

**PROJECT KICK-OFF MEETING  
MINUTES**

---

<b>Project Title</b>	A feasibility study of road/culvert bridge deck deicing using geothermal energy		
<b>Date of Meeting</b>	July,14, 2020	Time	12:00-13:00 PM

---

**1. Meeting Objective**

1. Provide everyone with policies/procedures about MDT research projects
2. Overview of the research tasks and schedule

---

**2. In Attendance**

Name	Organization	Affiliation	Role
Mohammad Khosravi	MSU	Assistant Professor	Consultant
Kathryn Plymesser	MSU	Assistant Professor	Consultant
Steve Perkins	MSU	Professor	Consultant
Mehran Pourakbar	MSU	PhD Student	Consultant
Vaneza Callejas	CTC & Associates LLC	Research and Project Associate	Research Project Manager
Susan Sillick	MDT	Research Section Supervisor	Research Programs Manager
Jeff Jackson	MDT	Geotechnical and Pavement Bureau Chief - Champion of Research Project	Technical Panel
DJ Berg	MDT	Pavement Analysis Engineer	Technical Panel
Scott Helm	MDT	Geotechnical Operations Manager	Technical Panel
Mike Murolo	MDT	Facilities Bureau Chief	Technical Panel
Drew Sielbach	FHWA	Structures Engineer	Technical Panel
Miles Yerger	MDT	Surfacing Design Supervisor	Technical Panel
Lee Grosch	MDT	Geotechnical District Manager	Technical Panel
Kyle Hanson	MDT	Bridge Engineering Specialist	Technical Panel

---

*Meeting Minutes*

<i>Agenda Item</i>	<i>Action by</i>	<i>Description of Discussion</i>
<i>Description of outline of everyone's role:</i>	Vaneza Callejas	<p>Presented some policy/procedure information</p> <p>Technical panel:</p> <ul style="list-style-type: none"> <li>• Oversees project from inception through implementation</li> <li>• Reviews all project products</li> <li>• Ensures the project stays on scope</li> <li>• Makes recommendations for MDT</li> </ul> <p>Research Project Manager:</p> <ul style="list-style-type: none"> <li>• Directs liaison between the TP and the consultant</li> <li>• Ensures that the project stays within scope and budget</li> </ul> <p>General information was provided by Vaneza to the consultant about:</p> <ul style="list-style-type: none"> <li>• Communication Protocols</li> <li>• Transferring Files</li> <li>• Meeting Rules</li> <li>• And products</li> </ul>
<i>Time extension of the project</i>	Mohammad Khosravi Vaneza Callejas Susan Sillick	<p>Mohammad:</p> <ul style="list-style-type: none"> <li>• asked about possible delay in the project due to COVID19 and how to address them during the project?</li> </ul> <p>Vaneza and Susan:</p> <ul style="list-style-type: none"> <li>• If there are some tasks still pending for the project due to any risks (e.g. COVID19), the consultant should address it in the risk section of the QPR, then the project managers can extend the time of the project after evaluating the risk effects on the project.</li> <li>• For COVID-19 delays, the researcher should also send the Research Project Manager (Vaneza) an email informing of the delay and requesting a time extension, if necessary. If a delay is affecting a due date deliverable, we should issue a contract amendment.</li> </ul>

<i>Presentation of Proposal</i>	Mohammad Khosravi	<p>A feasibility study of road culvert/bridge deck deicing using geothermal energy</p> <ul style="list-style-type: none"> <li>• Application of geothermal foundation</li> <li>• Research Objective</li> <li>• Overview of task and schedule</li> <li>• Literature Review</li> <li>• Research Plan</li> </ul>
<i>Discussion</i>	Jeff Jackson	<ul style="list-style-type: none"> <li>• Asked MDT panel to be more involved in the panel and provide TP with their comments.</li> <li>• Clarified that MDT is willing to provide any essential information for the project, however, the consultants should consider a lead time of about a month or two to receive those information.</li> </ul>



## A Feasibility Study of Road Culvert / Bridge Deck Deicing Using Geothermal Energy

Department of Civil Engineering  
Montana State University

July 14, 2020



Mountains & Minds

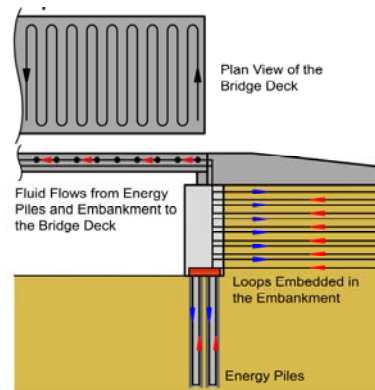
### RESEARCH TOPIC

#### **Title: A Feasibility Study of Road Culvert / Bridge Deck Deicing Using Geothermal Energy**

*Application of geothermal foundation or boreholes for deicing of bridge decks and road culverts.*



*Sidewalk heating in operation (Eugster, 2007)*

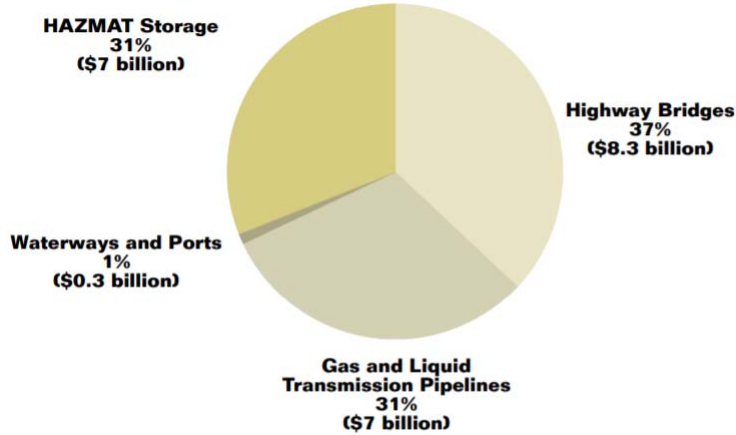


*(Olgun and Bowers, 2013)*



Mountains & Minds

## RESEARCH OBJECTIVES



*Annual cost of corrosion in the infrastructure category  
(Koch et al, 2002).*



**MONTANA**  
STATE UNIVERSITY

College of  
**ENGINEERING**

Mountains & Minds

## RESEARCH OBJECTIVES

- Primary Objective:
  - Investigate the feasibility of the use of a Ground Source Heat Pump (GSHP) system that utilizes heat energy harvested from the ground as an alternative for deicing bridges and road culverts.
  - Define important design requirements and operational considerations.
- Secondary Objective:
  - Study the potential use of bio-mediated soil improvement and higher thermal conductive concrete to improve the efficiency of ground source heat pump systems

*If successful, the novel technology will: 1) improve the safety of driving in the inclement weather conditions, and 2) extend the service life of bridge deck and culvert.*



**MONTANA**  
STATE UNIVERSITY

College of  
**ENGINEERING**

Mountains & Minds

## OVERVIEW OF TASKS AND SCHEDULE

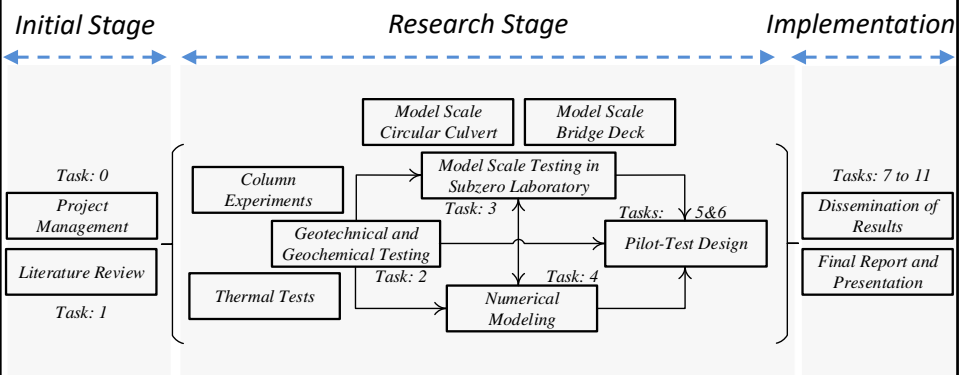


MONTANA STATE UNIVERSITY

College of ENGINEERING

Mountains & Minds

## OVERVIEW OF TASKS



MONTANA STATE UNIVERSITY

College of ENGINEERING

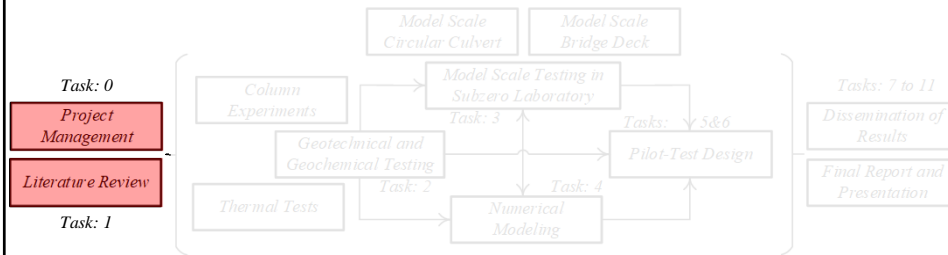
Mountains & Minds

## OVERVIEW OF TASKS

### Initial Stage

Task 0: Project Management

Task 1: Literature Review



## OVERVIEW OF SCHEDULE

Research Task	Time Schedule																													
	Year 1				Year 2				Year 3																					
	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
<b>Task #0: Project Management</b>																														
Task #0.1 - TP Meeting #1: kick-off meeting																														
Deliverable: TP meeting attendance, presentation, minutes and notes																														
<b>Task #1: Literature Review</b>																														
Task 1 report: Literature Review																														
Deliverable: Task 1 report and quarterly progress reports																														
<b>Task #2: Geotechnical and Geochemical Testing and Analysis</b>																														
Task #2.1 - Thermo-Mechanical (T-M) Experiments of Soils and Concrete																														
Deliverable: Task 2.1 report and quarterly progress reports																														
Task #2.2 - Model-Scale Experiments in MSST's Subzero Lab																														
Task #2.3 - Model design and construction																														
Task #2.4 - Model testing in Subzero Research Lab (SRL)																														
Task #2.5 - Laboratory data analysis																														
Task #2.6 - TP Meeting #2																														
Deliverable: Task 2 report																														
<b>Task #3: Numerical Modeling</b>																														
Task #3.1 - Model development and validation																														
Task #3.2 - Synthesis of laboratory and numerical data																														
Deliverable: Task 3 report																														
<b>Task #4: Pilot-Test Design</b>																														
Task #4.1 - Pilot-Test Design																														
Deliverable: Task 4 report																														
<b>Quarterly Progress Reports</b>																														
Deliverable: Quarterly Progress Reports																														
<b>Task #5: Draft Final Report</b>																														
Deliverable: Draft Final Report																														
<b>Task #6: TP Meeting #4</b>																														
Deliverable: TP meeting attendance, presentation, minutes and notes																														
<b>Task #7: Draft Implementation and Performance Metrics Report</b>																														
Deliverable: Implementation and Performance Metrics Report																														
<b>Task #8: Draft Project Summary Report</b>																														
Deliverable: Project Summary Report																														
<b>Task #9: Final Report, Website, and Presentation</b>																														
Deliverable: Final Report and Presentation																														

## OVERVIEW OF TASKS

### Research Stage

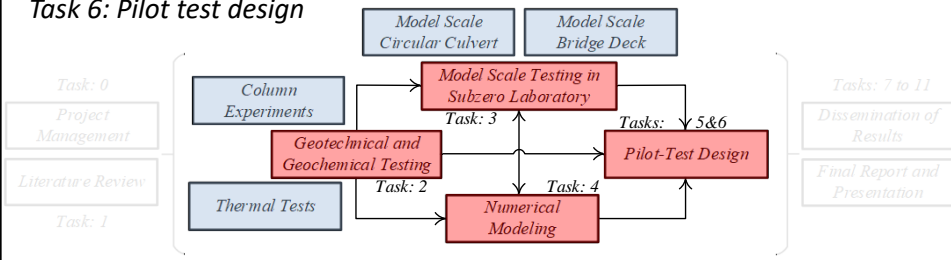
Task 2: Geotechnical and geochemical testing and analysis

Task 3: Model-scale instrumented experiments on both culvert and bridge deck systems in MSU's Subzero Research Laboratory (SRL)

Task 4: Numerical modeling

Task 5: TP Meeting #3

Task 6: Pilot test design



## OVERVIEW OF SCHEDULE

Research Task	Time Schedule																																									
	Year 1												Year 2												Year 3																	
	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
<b>Task #0: Project Management</b>	Time Frame:																																									
Task #0.1 - TP Meeting #1	Task 2: Geotechnical Testing and Analysis: Dec 2020 – May 2021																																									
Deliverable: TP meeting #1																																										
Task #1: Literature Review																																										
Task 1 report: Literature Review																																										
Deliverable: Task 1 report																																										
<b>Task #2: Geotechnical and Geochemical Testing and Analysis</b>																																										
Task #2.1 - Thermo-Mechanical (TM) Experiments of Soils and Concretes																																										
Deliverable: Task 2 report and quarterly progress reports																																										
<b>Task #3: Model-Scale Experiments in MSU's Subzero Lab</b>																																										
Task #3.1 - Model design and construction																																										
Task #3.2 - Model testing in Subzero Research Lab (SRL)																																										
Task #3.3 - Laboratory data analysis																																										
Task #3.4 - TP Meeting #2																																										
Deliverable: Task 3 report and quarterly progress reports																																										
<b>Task #4: Numerical Modeling</b>																																										
Model development and validation																																										
Synthesis of laboratory and numerical findings																																										
Deliverable: Task 4 report and quarterly progress reports																																										
<b>Task #5: TP Meeting #3</b>																																										
Deliverable: TP meeting attendance, presentation, minutes and notes																																										
<b>Task #6: Pilot-Test Design</b>																																										
Pilot test design																																										
Deliverable: Task 6 report																																										
Quarterly Progress Reports																																										
Deliverable: Quarterly Progress Reports																																										
Task #7: Draft Final Report																																										
Deliverable: Draft Final Report																																										
Task #8: TP Meeting #4																																										
Deliverable: TP meeting #4																																										
Task #9: Draft Implementation																																										
Deliverable: Implementation																																										
Task #10: Draft Project Summary																																										
Deliverable: Project Summary																																										
Task #11: Final Report, Website, and Presentation																																										
Deliverable: Final Report and Presentation																																										



## OVERVIEW OF TASKS

### Implementation

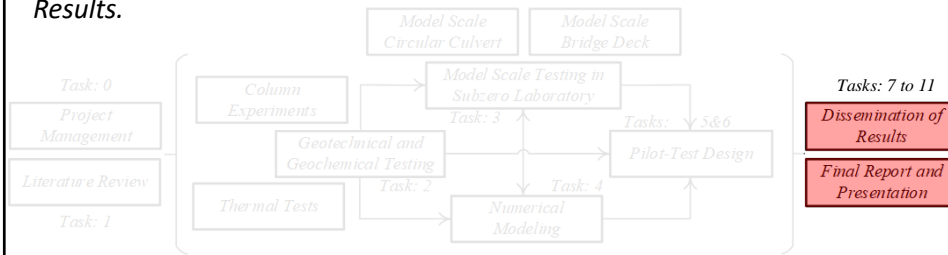
Task 7: Draft Final Report.

Task 8: TP Meeting #4.

Task 9: Draft Implementation and Performance Measures Reports.

Tasks 10: Draft Project Summary Report.

Tasks 11: Final Report, Webinar, Presentation, and Dissemination of Results.



## OVERVIEW OF SCHEDULE

Research Task	Time Schedule																													
	Year 1				Year 2				Year 3																					
	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N
Task #0: Project Management Deliverable: TP Meeting #1: kick-off meeting																														
Task #1: Literature Review Deliverable: Task 1 report and quarterly progress reports																														
Task #2: Geotech Deliverable: TP																														
Task #3: Model S Deliverable: TP																														
Task #4: Numeri Deliverable: TP																														
Task #5: TP Me Deliverable: TP																														
Task #6: Pilot-Test Design Deliverable: TP																														
Quarterly Progress Reports Deliverable: Quarterly Progress Reports																														
Task #7: Draft Final Report Deliverable: Draft Final Report																														
Task #8: TP Meeting #4 Deliverable: TP meeting attendance, presentation, minutes and notes																														
Task #9: Draft Implementation and Performance Measures Reports Deliverable: Implementation and Performance Measures Reports																														
Task #10: Draft Project Summary Report Deliverable: Project Summary Report																														
Task #11: Final Report, Webinar, and Presentation Deliverable: Final Report and Presentation																														

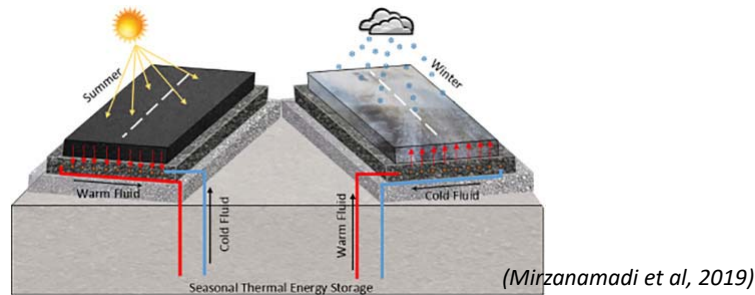
## TASK 2: LITERATURE REVIEW

## TASK 1: LITERATURE REVIEW

- *This task will include:*
  - *A definition of the problem and research question;*
  - *A theoretical context;*
  - *Methods that may be used to answer the research question with a focus on Montana climate/conditions; and,*
  - *Data resources, including availability and quality.*
- *Survey various types of bridges and culverts to select the typical bridge deck/culvert design that is used in Montana*
- *Discuss various power sources for the GSHP systems (e.g. electricity for urban area v.s. solar energy for remote areas)*
  
- *Time Frame: June 2020 – Nov 2020*

## INTRODUCTION: GROUND TEMPERATURES - HEAT EXCHANGE

- Ground source deicing: warm fluid is extracted from the energy piles and circulated in the culvert/bridge deck
- Thermal recharge: Collect solar energy during the summer and store in the ground for use in the winter



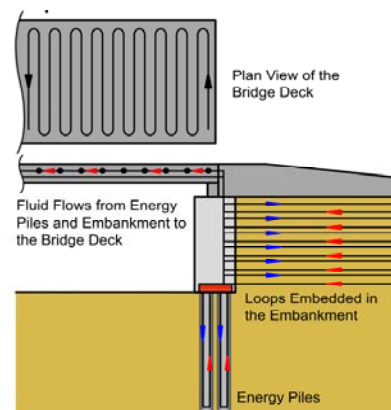
MONTANA  
STATE UNIVERSITY

College of  
ENGINEERING

Mountains & Minds

## INTRODUCTION: GEOTHERMAL BRIDGE DECK DEICING

- Heat exchanger foundation elements can:
  - be used to deice bridge decks and road culverts in the winter.
  - reduce bridge deck and culvert deterioration and aging.
- Bridge deck and the tubing system can be used for heat collection in the summer.
- In bridge deck, it can also utilize the approach embankment as a thermal mass for heat storage and extraction.



MONTANA  
STATE UNIVERSITY

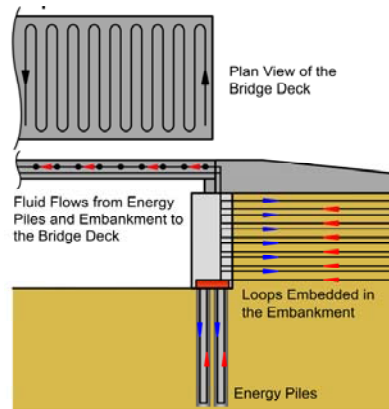
College of  
ENGINEERING

Mountains & Minds

## INTRODUCTION: GEOTHERMAL BRIDGE DECK DEICING

### Ground-source deicing:

- Fluid is warmed as it circulates through the energy piles and approach embankment and then circulated in the deck, heating the deck
- It can be operated in reverse during the summer
- It is not intended to replace mechanical ice removal

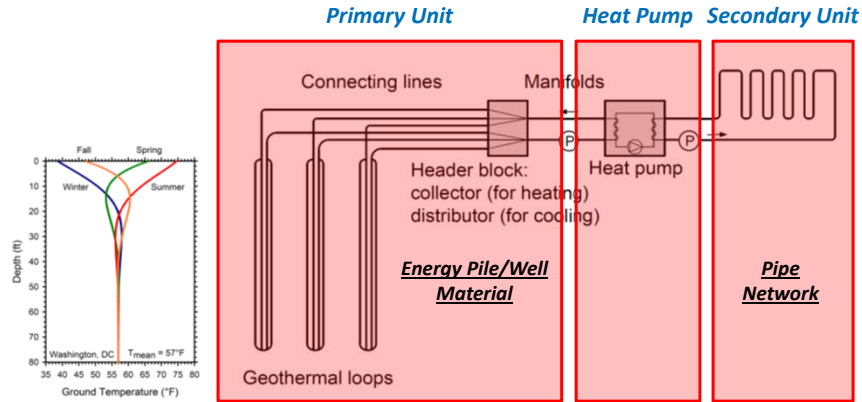


(Olgun and Bowers, 2013)

## INTRODUCTION: GEOTHERMAL BRIDGE DECK DEICING

- Basic idea has been around for a long time – make use of the heat energy stored in the ground; access this energy using heat exchangers buried in the ground (fluid-filled HDPE loops).
- In ideal conditions, these systems can provide the majority of required heating/cooling energy and significantly reduce costs and carbon footprint

INTRODUCTION: GROUND TEMPERATURES - HEAT EXCHANGE



Utilize the relatively constant temperature of the ground and use it for heating in the winter and cooling in the summer (Bowers, 2016)



MONTANA STATE UNIVERSITY

College of ENGINEERING

Mountains & Minds

TASKS 3 TO 6



MONTANA STATE UNIVERSITY

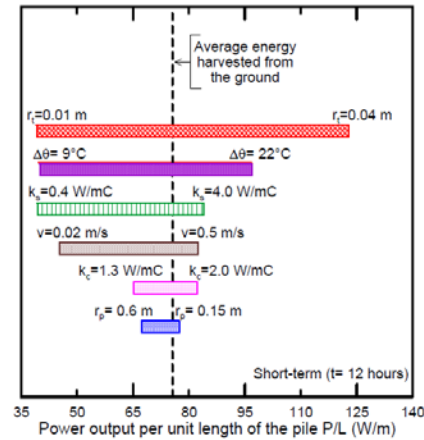
College of ENGINEERING

Mountains & Minds

## RESEARCH PLAN

Previous studies have suggested that the variation of energy harvested from the ground depends on:

- Radius of circulation tube,  $r_t$
- Initial temperature difference,  $\theta$  ( $= T_{inlet} - T_{initial}$ )
- Soil thermal conductivity,  $k_s$
- Thermal conductivity of the concrete/grout,  $k_c$



Effects of important parameters on the harvested energy (Ghasemi-Fare and Basu, 2016)



MONTANA  
STATE UNIVERSITY

College of  
ENGINEERING

Mountains & Minds

## TASK 2: GEOTECHNICAL TESTING AND ANALYSIS

- measure the mechanical and thermal properties of concrete and soil
  - Current mix design and the chemicals admixtures used by MDT will be prepared in the lab to measure their thermal conductivity of the concrete
- investigate the effect of bio-cementation and higher thermal conductive concrete on the efficiency of GSHP systems
- Time Frame: **Dec 2020 – May 2021**



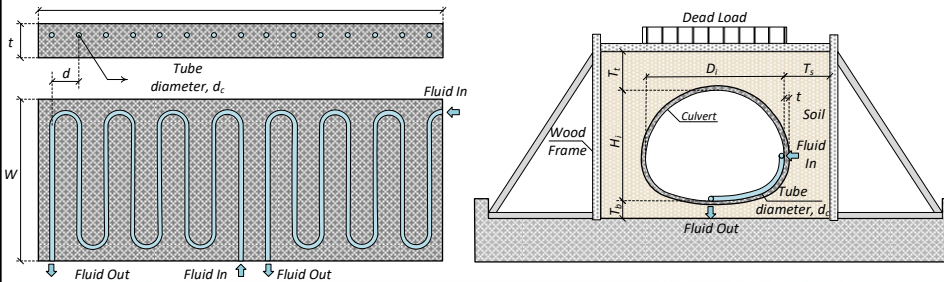
MONTANA  
STATE UNIVERSITY

College of  
ENGINEERING

Mountains & Minds

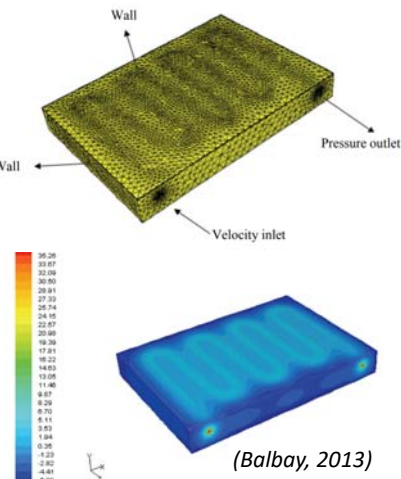
### TASK 3: MODEL-SCALE INSTRUMENTED EXPERIMENTS

- investigate snow and ice accumulation, and the efficacy of geothermal energy as a deicing alternative
- will incorporate environmental field data from a site in Montana where icing and maintenance are known to be a problem
- Time Frame: **June 2021 – May 2022**



### TASK 4: NUMERICAL MODELING

- study the heat transfer mechanism of the geothermal heat pump systems
- predict and quantify the energy harvested from the ground and energy required to de-ice the deck and culvert in different ground conditions
- quantify and optimize heat transfer within the experimental concrete bridge deck and culvert
- Time Frame: **June 2020 – Nov 2022**



## TASK 6: PILOT TEST DESIGN

- *Design based on the life cost analysis and energy required to anti-ice/de-ice the surface*
- *The pilot study will include:*
  - *an energy pile/well used to harvest thermal energy from the ground,*
  - *prototype bridge deck/culvert with a design similar to the bridge deck test performed by Bowers and Olgun (2015).*
- *Time Frame:*  
**Jan 2023 – April 2023**



MONTANA  
STATE UNIVERSITY

College of  
ENGINEERING

Mountains & Minds

## TASKS 7 TO 11



MONTANA  
STATE UNIVERSITY

College of  
ENGINEERING

Mountains & Minds



## IMPLEMENTATION

- *material detailing the design requirements and operational considerations for the use of geothermal energy in Montana as it relates to bridge decks and roadway culverts.*
- *design of a bridge deck and/or roadway culvert pilot study for an existing site within MDT's network based on the life cost analysis and energy required to anti-ice the surface.*

## OVERVIEW OF TASKS

- *Task 7: Draft Final Report.*
  - *June 2021 – May 2022*
- *Task 8: TP Meeting #4.*
  - *Aug 2023*
- *Task 9: Draft Implementation and Performance Measures Reports.*
  - *Sept 2023*
- *Tasks 10: Draft Project Summary Report.*
  - *Oct 2023*
- *Tasks 11: Final Report, Webinar, Presentation, and Dissemination of Results.*
  - *Oct 2023 - Nov 2023*

*DISCUSSION*