Design Concept
The purpose of this project was to find the ideal sieving process of a 50/50 mixture of Mt. Mazama ash and Portland cement which produced the best possible compression strength, as tested with standardized cubes.

Materials and Methods
For our slurry mixture, we converted a mortar cube mixture that was pre-determined by the Mortar Cube Testing Standards (ASTM Standard) to suit a mixture with ash from Mt. Mazama. The mixture was made up of 883g Ash, 792g Sand, 250g Cement, and 242g (+75g/100g water, depending on ash percentage of sieve) Water.

End Results
After testing the compression strength of each of our mortar cubes made from -16, -30, and –50 sieved ash at the intervals of 7, 14, and 21 days we found the past 16 to be the strongest as well as the easiest to work with. Results shown in figures 2 and 3:

<table>
<thead>
<tr>
<th># Sieve Ash Used</th>
<th>Strength of the Cubes (Avg PSI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7 days</td>
</tr>
<tr>
<td>50</td>
<td>94</td>
</tr>
<tr>
<td>16</td>
<td>598.5</td>
</tr>
<tr>
<td>50</td>
<td>598.5</td>
</tr>
</tbody>
</table>

Figure 1: The image shows the concrete compression machine used to calculate the PSI that each cube could withstand.

Figure 2: The table above shows the results of the average PSI that each of the mortar cubes were able to withstand.

Analysis
Throughout the testing process our group learned a lot about the process of making and testing mortar cubes. After reviewing the ASTM for mortar cube testing, we found there are a lot of specifications in how cubes are made. An example of this being that during the cube making process, the way in which cubes are compacted affects their strength during testing. We now know that when we are doing testing where we make an abundant number of cubes, it is important that we try to control as many variables as we can so that our data can be consistent as possible. See examples of mortar cubes in figure 4:

Figure 3: Bar graph showing results of compressive strength tests on each of the cubes at 7, 14, and 21 days.

Conclusions
With our test we were hoping to find that -16 sieved ash would provide us with the best strength of our three-testing amounts. These was –16, -30, and –50. Though the difference in the average of –30 and –16 was not that great –16 was still the strongest. This is very different from the initial mix as it consisted of –50 ash, and now being able to use –16, it will cut back a lot of the labor time and will provide us with a trail surface that is strong and ADA accessible. For better more accurate results in the future I would recommend testing more cubes to be able to set apart the outliers and get possibly more accurate results than

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Design Concept

Our group was tasked with processing the raw materials supplied for construction of the trail. This requirement translated to sifting a large quantity of ash from Mount Mazama to certain specification.

We were tasked initially with finding the ideal grain of the ash sifted, of which we were asked to provide samples of grains pass 16, 30, and 50 for the mortar-cube testing and surface applicator groups respectively.

Materials and Methods

Our group approached the project in a task-based manner, assigning weekly goals to retain progress momentum.

Materials

The materials used consisted of approximately 16 cubic meters of Mount Mazama ash, which was processed utilizing an automated sifting machine, then our group shoveled several batches of the material on sheets of tarp to dry for more effective sifting.

Final Product

The project resulted in several samples being provided to groups of interest, and an acknowledgement of the restraints our materials imposed. Our project operated on a budget of $160, which we were planning on allocating to form a contraption out of two by four wooden frames, which we would attach a wire mesh using nails; however, implementation was unfortunately unavailable due to the shipping inconveniences from the company we ordered mesh from.

Analysis

The pass 16 is the most optimal and realistic size to use for the volcanic ash. The pass 30 is ideal to use however, the issue lies in the amount that would be needed for the project. The amount of sieved ash that would gather from the pass 30 may not be enough material to complete the project. The pass 50 is too fine to be used and the amount produced will also not be enough. Therefore, we concluded from our testing that pass 16 will be most optimal. The sources of error that could have occurred are inconsistencies of the wire meshes, human error was introduced because different participants tested the other grades of meshes. Issues which still need to be resolved involve the storing of the ash, the sieving of the remainder of the ash, and lastly the transportation of the material to the site, of which will need to be figured out as well.

Acknowledgments

Funding for the project was provided by the Wingwatchers nonprofit organization. Special thanks to the ENGR 102 staff for the support.

Conclusions

After finding out that the best course of action was to sift all material to a pass 16 the next step would be to create a larger sieve that could handle more material at a time.

Acknowledgments

Funding for the project was provided by the Wingwatchers nonprofit organization. Special thanks to the ENGR 102 staff for the support.

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Design Concept
The project goals were to calculate the Embodied Carbon of our project, and the Sustainability of our project. The project measured that by comparing concrete with and without ash. This Project calculated carbon emissions of the Wing Watcher Trail project.

Embodied Carbon Calculation
This project calculated the carbon emissions using the EC3 tool. This tool can take in input variables and generate a boxplot.

Materials and Methods
This project used the EC3 tool and the Envision Rating system to evaluate our projects sustainability. Present Gantt chart.
This project tested concrete mixes that used ash in the mix to lower the carbon emissions of concrete production.
Massachusetts Institute of Technology has found that using ash in concrete mixes leads to a 16% reduced carbon emission count. This is how the projects result was calculated.

Final Product
The projects final mix was calculated to be approximately 221 kgCO2E per cubic yard. The Envision Sustainability Rating have evaluated this project to be Gold level (42% of the total applicable points).

Analysis
As the reader can see from figure 1, the project mix is below the average carbon emissions for traditional concrete mixes.
As seen in Figure 2, The Envision Rating System has evaluated the project at 42% total applicable points, which returns as a Gold award.

Conclusions
This project has calculated the efficiency and sustainability of the project and total carbon count of 50% ash mix in the concrete count. This project discovered that this method was very sustainable and has reduced the embodied carbon count compared to traditional concrete mixes. This project results prove that the work the project has done can be built upon, which can lead the world to reducing carbon emissions in construction.

Acknowledgments
Dr. Salem, Dr. Greer, Dr. Riley

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Design Concept
The surface applicator consists of three main components: a trailer, an agitator, and the applicator. Our design uses gravity to pull the aggregate out of the agitator and into the applicator. The purpose of this device is to provide an even layer of concrete that will make the Wing Watchers Trail more ADA accessible.

Methodology
The final product has changed greatly. We first started with a bucket that poured the aggregate into a PVC tube with holes, which clogged too easily. We then found that the fertilizer spreader did not clog and covered a much greater area.

Analysis
With the knowledge that the fertilizer spreader worked, we went and tested it outside with the mix the previous professor made and found that the fertilizer spreader worked well in spreading the concrete.

Learning Outcomes
We learned how to prototype a new technology/device that has not been done before.

Components
- 2” PVC pipe
- 44 gal container
- 2” bulk head fitting
- 2” valve
- Generator
- Paint mixer
- Fertilizer spreader
- Flex Seal™
- Trailer

Final Test and Conclusion
We were finally able to conduct a full test on the last day of class and the results surprised everyone. It left behind a perfect, even layer of concrete in the gravel. From the testing, it looks to fulfill are needs in applying the concrete mixture.

Acknowledgements
Dr. Ashton Greer, Pat Kile, Dr. Charles Riley, Dr. Aboubakr Salem, Caroline Schulze
**Design Concept**

Original goals were to create surveys for public input and end user reviews while providing infographics on the trail resurfacing. The measurable aspect of this portion is the data from the surveys, the surveys themselves, and the infographics, which includes a couple of brochures and an interpretive sign.

**Materials and Methods**

- **Materials**
  - Metal drop box, screws, wooden post

- **Methods**
  - 2 sub-teams
    - Build/implement materials
    - Develop surveys/brochures
  - Online survey/physical survey/QR code

**Final Product**

- **Three surveys**
  - Two were created to gather opinions before resurfacing
  - Last was created to gather opinions after resurfacing

- **Survey drop box**
  - Designed for paper surveys

- **Brochures**
  - Adult
  - Children

- **Adjustments**
  - QR Code

**Analysis**

- **Testing period**
  - Surveys presented to local organizations

- **Feedback**
  - Some see room for improvements as seen below on the two highlighted questions

**Conclusions**

- **Main Goal**
  - Method of communication with the trail users and individual groups working on related projects

- **Corrections**
  - Implement surveys sooner (physical copies and QR code)

- **Benefits**
  - Aid future projects
  - Older data to base estimations off of

**Acknowledgments**

Thank you NITC for providing funding and research for the trail resurfacing.

**For further information:**

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Design Concept
Design and check for physical and financial feasibility of an off-grid PV system for lights and/or other means of power delivery for the Wing Watcher’s Trail (WWT) to allow better trail conditions for the public and those under the ADA.

Shadow Analysis/Site Survey
Shadow analysis conducted to determine average annual efficiency loss of the PV system. A calculation method based on measured angles of obstructions was used to measure how many sun hours are lost due to the surroundings every year. This enabled us to determine if PVs were physically feasible of being used within the WWT area.

Materials and Methods
A budget was based on the average environmental grant award size of $14,000. Costs of shipping was not accounted for due to supply chain issues with COVID-19, nor cost of labor as the proposal could be turned into a student project. System was designed with a “bare-bones” mentality to minimize price and a 15% additional cost was added to account for incidentals. Materials were chosen based on cheapest price and system requirements. System requirements were determined through prior knowledge of topics, like electricity and circuitry, and through the plethora of online calculators and off-grid design websites freely available on the internet.

Final Product
The solar feasibility section of the trail improvement did not require a physical final product. We were made aware that WW did not even need lighting in this project. Based on our own set target of $14k, we successfully made a system with material costs below this target. Original plans had energy requirements that would’ve exceed our budget and had to be reworked to an acceptable level.

Conclusions
Although it is feasible, putting any sort of PV system with lighting on this trail would not be reasonable. The money going toward this project would not be worth the outcome—which is part of the reason it was not funded. That being said, feasibility of the use of PV panels to power an off-grid system on the WWT was confirmed. To improve our design, we would consider consulting a professional engineering firm on their design choices and have the ability to test different types of panels. After having success with this project, there is a possibility to provide an alternative proposal with more efficient power supplies and materials that accounts for labor, shipping costs, and cost of maintenance. Our success with the lights and panels could encourage other similar local projects to lean towards using PVs as a generation source.

Acknowledgments
Ashton Greer, Aboubakr Salem, Jennifer Berdyugin, Wingwatcher team

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Analysis
We learned how expensive storage is compared to PV panels, as well as the requirements for sustaining power when solar power is not accessible. Our initial battery bank size and days operating with no sunlight was too much for our budget.

Figure 1: WWT near most viable zone for project
Figure 2. The clinometer used for shadow analysis
Figure 3: Resulting Solar Sun chart from clinometer
Figure 4. Basic PV System Schematic with integral circuitry components
Figure 5. Simplified Bill of Materials for PV System
Design Concept
- Our goals were to make a functioning vibration sensor and outline the ADA requirements for the trail.
- Measurable aspects were the amount of vibration on the wheelchair and the required measurements for ADA access.

Vibration Calculation
- We built a vibration sensor using an arduino microcontroller.
- We set a threshold amount of vibration so that on smooth indoor concrete we would not pick up anything. Then on a rough surface we would sense a lot of vibration and this data would be displayed on our computer.

ADA Assessment
Width: Min 32 in., goal 36 in. min, 60 in. min for passing/turning
Slope: Max 10% grade, goal 5% grade max for parallel; Max 3% grade for perpendicular

Materials and Methods
- Our methodology was to build a wheelchair mounted vibration sensor.
- Derek/Logan focused mainly on the sensor while Hunter/Tyler were on the ADA compliance side.
- Materials were selected for use based on cost and reliability.
- Electronic components were sourced to provide sufficient readings with minimal component connections, and tested for adequate survivability for field conditions.
- Data was collected by going over various surfaces with the wheelchair sensor.
- Results are as followed

Final Product
Our finished product is a wheelchair vibration sensor to measure the smoothness of different surfaces to compare to Mazama Ash concrete. We deviated from our original plan slightly as there was supply chain issues and we were not able to obtain the case for the sensor, otherwise the original plan was followed through. Our budget was $100 while only $50 was used.

Analysis
- We learned that most man made surfaces have less vibration than natural ones.
- We learned this by looking at our results and seeing that outdoor concrete and indoor concrete and the gravel path had the least amount of vibration.
- Overall our analysis of data concludes the outdoor concrete of Mazama Ash/P cement would be safe for a wheelchair.
- Our Gantt Chart is below

Conclusions
- Prototype is viable for field work.
- Improvements can be made to the casing and attachment to the wheelchair.
- Clear difference found in different surfaces.
- Concrete had a severe difference with testings then Grass and Gravel.
- Due to the degraded nature of the Geo-trail some testings were undeterminable.
- Trail is already ADA compliant, smoother surface needed.

Acknowledgments
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Project Goal
The goal of the surveying and mapping group is to accurately survey the trail, as well as make a topographical map and plot the change of elevation we see throughout the trail.

The measurable aspect that can be defined, consists of the elevation of the contour lines.

Elevation Calculation
Using a differential leveling method the team began the survey. Recording the backsight (BS) and foresight (FS) at each tripod’s location utilizing the leveling rods and measuring the height of the instrument (HS) the data was put into the field notes for later editing if the data from the GPS was faulty. Once the trail data was collected, it was compared to data collected from Google Earth and then put into “Civil3D”.

Final Product
Using the data from Google Earth and from the differential leveling a topographical map was made.

Figure 1: Wing Watcher’s Map

Figure 1 shows the resulting map along with the trail highlighted in green. From the differential leveling a table of elevation values was made and assessed for error.

Table 1: Differential Leveling (Measured in Feet)

<table>
<thead>
<tr>
<th>BM</th>
<th>STA</th>
<th>BS (+)</th>
<th>HI</th>
<th>FS (-)</th>
<th>ELEV. ADJ. ELEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.65</td>
<td>4070</td>
<td>4074.65</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TP1</td>
<td>2.78</td>
<td>4.1</td>
<td>4070.55</td>
<td>4070.56</td>
<td></td>
</tr>
<tr>
<td>TP2</td>
<td>2.75</td>
<td>6.19</td>
<td>4067.14</td>
<td>4067.15</td>
<td></td>
</tr>
<tr>
<td>TP3</td>
<td>5.29</td>
<td>2.63</td>
<td>4067.26</td>
<td>4067.27</td>
<td></td>
</tr>
<tr>
<td>TP4</td>
<td>4.61</td>
<td>4.67</td>
<td>4067.88</td>
<td>4067.89</td>
<td></td>
</tr>
<tr>
<td>TP5</td>
<td>3.93</td>
<td>3.86</td>
<td>4068.63</td>
<td>4068.64</td>
<td></td>
</tr>
<tr>
<td>TP6</td>
<td>4.77</td>
<td>4.69</td>
<td>4067.87</td>
<td>4067.88</td>
<td></td>
</tr>
<tr>
<td>TP7</td>
<td>2.96</td>
<td>5.4</td>
<td>4067.24</td>
<td>4067.25</td>
<td></td>
</tr>
<tr>
<td>TP8</td>
<td>6.75</td>
<td>3.09</td>
<td>4067.11</td>
<td>4067.11</td>
<td></td>
</tr>
<tr>
<td>TP9</td>
<td>4.83</td>
<td>3.35</td>
<td>4070.51</td>
<td>4070.52</td>
<td></td>
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<tr>
<td>BM</td>
<td>5.46</td>
<td>4069.88</td>
<td>4069.89</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2: Illustration of Leveling

Analysis
Looking at the topographic map shows that the trail’s path does not experience much change in elevation. This observation can be confirmed by looking at the elevation profile generated from the topographic map shown in Figure 2.

Figure 3: Wing Watcher’s Profile

Conclusions
From the measurements of the trail elevation recorded and observed it does not seem like slope will be a major consideration when looking for more ways to improve the Wing Watcher’s trail. If this analysis was done again it would be better to ensure the GPS used provides accurate measurements. Additionally, looking for topographic data that is fully accurate, by taking the roads and lake into account, could improve the final topographic map.

Acknowledgments
Dylan Anspach, ENGR 102 TA
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Abstract

Task: Responsible for determining the best methods of stormwater management in the process of resurfacing the Wingwatchers Trail.

Goal: collect samples of the trail and carry out tests that could produce quantifiable measurements regarding the rate of infiltration from the Old Trail surface versus the New Trail Surface.

Method

Survey of the Trial site to collect soil samples.

Constant Head Permeability Test to determine the permeability coefficient and soil moisture content.

Runoff Calculations to calculate peak flow.

Develop a drainage infrastructure plan.

Runoff Calculations

\[ Q = C i A \]

Where:

\[ Q = \text{Runoff in ft}^3/\text{s} \]
\[ C = \text{Runoff Coefficient} \]
\[ i = \text{Rainfall Intensity in/hr} \]
\[ A = \text{Area of Watershed} \]

Time of Concentration

\[ t_c = 0.0078 L^{0.77} \left( \frac{E_2 - E_1}{L} \right)^{0.385} \]

\[ E_2 - E_1 = \text{Elevation Difference of Farthest point of Watershed} \]
\[ L = \text{Distance of Farthest point of Watershed} \]

\[ t_c = \text{Time of Concentration} \]

Analysis

In each location where data was obtained the Coefficient of Permeability was very low and most of the soil will easily drain water overtop without soaking in (Figure 4).

The peak flow calculations for before and after construction shows the minimal change that will occur as the trail is renovated (Figure 3).

Developing a Solution

Conclusion: minimal drainage infrastructure is required in this section of the trail.

Plan: implement a channel drain in between sections of the paved trail.

- Allows water to easily run across the trail without causing stagnant water to build up and lay in the middle of the trail.

Impact: Ensures that the new top coating being applied will last for years to come.

- Prevent future problems with potholes or wet areas that could inhibit those who are disabled from using the trail.

For further information

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Introduction:

Oregon Tech was approved for a grant to resurface a quarter mile stretch of the Wingwatchers trail, located on Lake Ewauna. Former professor Dr. Sleep's plan was to use a mixture of Mt. Mazama ash and Portland cement. The existing surface was tested to ensure a successful ADA application. Multiple tests took place including sieve, proctor, rotational penetrometer, water percentage, and sand cone to analyze characteristics compaction, density, water composition, and grade.

Analysis:

Table 1: Sample labels and information

<table>
<thead>
<tr>
<th>Sample</th>
<th>Depth (in)</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top 1</td>
<td>0” - 3”</td>
<td>42°43’34” N</td>
<td>121°47’24” W</td>
</tr>
<tr>
<td>Bottom 1</td>
<td>3” to 6”</td>
<td>42°43’34” N</td>
<td>121°47’24” W</td>
</tr>
<tr>
<td>Top 2</td>
<td>0” - 2”</td>
<td>42°43’00” N</td>
<td>121°47’25” W</td>
</tr>
<tr>
<td>Bottom 2</td>
<td>2” to 5”</td>
<td>42°43’00” N</td>
<td>121°47’25” W</td>
</tr>
<tr>
<td>Top 3</td>
<td>0” - 2”</td>
<td>42°43’25” N</td>
<td>121°47’03” W</td>
</tr>
<tr>
<td>Top 4</td>
<td>0” - 1”</td>
<td>42°43’11” N</td>
<td>121°47’05” W</td>
</tr>
</tbody>
</table>

Table 2: Calculated water percent and recorded values per sample

<table>
<thead>
<tr>
<th>Sample</th>
<th>Water Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top 1</td>
<td>6.29%</td>
</tr>
<tr>
<td>Top 2</td>
<td>18.34%</td>
</tr>
<tr>
<td>Top 3</td>
<td>7.17%</td>
</tr>
<tr>
<td>Top 4</td>
<td>22.18%</td>
</tr>
<tr>
<td>Bottom 1</td>
<td>9.74%</td>
</tr>
<tr>
<td>Bottom 2</td>
<td>20.45%</td>
</tr>
</tbody>
</table>

Table 3: Sieve sizes and measured weights of percent finer for each sample

<table>
<thead>
<tr>
<th>Sample</th>
<th>Sieve Size (in)</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
<th>Sample 4</th>
<th>Sample 5</th>
<th>Sample 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Top 1</td>
<td>0” - 3”</td>
<td>50</td>
<td>30</td>
<td>50</td>
<td>30</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>Bottom 1</td>
<td>3” to 6”</td>
<td>50</td>
<td>30</td>
<td>50</td>
<td>30</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>Top 2</td>
<td>0” - 2”</td>
<td>30</td>
<td>20</td>
<td>30</td>
<td>20</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Bottom 2</td>
<td>2” to 5”</td>
<td>30</td>
<td>20</td>
<td>30</td>
<td>20</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Top 3</td>
<td>0” - 2”</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>Top 4</td>
<td>0” - 1”</td>
<td>150</td>
<td>75</td>
<td>150</td>
<td>75</td>
<td>150</td>
<td>75</td>
</tr>
</tbody>
</table>

Table 4: Rotational penetrometer average values for firmness and stability

<table>
<thead>
<tr>
<th>Location</th>
<th>Firmness (mm)</th>
<th>Stability (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location 1</td>
<td>0.1568</td>
<td>0.2452</td>
</tr>
<tr>
<td>Location 2</td>
<td>0.1886</td>
<td>0.4016</td>
</tr>
<tr>
<td>Location 3</td>
<td>0.1727</td>
<td>0.3234</td>
</tr>
<tr>
<td>Calibration</td>
<td>0.173</td>
<td>0.323</td>
</tr>
</tbody>
</table>

Table 5: Sand cone values

<table>
<thead>
<tr>
<th>Trial</th>
<th>Density Calibration</th>
<th>Cone calibration factor</th>
<th>Volume of test hole</th>
<th>Wet Density</th>
<th>Dry density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td>96.5</td>
<td>3.872</td>
<td>0.009426</td>
<td>353.929</td>
<td>101.699</td>
</tr>
<tr>
<td>Trial 2</td>
<td>96.5</td>
<td>3.872</td>
<td>0.001527</td>
<td>353.929</td>
<td>309.89</td>
</tr>
</tbody>
</table>

Method: Water Percentages: Collect soil from trail, measure mass of wet soil using equation 1. The soil was then dried in the oven to remove all water content. Equation 2 was next used to find water percent. X = soil in can, y = can, and z = soil. Proctor: Collected 5 lbs. of dried soil, added 5% of water from total weight of soil, mixed, added soil into mold where we smashed it a total of 75 times to fully compact wet soil. The purpose was to find optimum moisture content. We then used equation 1 to find soil mass. We continued process until weight of soil decreased. This told us water percent in each soil sample. We used equation 2 to find water percent. After removing the soil from the hole, the sand cone system was used to find the density of the soil. The system was weighed, and Equation 1 was used to determine the amount of sand that had been used. Using preliminary data, the volume of the hole was calculated and compared with the density of the soil to find the compaction of the trail. Two trials of the sand cone test were conducted.

Sand Cone: The purpose was to find the density of the soil. A small hole was dug on the trail surface within the circumference of the sand cone base plate. The soil removed from the hole was collected, weighed, and the water percent was found. After removing the soil from the hole, the sand cone system was used to find the density of the soil. The system was weighed, and Equation 1 was used to determine the amount of sand that had been used. Using preliminary data, the volume of the hole was calculated and compared with the density of the soil to find the compaction of the trail. Two trials of the sand cone test were conducted.

Conclusion:

In conclusion, water percent, stiffness, density and the grade of the soil have been collected and analyzed giving adequate information about the existing surface characterization. This data can be used in the future when this trail is actually resurfaced. The sieve test found that along the trail the soil is well graded. The rotational test found that the firmness of the trail’s soil, showed similarities to smooth concrete within .03mm, also that the trail is significantly less stable than smooth concrete. The proctor test found that the amount of water preferred in the soil is, and it compared similar to what was present in the water percentage test. Lastly, the sand cone test discovered the density of the trails soil and how dense it is in relation to water percentage.

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Design Concept
The goal was to create a functioning pedestrian sensor which could accurately and consistently count people. The success of our project was primarily based on whether our sensor could count people or not.

Materials and Methods
We used a HiLetgo AM312 mini pyroelectric infrared human sensor, ELEGOO Uno R3, and an LCD display.

The sensor can detect a max of 3-5 meters, which is large enough to detect the largest width of the trail, 5ft, without infringing on the path.

Final Product
Our final product is a pedestrian sensor consisting of an infrared human sensor, ELEGOO Uno R3 microcontroller, and an LCD display screen that effectively counts people walking in front of it. There were no feasible changes to be made from our original design.

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Conclusions
The use of a camera instead of an infrared sensor would decrease error and could give more detailed readings. If we could this again, next time we would add a 3D printed protective case. As of right now if we were to put our sensor on the trail, it could easily be damaged by weather, humans, animals, etc. We believe that a 3D printed protective case would solve this problem.

Materials and Methods

- HiLetgo AM312 mini pyroelectric infrared human sensor
- ELEGOO Uno R3
- LCD display

Analysis
We learned that counting the rising edge rather than when the sensor is active will give a more accurate result. We found that the sensor struggles to differentiate when two people walk in front of it and will often count only one person. This is simply beyond the capabilities of an infrared sensor and can almost only be resolved using a camera.