ENGR102 – Introduction to Engineering II Mix Design

Concrete Crew

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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.

Figure 1: Local wing watchers trail here in Klamath Falls

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.

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

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:

# Sieve Ash Used	Strength of the Cubes (Avg PSI)		
	7 days	14 days	21 days
-50	301	707	0
-30	528.5	811	853.5
-16	984.5	877.5	1042.5

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

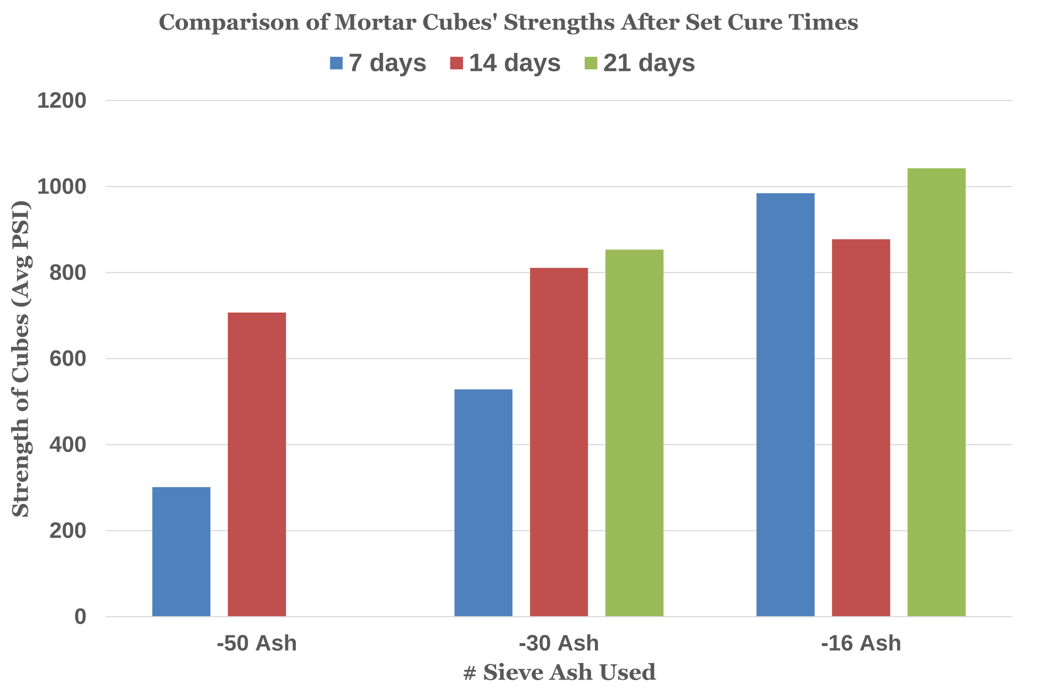

Figure 3 : Bar graph showing results of compressive strength tests on each of the cubes at 7, 14, and 21 days

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 4: Two -16 ash mortar cubes

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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ENGR102 – Introduction to Engineering II Wing Watchers Trail Mass Material Handling

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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.

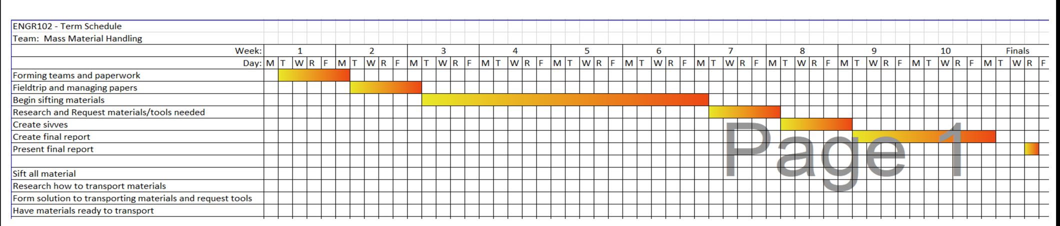

Figure 1. Illustrates the Gantt chart created by our group to map out and keep pace with various aspects of the project.

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 unviable 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.

U.S. Sieve Size	Opening in mm	Opening in inches
No. 16	1.19	0.0469
No. 30	0.595	0.0234
No. 50	0.297	0.0117

Figure 2. Chart describes the different sizes of sieves and their opening measurements in different units.

Sieve size	Total Ash (lbs.)	Usable Ash (lbs.)	Waste (lbs.)	Usable Ash Percentage	Waste Percentage
No. 16	5.0705	4.3310	0.6675	85.42 %	13.16%
No. 30	5.0130	3.460	1.4575	69.18%	29.07%
No. 50	5.0790	1.5490	3.3620	30.50%	66.19%

Figure 3. Chart describes the amount of different sized ash collected from a 5 lbs. sample

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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ENGR102 – Introduction to Engineering II Wing Watcher Trail Embodied Carbon and Sustainability

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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.

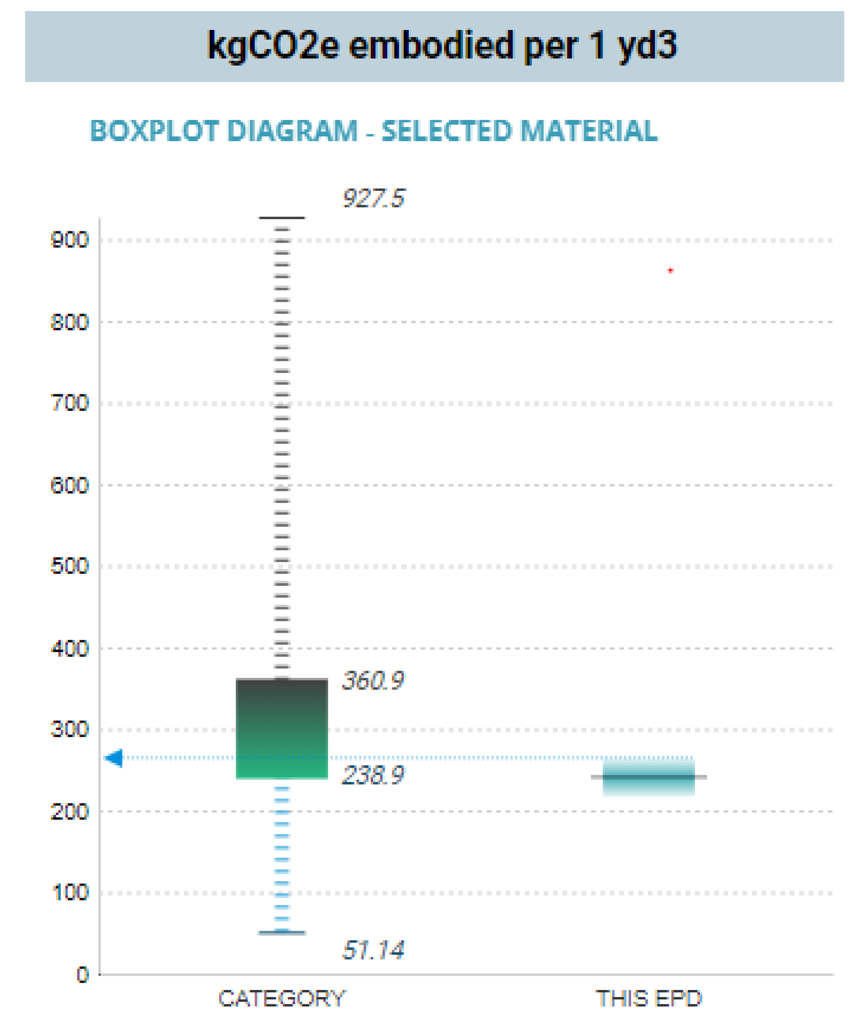

Figure 1. Boxplot of potential carbon emissions.

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).

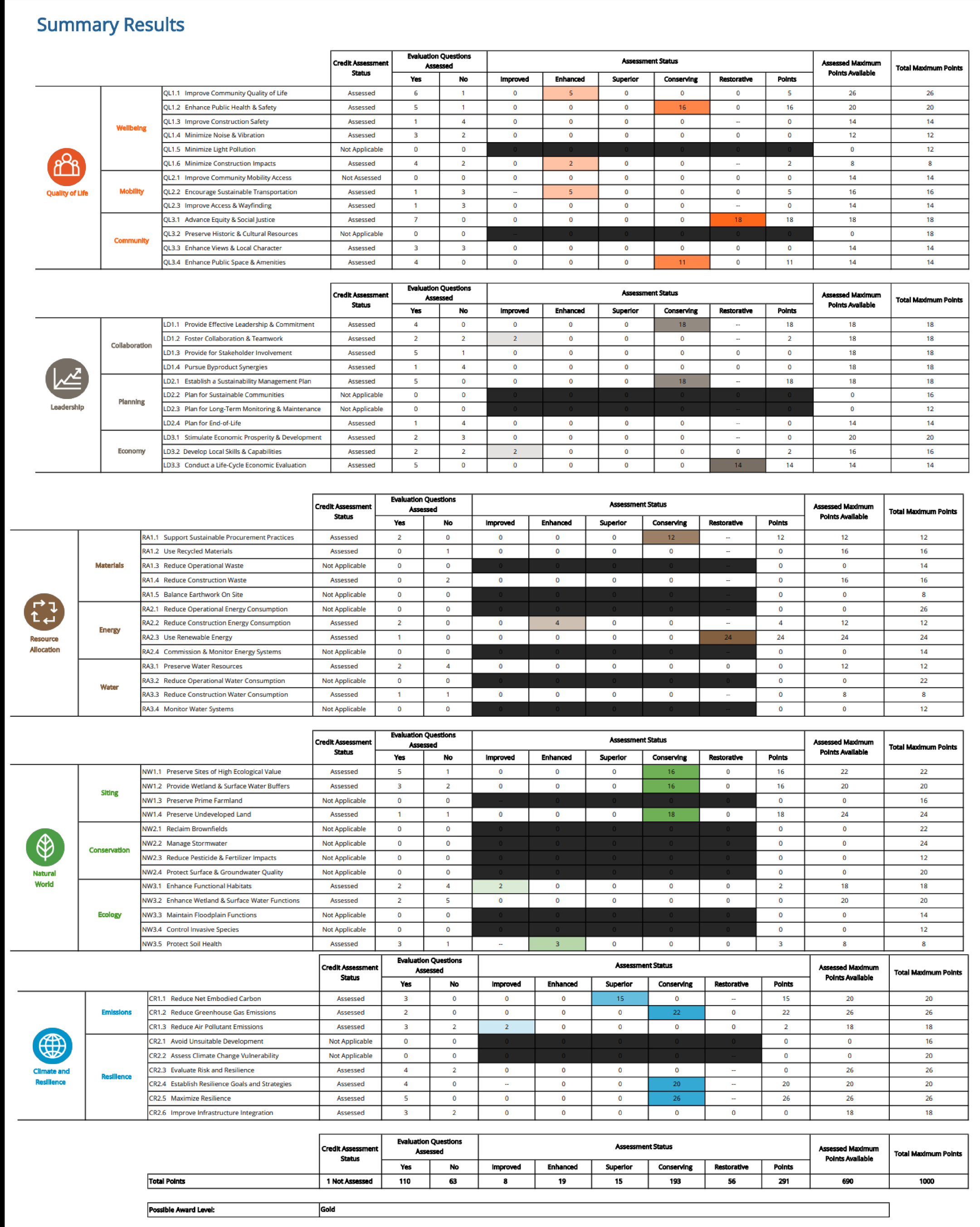

Figure 2. Envision Rating System Results

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 mix. 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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Oregon TECH

ENGR102 – Introduction to Engineering II
Surface Applicators

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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.

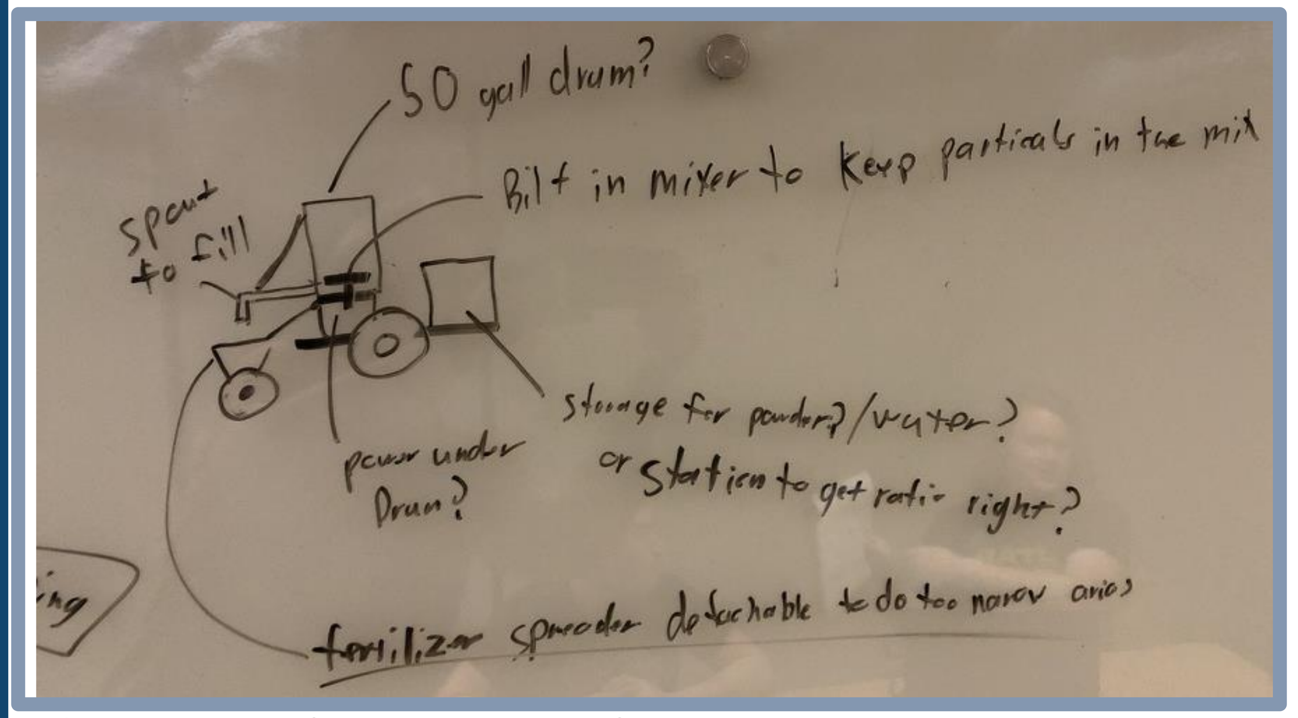

Figure 1. Early prototype plans

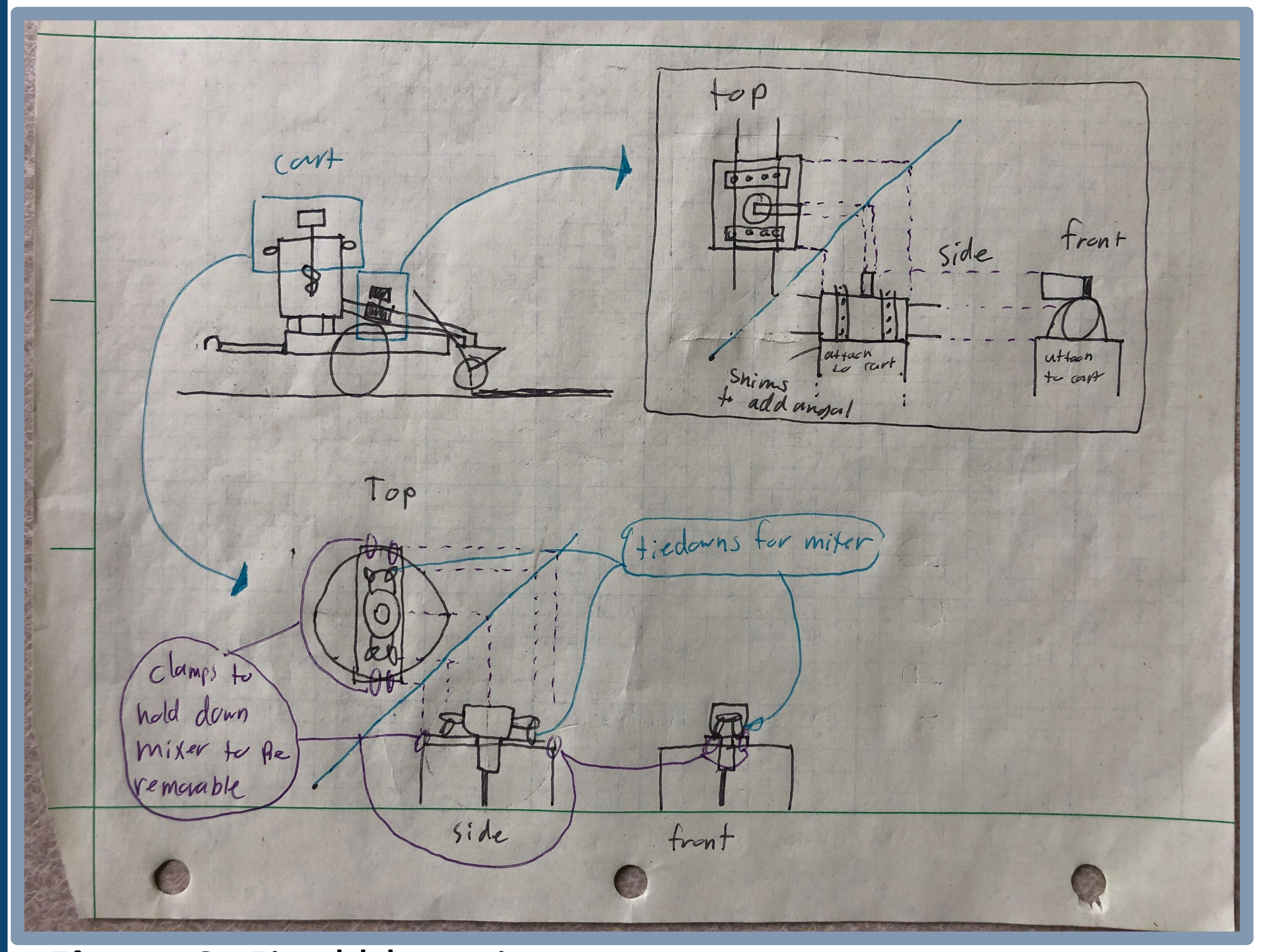

Figure 2. Final blueprints

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.

Figure 3. Bucket and PVC tube test

Figure 4. Fertilizer spreader test

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.

Figure 5. Before and after fertilizer spreader test

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.

Figure 6. Applicator in operation and surface after application

Figure 7. Final product

Acknowledgements

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Oregon TECH

ENGR102 – Introduction to Engineering II Trail Resurfacing

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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.

Figure 1. A picture of the original trail before resurfacing

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

Figure 2. The survey drop box.

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

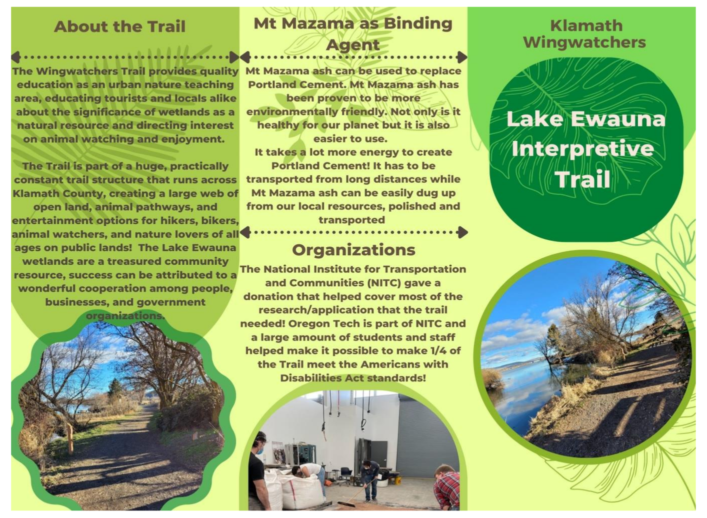


Figure 3. Picture of Brochure created by group, meant for a young audience

Figure 4 and 5. Both pictures are from one of the brochures that our group created from provided data and pictures

Analysis

- **Testing period**
  - Surveys presented to local organizations
- **Feedback**
  - Some see room for improvements as seen below on the two highlighted questions

Figure 6. Shows how many times a person frequents the trail per year

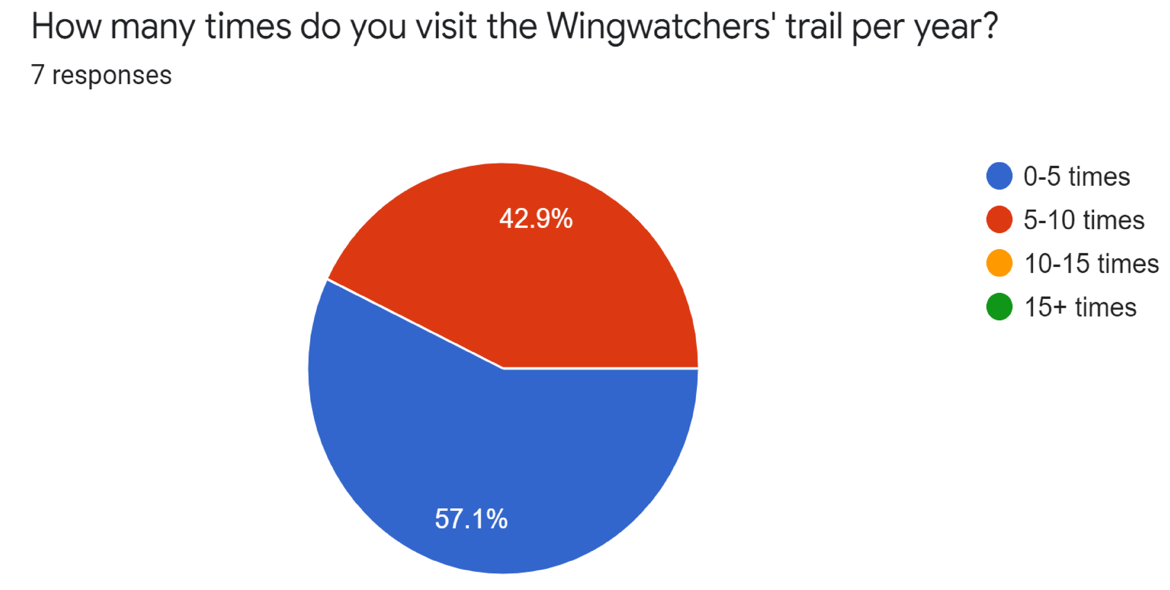
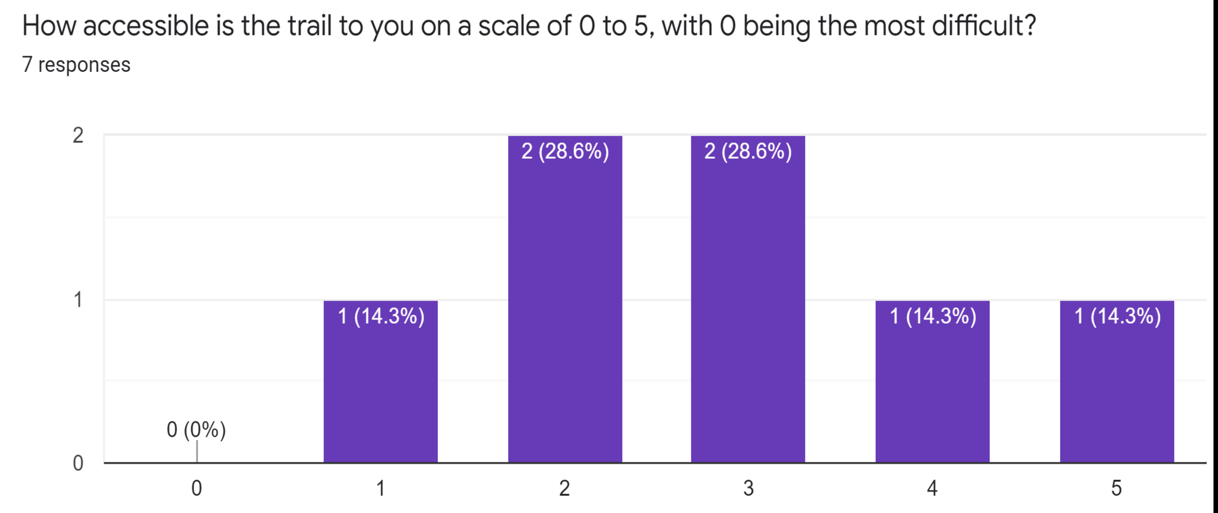


Figure 7. Illustrates the accessibility of the trail to the public on a scale of 0 to 5



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

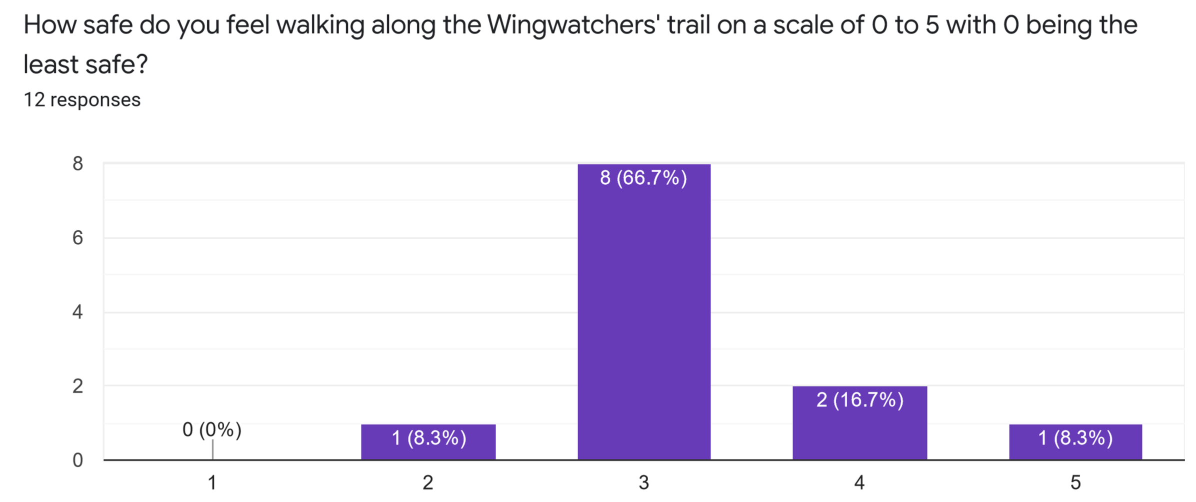


Figure 8. Details how safe people feel when walking on the trail at any moment in time

Acknowledgments

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

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ENGR102 – Introduction to Engineering II Trail Improvement
Solar Feasibility Group

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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.

Figure 1: WWT near most viable zone for project

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.

Figure 2. The clinometer used for shadow analysis

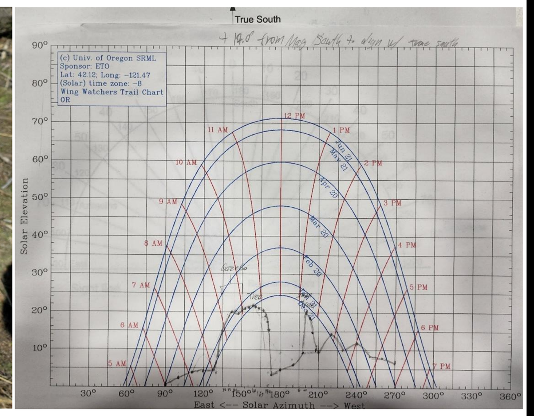

Figure 3: Resulting Solar Sun chart from clinometer

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.

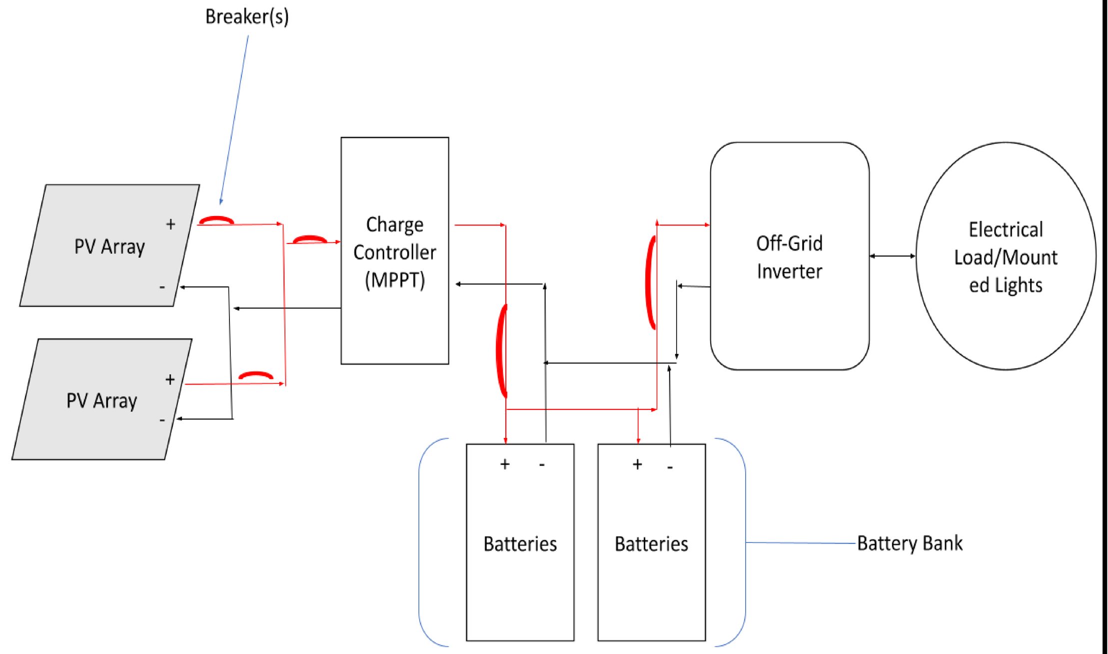

Figure 4. Basic PV System Schematic with integral circuitry components

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.

Component	Quantity	Price Per Item ($)	Total for Components ($)
Solar Panel	4	210.00	840.00
MPPT Charge Controller	1	226.00	226.00
Battery	28	75.6	2116.80
Inverter/Charger	1	1,911.65	1911.65
Lights	22	48.45	1065.90
35 A Circuit Breaker	1	4.53	4.53
20 A Breaker	2	5.52	11.04
80 ACircuit Breaker	1	13.95	13.95
280 ACircuit Breaker	1	8.29	8.29
Storage Shed	1	187.99	187.99
Shelving Unit	1	242	242.00
Wiring	2796	0.45	1258.20
Lock	1	19.93	19.93
Mounting Pole	22	79.99	1759.78
Solar Panel Mount Brackets	4	31.99	127.96
		Total	$9,794.02
		With Excess/incidentals	**$11,263.12**

Figure 5. Simplified Bill of Materials for PV System

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.

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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ENGR102 – Introduction to Engineering II WingWatchers Trail ADA/WHeelchair

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Design Concept

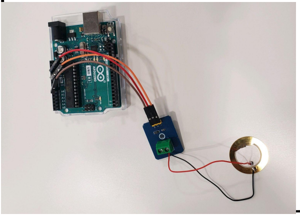
- Our goals were to make a functioning vibration sensor and outline the ADA requirements for the trail.
- Measurable aspects were the amount of vibration on the wheelchair and the required measurements for ADA access.

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.

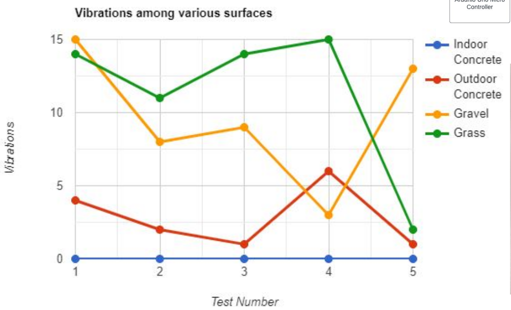
ADA Assessment

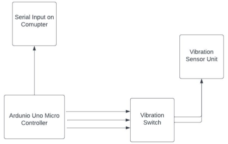
Width: Min 32 in., goal 36 in. min, 60 in. min for passing/turning
Slope: Max 10% grade, goal 5% grade max for parallel; Max 3% grade for perpendicular

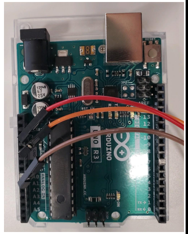


Materials and Methods

- 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





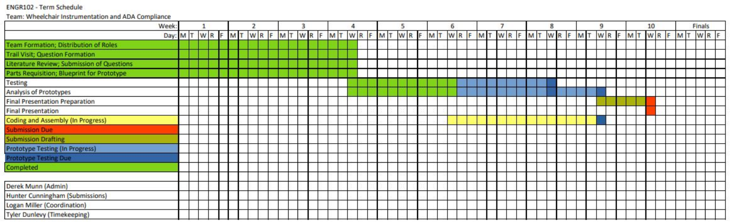


Final Product

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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ENGR102 – Introduction to Engineering II WW Trail

Surveying and Mapping

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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 topological map was made.

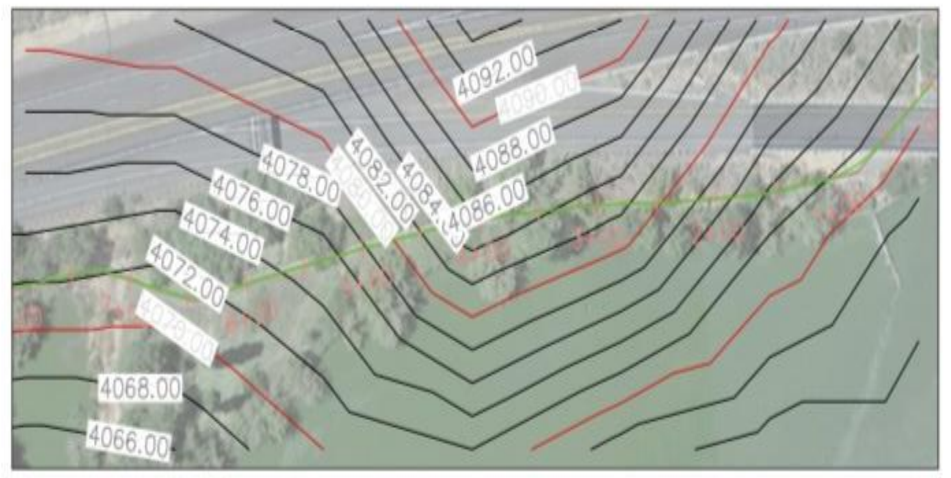

Figure 1: Wing Watcher's Map

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)

STA	BS (+)	HI	FS (-)	ELEV.	ADJ. ELEV
BM	4.65			4070	
		4074.65			
TP1	2.78		4.1	4070.55	4070.56
		4073.33			
TP2	2.75		6.19	4067.14	4067.15
		4069.89			
TP3	5.29		2.63	4067.26	4067.27
		4072.55			
TP4	4.61		4.67	4067.88	4067.89
		4072.49			
TP5	3.93		3.86	4068.63	4068.64
		4072.56			
TP4	4.77		4.69	4067.87	4067.88
		4072.64			
TP3	2.96		5.4	4067.24	4067.25
		4070.2			
TP2	6.75		3.09	4067.11	4067.11
		4073.86			
TP1	4.83		3.35	4070.51	4070.52
		4075.34			
BM			5.46	4069.88	4069.89

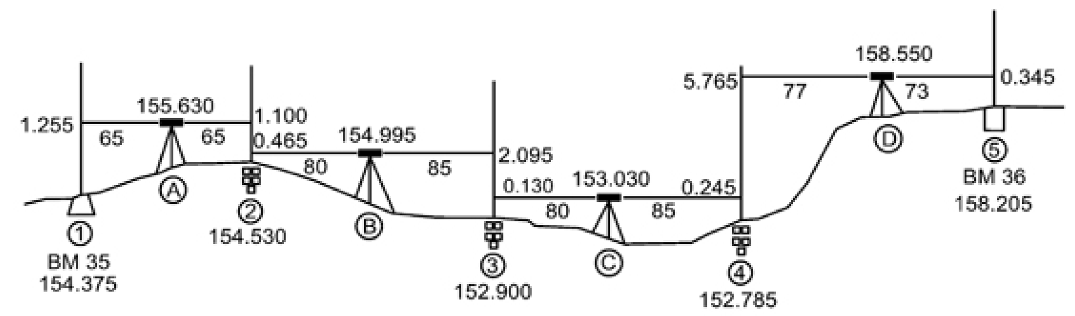

Figure 2: Illustration of Leveling

Analysis

Looking at the topographic map shows that the trails 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.

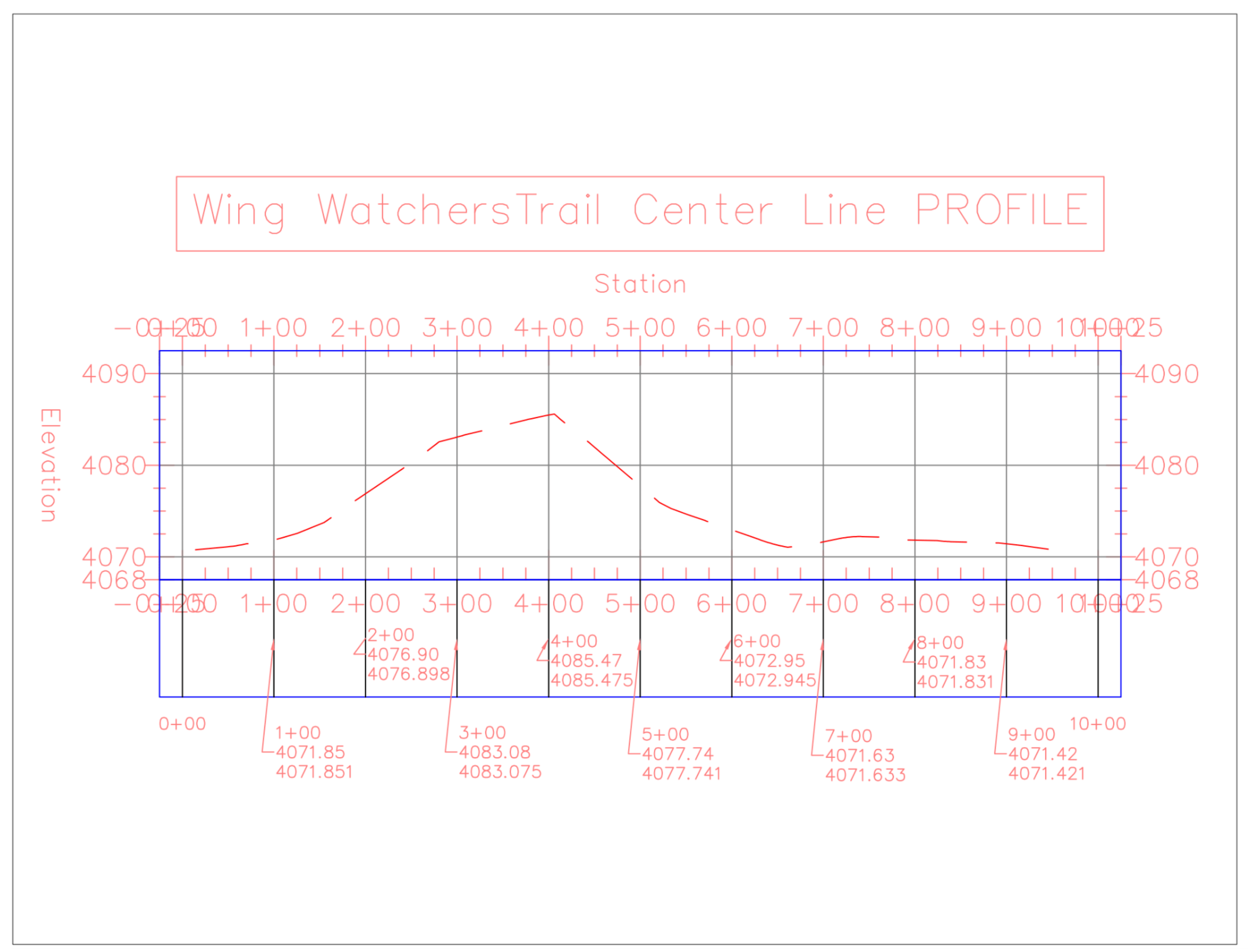

Figure 3: Wing Watcher's Profile

Out observation can also be confirmed by looking at the change in elevation recorded from differential leveling.

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

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Introduction to Engineering II Stormwater Analysis

Make it Rain

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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.

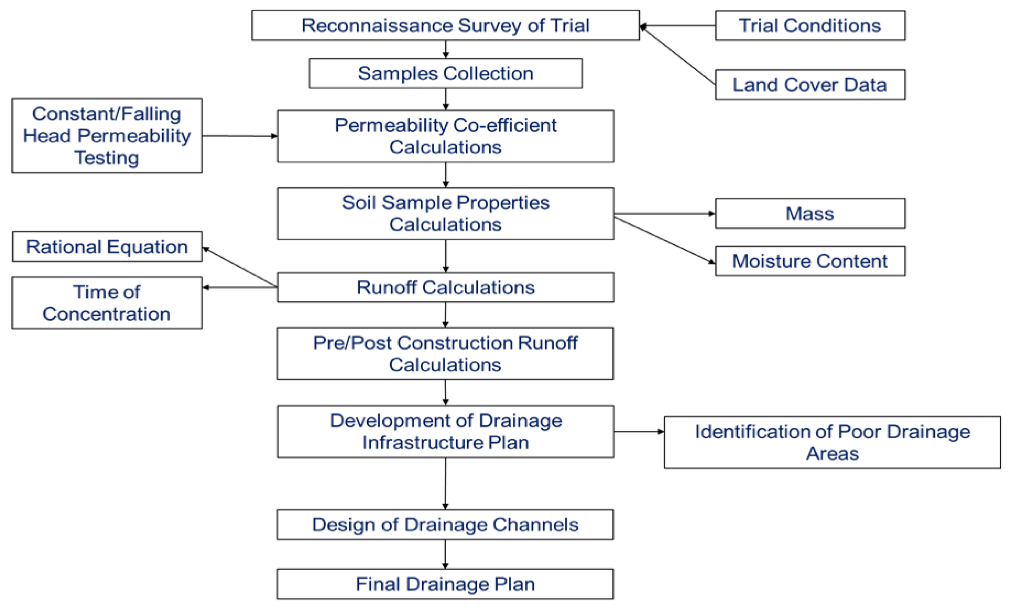

Figure 2. Process

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=CiA

Where:

Q=Runoff in ft3/s

C=Runoff Coefficient

i=Rainfall Intensity in/hr

A=Area of Watershed

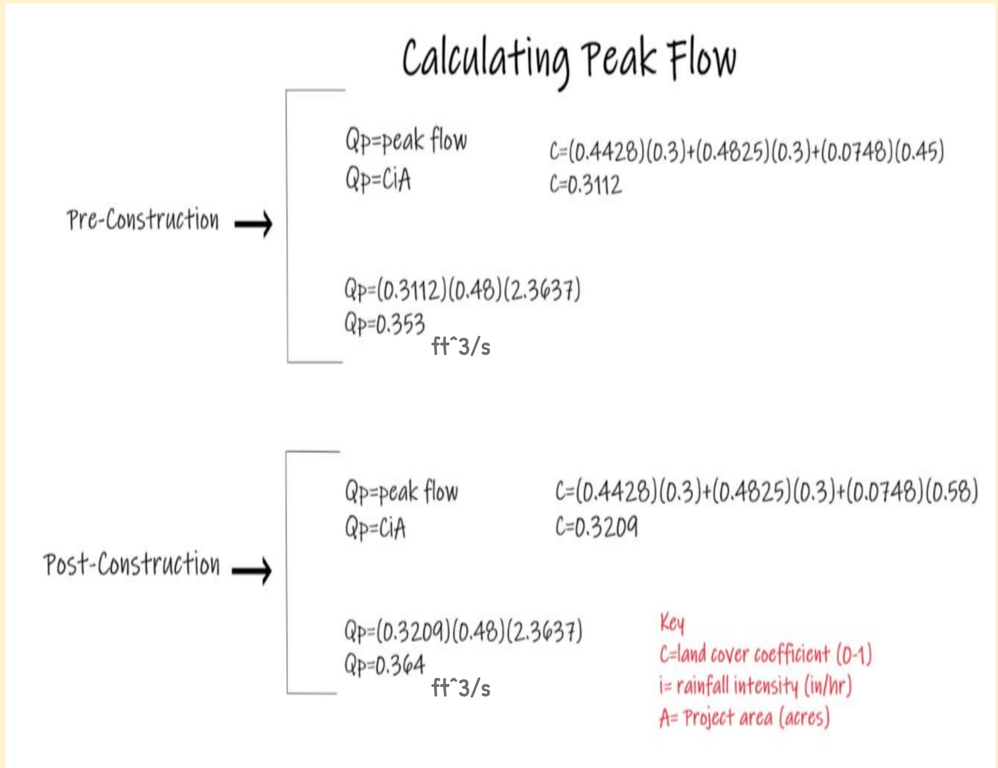

Figure 3. Calculating Peak Flow

Time of Concentration

$tc = 0.0078L^{0.77}$ [$(E_2 - E_{,1}) / L$] 0.385

$E_2 - E_{,1}$ = Elevation Difference of Farthest point of Watershed

L =Distance of Farthest point of Watershed

tc = Time of Concentration

Soil Type	Coefficient of Permeability
Top 1	5.2×10^{-4} m/s
Top 2	2.3×10^{-4} m/s
Top3	1.0×10^{-3} m/s

Figure 4. Permeability Test Results

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).

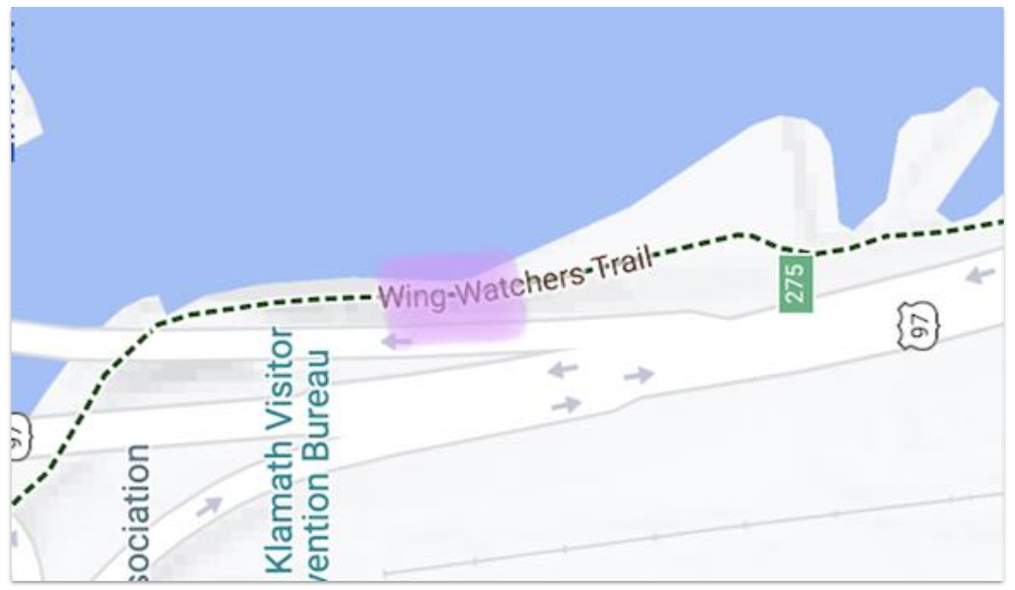

Figure 1. Map of Poor Drainage Areas

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.

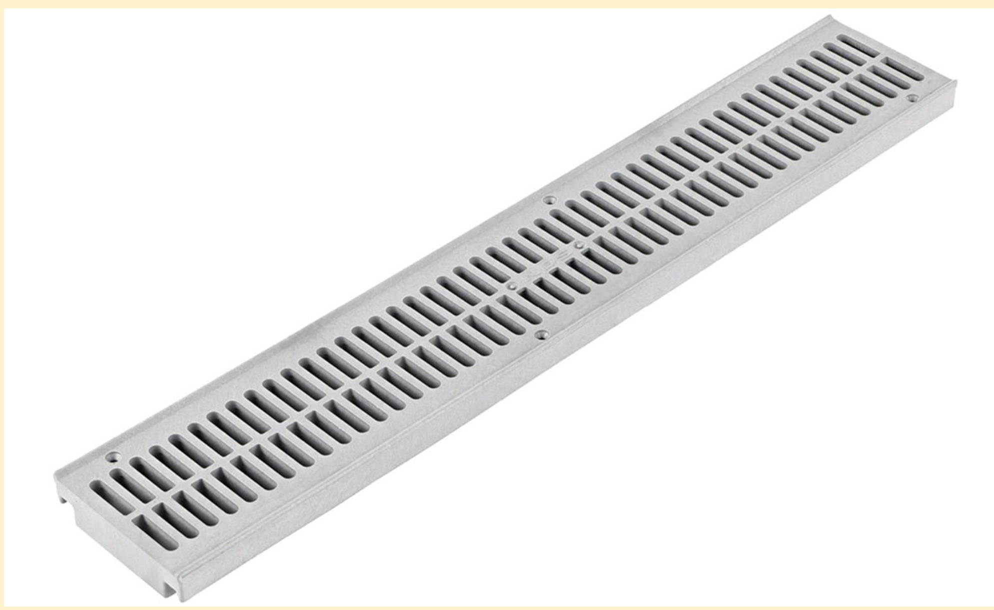

Figure 5. Channel Drain Example

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ENGR102 – Introduction to Engineering II

Existing Surface Characterization

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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.

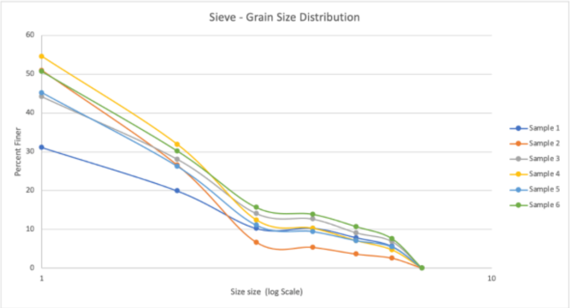

Figure 1: Sieve analysis for six samples using measured values

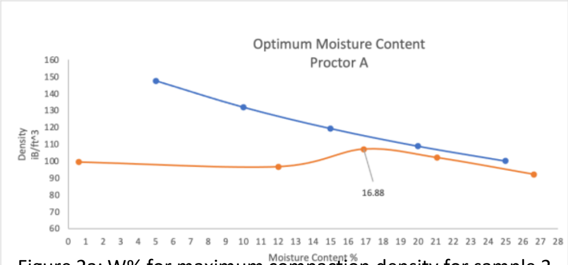

Figure 2a: W% for maximum compaction density for sample 2

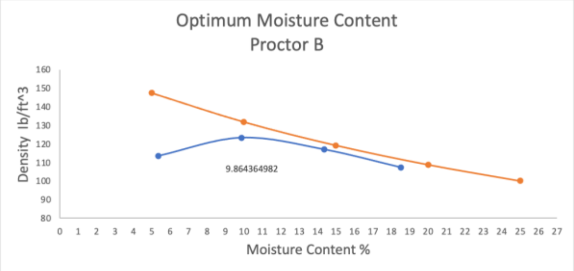

Figure 2b: W% for maximum compaction density for sample 5

Analysis:

Table 1: Sample labels and information

Trials	Samples	Depth (in)	Latitude	Longitude
1	Top 1	0" – 3"	042*13'14" N	121*47'24" W
2	Bottom 1	3" to 6"	042*13'14" N	121*47'24" W
3	Top 2	0" - 2 "	042*13'20" N	121*43'25" W
4	Bottom 2	2" to 4"	042*13'20" N	121*43'25" W
5	Top 3	0" - 2"	042*12'57" N	121*47'20" W
6	Top 4	0" - 1 "	042*13'11" N	121*46'05" W

Table 2: Calculated water percent and recorded values per sample

Cup #	% Water
1	6.297
2	18.347
3	7.176
4	22.189
5	9.740
6	20.245

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

Sieve No.	Sieve Size (mm)	Percent Finer					
		Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6
10	2	31	50.99	44.19	54.57	45.24	50.71
20	0.85	20	26.55	28.08	31.92	26.26	30.22
60	0.25	10	6.65	14.07	12.43	11.06	15.64
100	0.147	10	5.36	12.66	10.31	9.45	13.90
140	0.104	8	3.63	9.12	7.12	7.10	10.72
200	0.075	6	2.59	6.89	4.74	5.49	7.65
Pan	NA	0	0.00	0.00	0.00	0.00	0.00

Table 4: Rotational penetrometer average values for firmness and stability

	Firmness (mm)	Stability (mm)
Location 1	0.1568	0.2452
Location 2	0.1886	0.4016
Location 3	0.1727	0.3234
Calibration	0.173	0.323

$$mass(soil + can) - mass(can) = mass(soil)$$

$$(mass(wet\ soil) - mass(dry\ soil))x100 = water\%$$

$$\frac{mass(soil\ in\ pan)}{mass(total\ soil)} * 100 = finer\%$$

Table 5: Sand cone values

	Trial 1	Trial 2
Density Calibration	96.5	96.5
Cone calibration factor	3.872	3.872
Volume of test hole	0.009426	0.001527
Wet Density	123.239	353.929
Dry density	101.699	309.89
Moisture %	21.23	14.21

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 upended onto the base plate and the sand was allowed to fill the hole and cone. 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.

Method:

Water Percentage: 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 occupied extra space and due to the lack of air volume.

Sieve: Add 500 grams of soil into a bucket. Pans were stacked with no. 10 sieve following with no. 20, no. 60, no. 100, no. 140 and finally ending with no. 200 sieve. The stack of sieve pans was then shaken by a shaker to ensure all particles passed through the appropriate sieve pan. To find soil mass, equation 2 where x= soil in pan, y= pan and z= soil. Finally, equation 3 was applied to find percent finer.

Rotational Penetrometer: We had two pieces of data, one being firmness and the other being stability of the surface. The firmness came from applying spring pressure for 10 seconds then writing down the data until the reading stabilized in the .001 range for 5 seconds. Stability came from twisting the wheel left and right, twice each time. Again, wait 10 seconds, then allow it to stabilize in the .001 range for 5 seconds.

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 penetrometer test, found the firmness of the trail's soil, showed similarities to smooth concrete within .03mm, also that the trail is significantly less stabile than smooth concrete. The proctor found what 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.

Acknowledgements: Huge Thank you to Professor Asthon Greer, Dylan Anspach, and Caroline Schulze

Oregon TECH

ENGR102 – Introduction to Engineering II Wingwatchers Trail Pedestrian Sensor

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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.

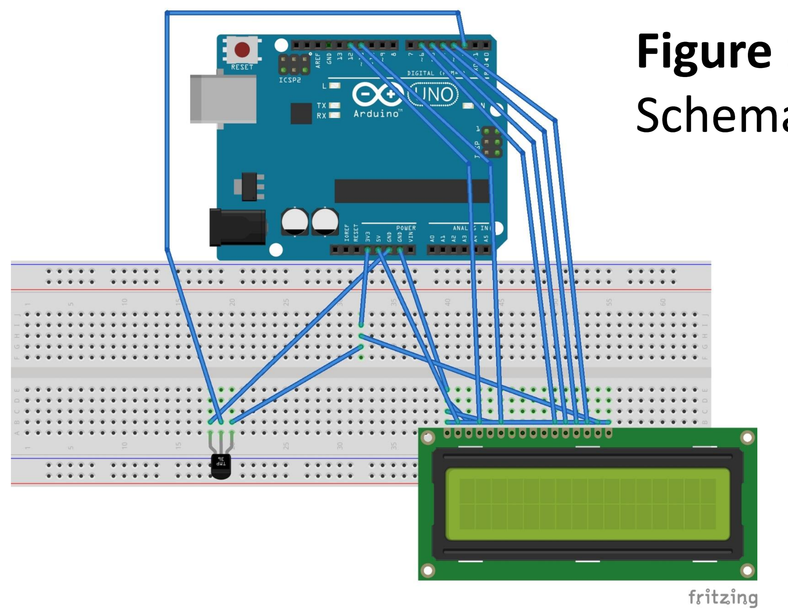

Figure 1. Original Schematic

The completed sensor would contribute to measurable aspects of other projects, such as the long-term durability of the trail in use, or the possible effects the updated trail has on community usage.

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.

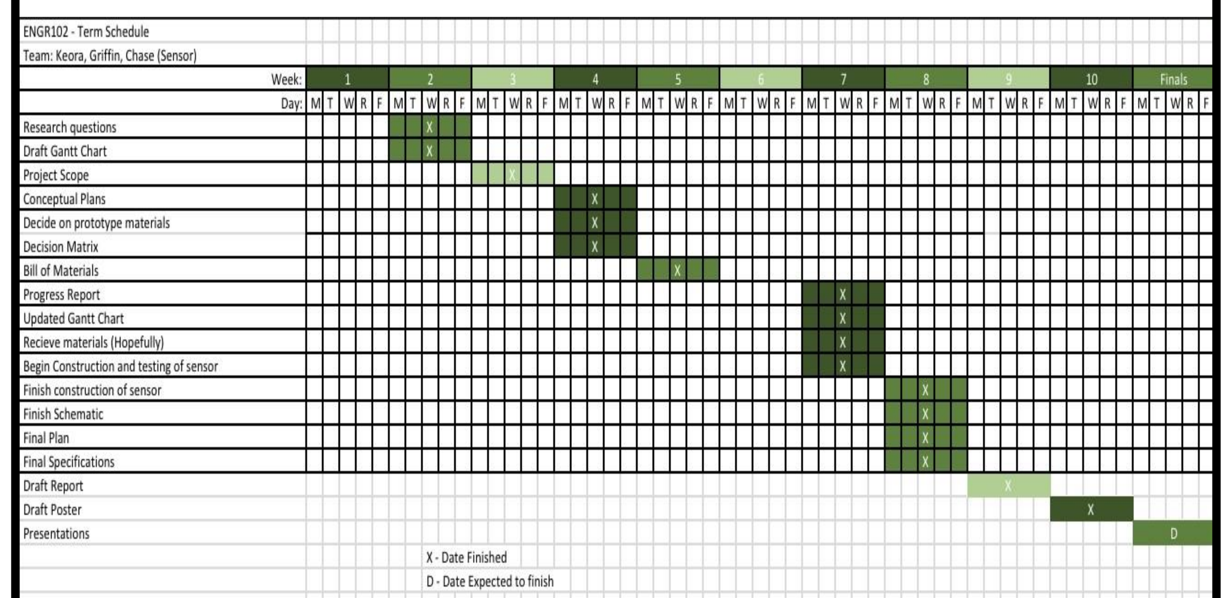

Figure 2. Gantt Chart. We used this to organize our due dates throughout the term

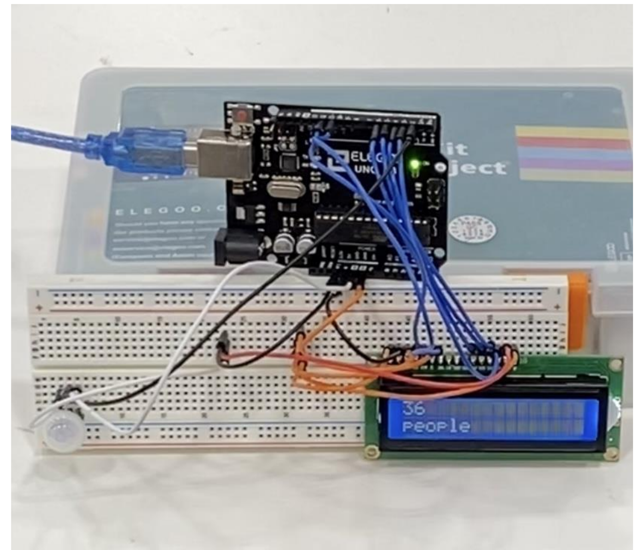

Figure 4. Sensor in action. The sensor counts number 36 after we have moved in front of it 36 times.

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.

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.

	Capability:	
Function:	YES	NO
Detect humans	X	
Count humans	X	
Range of 5m	X	
Differentiate people and animals		X
Weatherproof		X
Efficeient	X	
Differentiate people in a group		X

Figure 5. Chart depicting the sensors functional capability.

Final Product

Our final product is a pedestrian sensor consisting or 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.

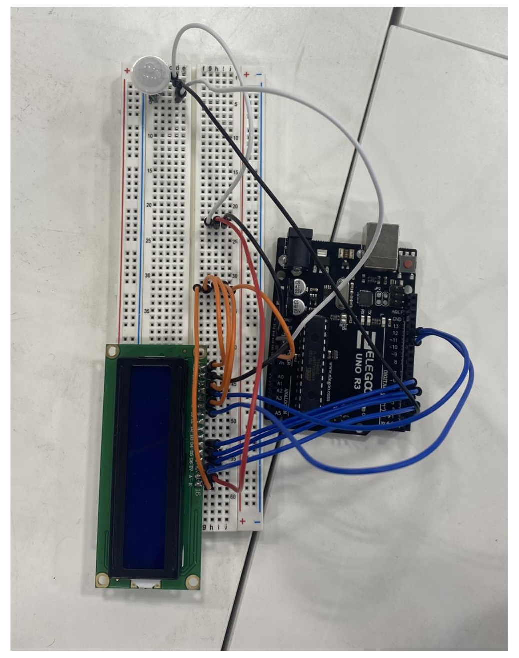

Figure 3. Final sensor. Top left of circuit board, (HiLetgo AM3 12 mini pyroelectric infrared human sensor). Bottom left, (LCD Display screen). Right side, (ELEGOO Uno R3 microcontroller)

Acknowledgments

Thank you to the Wing Watchers group for their help and cooperation. Thank you to the Engineering 102 professors and teacher's assistants for helping with the process.

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