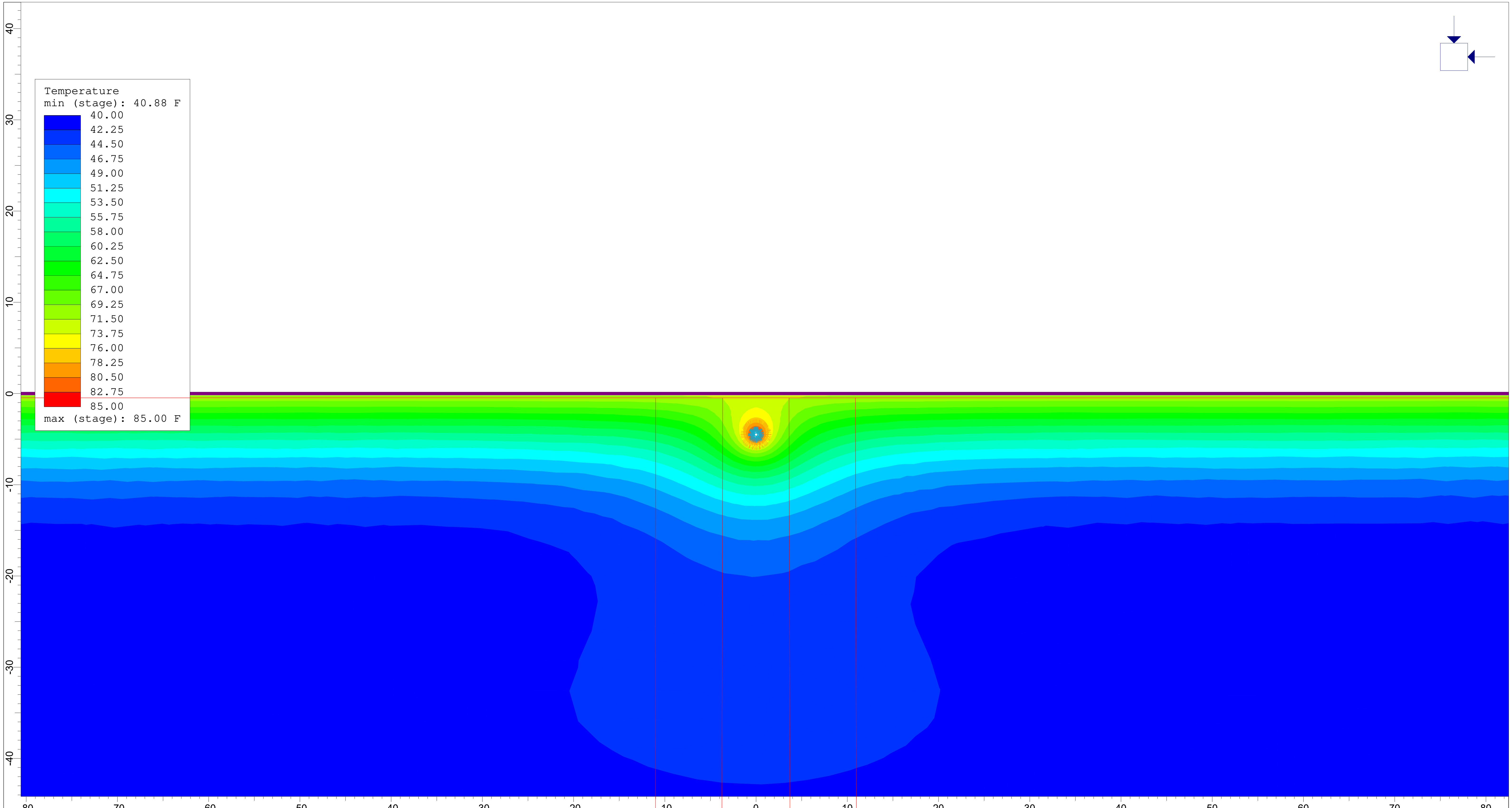
rocscience	Project: Summit Carbon - 12 Inch Pipeline		
	Analysis Description: Thermal Analysis		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 12in Pipe.fez

12IN PIPE - COARSE GRAIN - 35% SATURATION - JANUARY



rocscience INTERPRET 11.023	Project: Summit Carbon - 12 Inch Pipeline		
	Analysis Description: Thermal Analysis		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
	Date: 6/3/2024, 10:56:45 AM		File Name: 12in Pipe.fez

12IN PIPE - COARSE GRAIN - 35% SATURATION - JULY

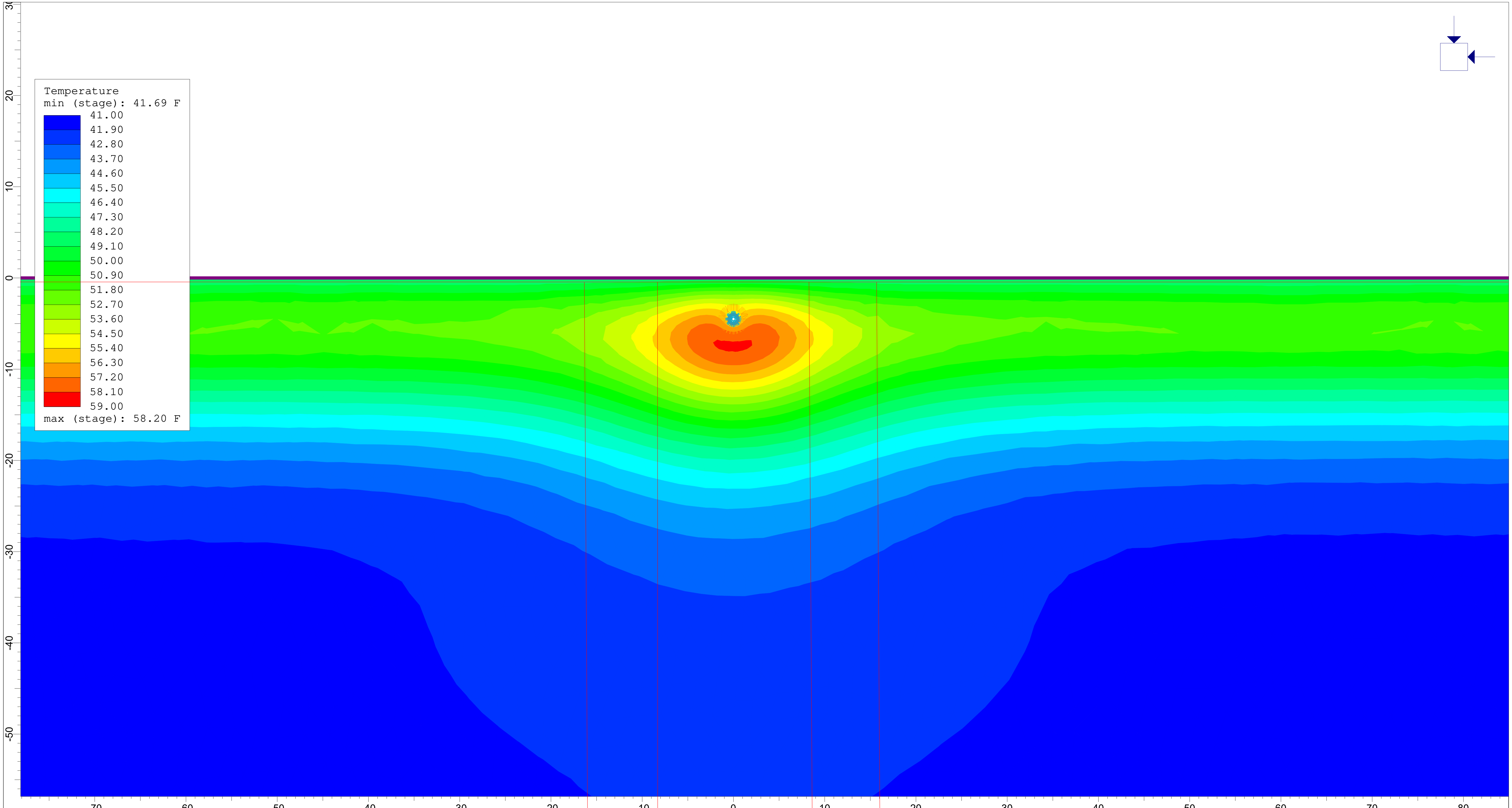


rocscience

INTERPRET 11.023

Project	Summit Carbon - 12 Inch Pipeline		
Analysis Description	Thermal Analysis		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	12in Pipe.fez

12IN PIPE - COARSE GRAIN - 35% SATURATION - OCTOBER

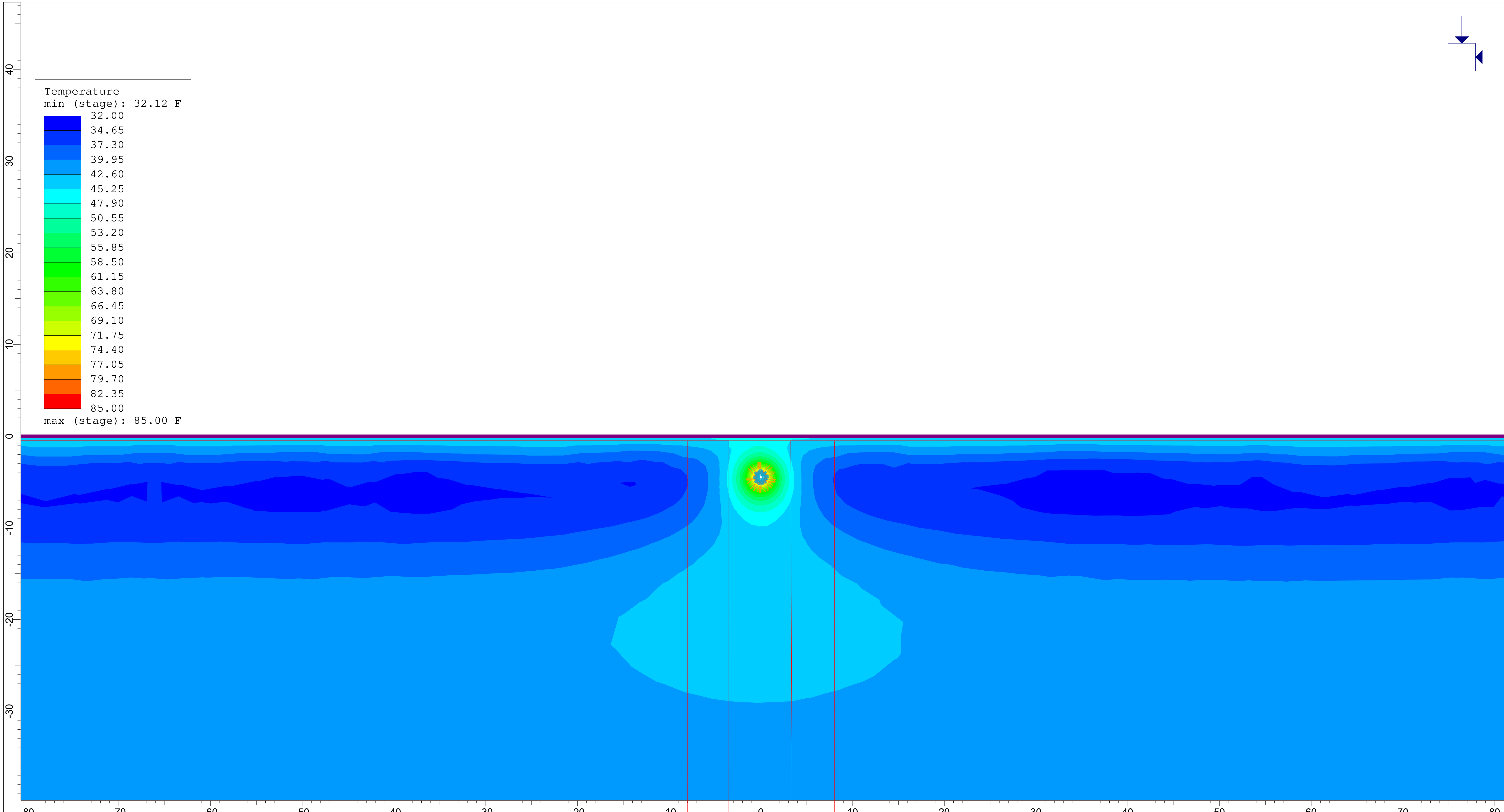


rocscience

INTERPRET 11.023

Project	Summit Carbon - 12 Inch Pipeline		
Analysis Description	Thermal Analysis		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	12in Pipe.fez

12IN PIPE - COARSE GRAIN - 55% SATURATION - APRIL

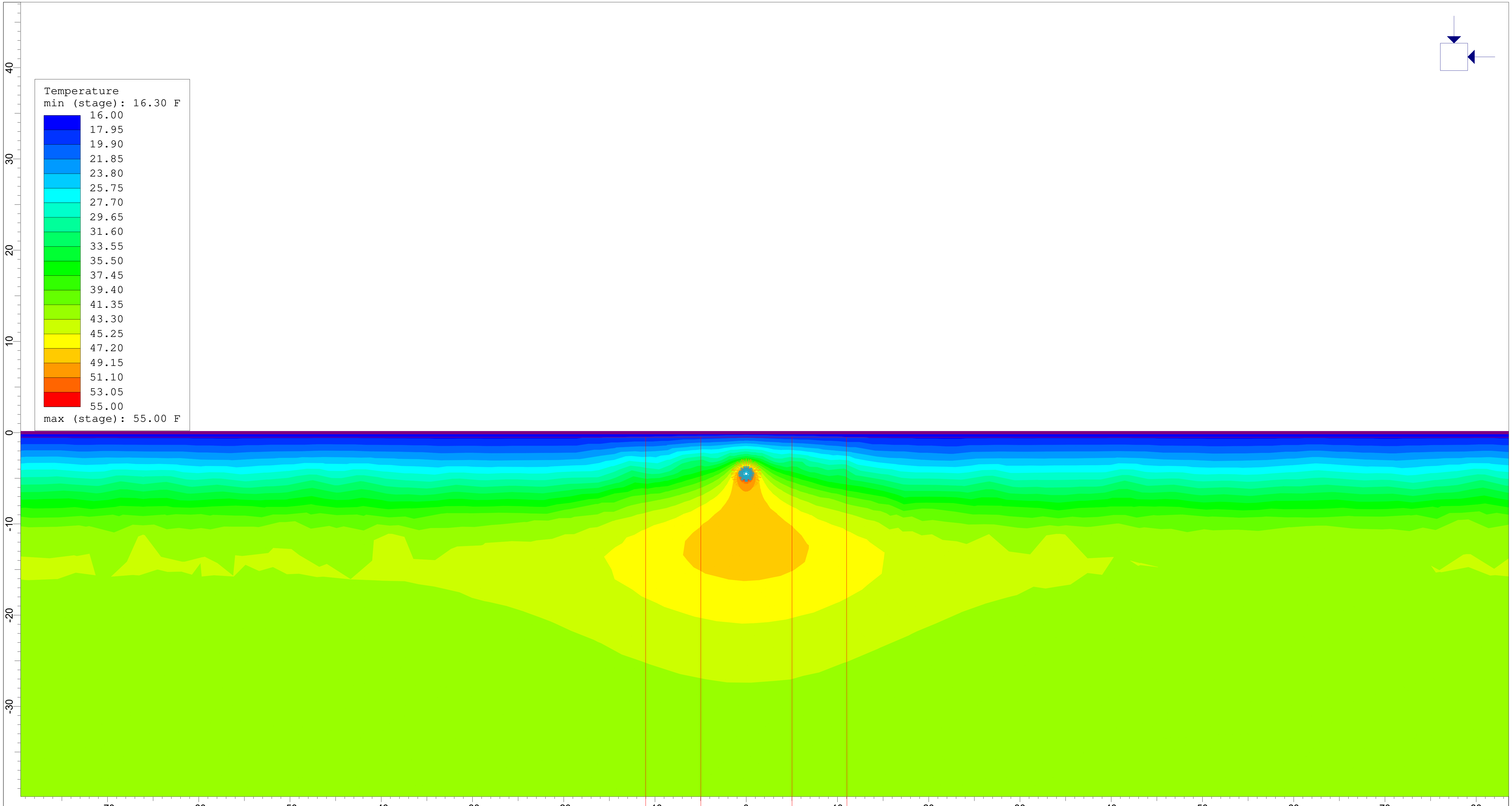


rocscience

INTERPRET 11.023

Project	Summit Carbon - 12 Inch Pipeline		
Analysis Description	Thermal Analysis		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	12in Pipe.fez

12IN PIPE - COARSE GRAIN - 55% SATURATION - JANUARY

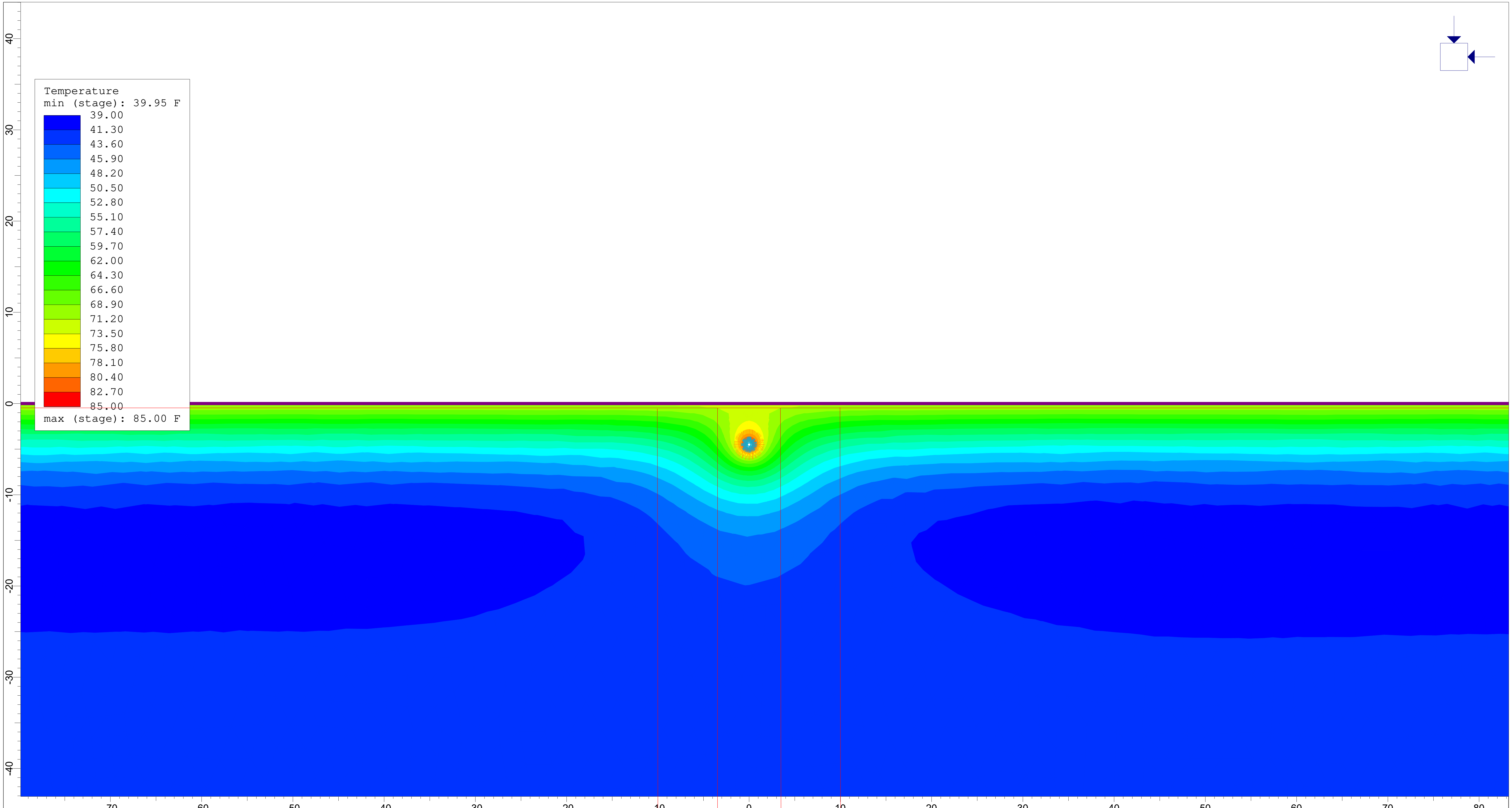


rocscience

INTERPRET 11.023

Project	Summit Carbon - 12 Inch Pipeline
Analysis Description	Thermal Analysis
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	12in Pipe.fez

12IN PIPE - COARSE GRAIN - 55% SATURATION - JULY

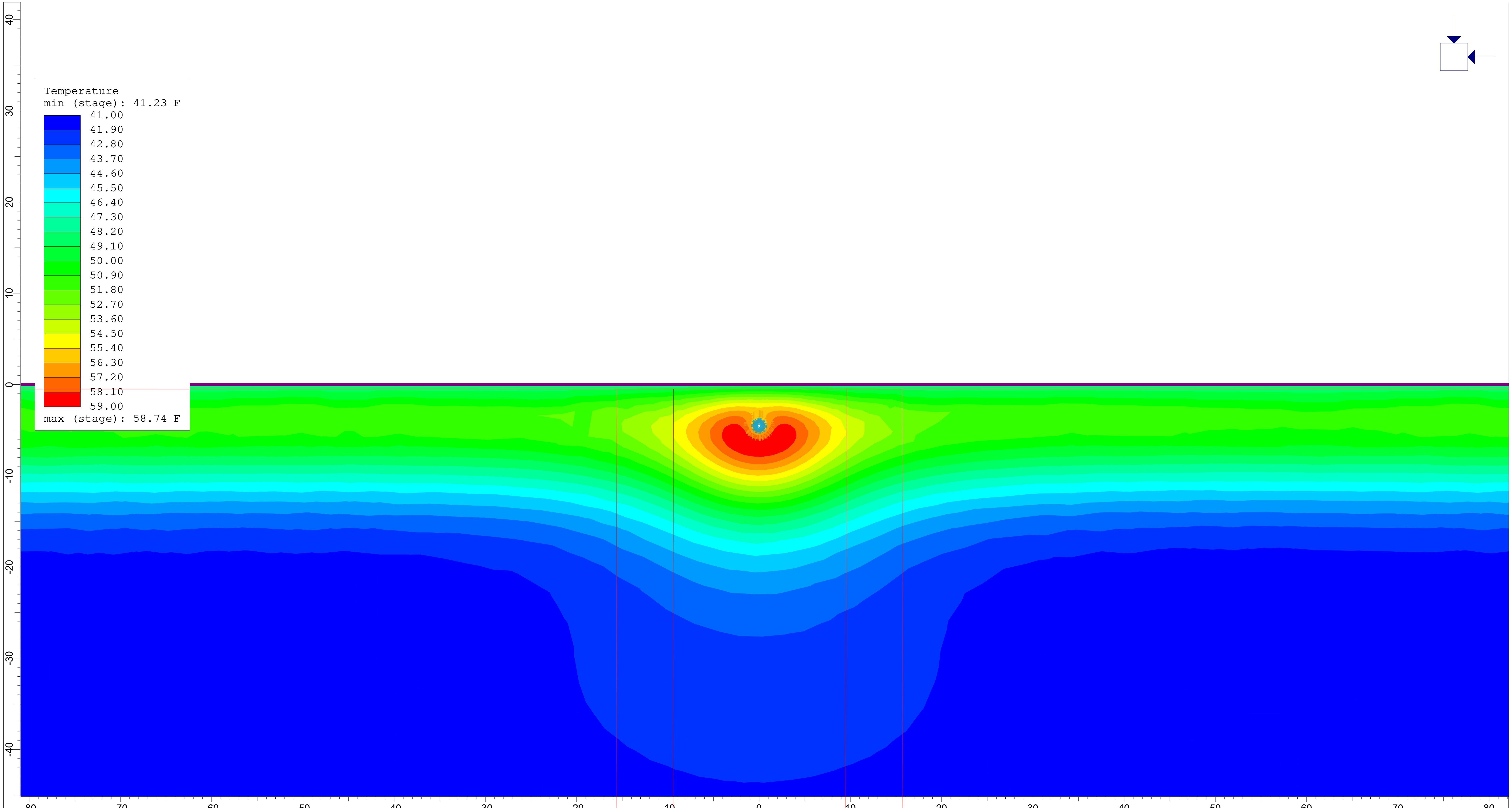


rocscience

INTERPRET 11.023

Project	Summit Carbon - 12 Inch Pipeline		
Analysis Description	Thermal Analysis		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	12in Pipe.fez

12IN PIPE - COARSE GRAIN - 55% SATURATION - OCTOBER

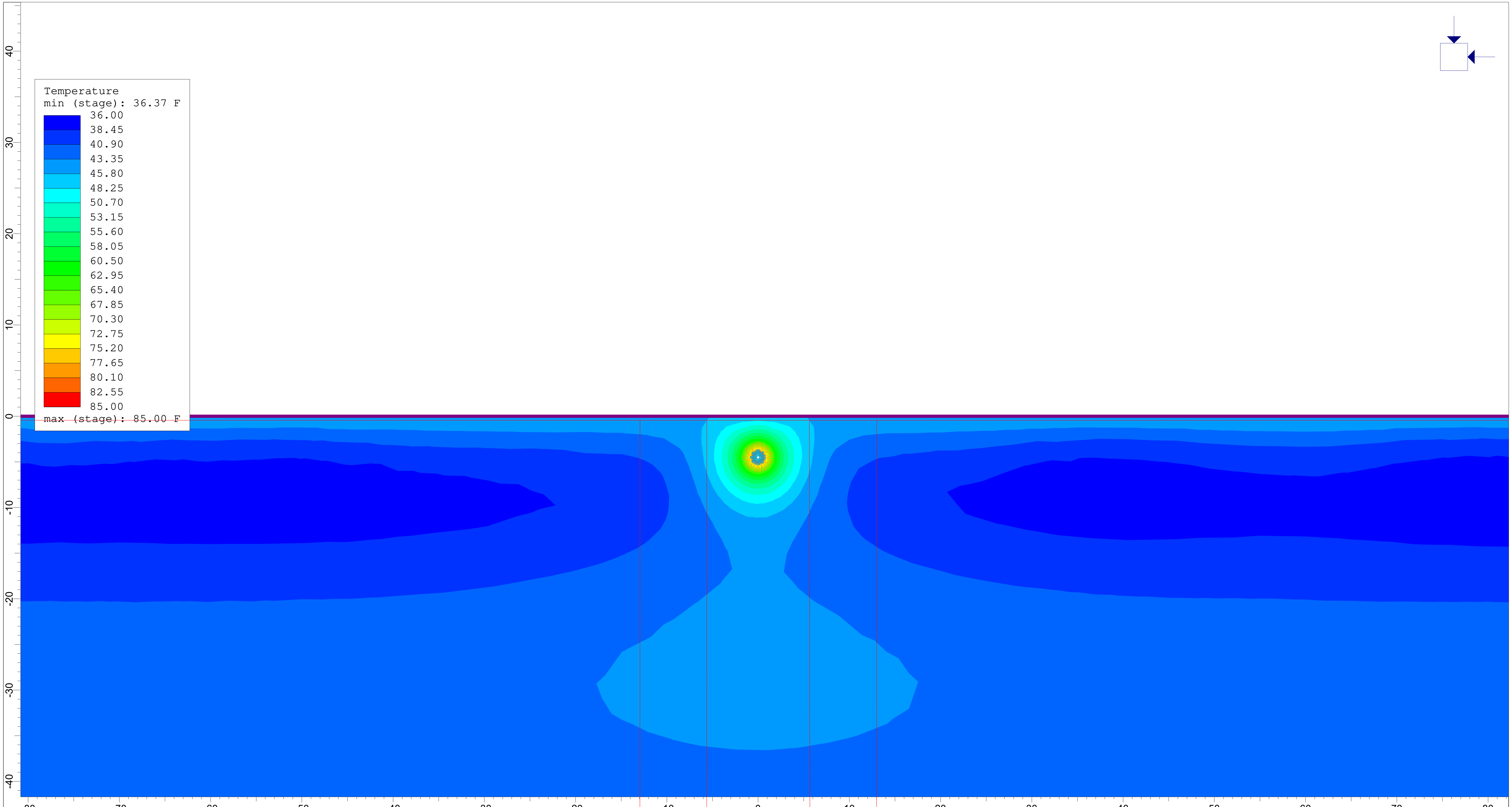


rocscience

INTERPRET 11.023

Project	Summit Carbon - 12 Inch Pipeline		
Analysis Description	Thermal Analysis		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	12in Pipe.fez

12IN PIPE - FINE GRAIN - 15% SATURATION - APRIL

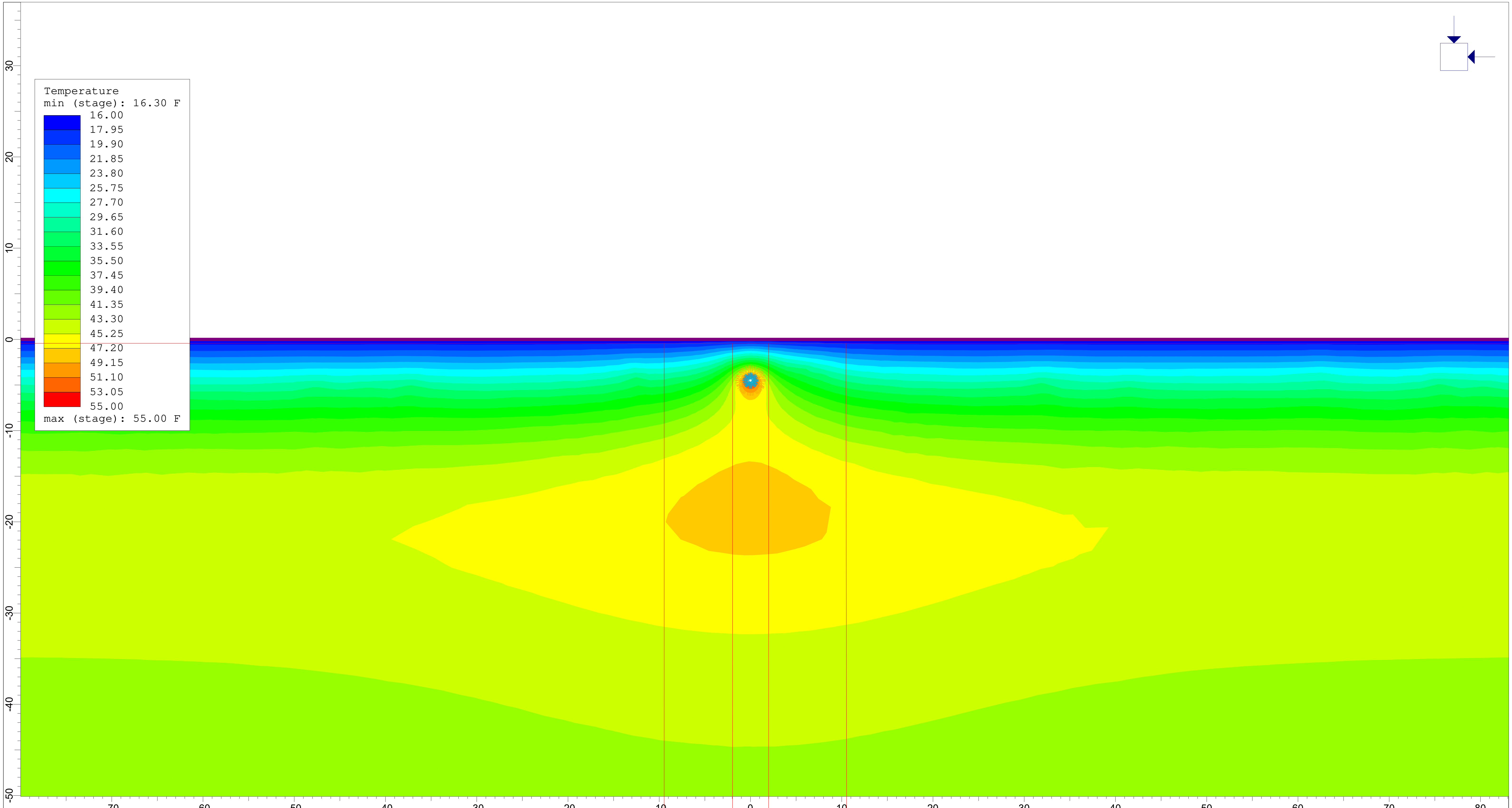


rocscience

INTERPRET 11.023

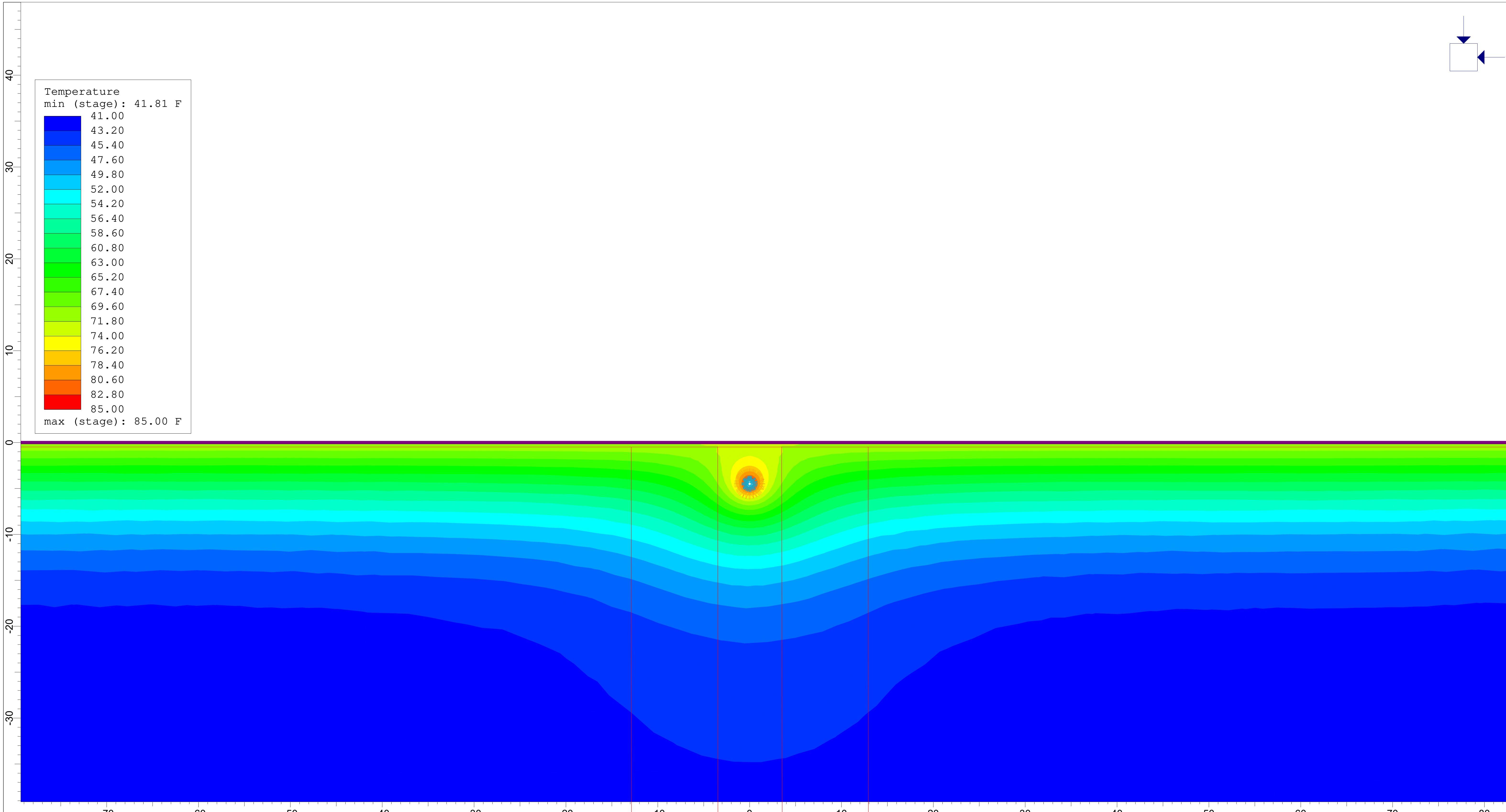
Project	Summit Carbon - 12 Inch Pipeline		
Analysis Description	Thermal Analysis		
Drawn By Connor Rankin	*Scale* 1:120	*Company*	Lake Superior Consulting
Date 6/3/2024, 10:56:45 AM		*File Name*	12in Pipe.fez

12IN PIPE - FINE GRAIN - 15% SATURATION - JANUARY



rocscience	*Project* Summit Carbon - 12 Inch Pipeline		
	Analysis Description Thermal Analysis		
	Drawn By Connor Rankin	*Scale* 1:120	*Company* Lake Superior Consulting
INTERPRET 11.023	*Date* 6/3/2024, 10:56:45 AM		*File Name* 12in Pipe.fez

12IN PIPE - FINE GRAIN - 15% SATURATION - JULY

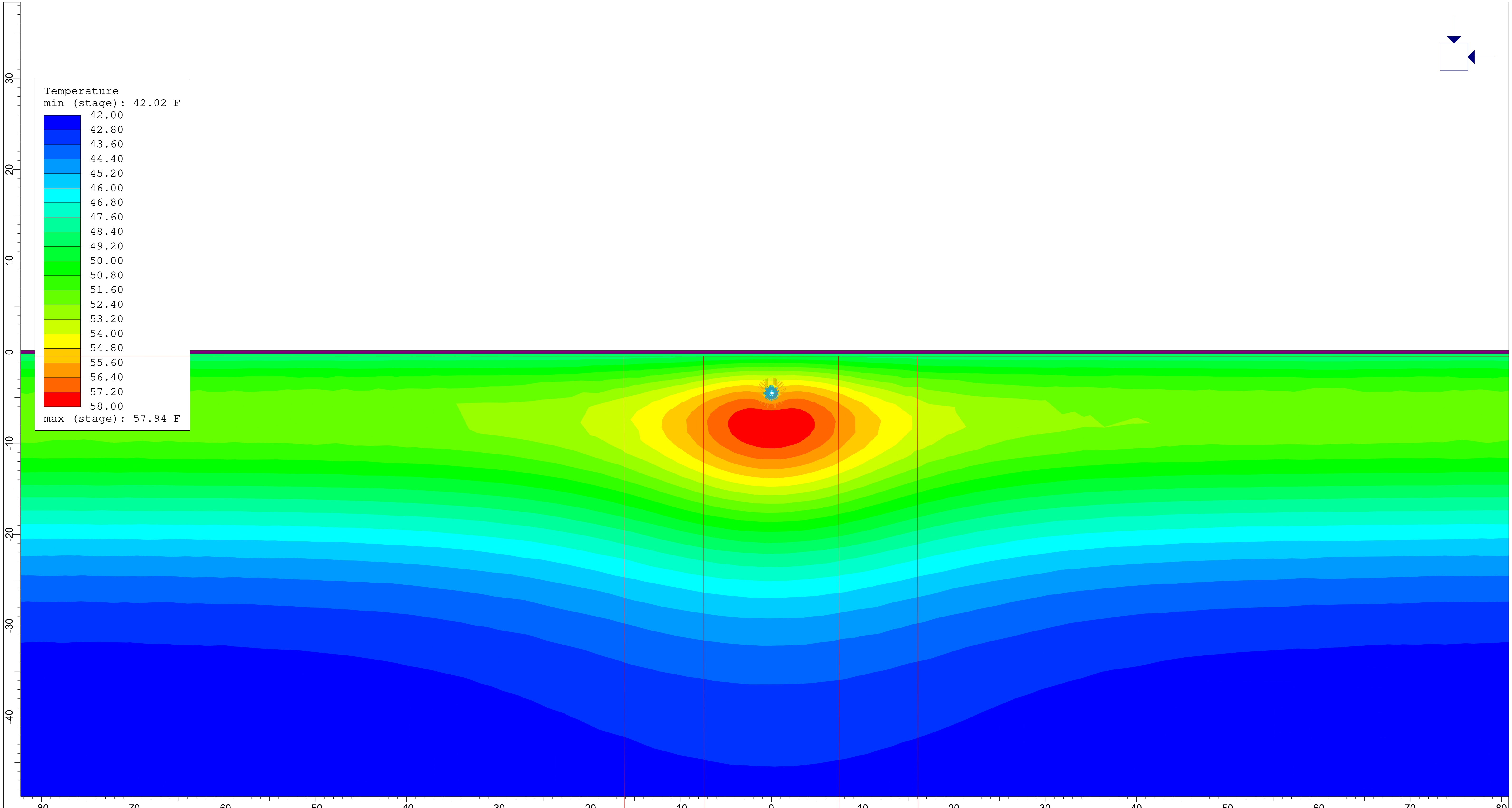


rocscience

INTERPRET 11.023

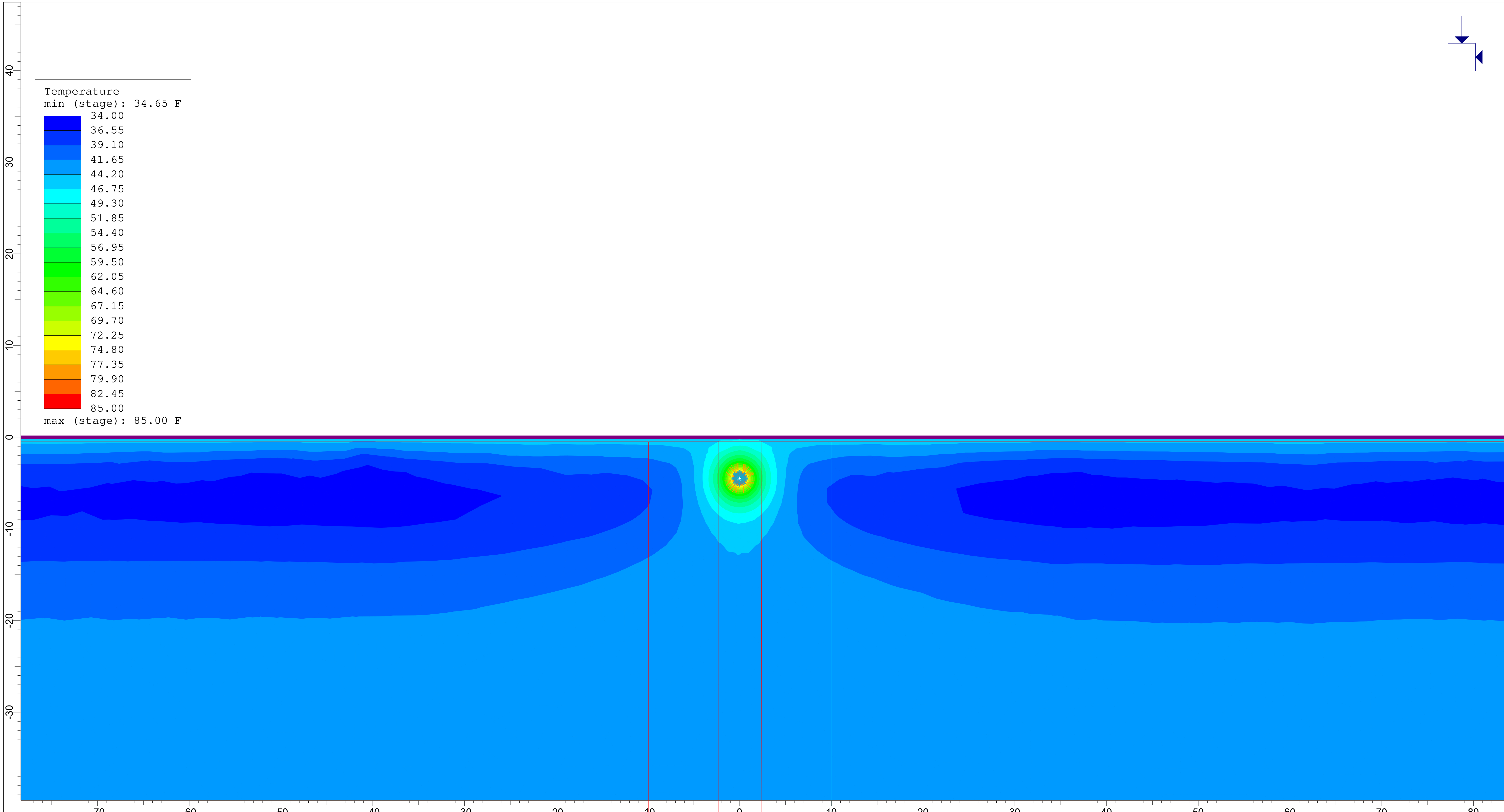
Project	Summit Carbon - 12 Inch Pipeline		
Analysis Description	Thermal Analysis		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	12in Pipe.fez

12IN PIPE - FINE GRAIN - 15% SATURATION - OCTOBER



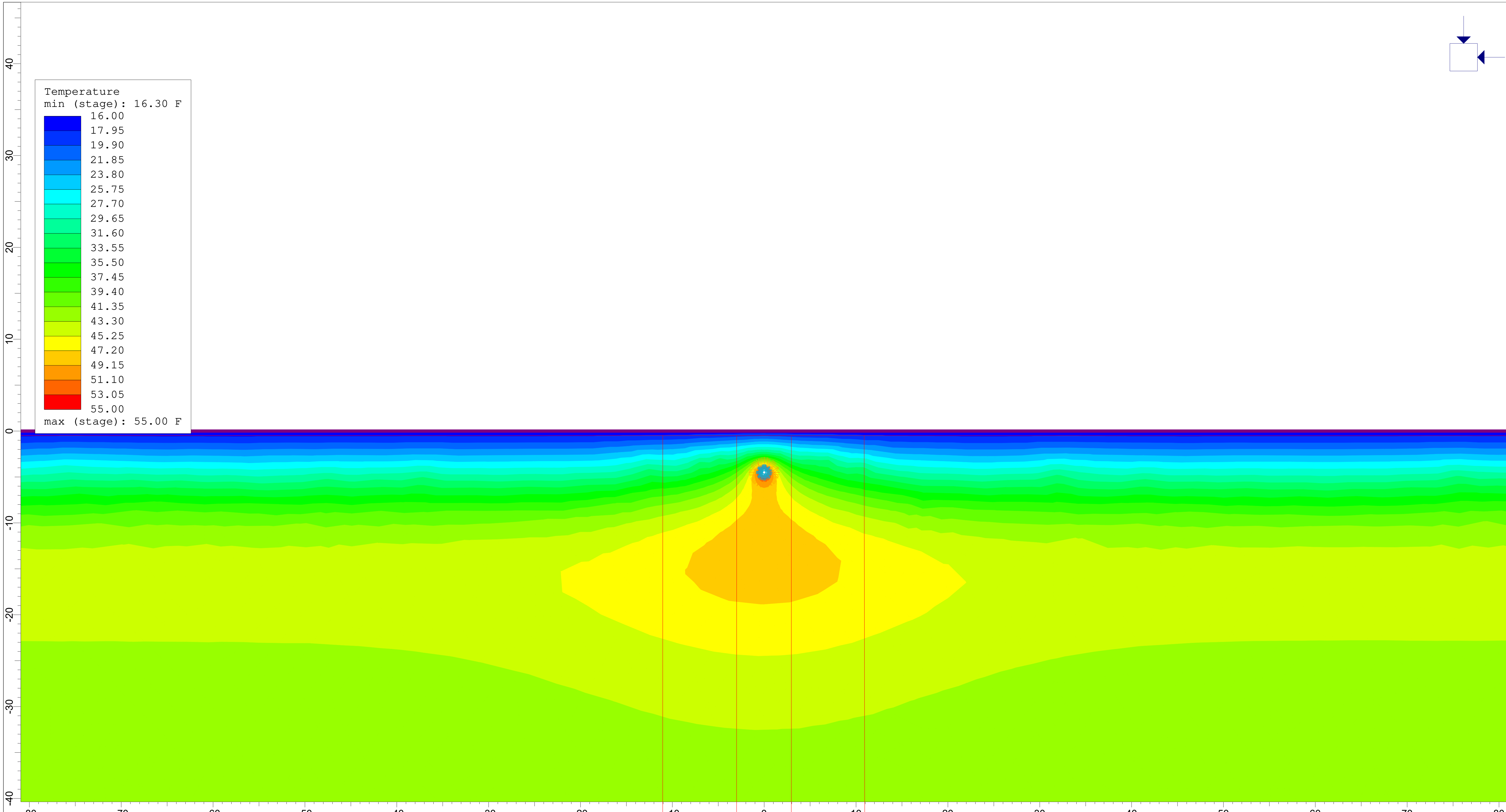
rocscience	Project: Summit Carbon - 12 Inch Pipeline		
	Analysis Description: Thermal Analysis		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 12in Pipe.fez

12IN PIPE - FINE GRAIN - 35% SATURATION - APRIL



rocscience	Project: Summit Carbon - 12 Inch Pipeline		
	Analysis Description: Thermal Analysis		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 12in Pipe.fez

12IN PIPE - FINE GRAIN - 35% SATURATION - JANUARY

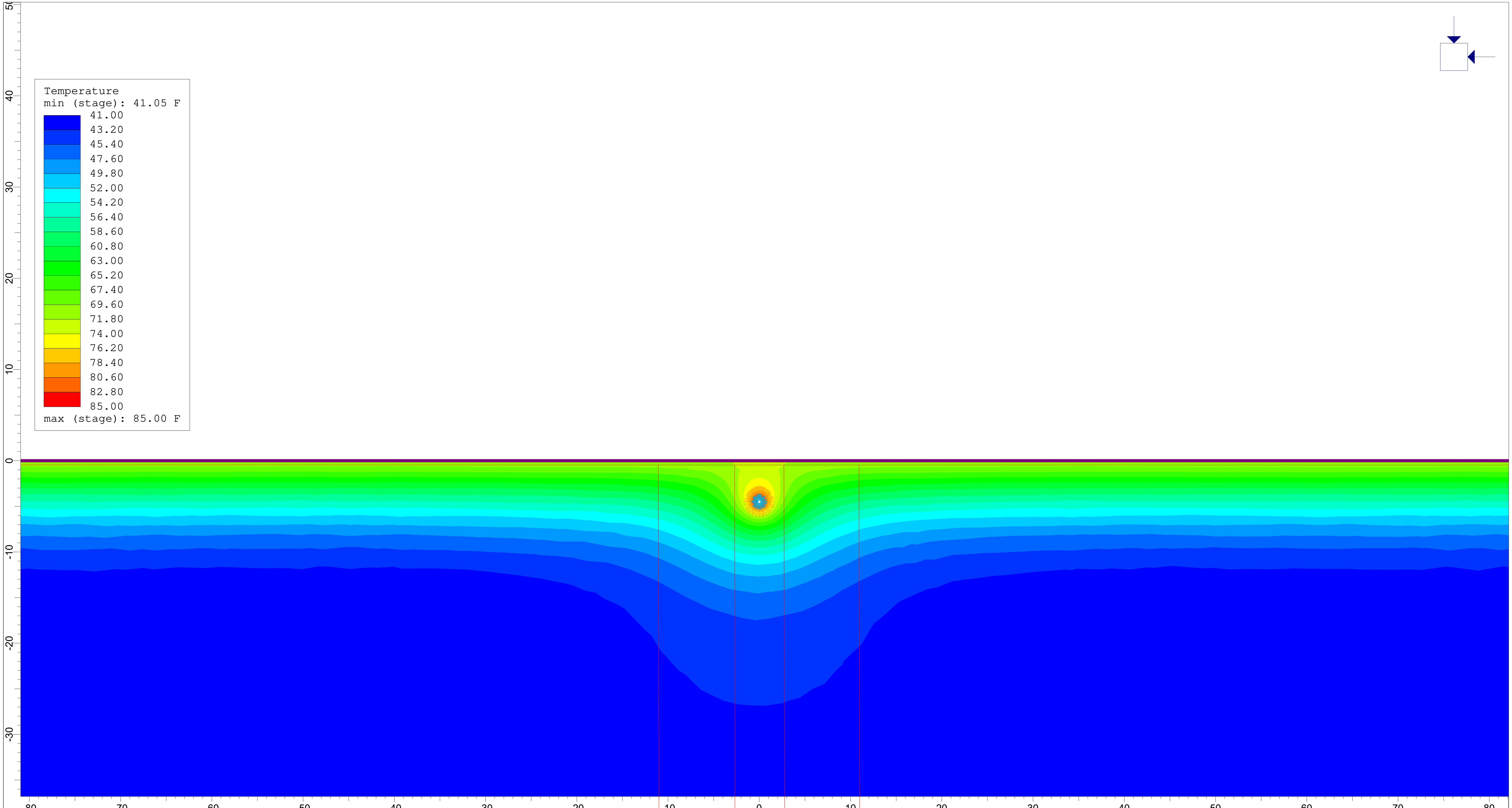


rocscience

INTERPRET 11.023

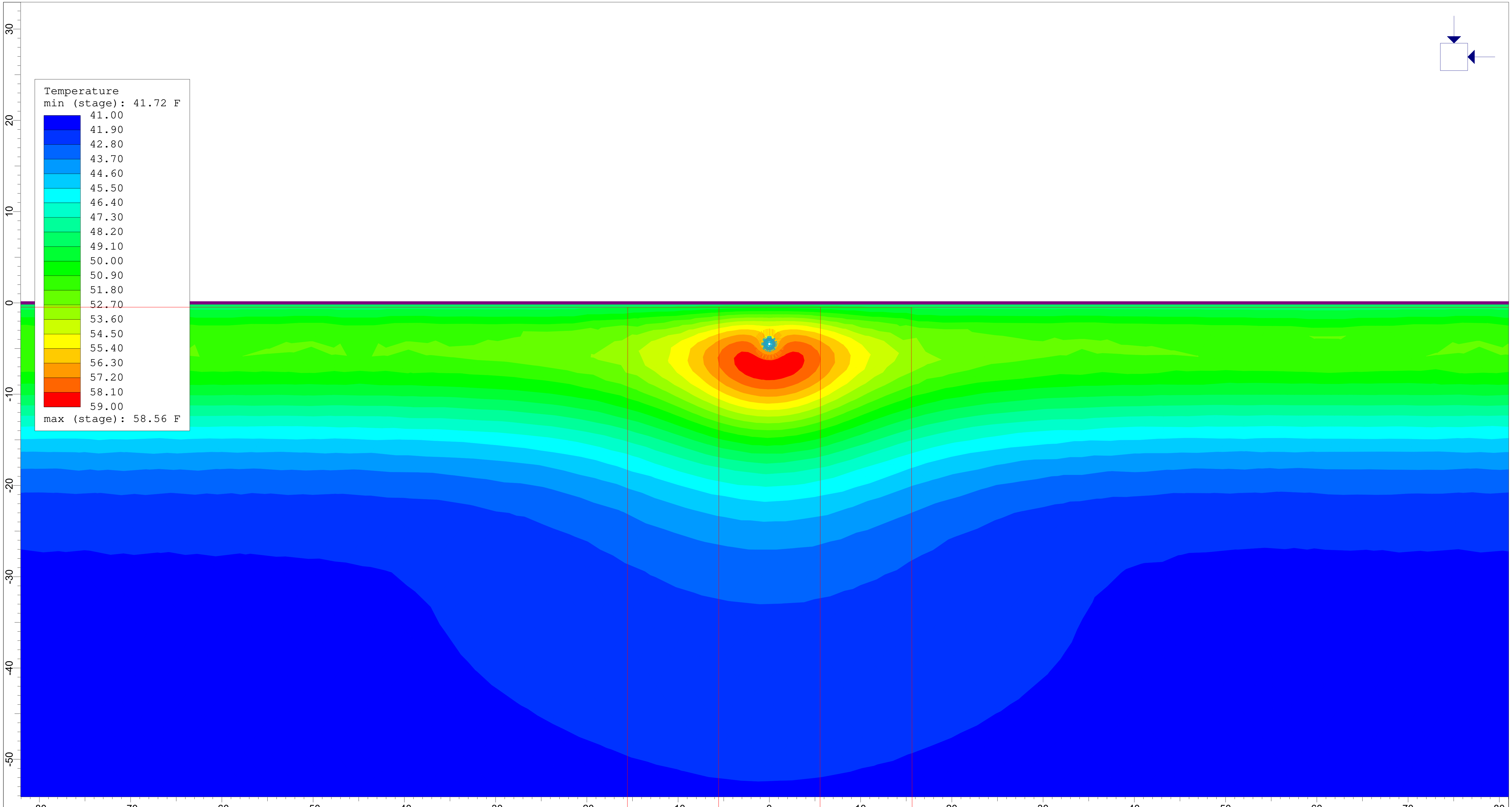
Project	Summit Carbon - 12 Inch Pipeline		
Analysis Description	Thermal Analysis		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	12in Pipe.fez

12IN PIPE - FINE GRAIN - 35% SATURATION - JULY



rocscience	Project	Summit Carbon - 12 Inch Pipeline	
	Analysis Description	Thermal Analysis	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 12in Pipe.fez

12IN PIPE - FINE GRAIN - 35% SATURATION - OCTOBER

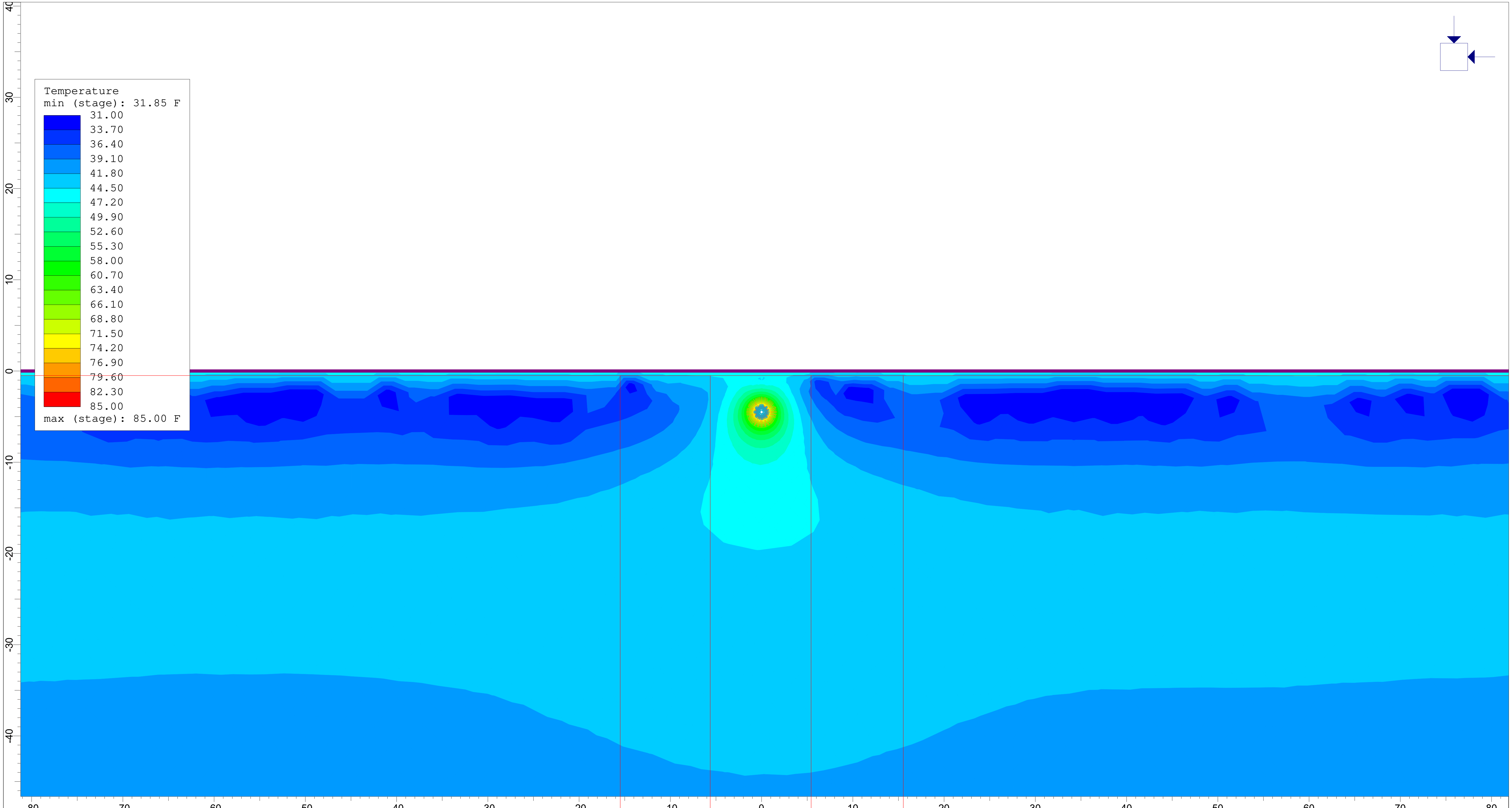


rocscience

INTERPRET 11.023

Project	Summit Carbon - 12 Inch Pipeline
Analysis Description	Thermal Analysis
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	12in Pipe.fez

12IN PIPE - FINE GRAIN - 55% SATURATION - APRIL

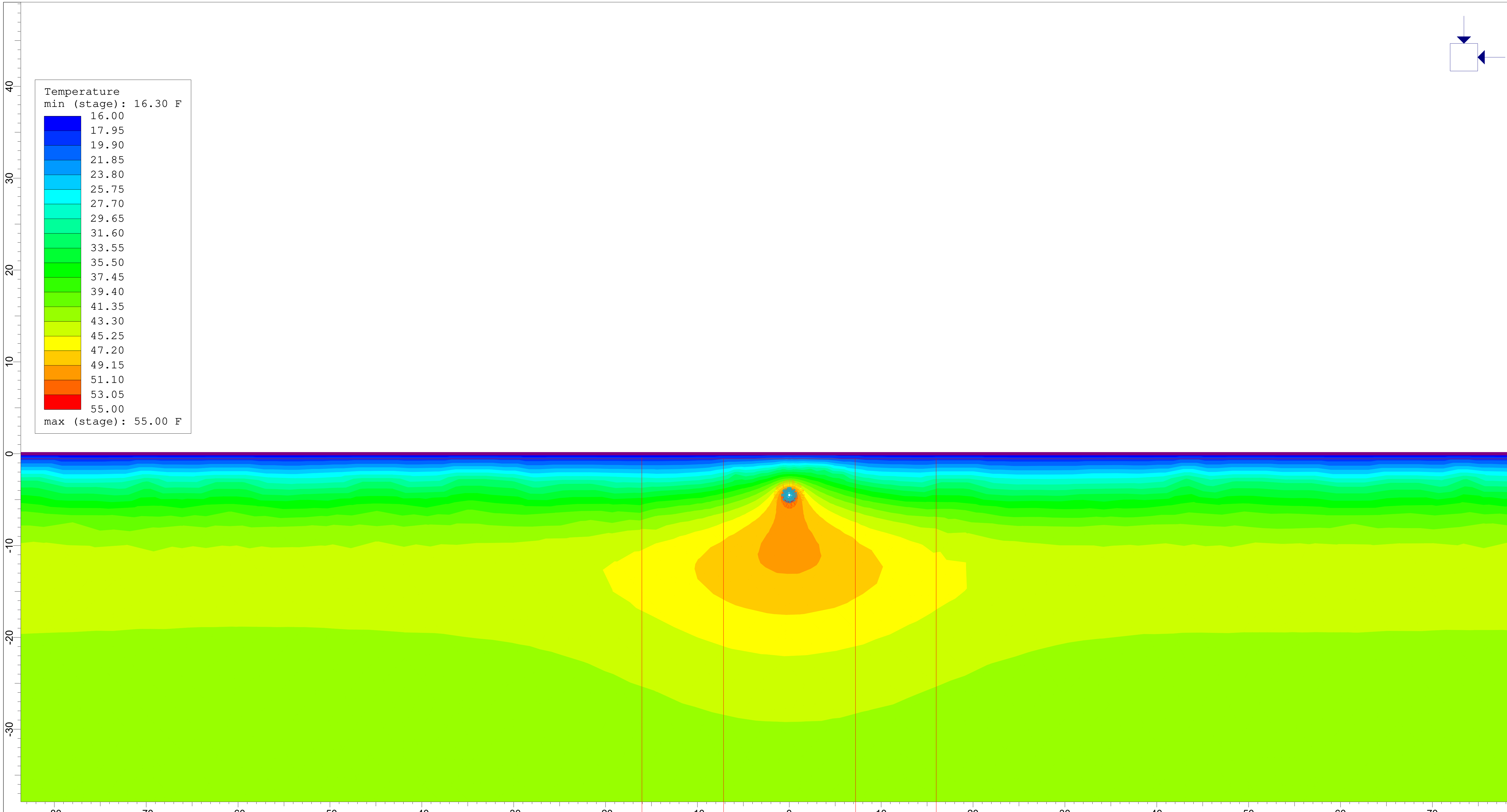


rocscience

INTERPRET 11.023

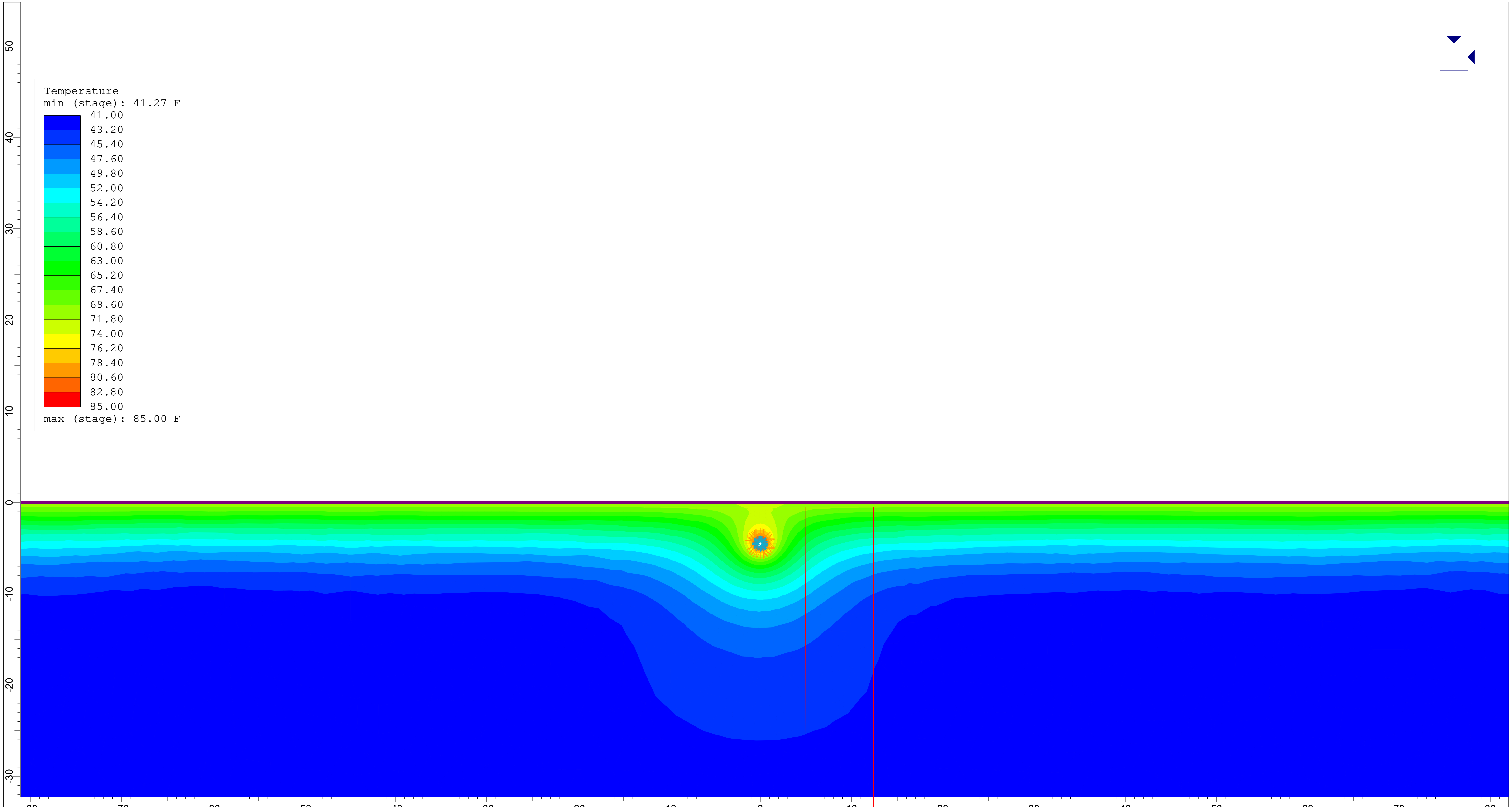
Project	Summit Carbon - 12 Inch Pipeline		
Analysis Description	Thermal Analysis		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	12in Pipe.fez

12IN PIPE - FINE GRAIN - 55% SATURATION - JANUARY



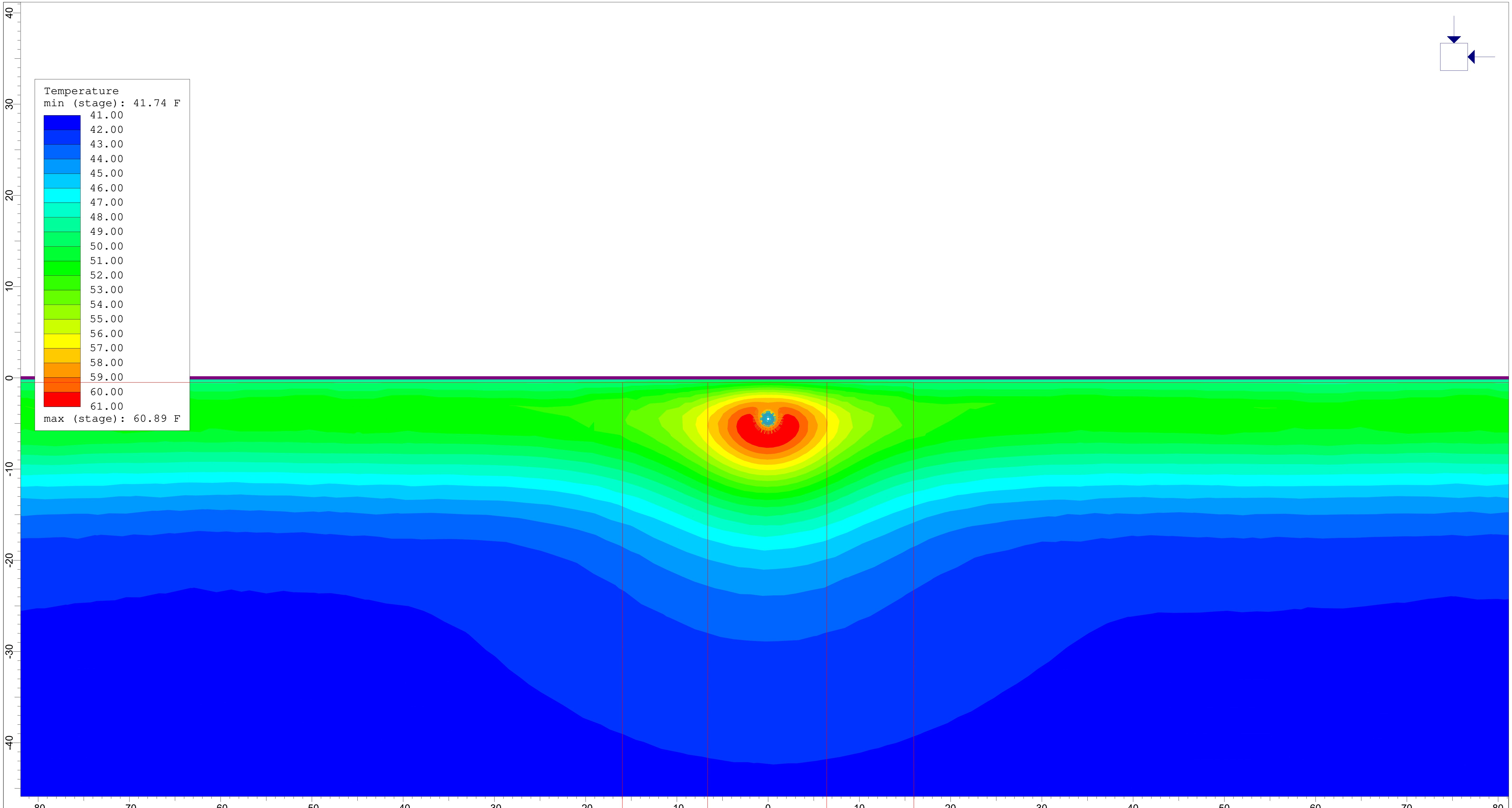
rocscience	Project	Summit Carbon - 12 Inch Pipeline	
	Analysis Description	Thermal Analysis	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 12in Pipe.fez

12IN PIPE - FINE GRAIN - 55% SATURATION - JULY



rocscience	Project	Summit Carbon - 12 Inch Pipeline	
	Analysis Description	Thermal Analysis	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 12in Pipe.fez

12IN PIPE - FINE GRAIN - 55% SATURATION - OCTOBER

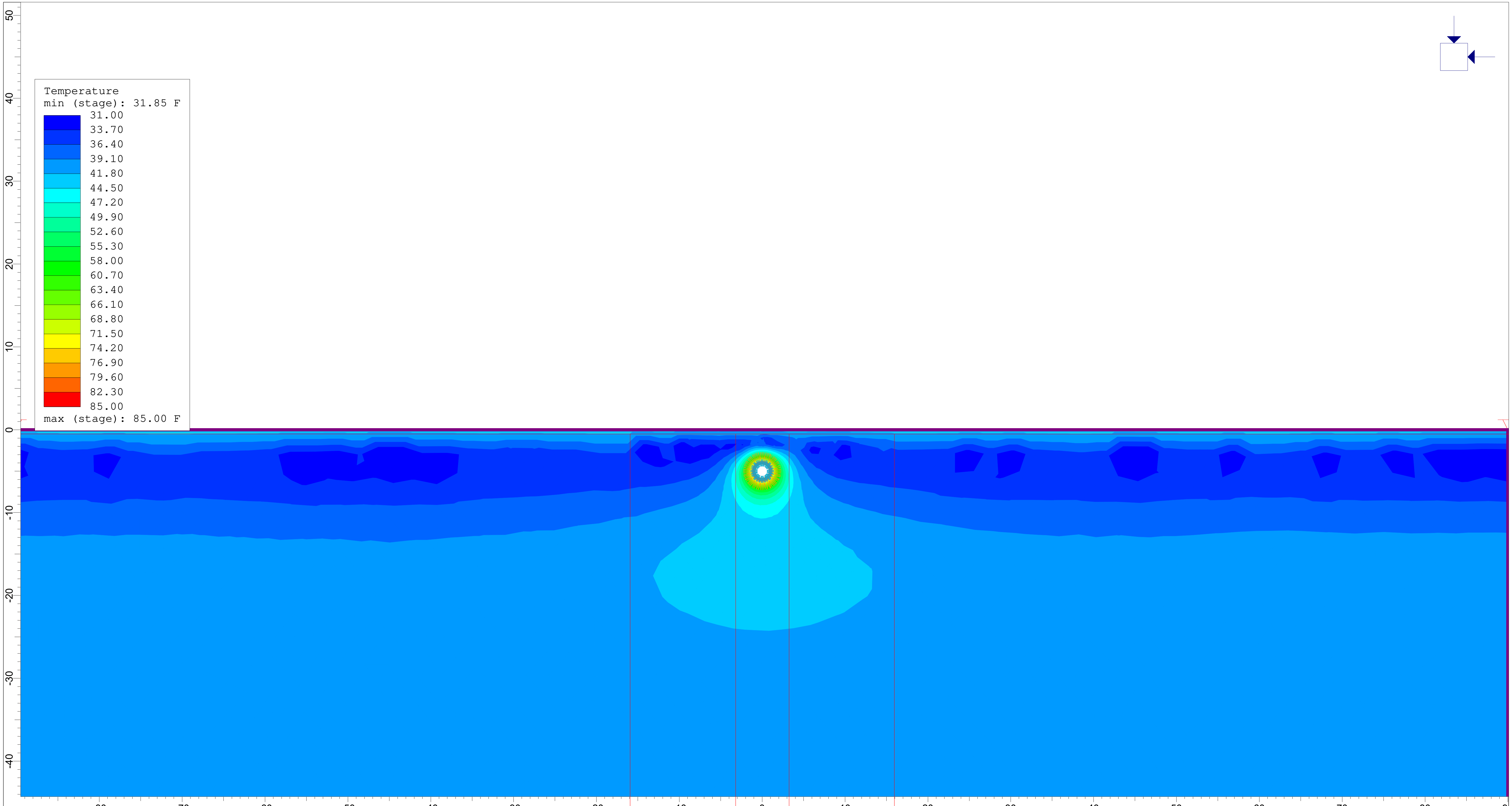


rocscience

INTERPRET 11.023

Project	Summit Carbon - 12 Inch Pipeline		
Analysis Description	Thermal Analysis		
Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting	
Date: 6/3/2024, 10:56:45 AM		File Name: 12in Pipe.fez	

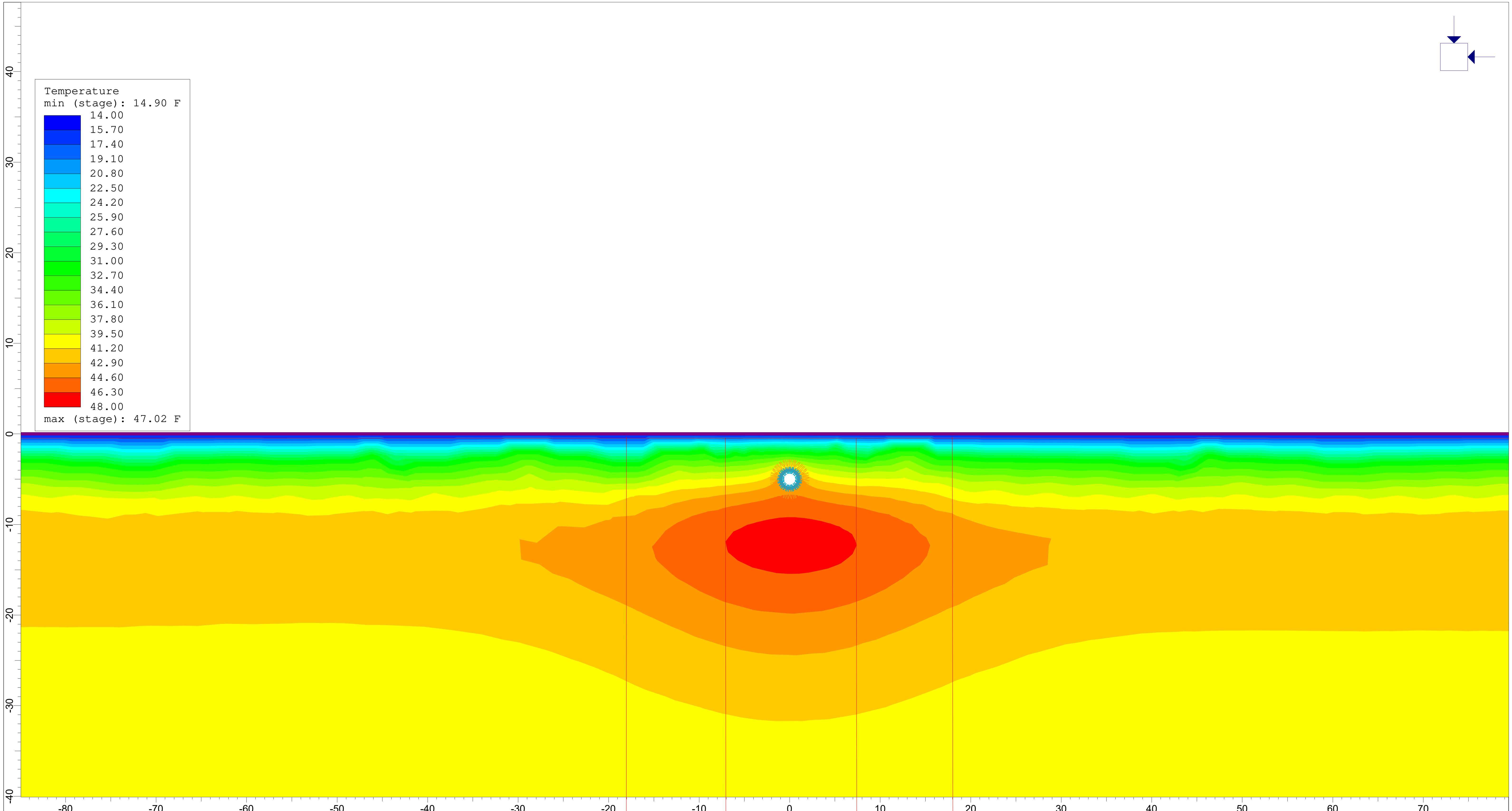
24IN PIPE 1 - COARSE GRAIN - 15% SATURATION - APRIL



Project	Summit Carbon - 24 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:132
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 1.fez

INTERPRET 11.023

24IN PIPE 1 - COARSE GRAIN - 15% SATURATION - JANUARY

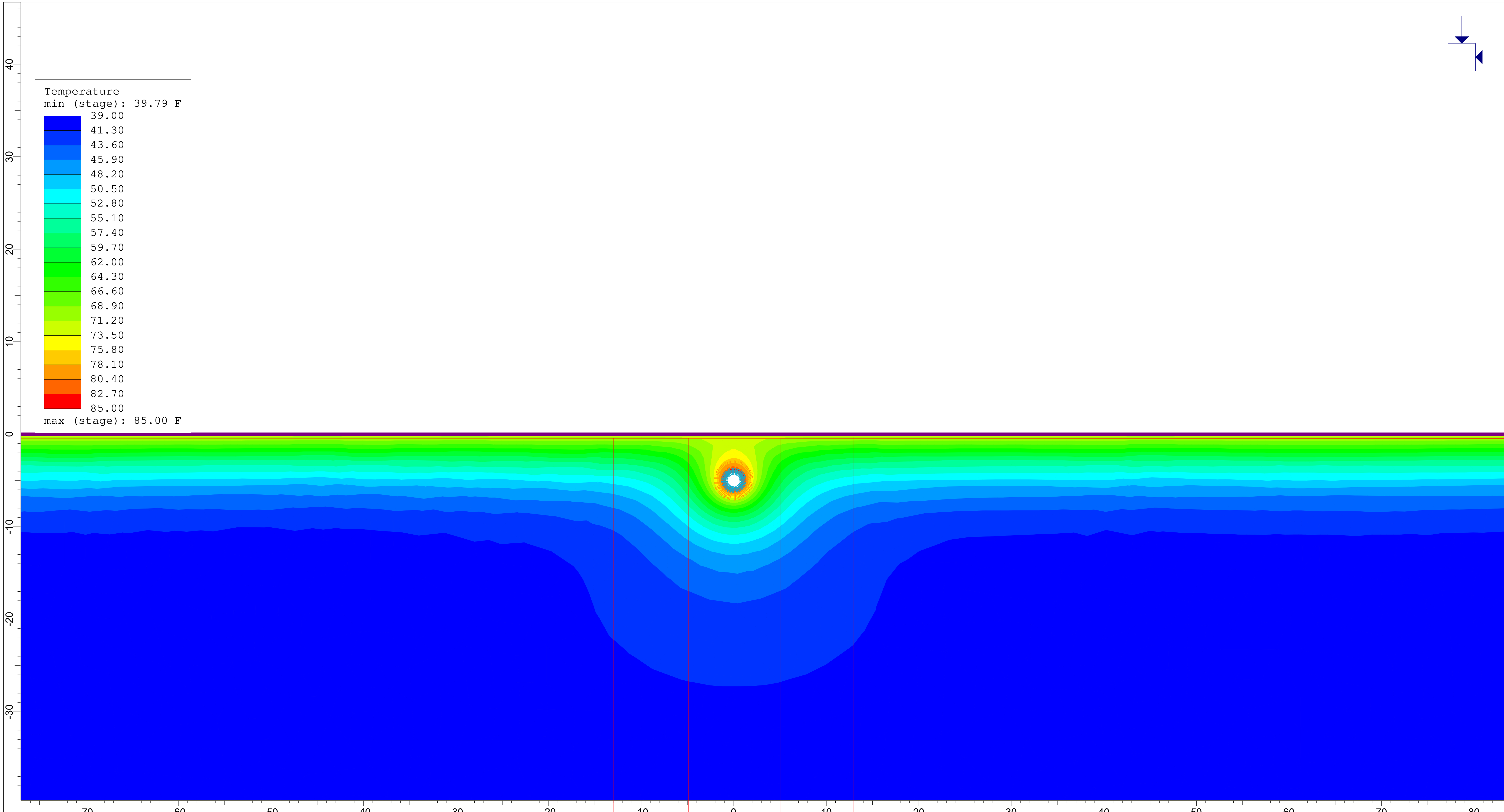


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (1)
Analysis Description	Thermal Influence
Drawn By	Connor Rankin
Scale	1:121
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	24in Pipe 1.fez

24IN PIPE 1 - COARSE GRAIN - 15% SATURATION - JULY

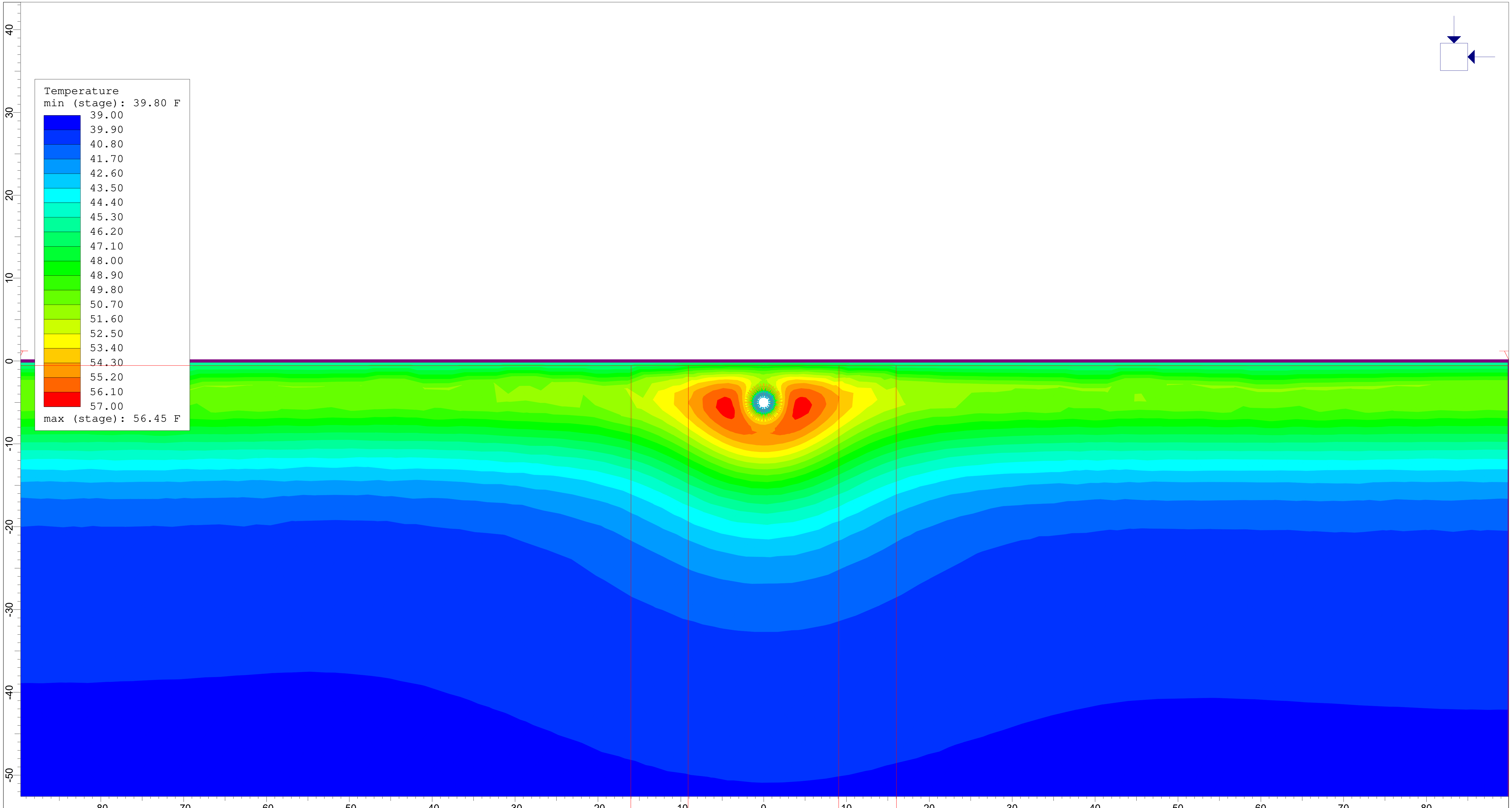


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:119
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 1.fez

24IN PIPE 1 - COARSE GRAIN - 15% SATURATION - OCTOBER

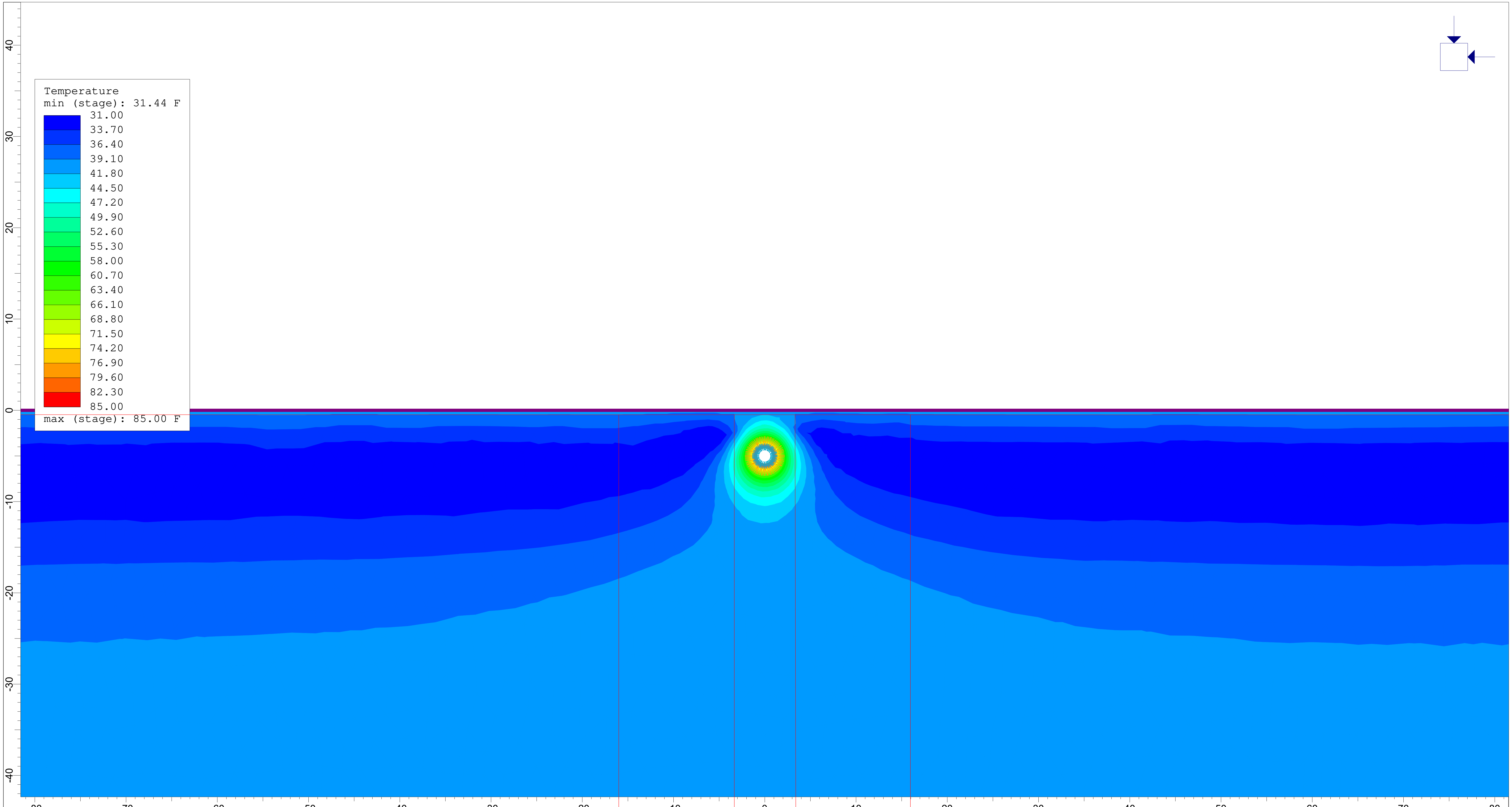


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (1)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale 1:132	Company: Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM		File Name: 24in Pipe 1.fez

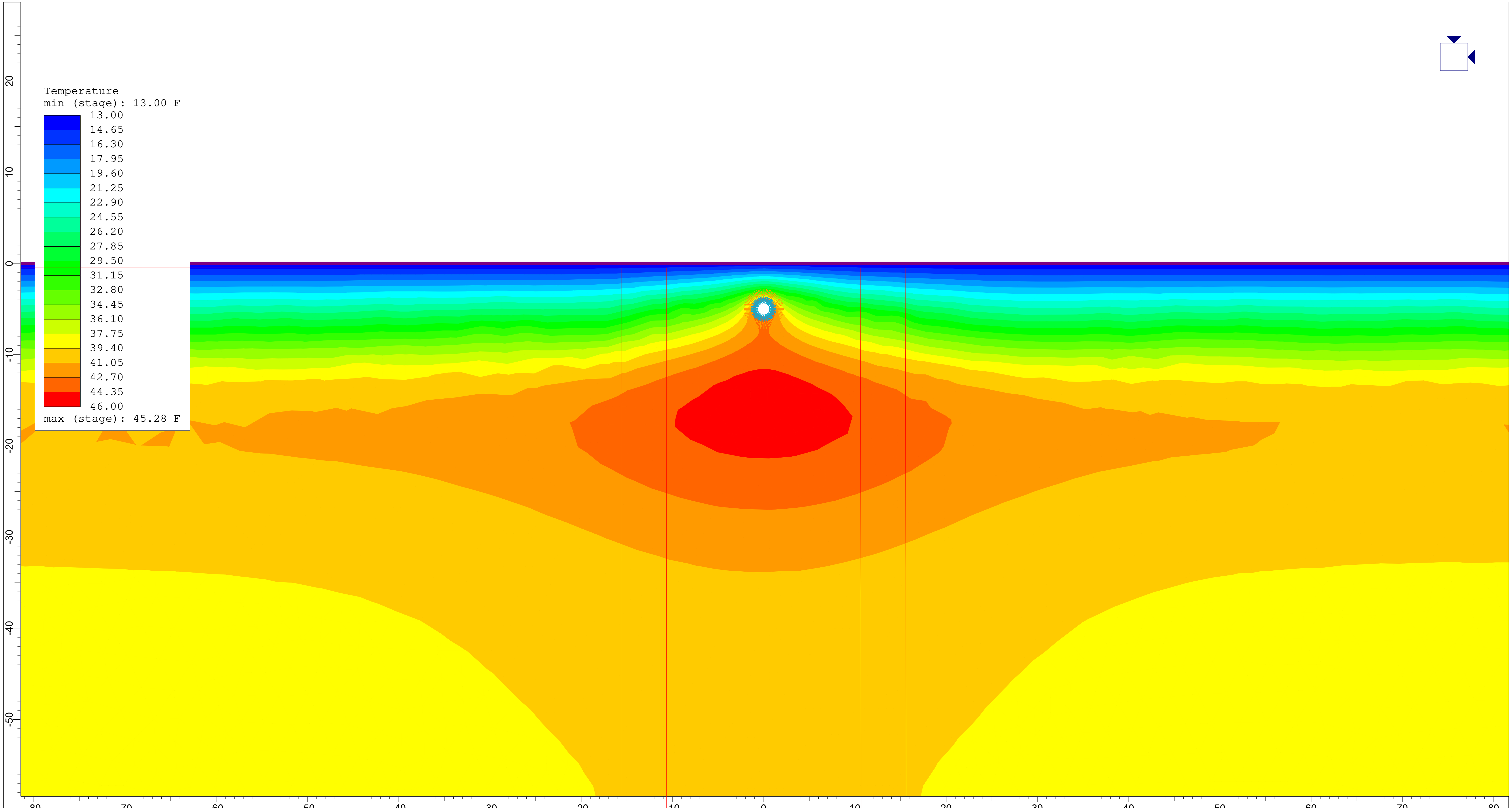
24IN PIPE 1 - COARSE GRAIN - 35% SATURATION - APRIL



Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

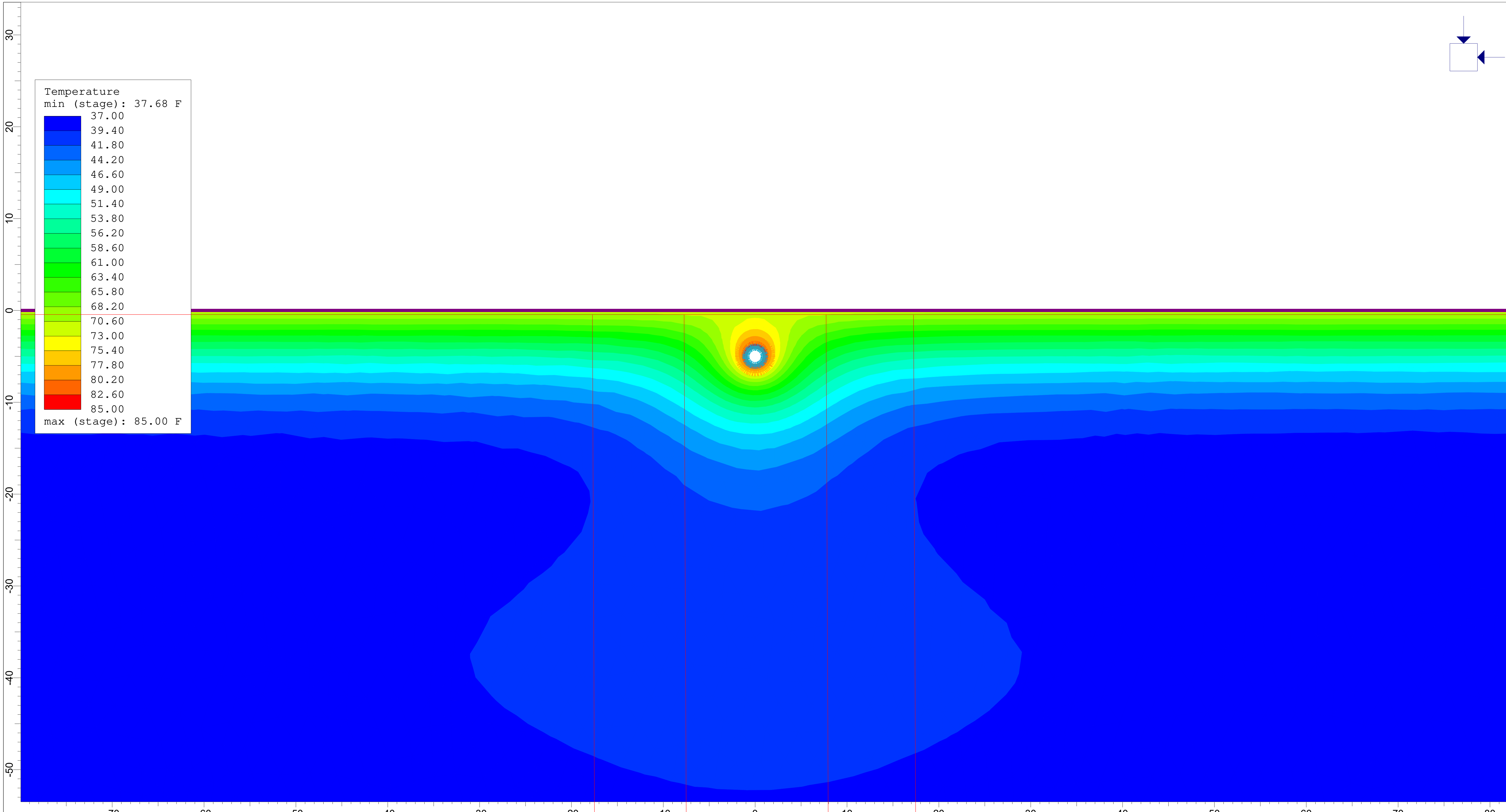
INTERPRET 11.023

24IN PIPE 1 - COARSE GRAIN - 35% SATURATION - JANUARY



rocscience	Project: Summit Carbon - 24 Inch Pipeline (2)		
	Analysis Description: Thermal Influence		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 24in Pipe 2.fez

24IN PIPE 1 - COARSE GRAIN - 35% SATURATION - JULY

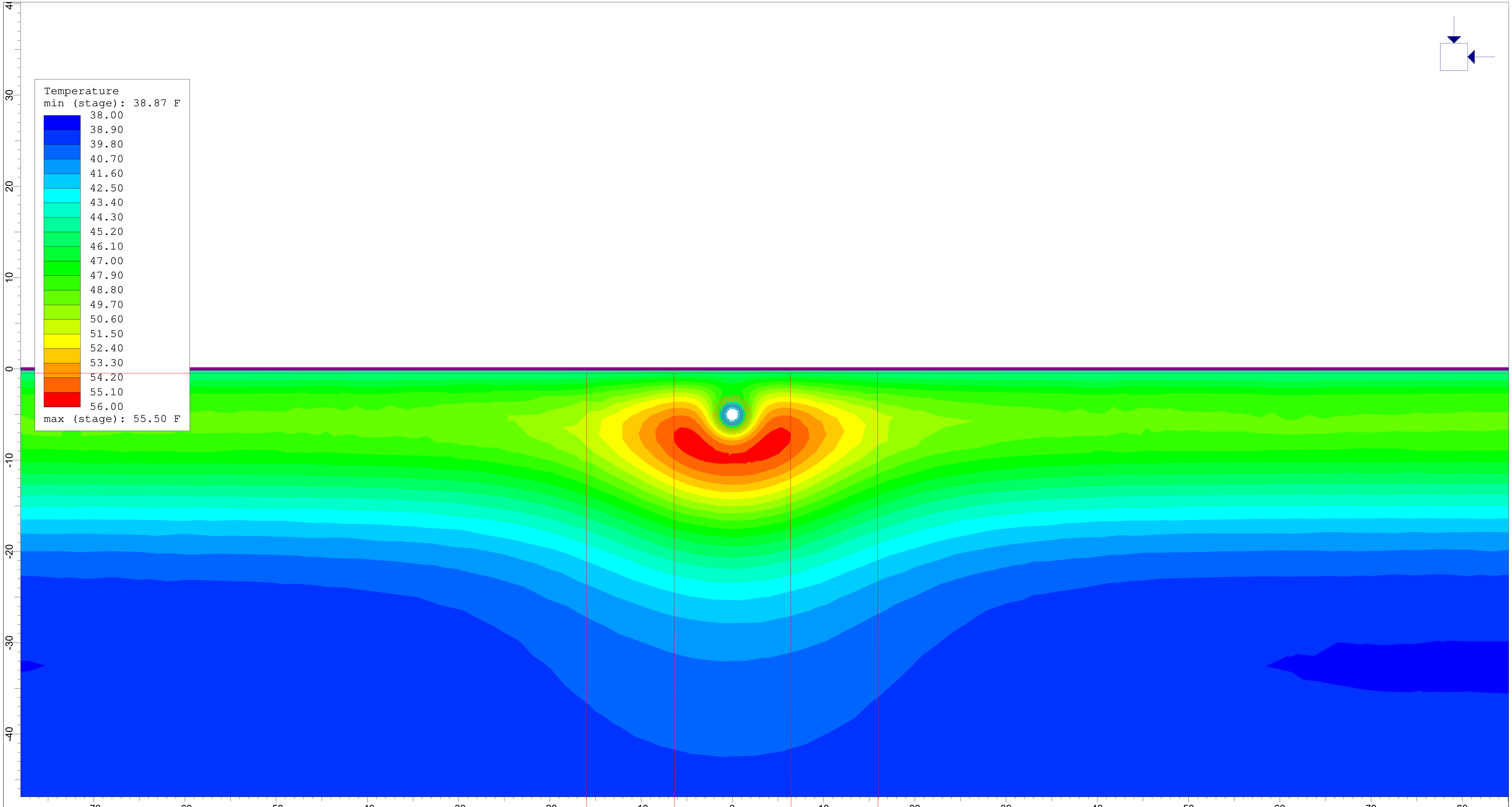


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

24IN PIPE 1 - COARSE GRAIN - 35% SATURATION - OCTOBER

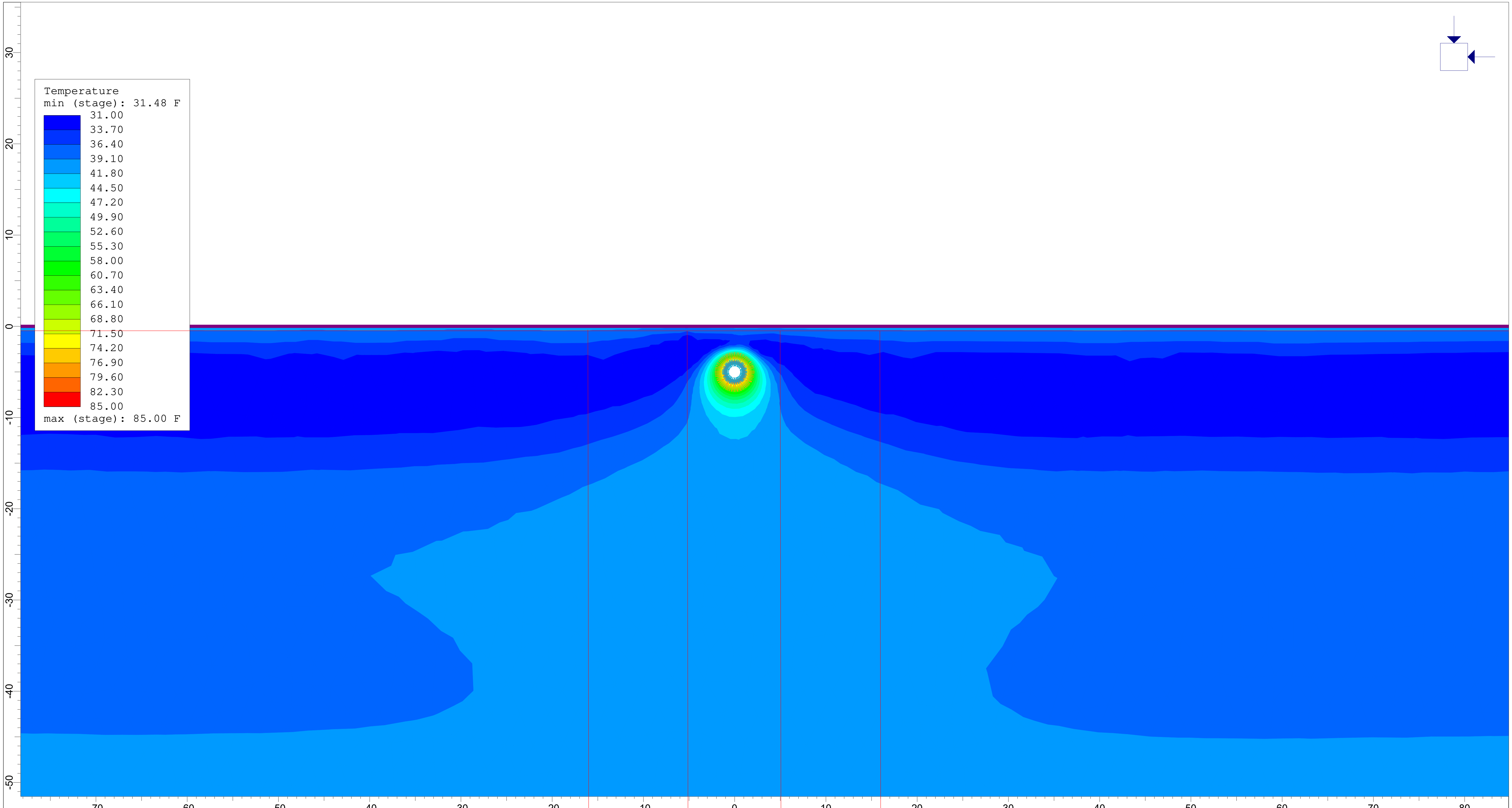


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)
Analysis Description	Thermal Influence
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	24in Pipe 2.fez

24IN PIPE 1 - COARSE GRAIN - 55% SATURATION - APRIL

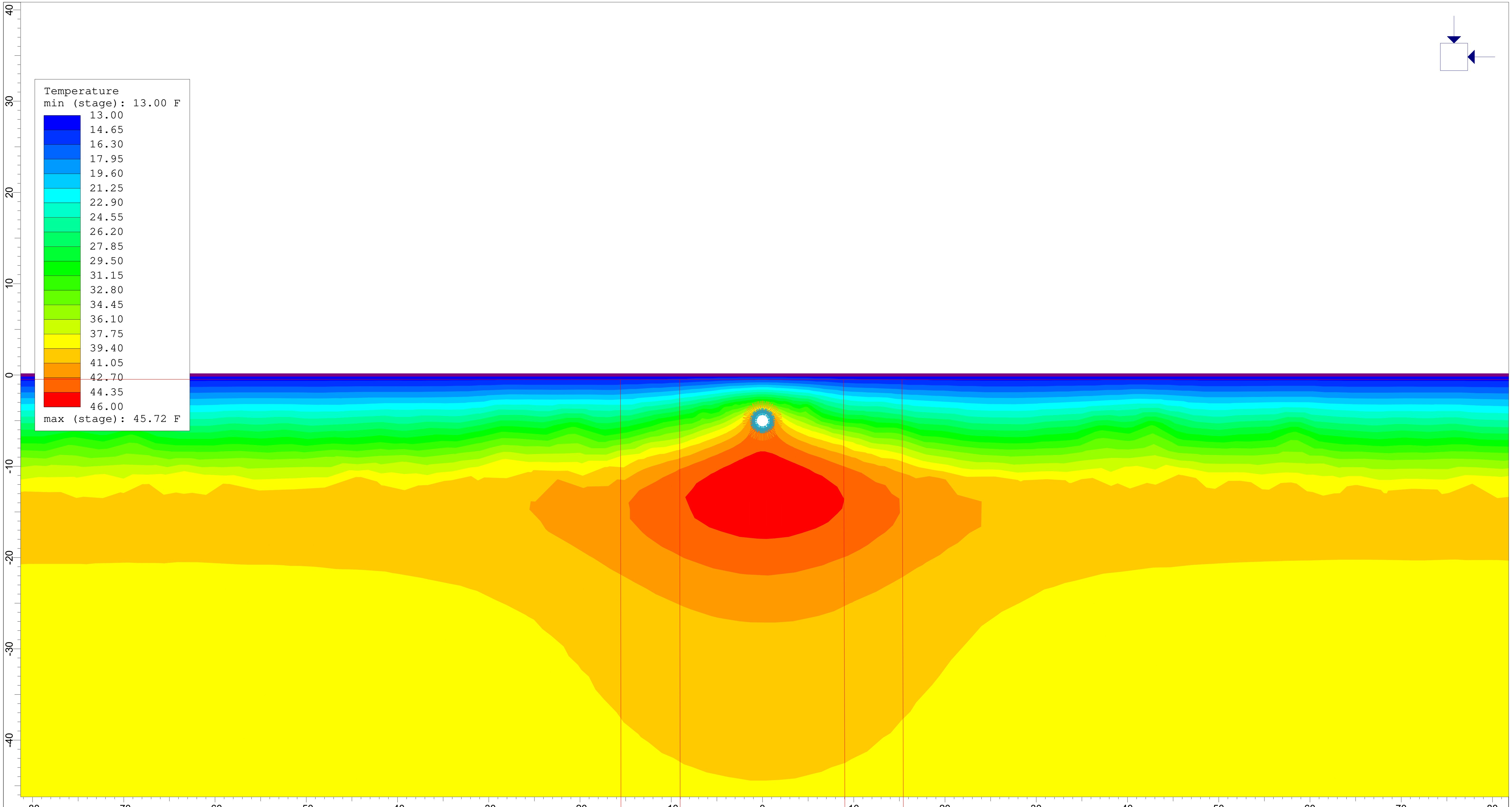


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

24IN PIPE 1 - COARSE GRAIN - 55% SATURATION - JANUARY

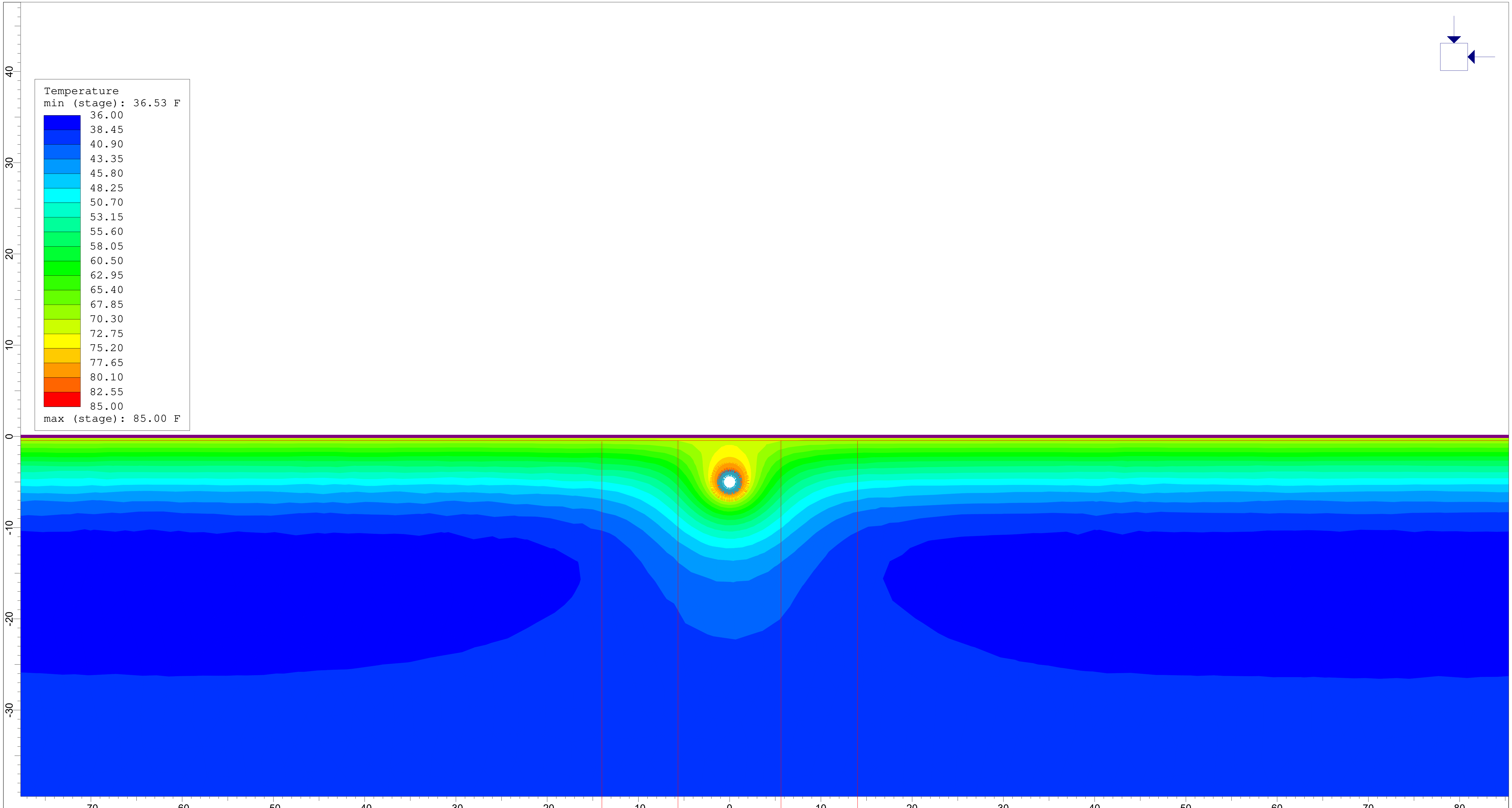


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	24in Pipe 2.fez

24IN PIPE 1 - COARSE GRAIN - 55% SATURATION - JULY

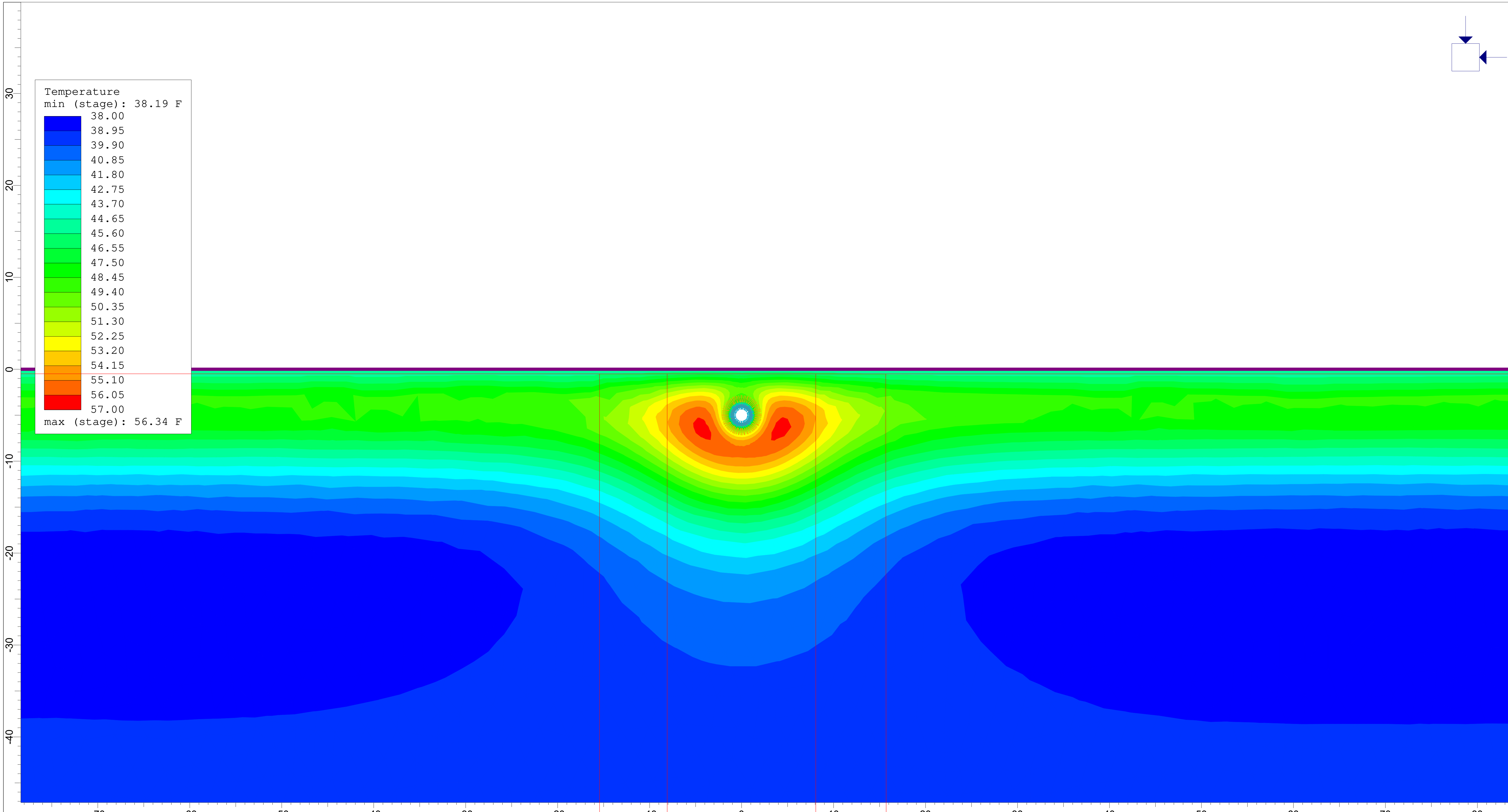


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	24in Pipe 2.fez

24IN PIPE 1 - COARSE GRAIN - 55% SATURATION - OCTOBER

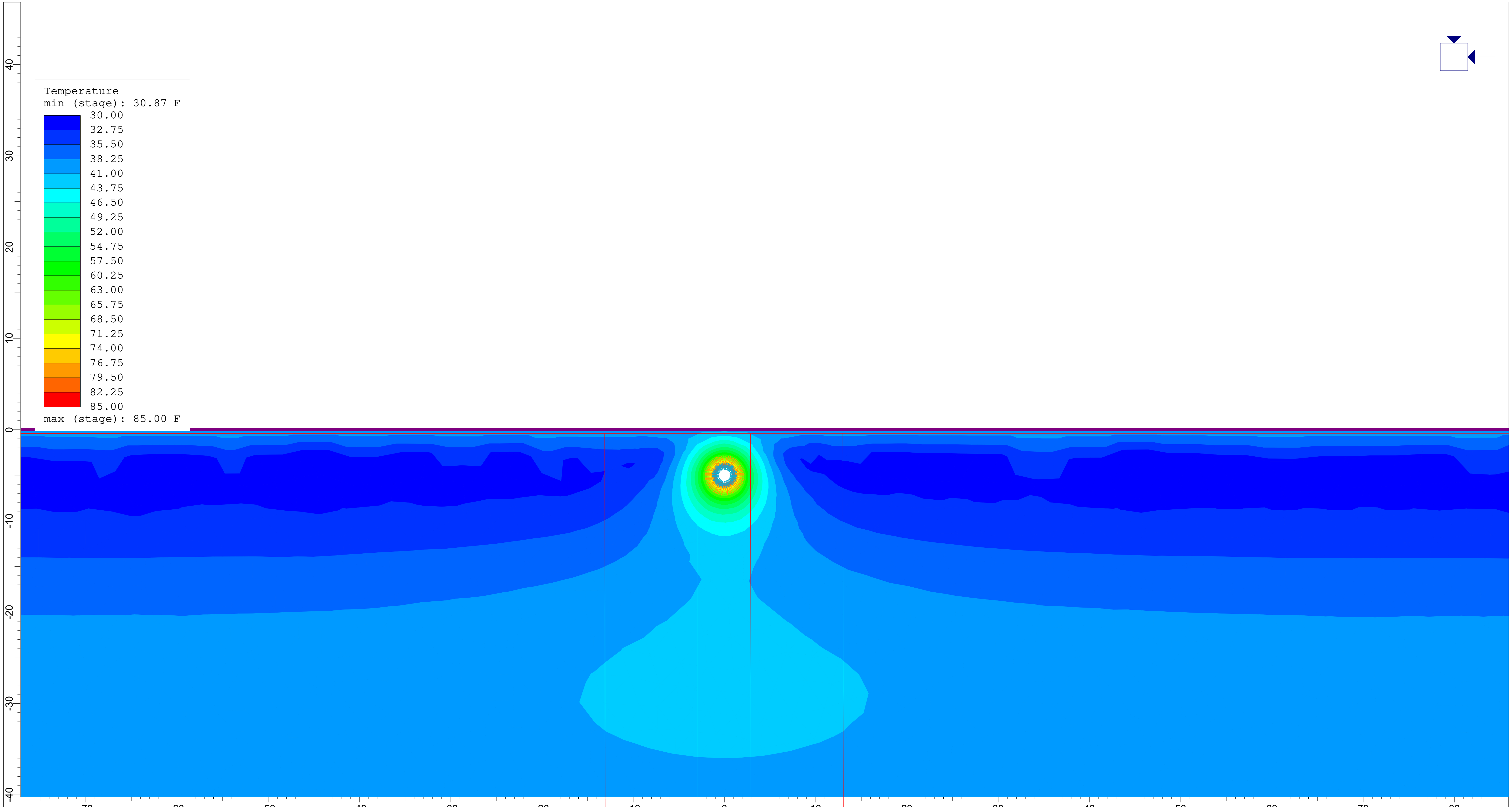


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	24in Pipe 2.fez

24IN PIPE 1 - FINE GRAIN - 15% SATURATION - APRIL

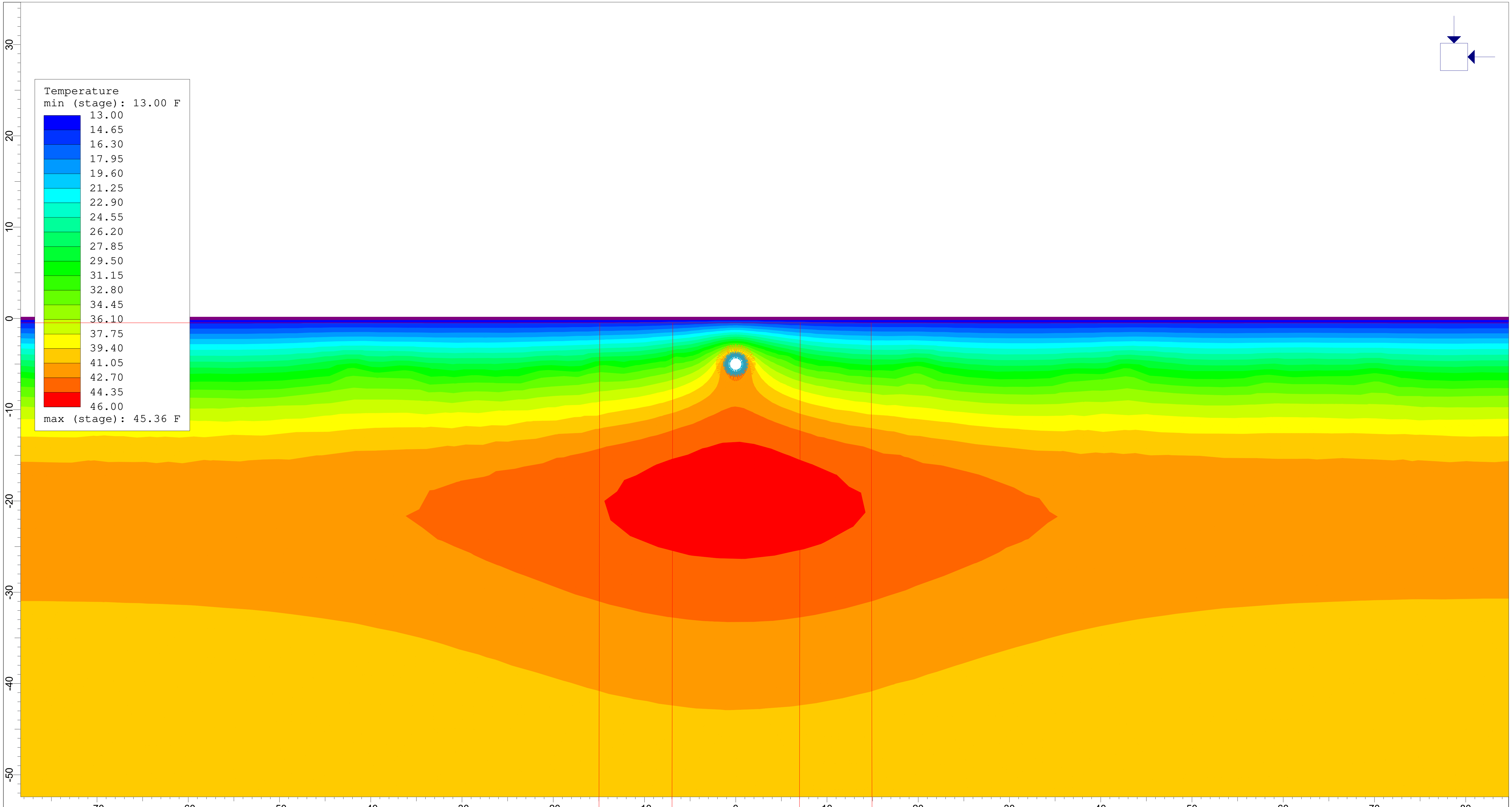


rocscience

INTERPRET 11.023

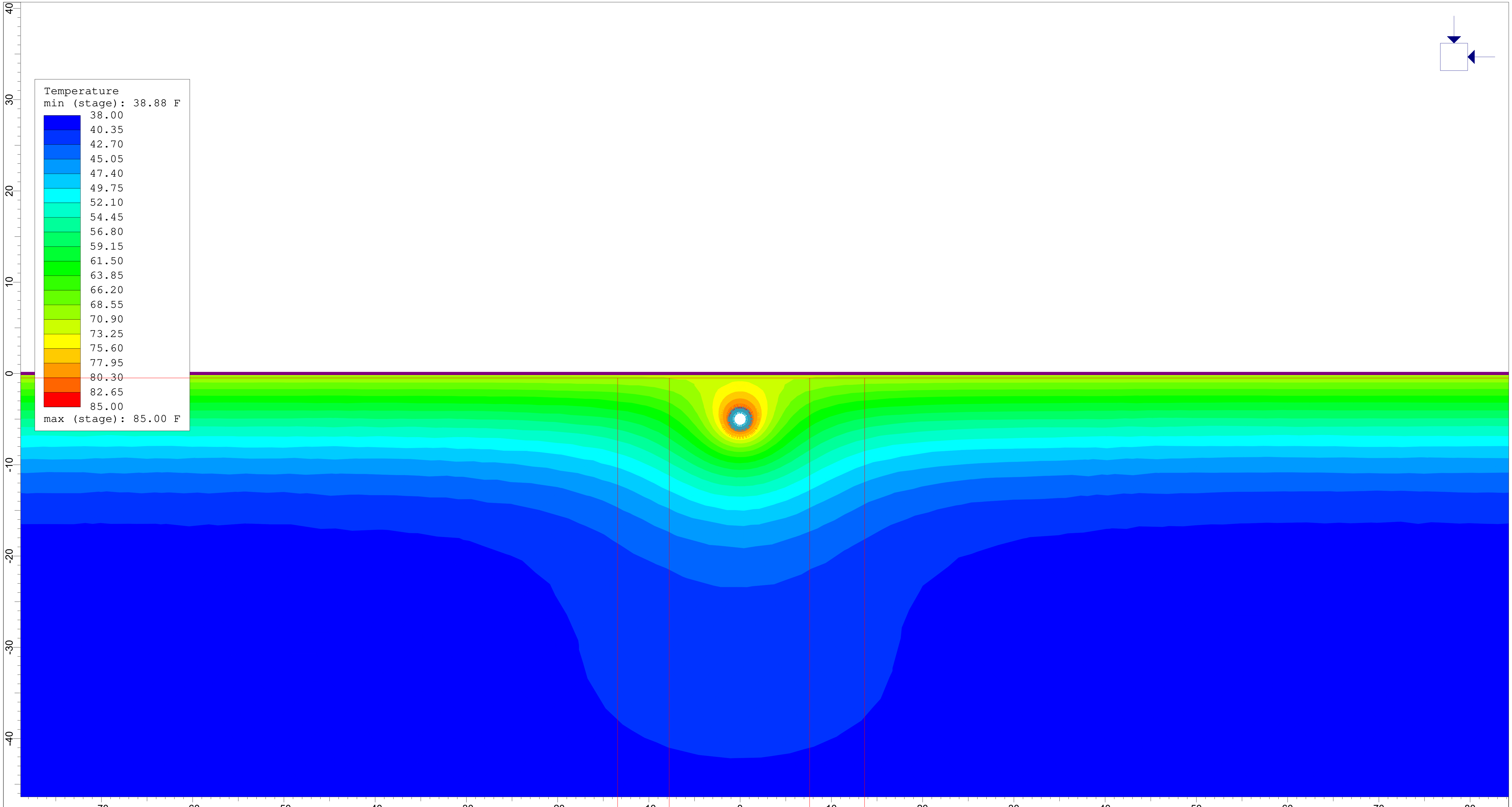
Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

24IN PIPE 1 - FINE GRAIN - 15% SATURATION - JANUARY



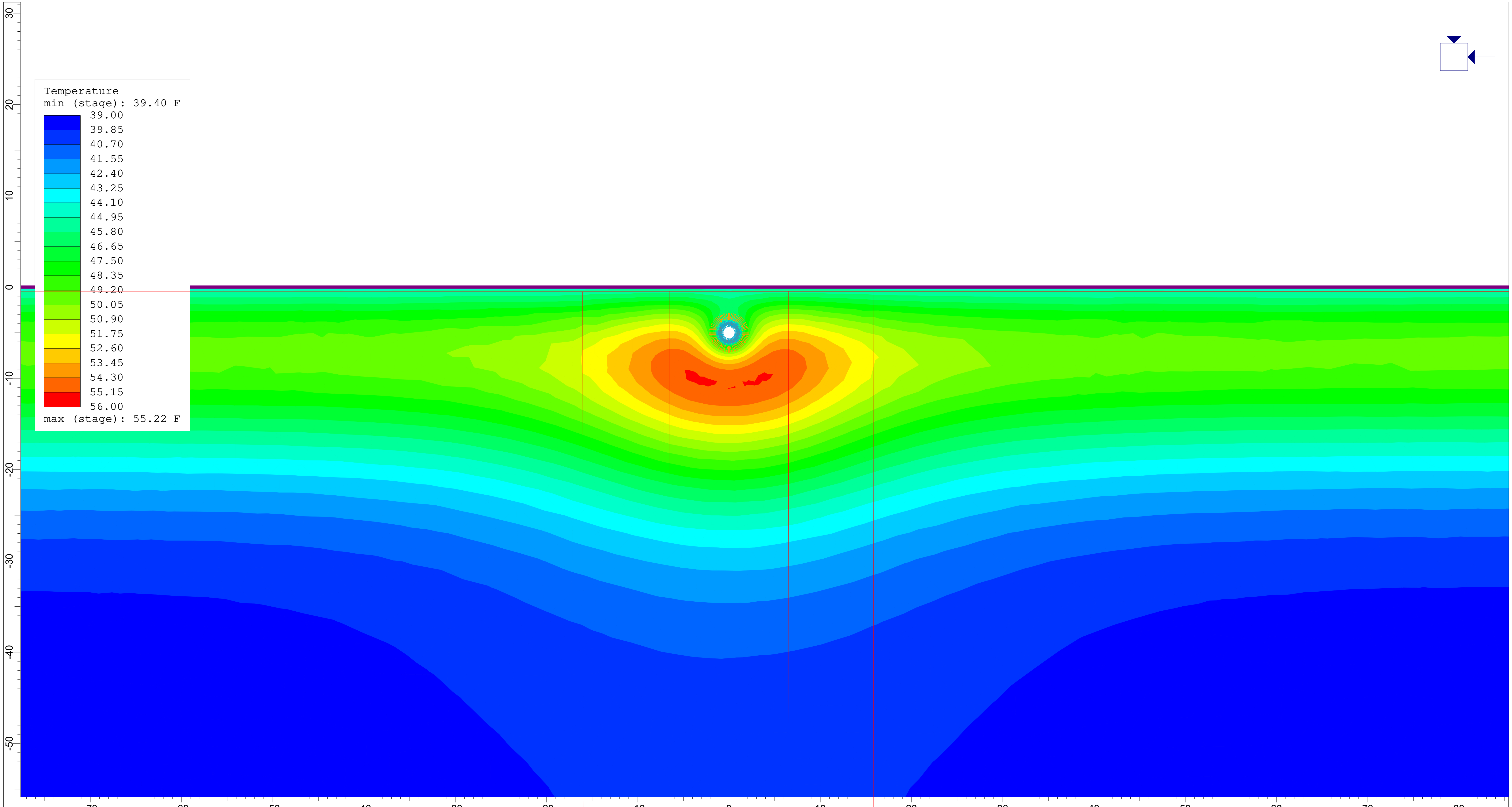
rocscience	Project: Summit Carbon - 24 Inch Pipeline (2)		
	Analysis Description: Thermal Influence		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 24in Pipe 2.fez

24IN PIPE 1 - FINE GRAIN - 15% SATURATION - JULY



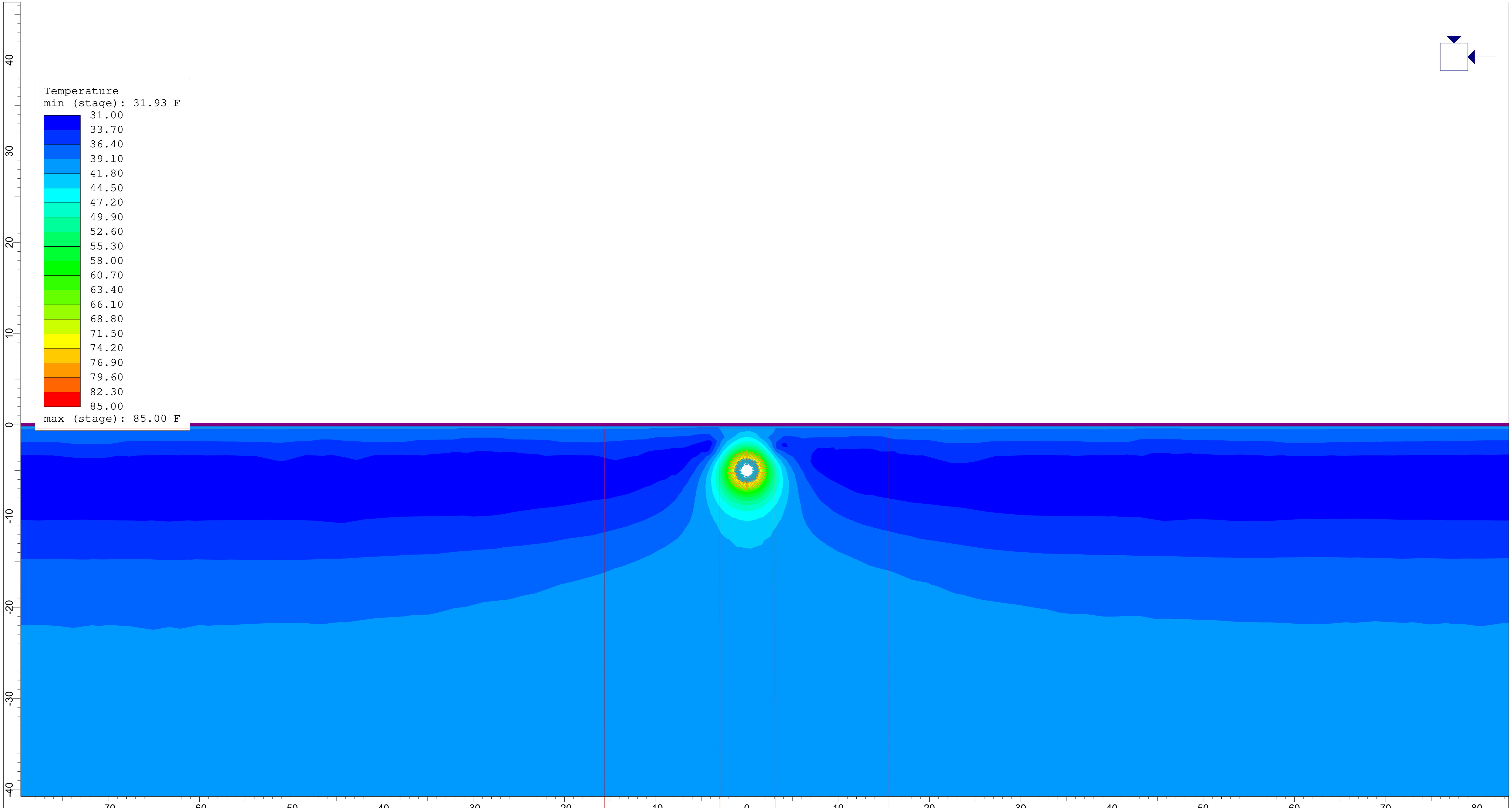
rocscience	Project	Summit Carbon - 24 Inch Pipeline (2)	
	Analysis Description	Thermal Influence	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 24in Pipe 2.fez

24IN PIPE 1 - FINE GRAIN - 15% SATURATION - OCTOBER



rocscience	Project	Summit Carbon - 24 Inch Pipeline (2)	
	Analysis Description	Thermal Influence	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 24in Pipe 2.fez

24IN PIPE 1 - FINE GRAIN - 35% SATURATION - APRIL

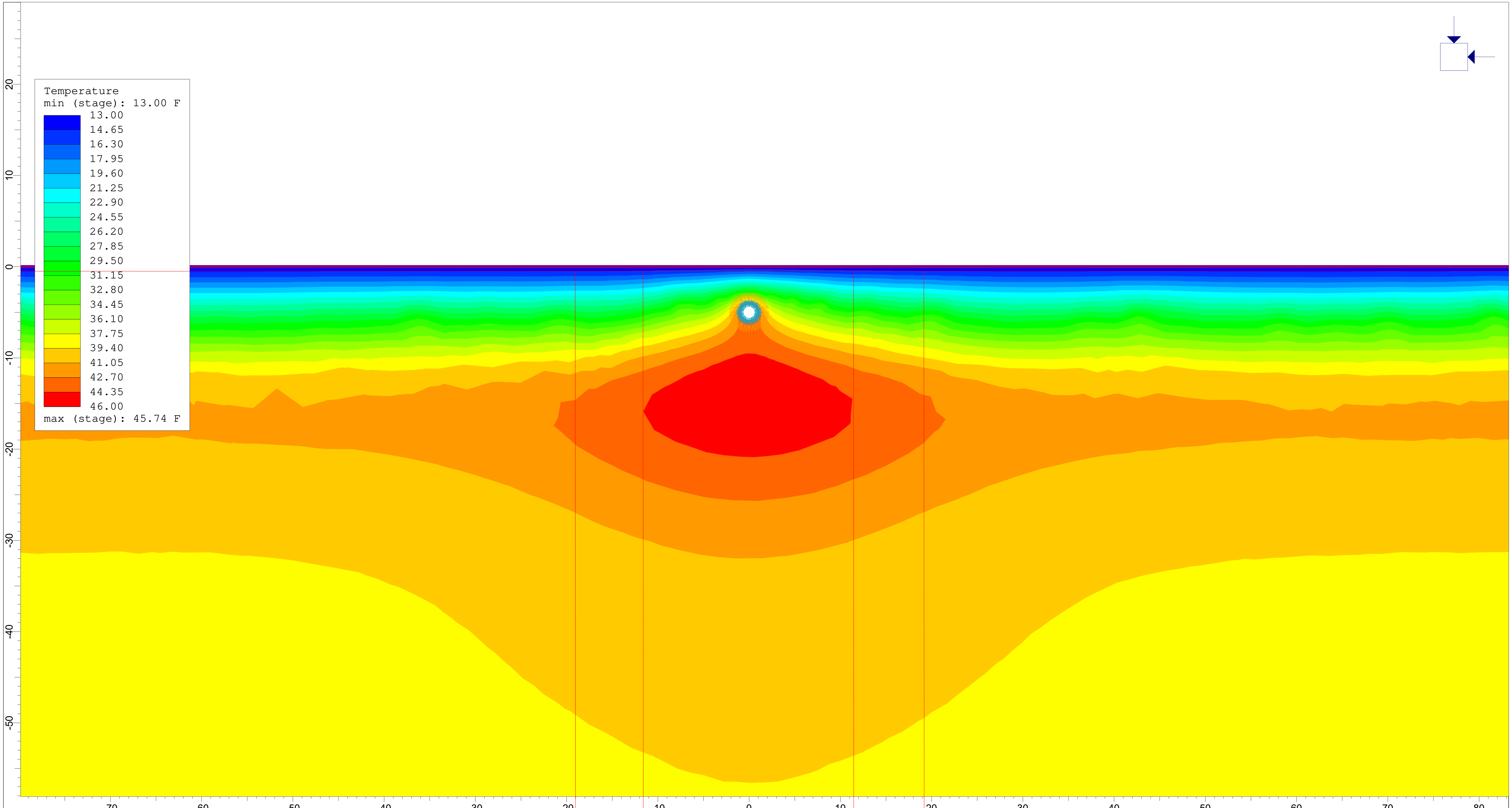


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)
Analysis Description	Thermal Influence
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	24in Pipe 2.fez

24IN PIPE 1 - FINE GRAIN - 35% SATURATION - JANUARY

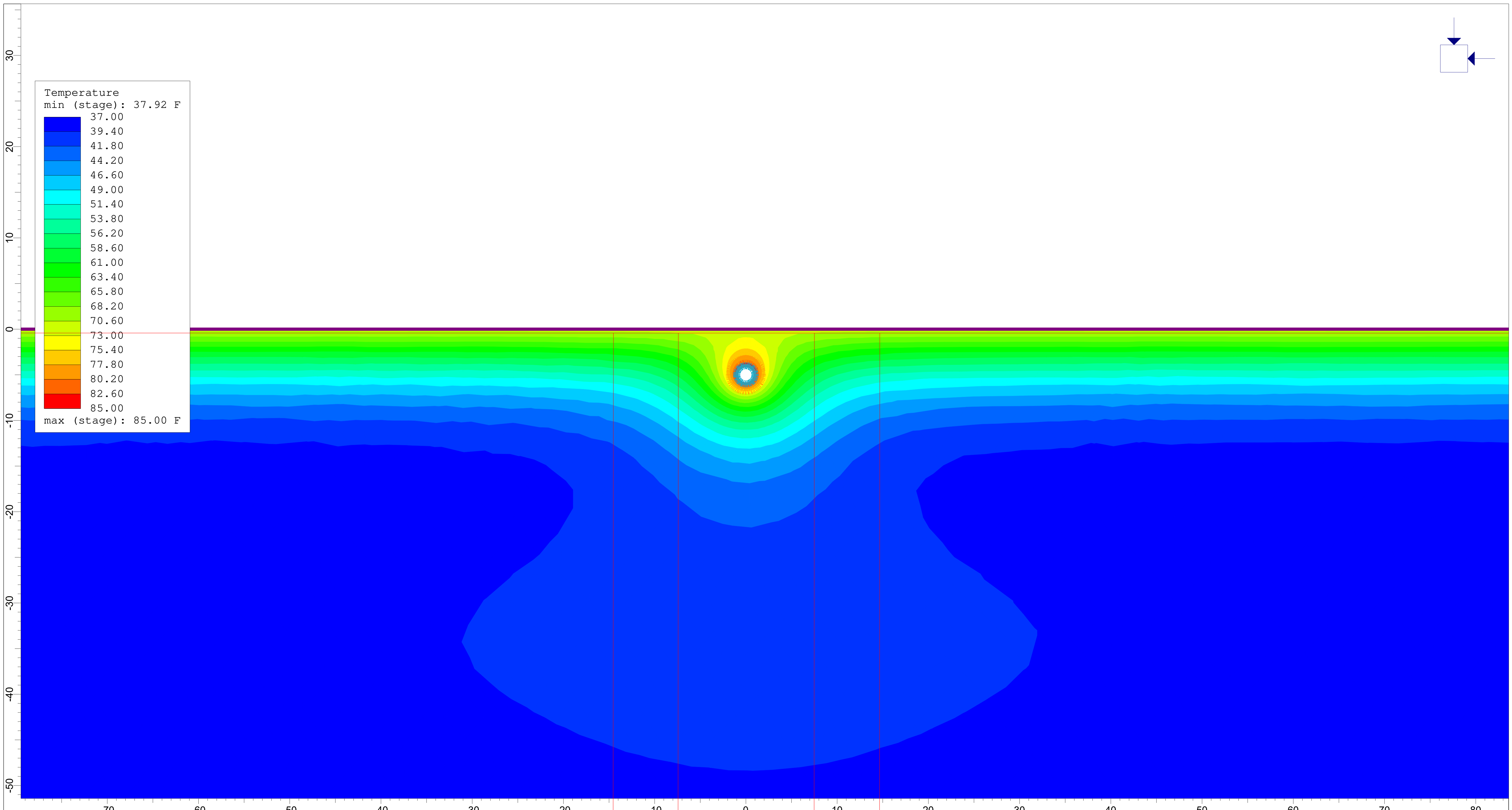


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

24IN PIPE 1 - FINE GRAIN - 35% SATURATION - JULY

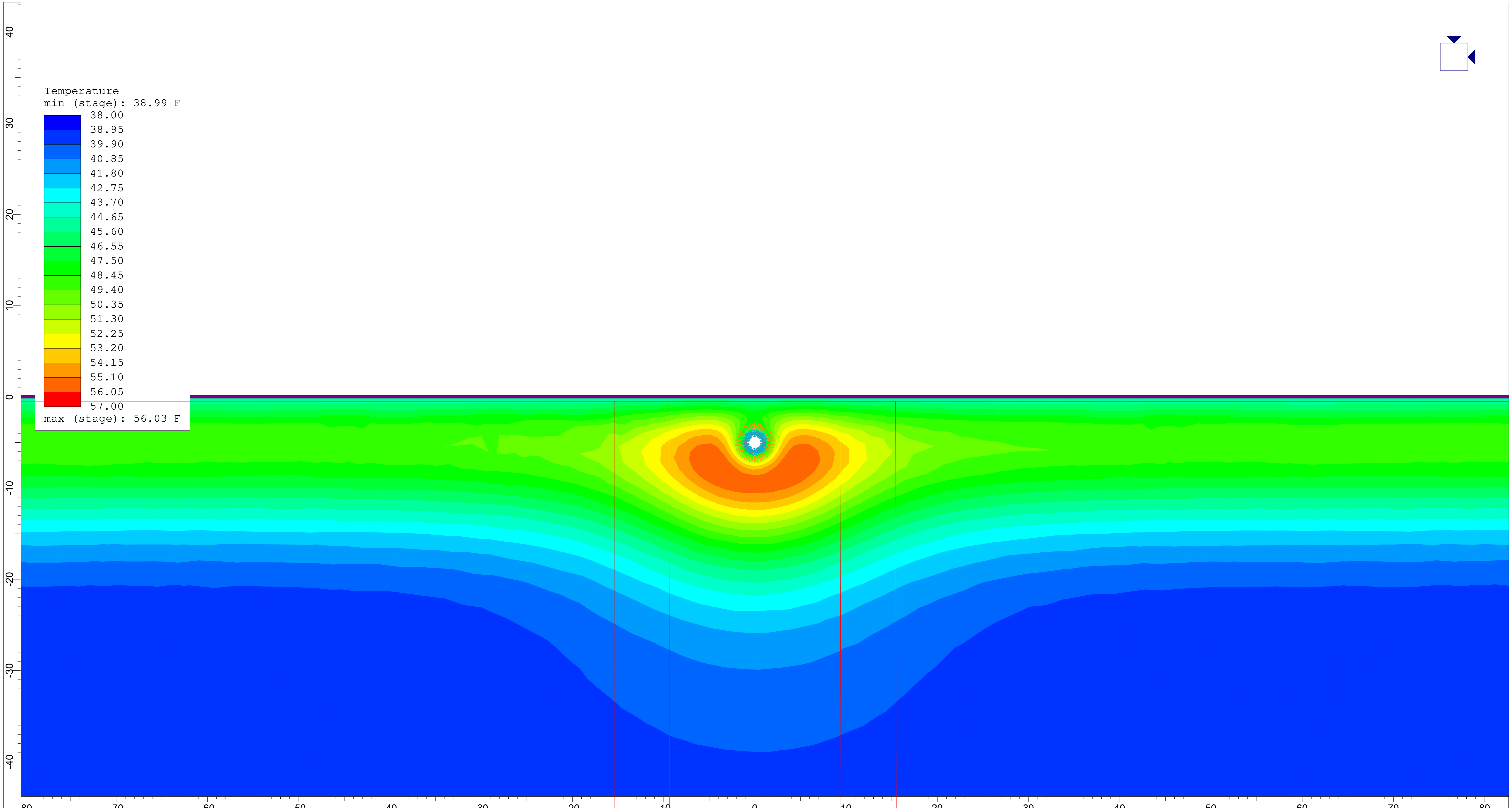


rocscience

INTERPRET 11.023

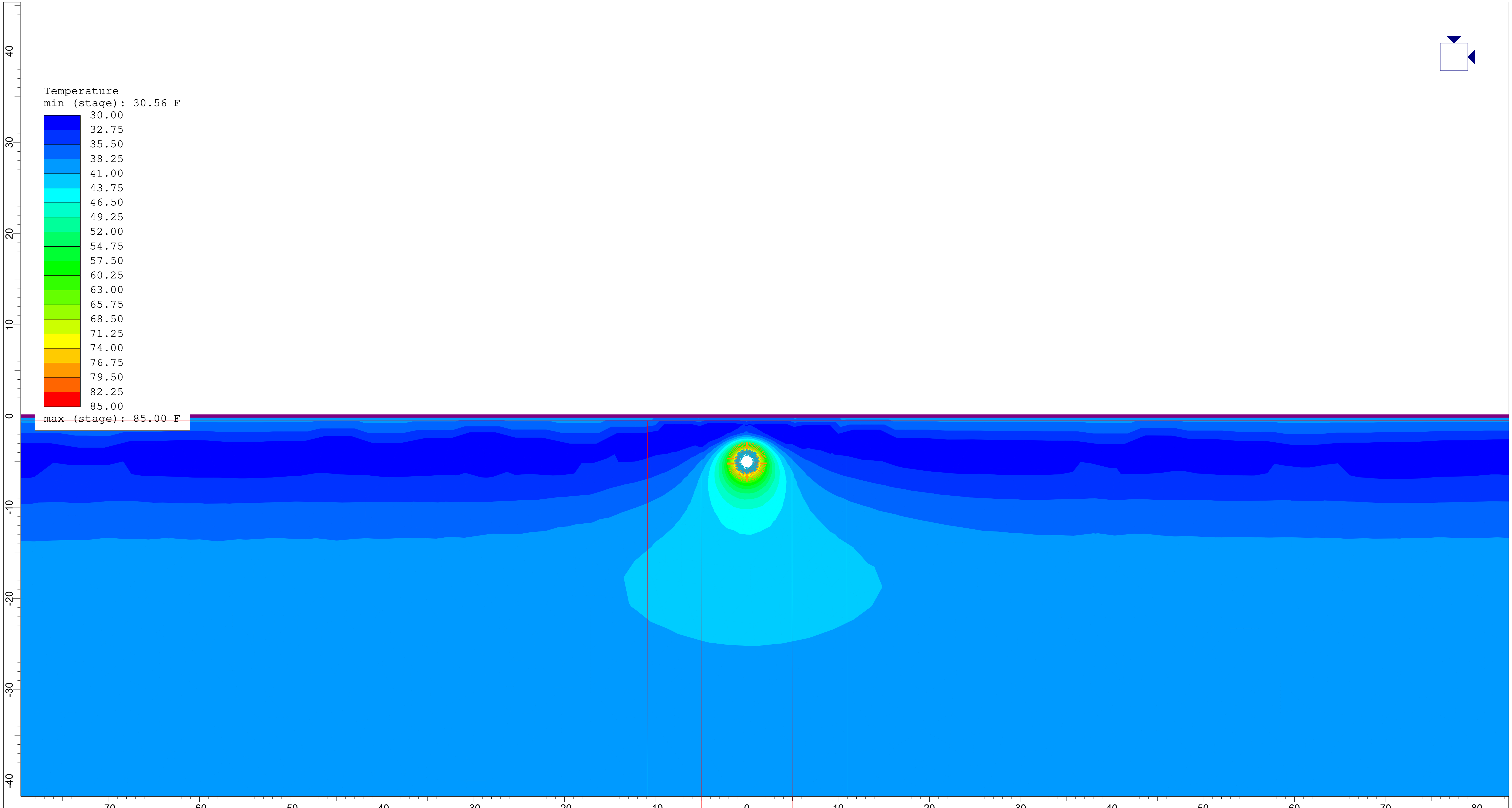
Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

24IN PIPE 1 - FINE GRAIN - 35% SATURATION - OCTOBER



rocscience	Project	Summit Carbon - 24 Inch Pipeline (2)		
	Analysis Description	Thermal Influence		
	Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name	24in Pipe 2.fez

24IN PIPE 1 - FINE GRAIN - 55% SATURATION - APRIL

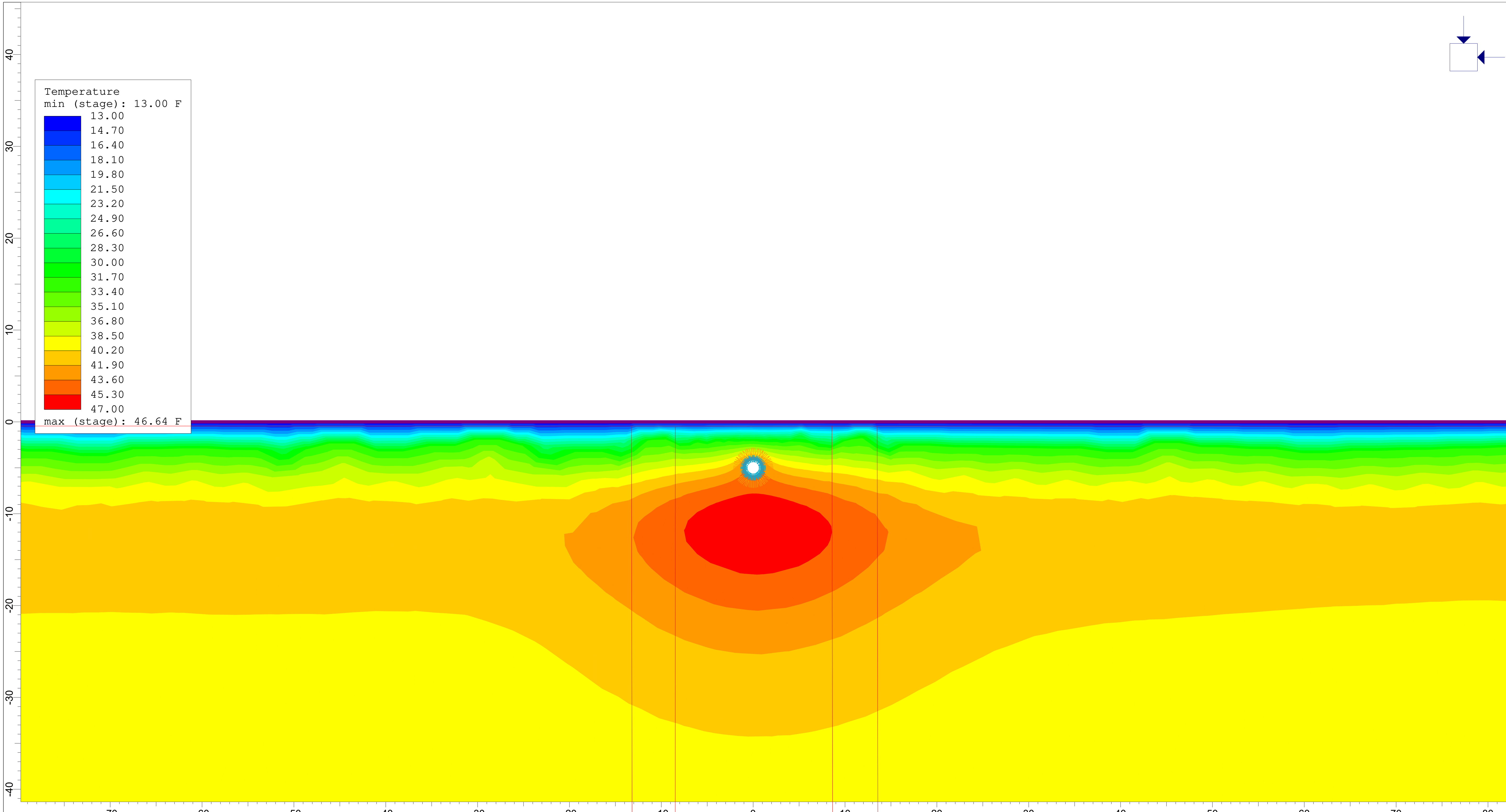


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

24IN PIPE 1 - FINE GRAIN - 55% SATURATION - JANUARY

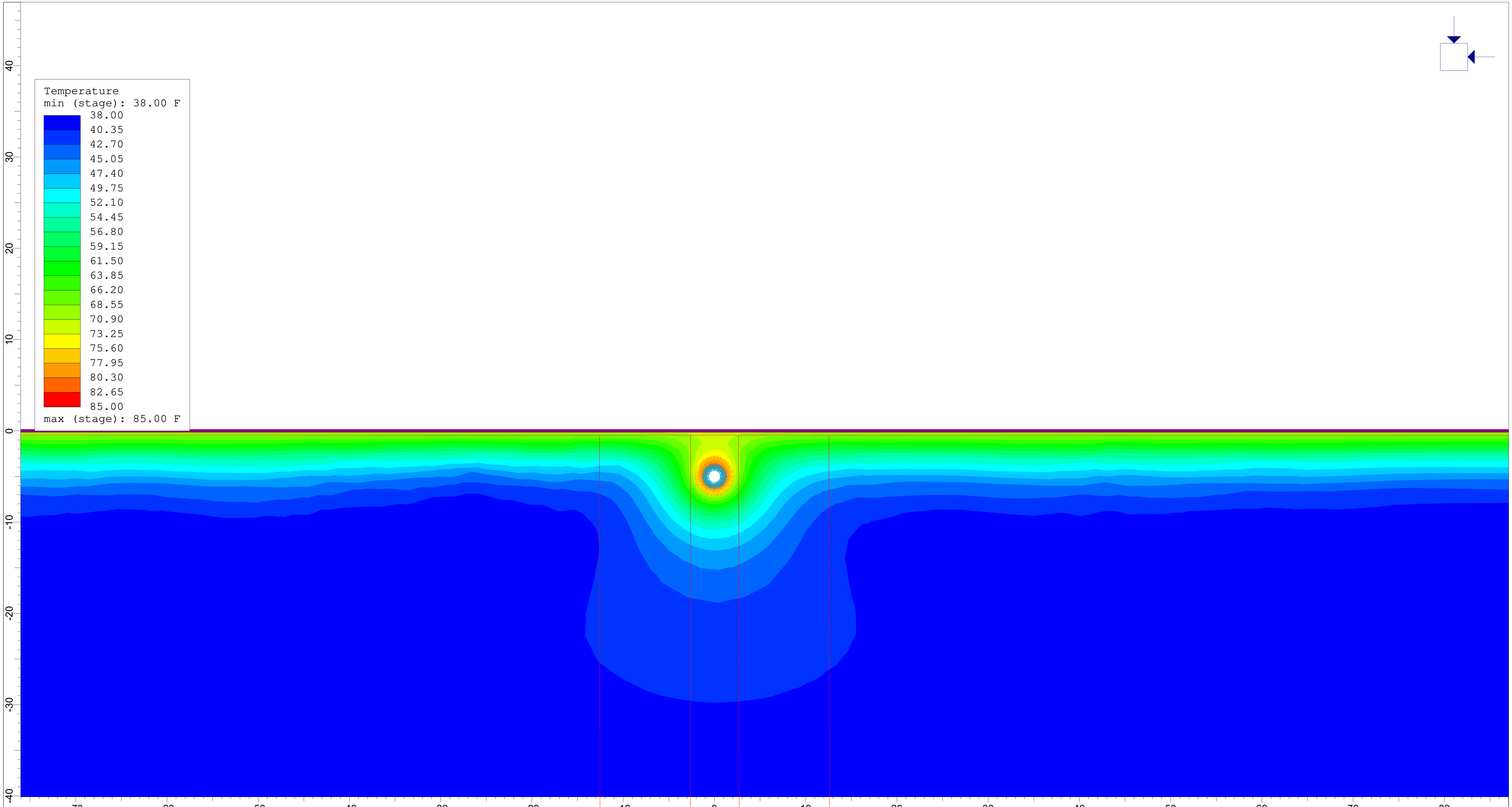


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

24IN PIPE 1 - FINE GRAIN - 55% SATURATION - JULY

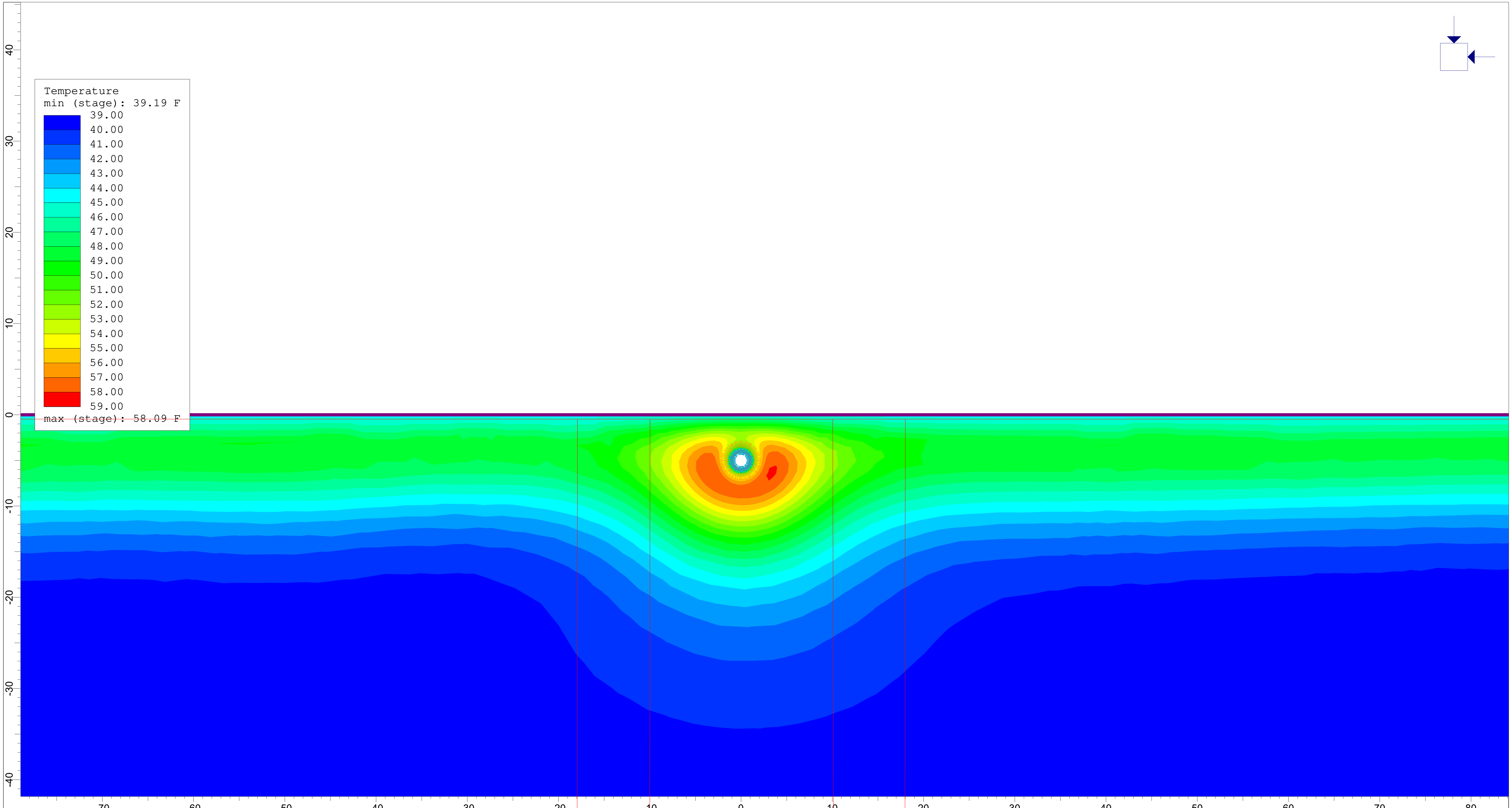


rocscience

INTERPRET 11.023

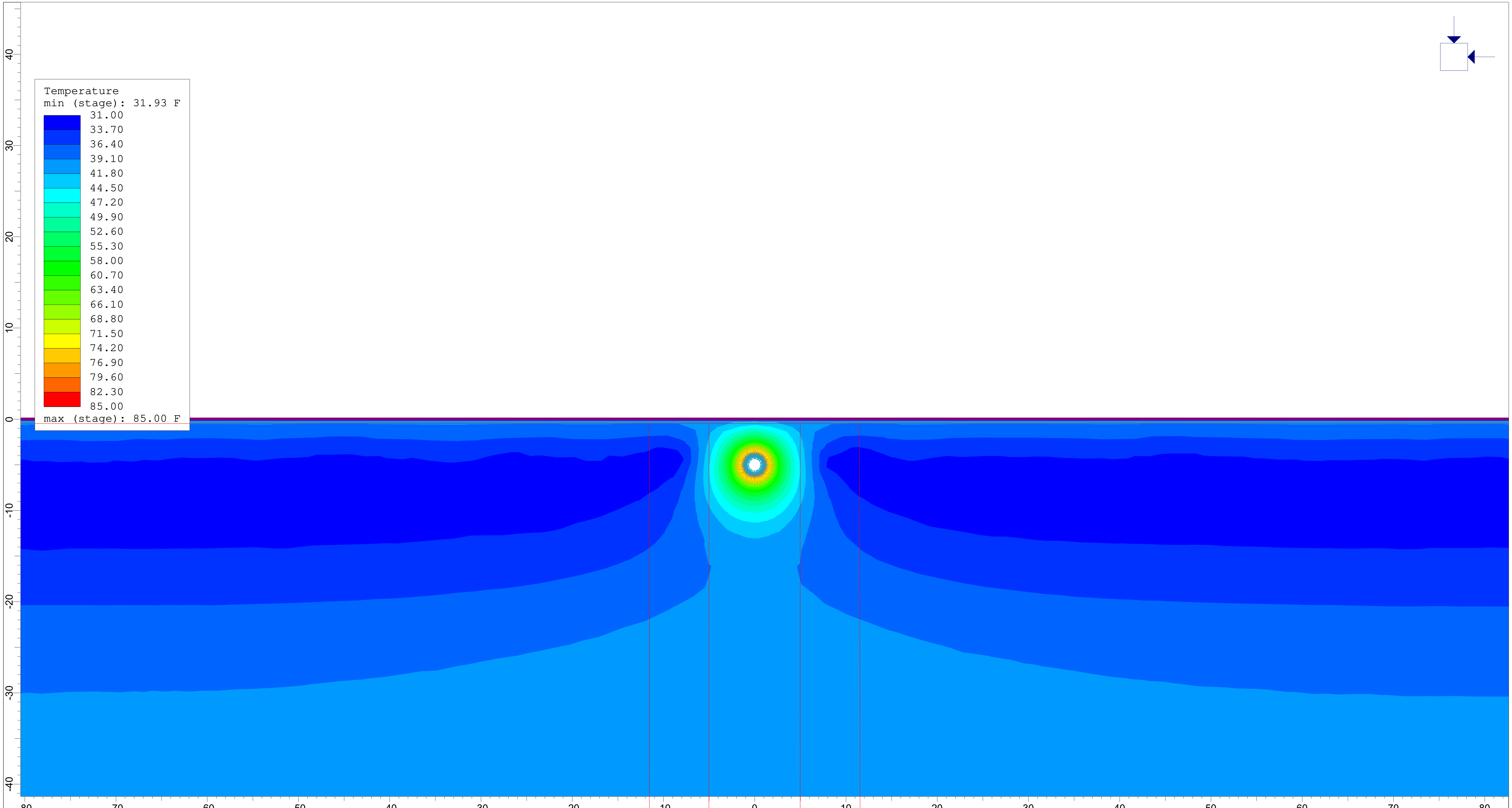
Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	24in Pipe 2.fez

24IN PIPE 1 - FINE GRAIN - 55% SATURATION - OCTOBER



rocscience	Project: Summit Carbon - 24 Inch Pipeline (2)		
	Analysis Description: Thermal Influence		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 24in Pipe 2.fez

24IN PIPE 2 - COARSE GRAIN - 15% SATURATION - APRIL

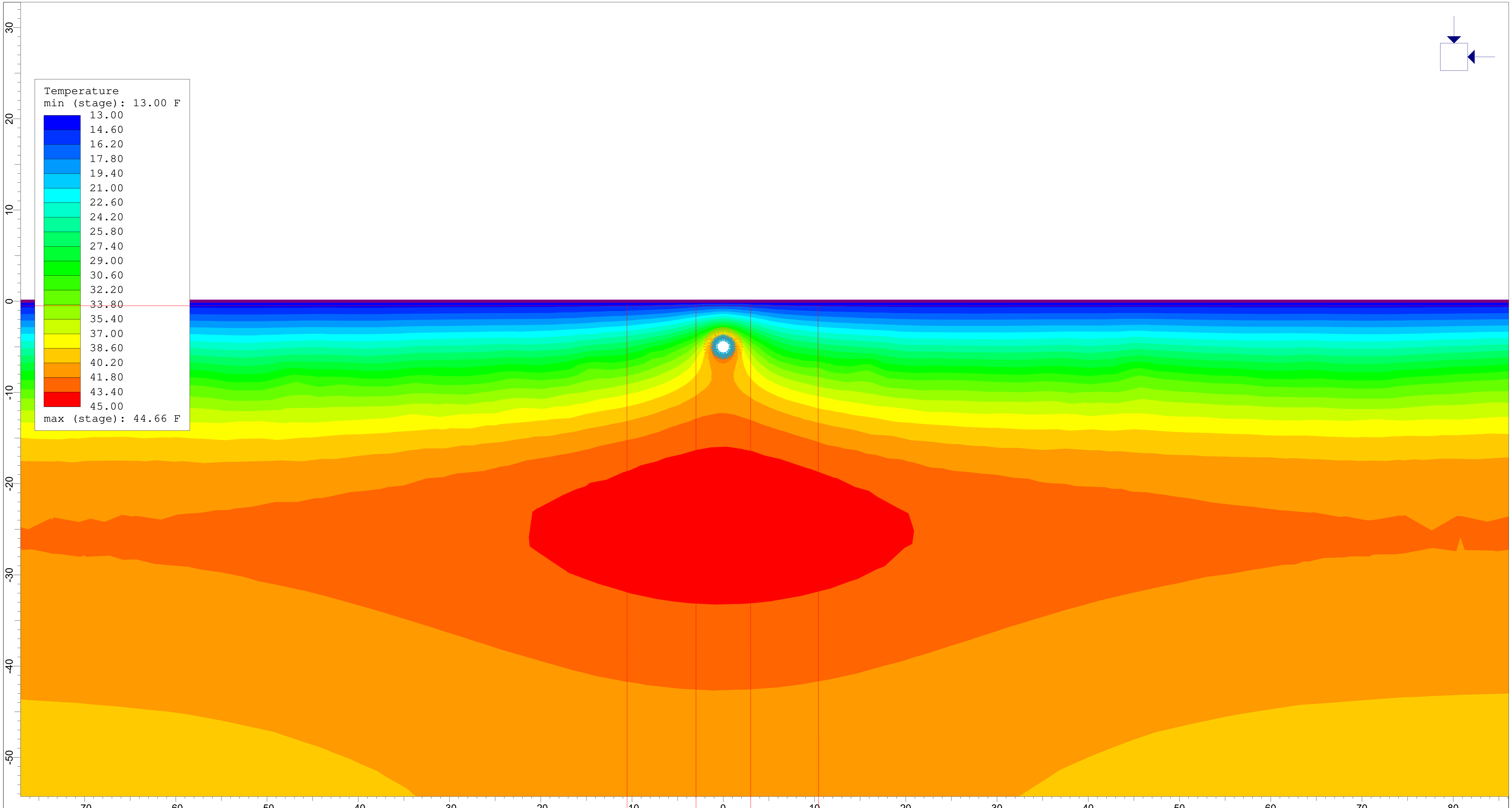


rocscience

INTERPRET 11.023

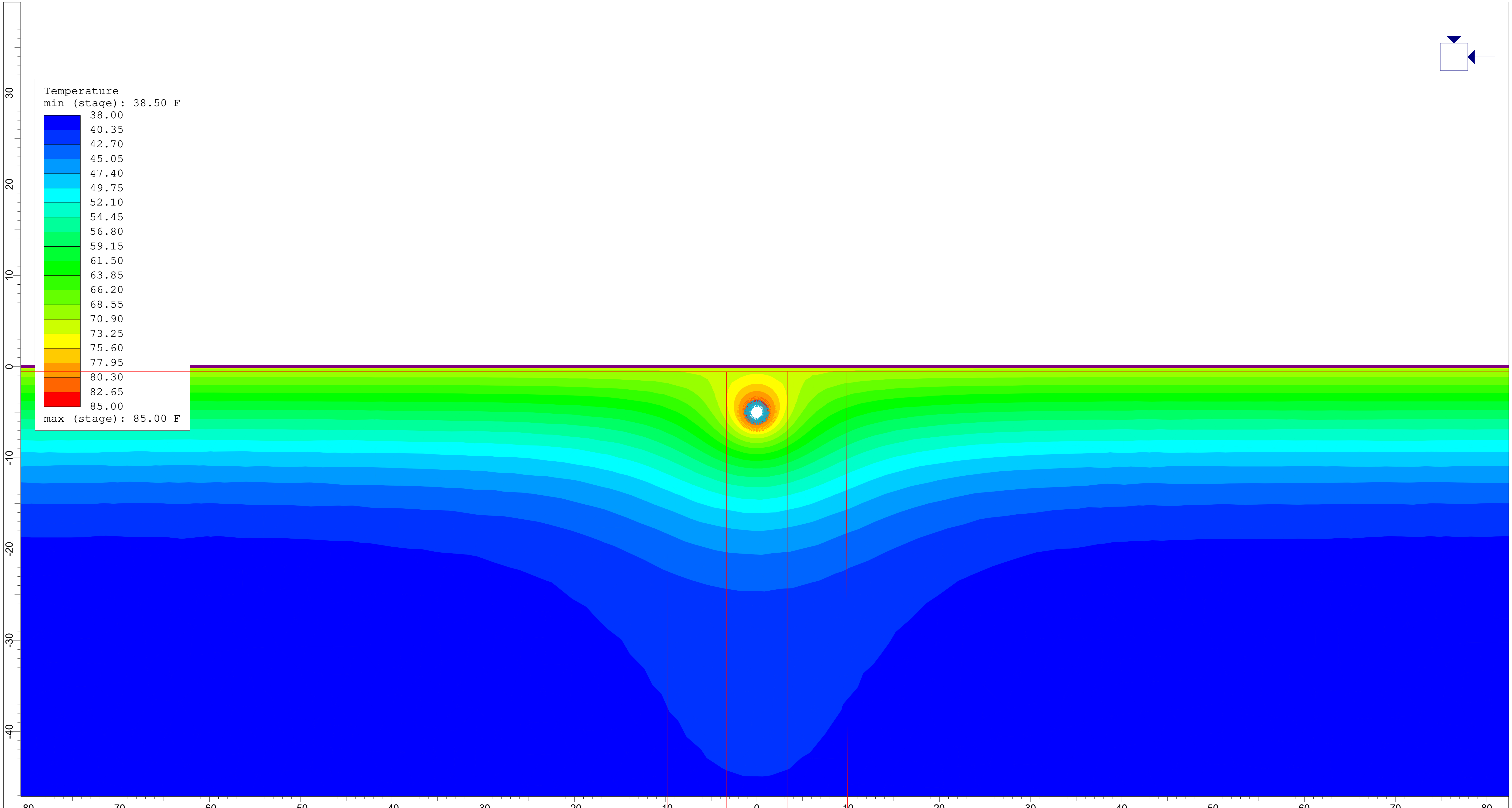
Project	Summit Carbon - 24 Inch Pipeline (2)
Analysis Description	Thermal Influence
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	24in Pipe 2.fez

24IN PIPE 2 - COARSE GRAIN - 15% SATURATION - JANUARY



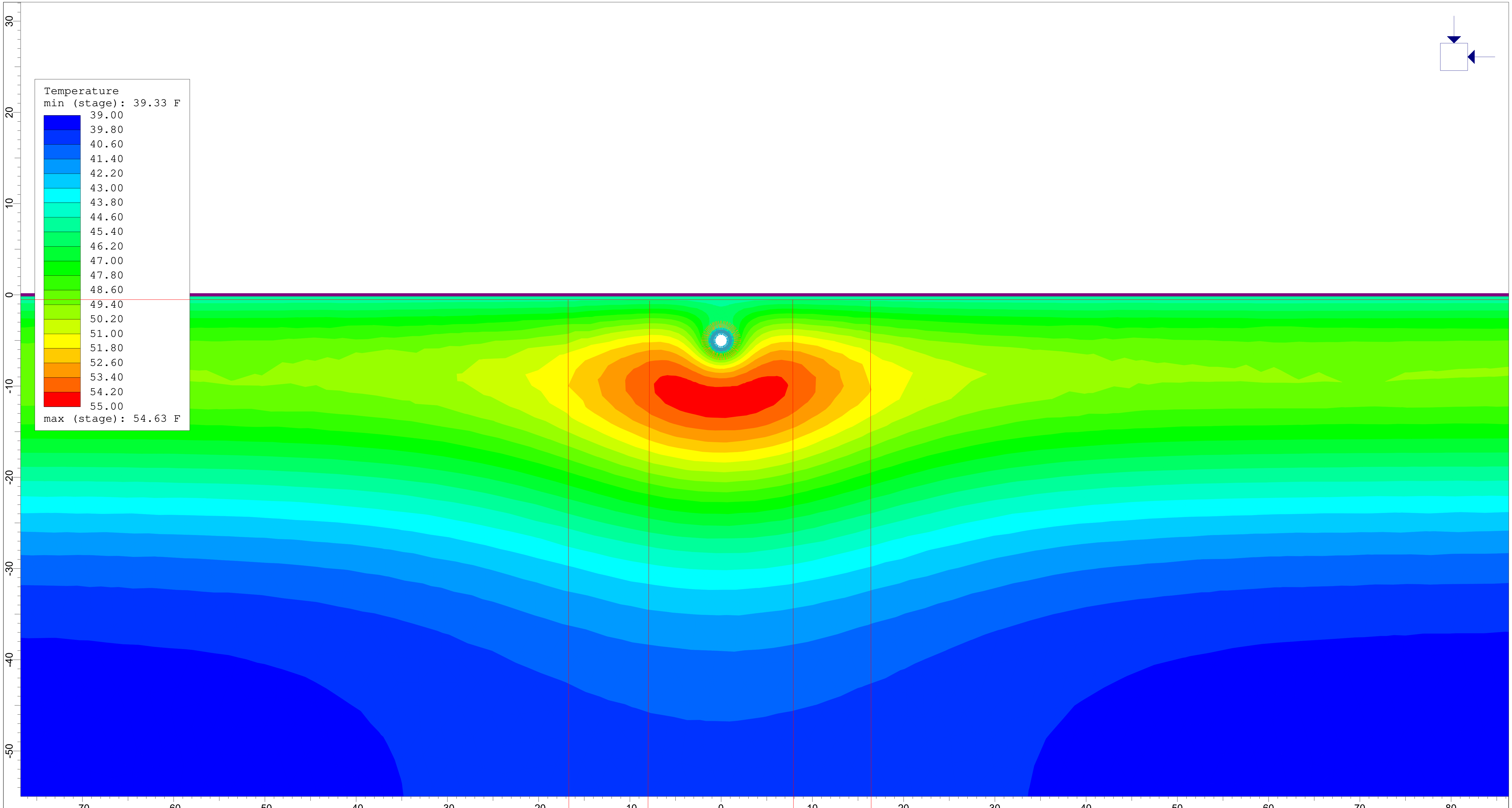
rocscience	Project: Summit Carbon - 24 Inch Pipeline (2)		
	Analysis Description: Thermal Influence		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 24in Pipe 2.fez

24IN PIPE 2 - COARSE GRAIN - 15% SATURATION - JULY



rocscience	Project: Summit Carbon - 24 Inch Pipeline (2)		
	Analysis Description: Thermal Influence		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 24in Pipe 2.fez

24IN PIPE 2 - COARSE GRAIN - 15% SATURATION - OCTOBER

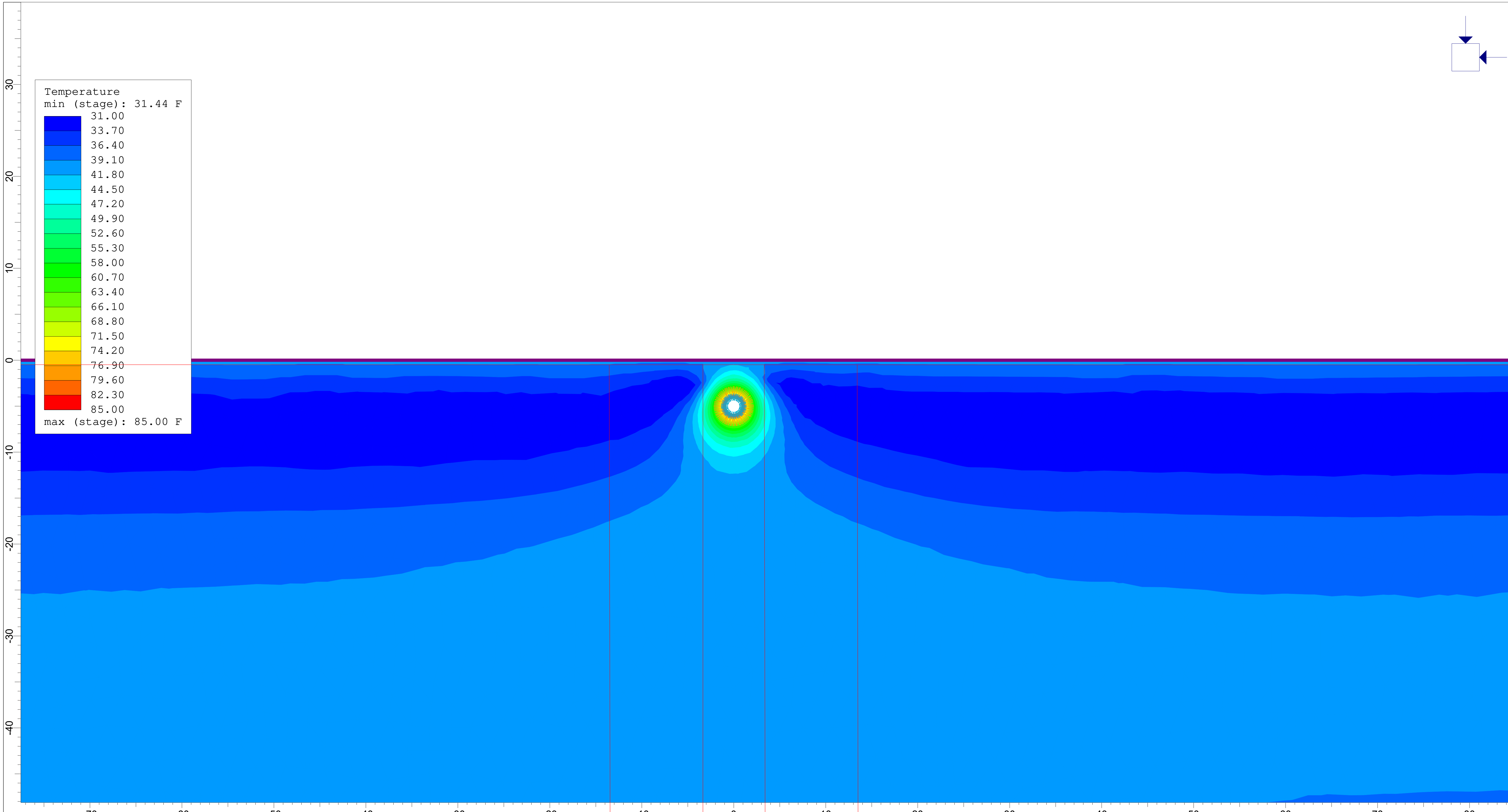


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)
Analysis Description	Thermal Influence
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	24in Pipe 2.fez

24IN PIPE 2 - COARSE GRAIN - 35% SATURATION - APRIL

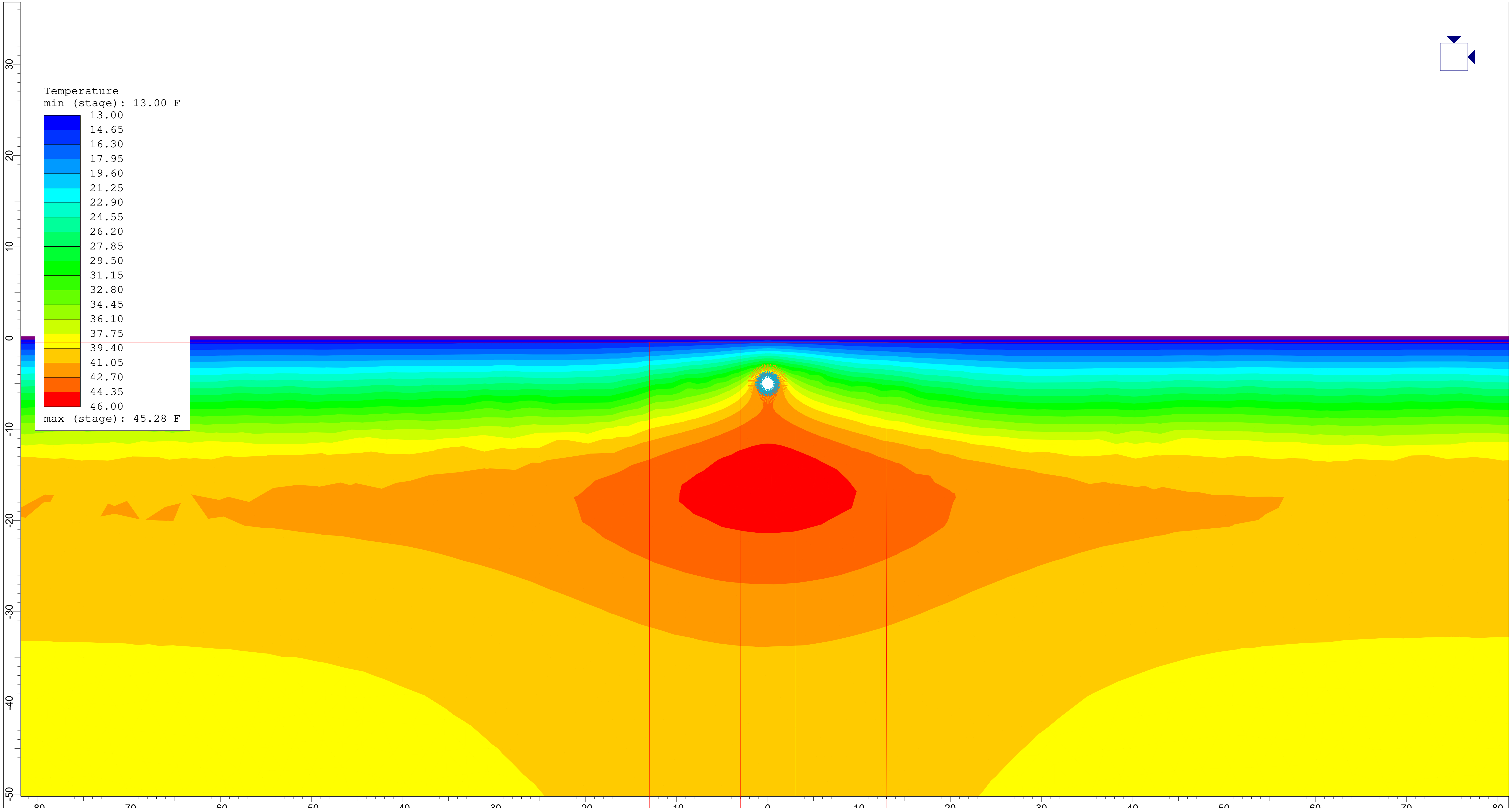


Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

rocscience

INTERPRET 11.023

24IN PIPE 2 - COARSE GRAIN - 35% SATURATION - JANUARY

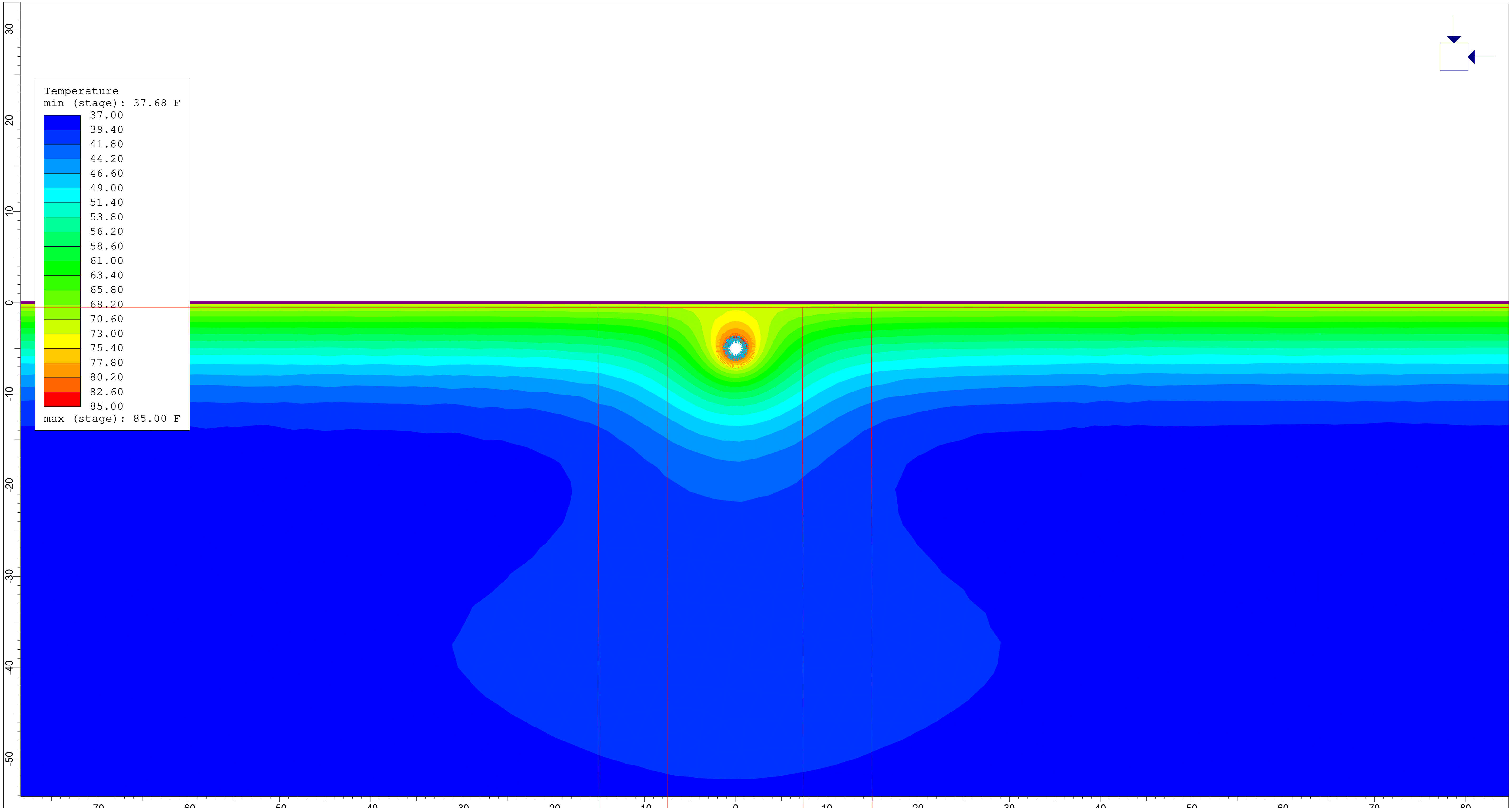


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	24in Pipe 2.fez

24IN PIPE 2 - COARSE GRAIN - 35% SATURATION - JULY

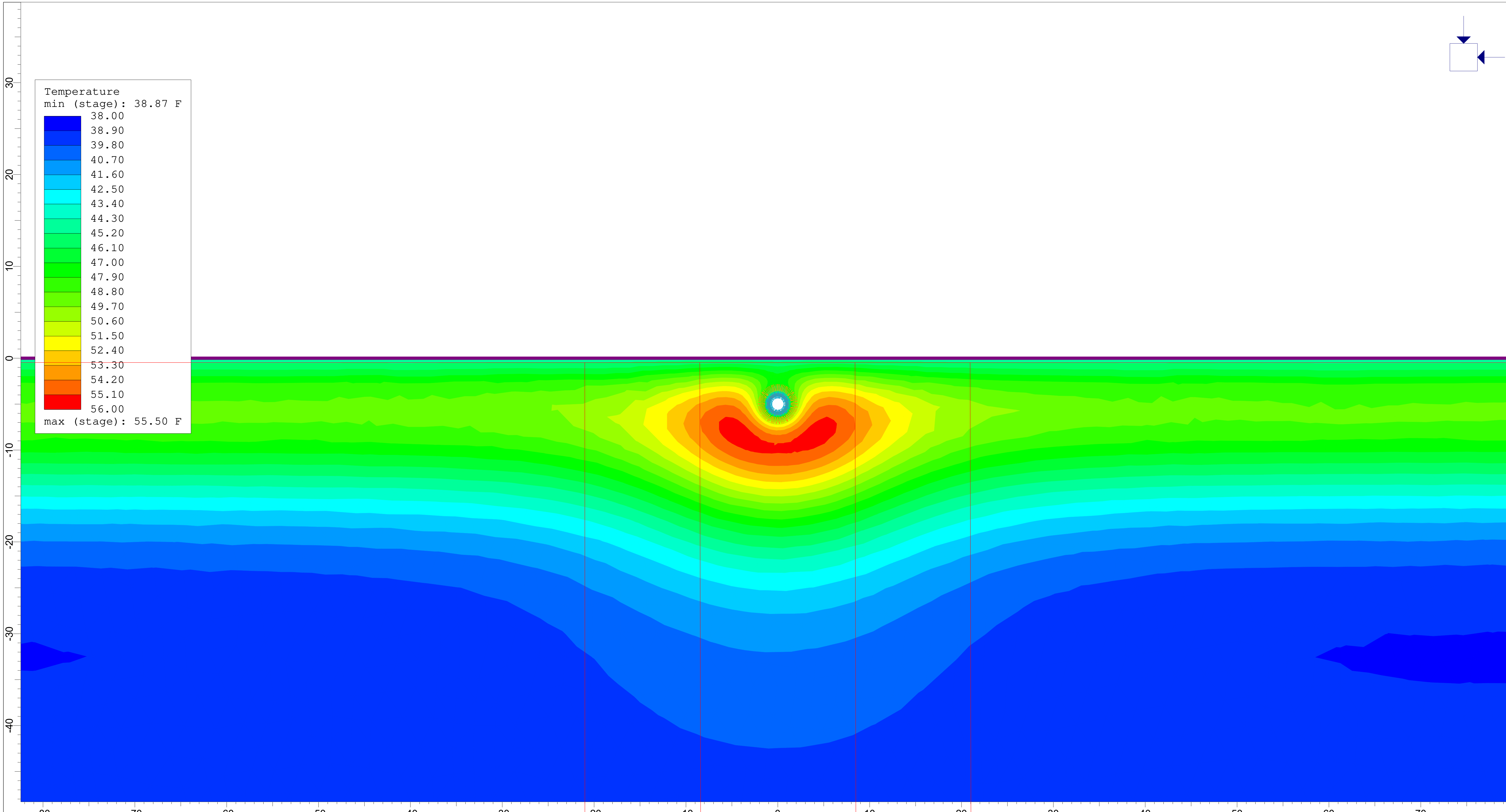


rocscience

INTERPRET 11.023

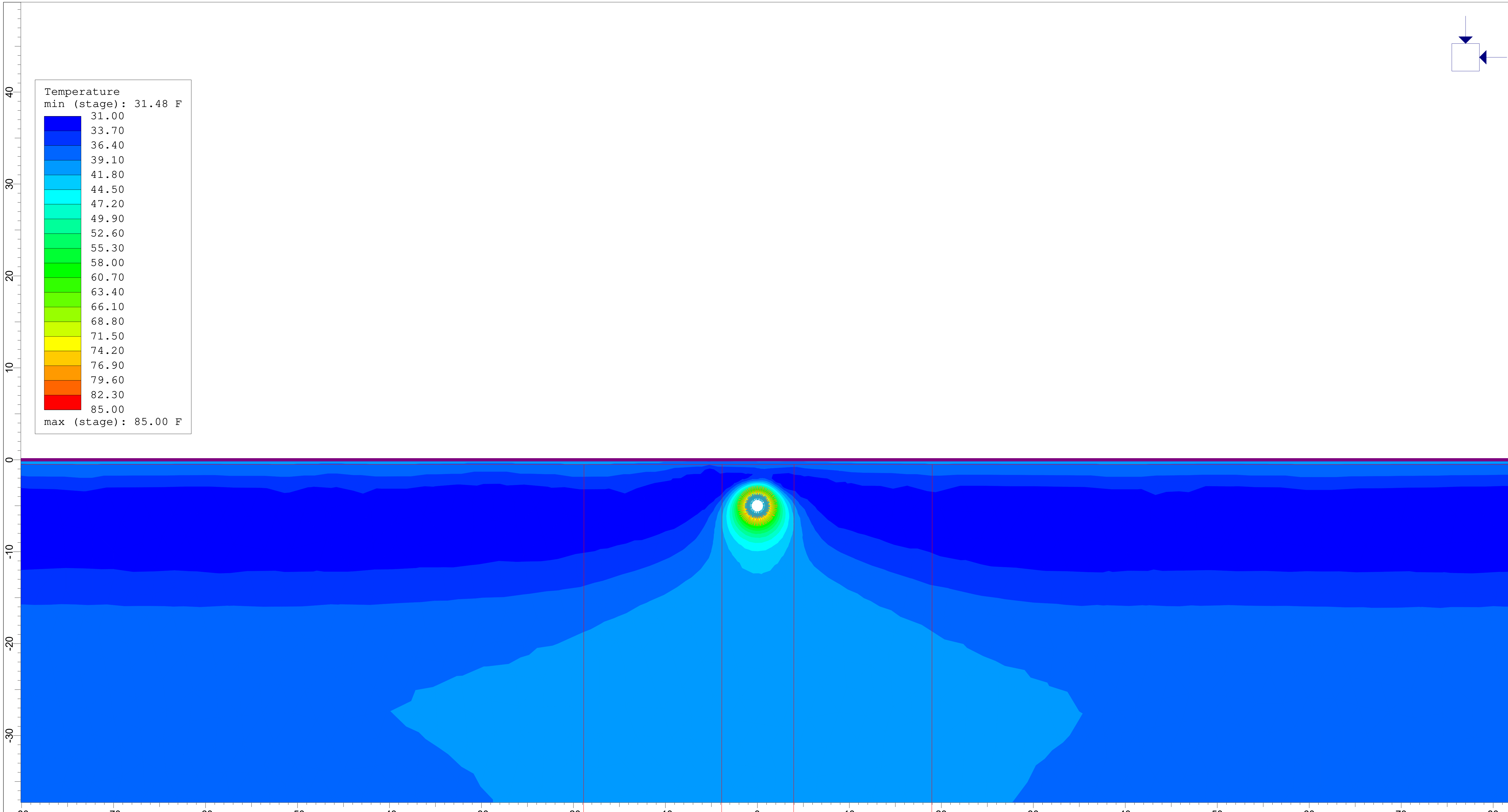
Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	24in Pipe 2.fez

24IN PIPE 2 - COARSE GRAIN - 35% SATURATION - OCTOBER



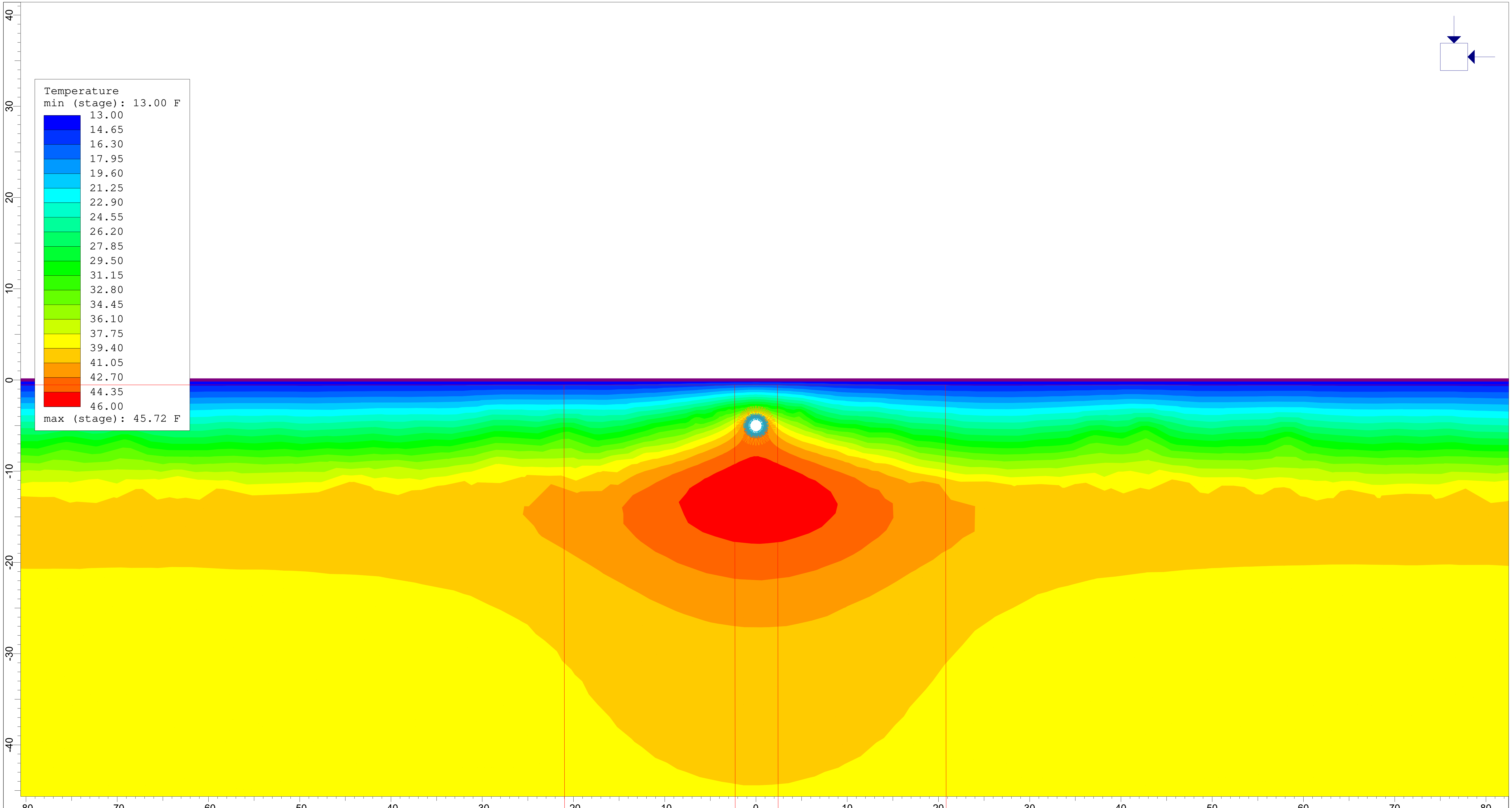
rocscience	Project: Summit Carbon - 24 Inch Pipeline (2)		
	Analysis Description: Thermal Influence		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 24in Pipe 2.fez

24IN PIPE 2 - COARSE GRAIN - 55% SATURATION - APRIL



rocscience	Project	Summit Carbon - 24 Inch Pipeline (2)	
	Analysis Description	Thermal Influence	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 24in Pipe 2.fez

24IN PIPE 2 - COARSE GRAIN - 55% SATURATION - JANUARY

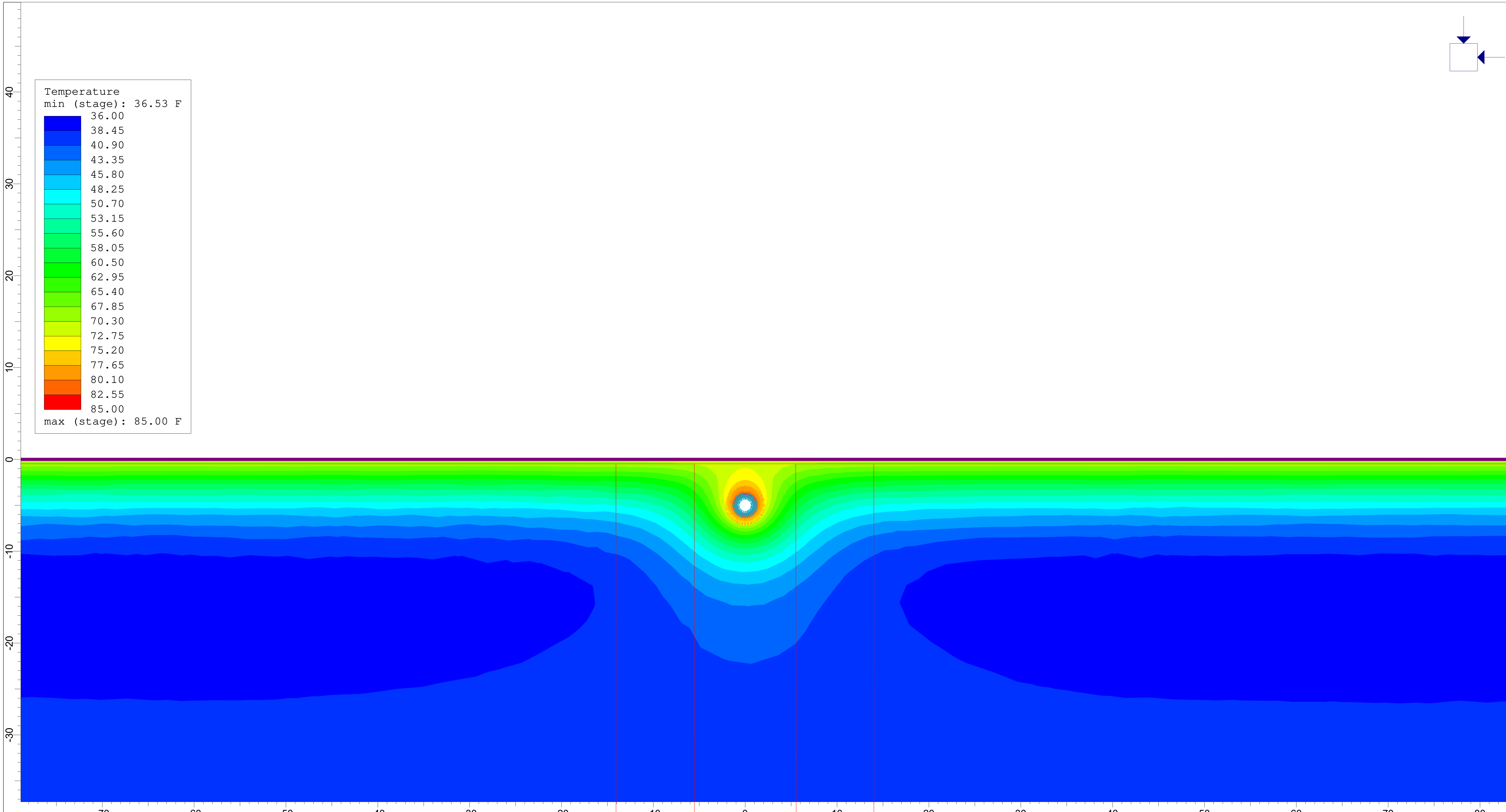


Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting	
Date: 6/3/2024, 10:56:45 AM		File Name: 24in Pipe 2.fez	

rocscience

INTERPRET 11.023

24IN PIPE 2 - COARSE GRAIN - 55% SATURATION - JULY

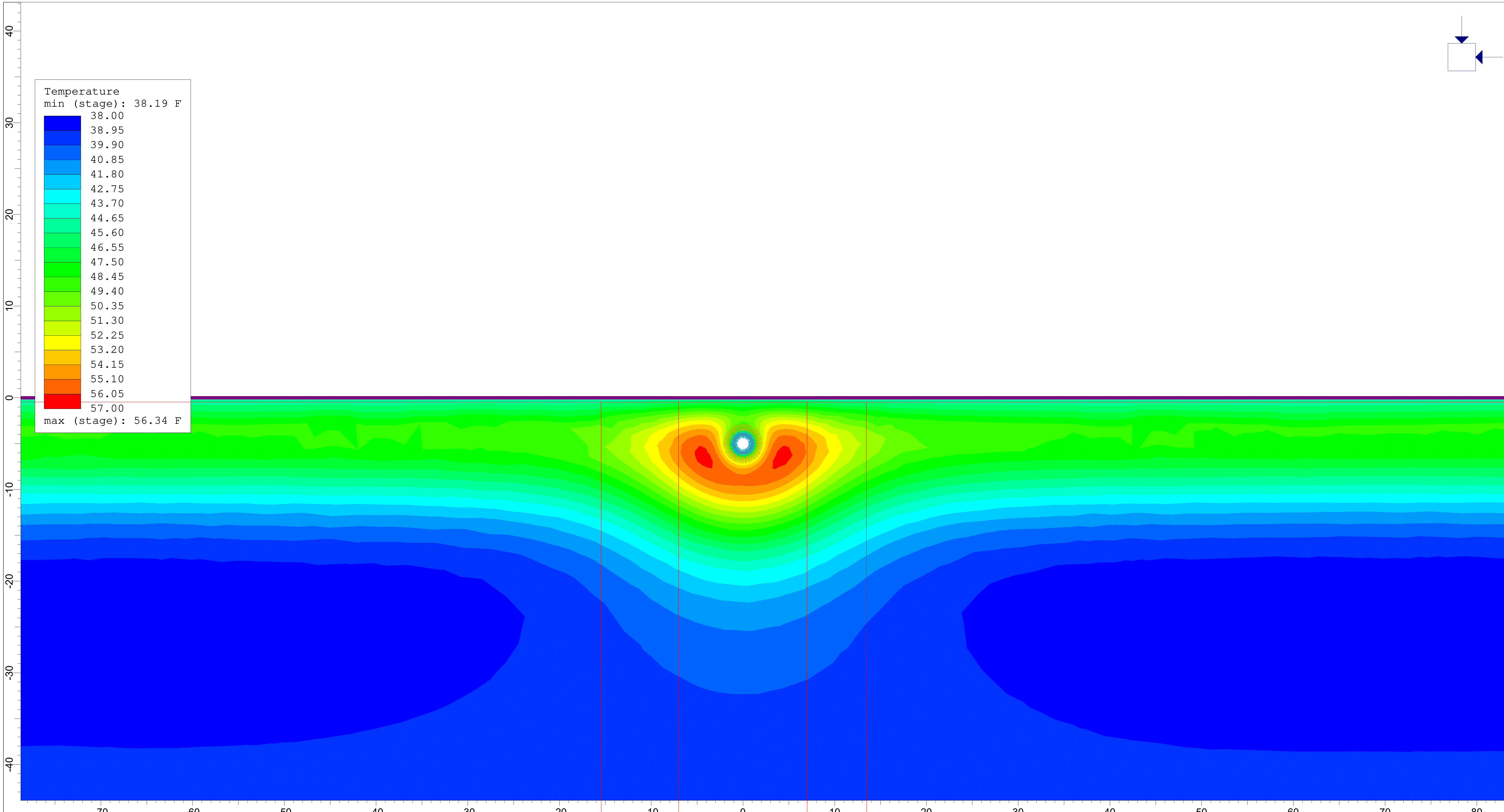


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

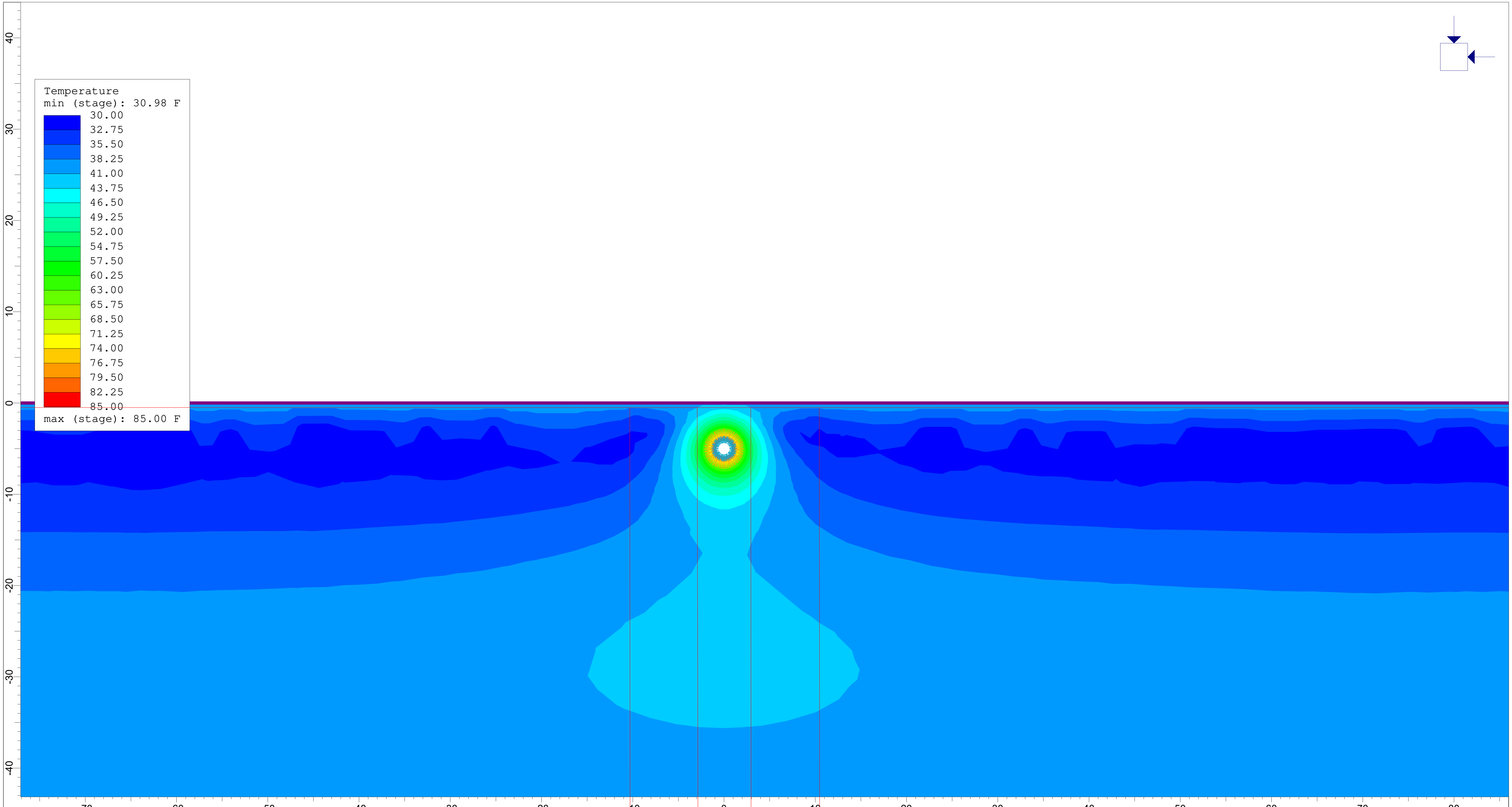
24IN PIPE 2 - COARSE GRAIN - 55% SATURATION - OCTOBER



Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

INTERPRET 11.023

24IN PIPE 2 - FINE GRAIN - 15% SATURATION - APRIL

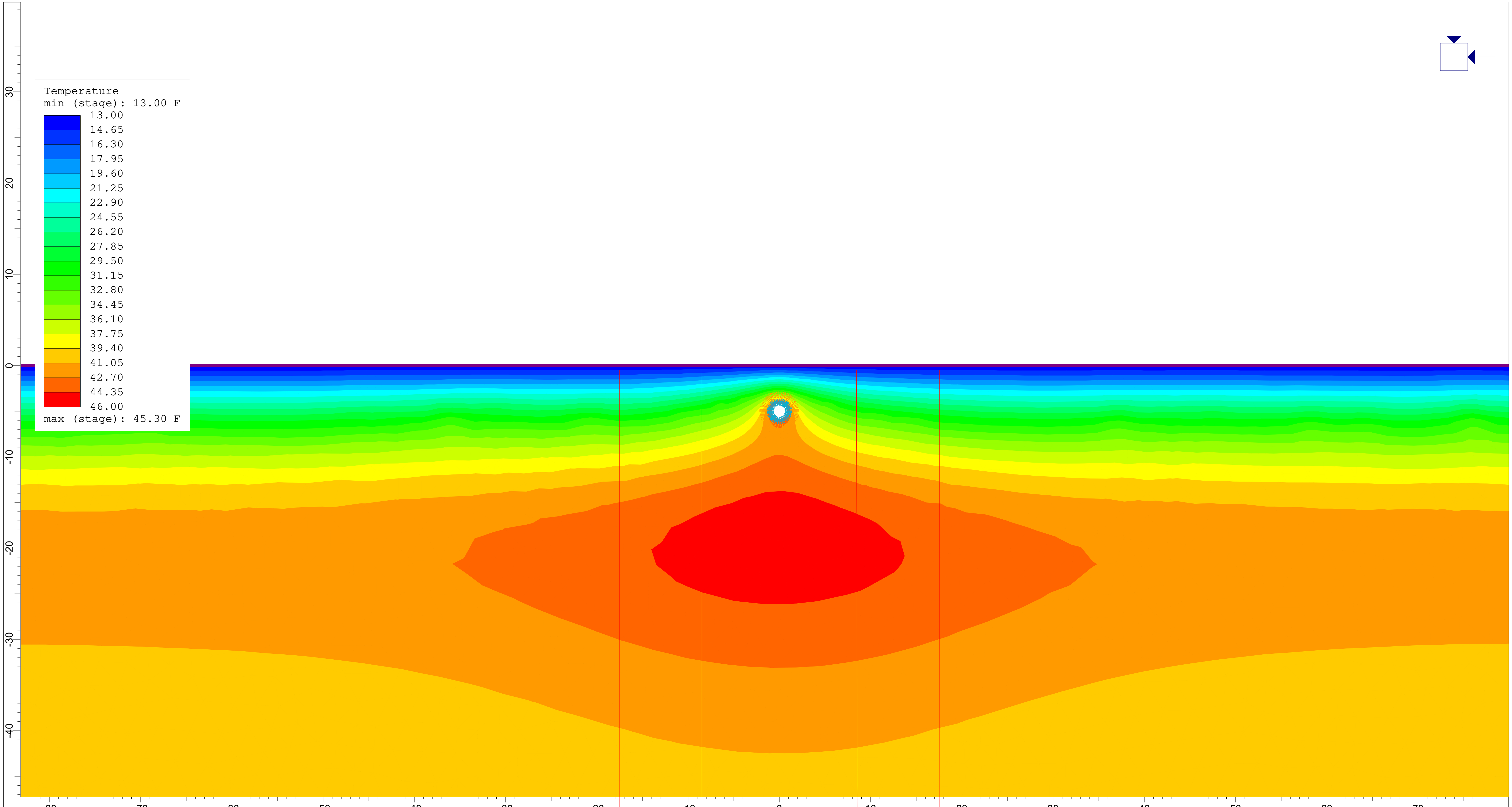


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	24in Pipe 2.fez

24IN PIPE 2 - FINE GRAIN - 15% SATURATION - JANUARY

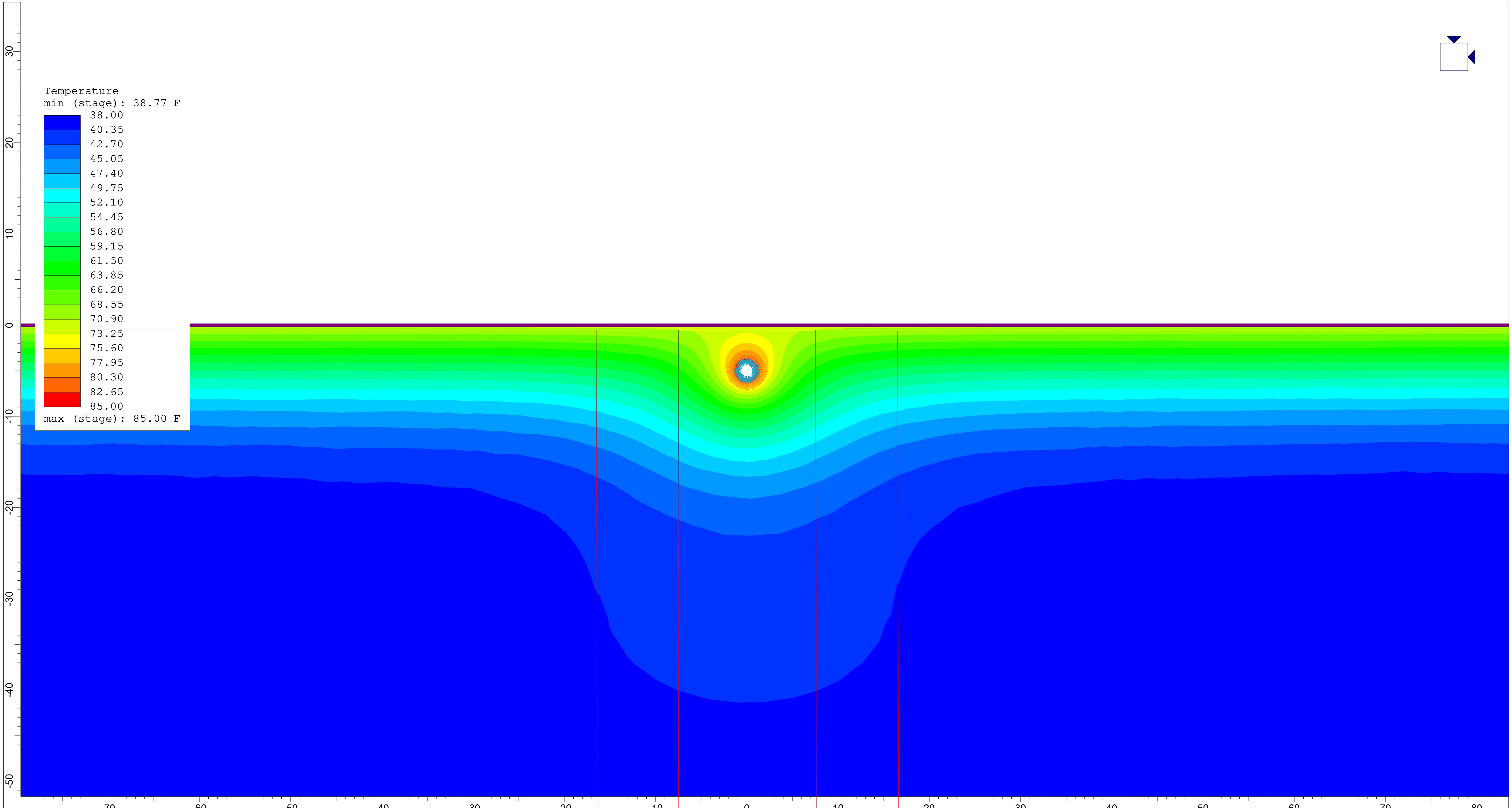


rocscience

INTERPRET 11.023

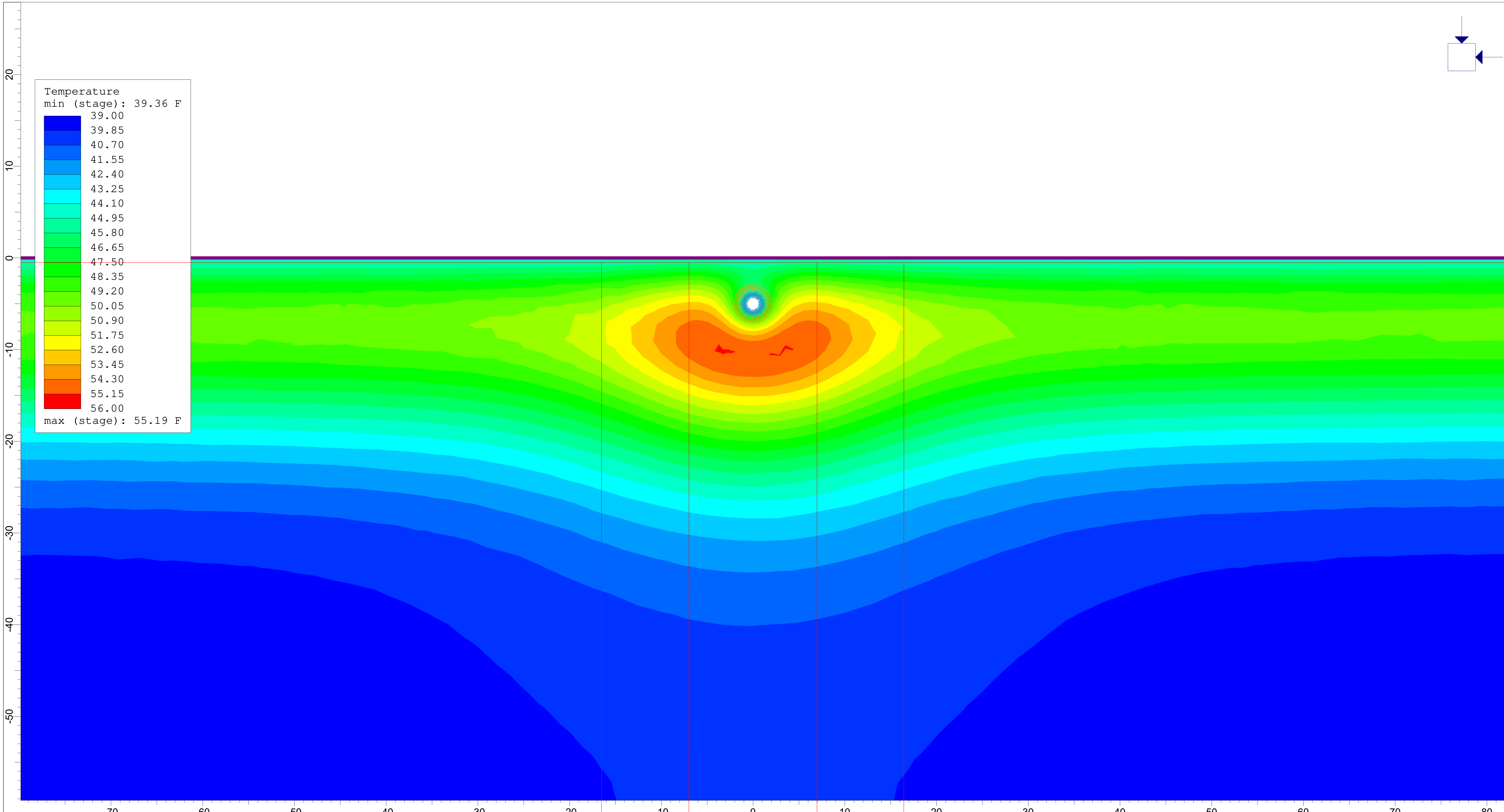
Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

24IN PIPE 2 - FINE GRAIN - 15% SATURATION - JULY



rocscience	Project	Summit Carbon - 24 Inch Pipeline (2)	
	Analysis Description	Thermal Influence	
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 24in Pipe 2.fez

24IN PIPE 2 - FINE GRAIN - 15% SATURATION - OCTOBER

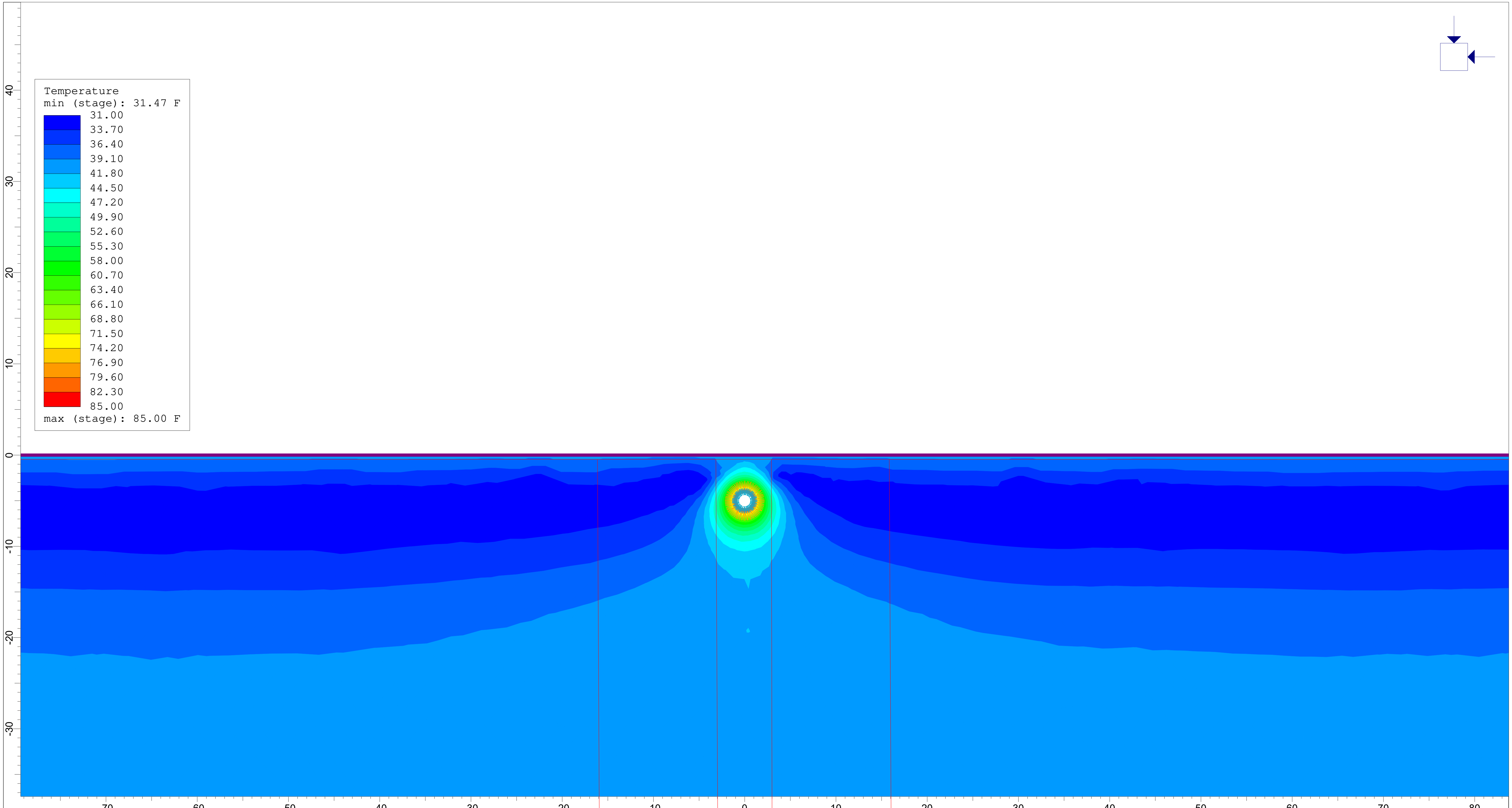


rocscience

INTERPRET 11.023

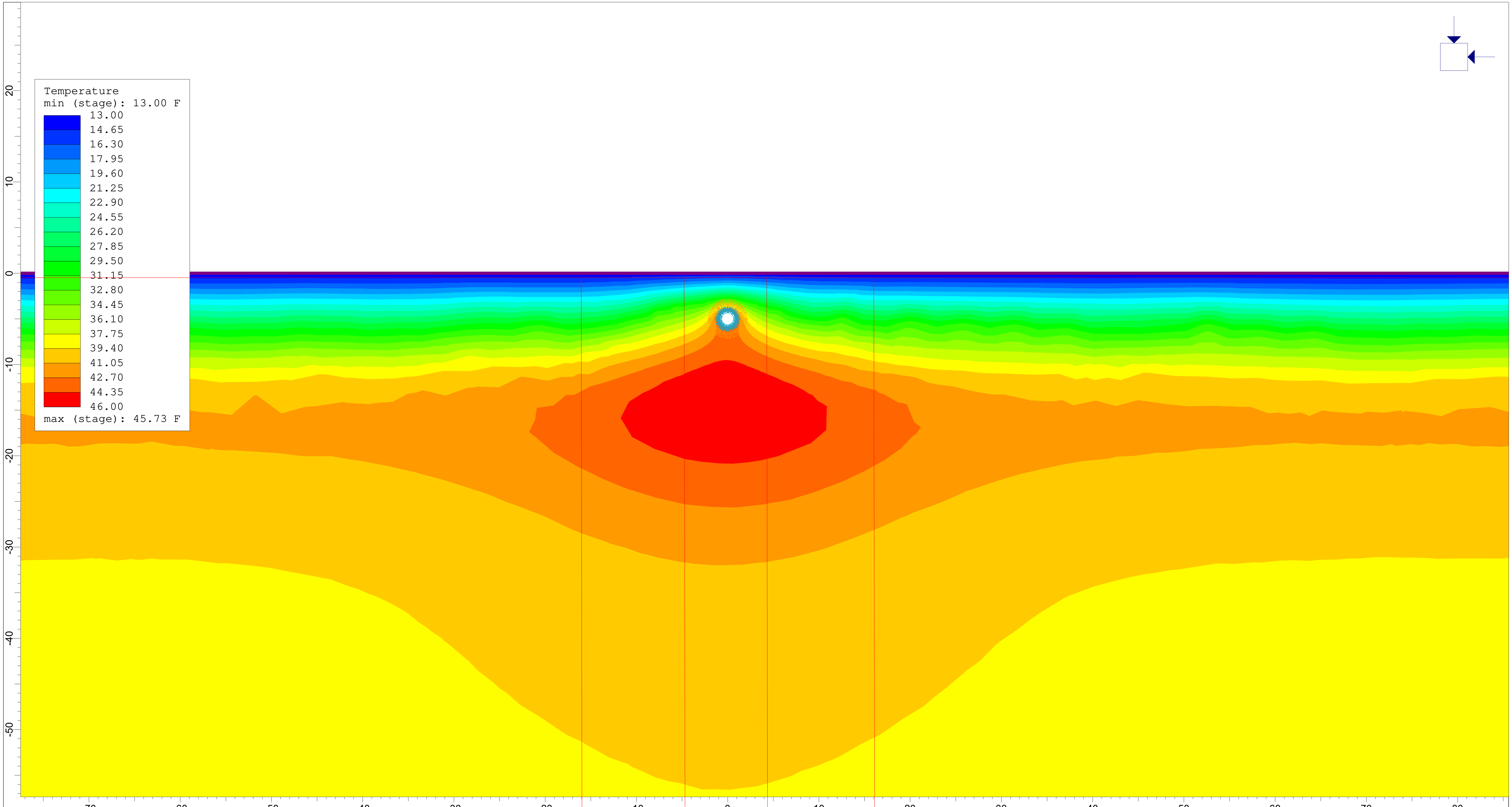
Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
Date: 6/3/2024, 10:56:45 AM		File Name	24in Pipe 2.fez

24IN PIPE 2 - FINE GRAIN - 35% SATURATION - APRIL



rocscience	Project	Summit Carbon - 24 Inch Pipeline (2)		
	Analysis Description	Thermal Influence		
	Drawn By: Connor Rankin	Scale: 1:120	Company	Lake Superior Consulting
INTERPRET 11.023	Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

24IN PIPE 2 - FINE GRAIN - 35% SATURATION - JANUARY

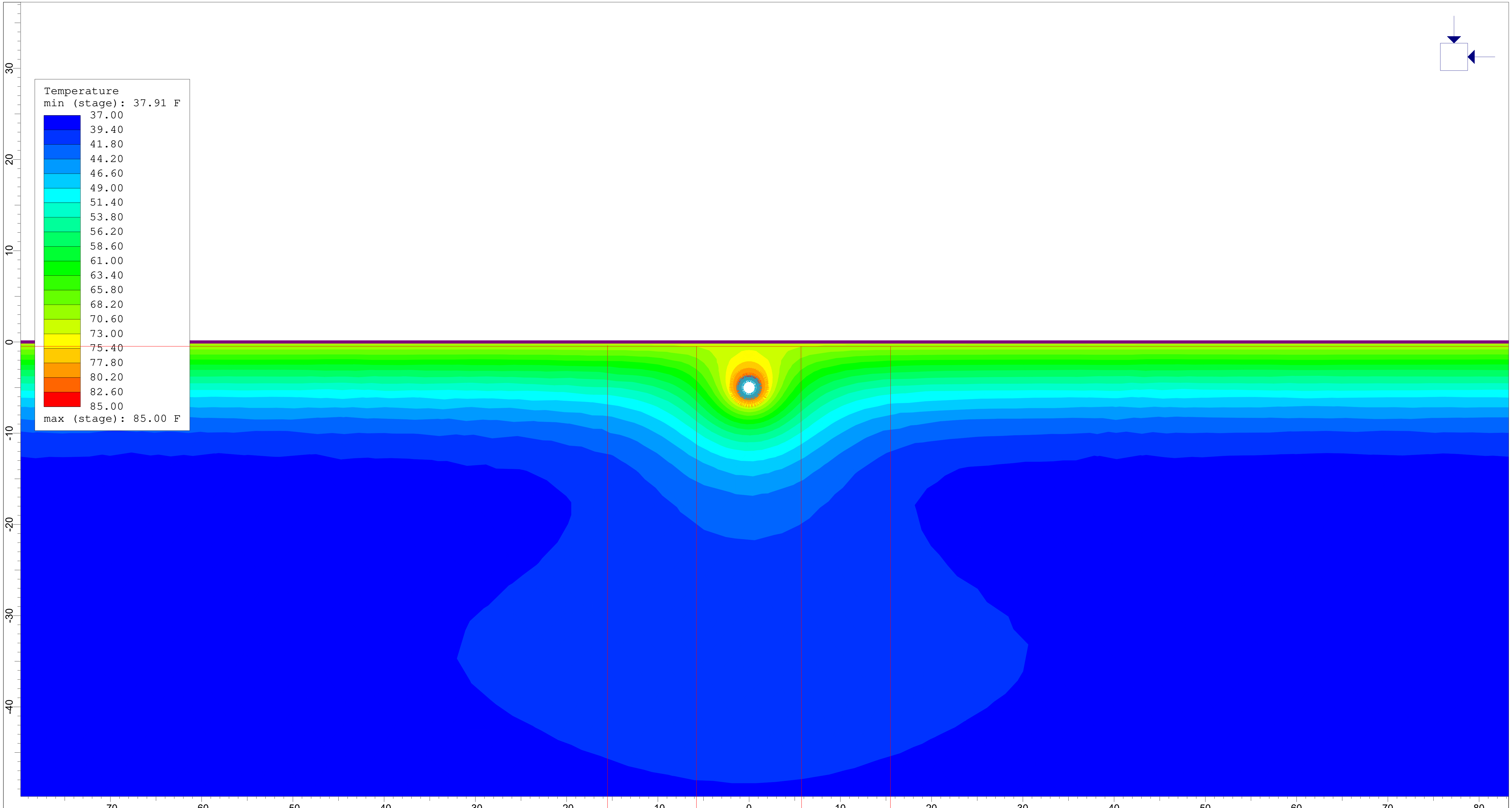


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)
Analysis Description	Thermal Influence
Drawn By	Connor Rankin
Scale	1:120
Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM
File Name	24in Pipe 2.fez

24IN PIPE 2 - FINE GRAIN - 35% SATURATION - JULY

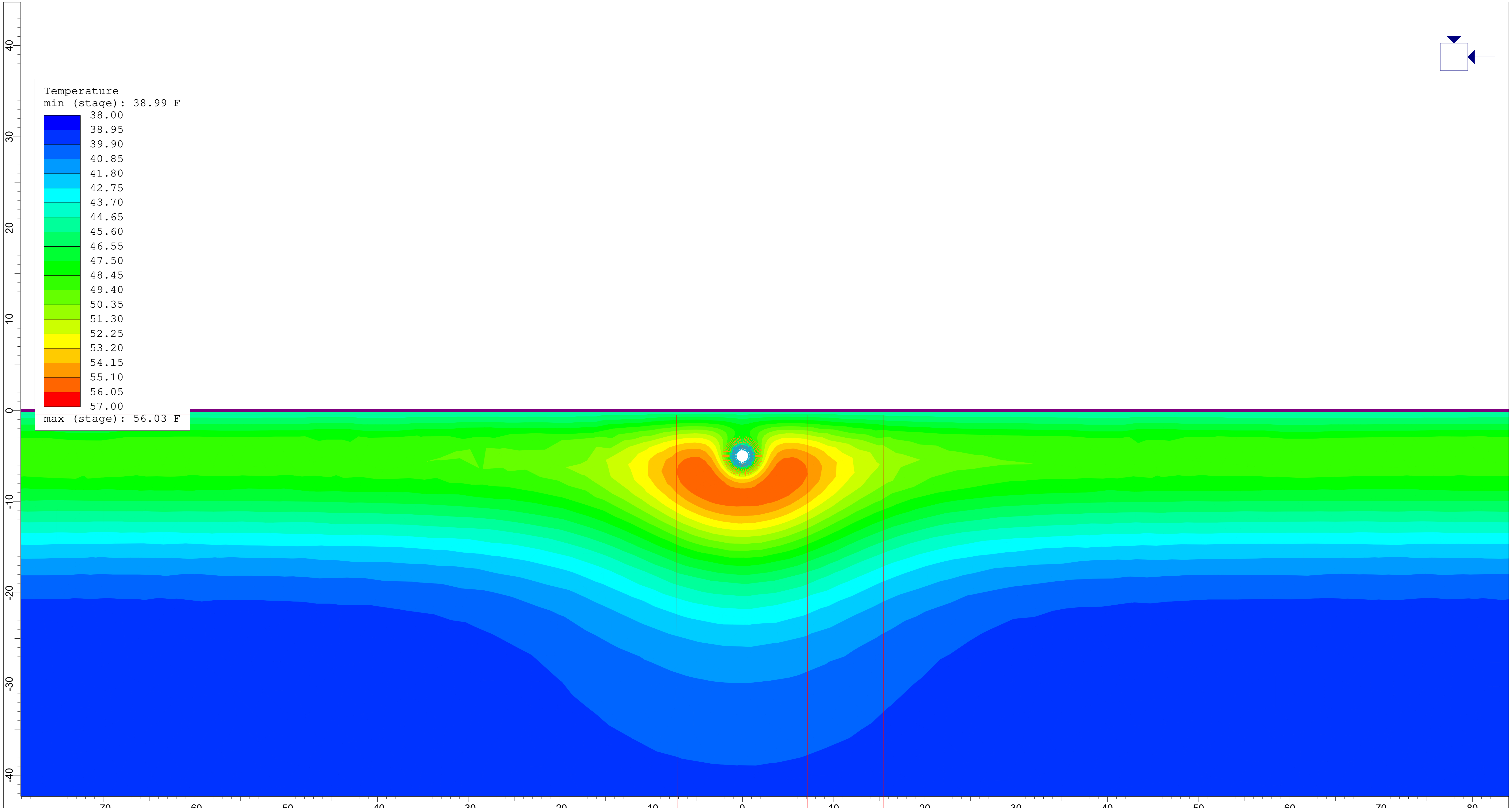


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

24IN PIPE 2 - FINE GRAIN - 35% SATURATION - OCTOBER

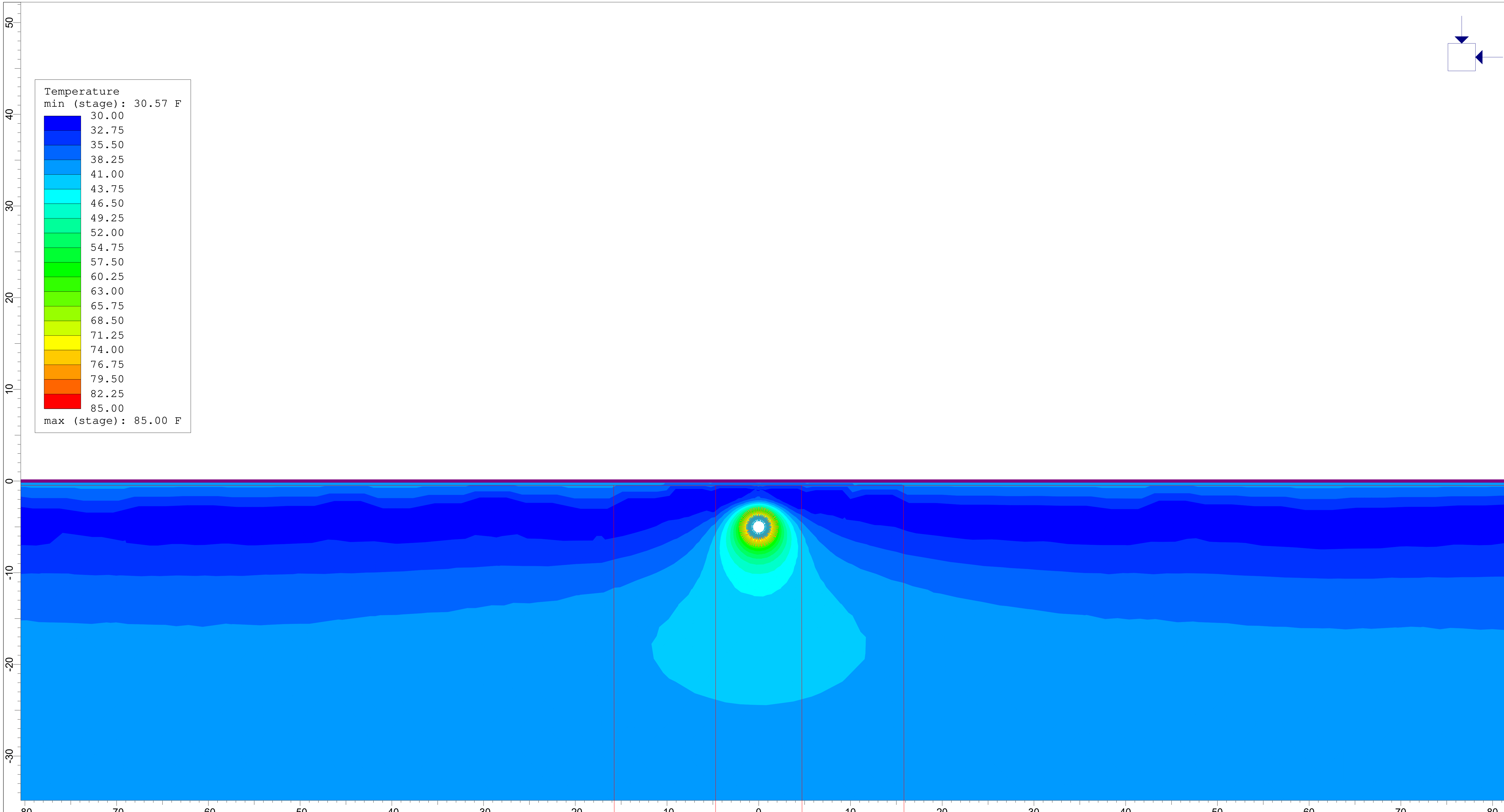


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

24IN PIPE 2 - FINE GRAIN - 55% SATURATION - APRIL

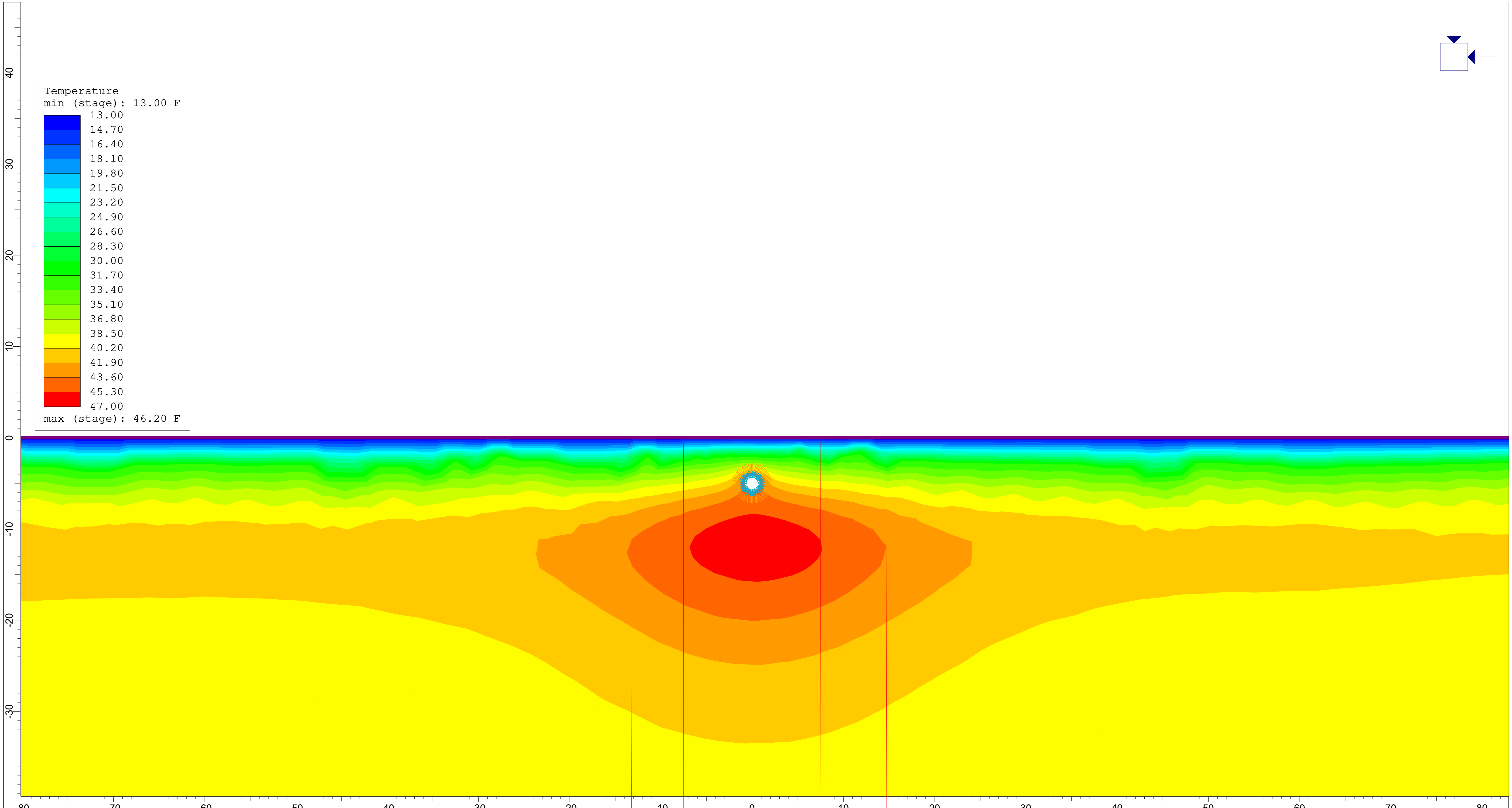


rocscience

INTERPRET 11.023

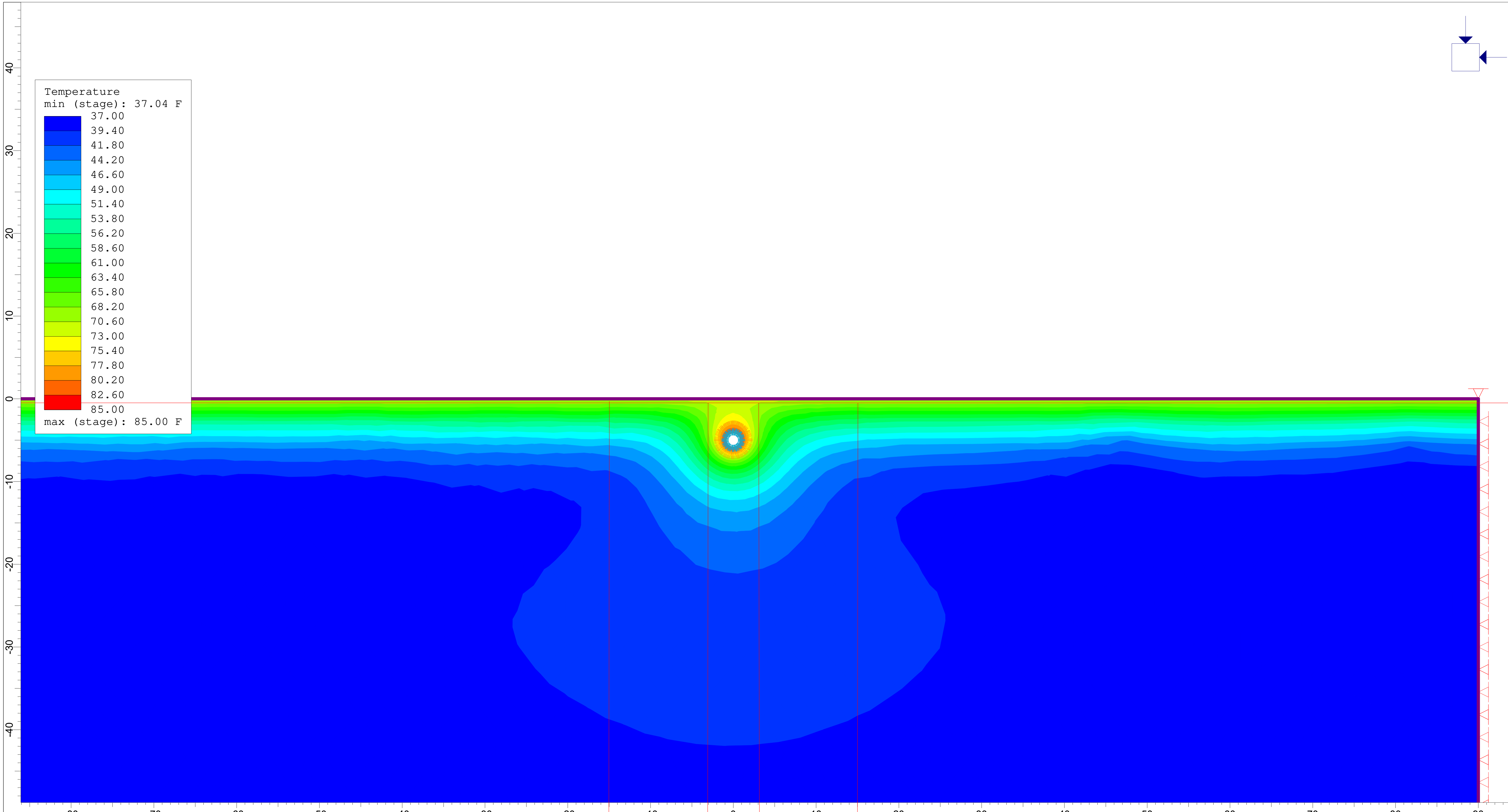
Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By	Connor Rankin	Scale	1:120
Company	Lake Superior Consulting		
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

24IN PIPE 2 - FINE GRAIN - 55% SATURATION - JANUARY



rocscience	Project: Summit Carbon - 24 Inch Pipeline (2)		
	Analysis Description: Thermal Influence		
	Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting
INTERPRET 11.023	Date: 6/3/2024, 10:56:45 AM		File Name: 24in Pipe 2.fez

24IN PIPE 2 - FINE GRAIN - 55% SATURATION - JULY

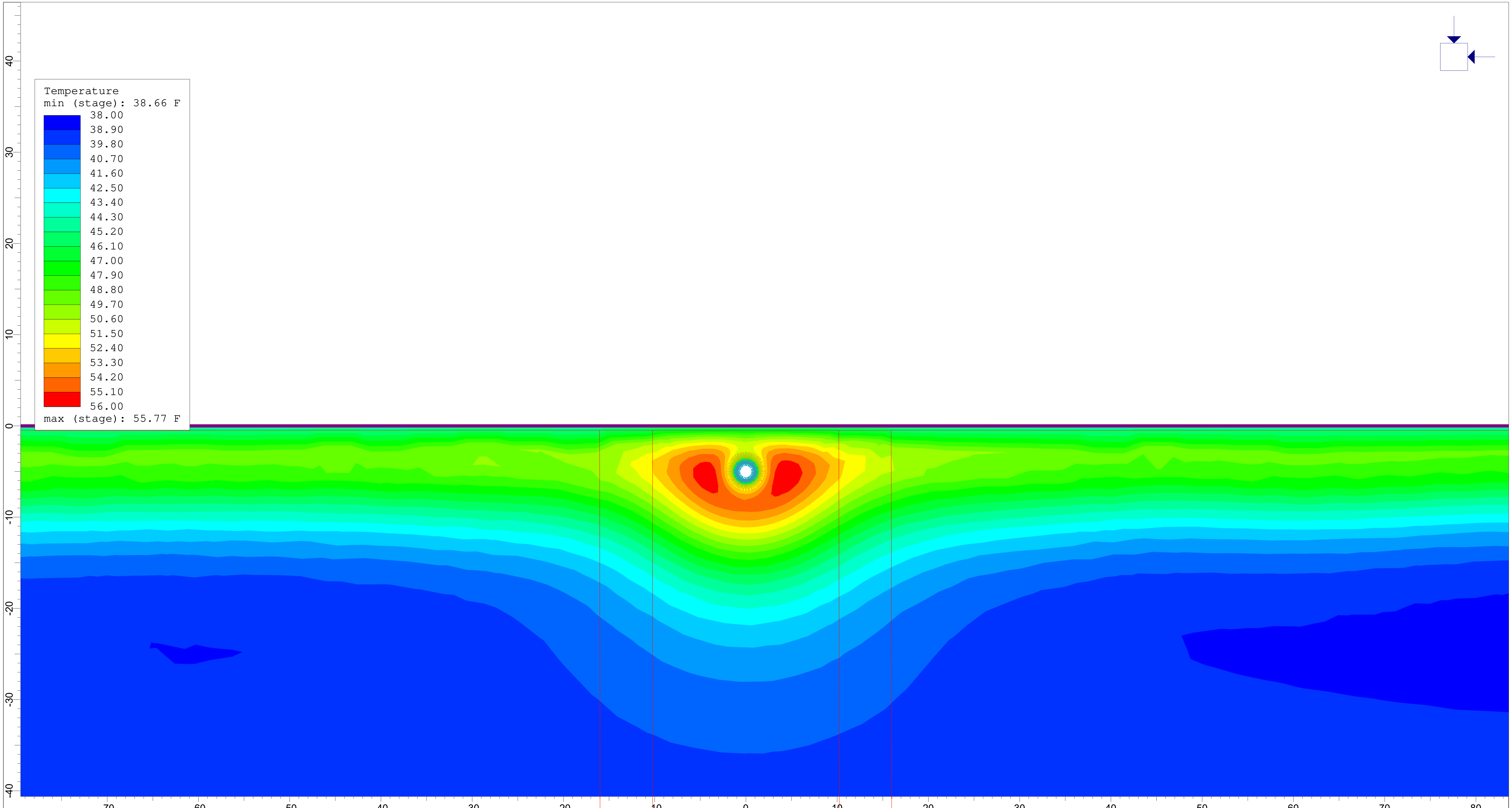


rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:133	Company	Lake Superior Consulting
Date	6/3/2024, 10:56:45 AM	File Name	24in Pipe 2.fez

24IN PIPE 2 - FINE GRAIN - 55% SATURATION - OCTOBER



rocscience

INTERPRET 11.023

Project	Summit Carbon - 24 Inch Pipeline (2)		
Analysis Description	Thermal Influence		
Drawn By: Connor Rankin	Scale: 1:120	Company: Lake Superior Consulting	
Date: 6/3/2024, 10:56:45 AM		File Name: 24in Pipe 2.fez	

CONTACT US

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info@lsconsulting.com

218.727.3141

LAKE SUPERIOR CONSULTING