Cover Page

Recreational Trail in the Yosemite Region Project

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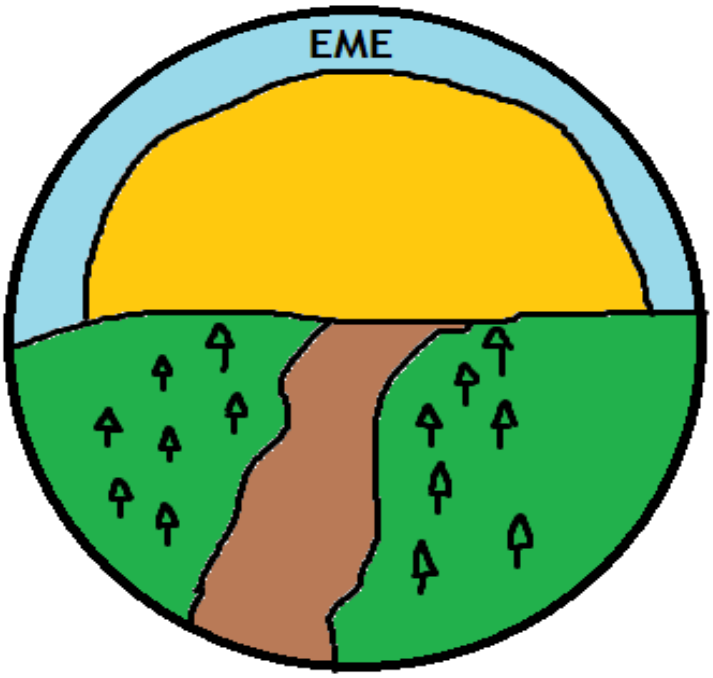

Table of Contents

Introduction and Background

Some problems Yosemite National Park has a history of are air pollution, fires, noise, overcrowding, and climate change. Making the route in this specified region can help prevent overcrowding by providing an alternative trail path to use in busier times. More different trails help prevent visitors from all going into one trail, which stops overcrowdedness and congestion. It can also act as an alternative path to help visitors still enjoy the environment when there is smoke or haze caused by air pollution or nearby fires on the other trails. With more trails, it gives visitors more opportunities of seeing the environments from different angles and also gives them alternative trails to go to when smoke or haze is covering the landscape at a certain trail. The objectives of this project are to design and construct a recreational ADA compliant trail in the Yosemite Region along with 2 ADA compliant parking spaces and one informational sign. Making an additional trail route can help better manage the congestion of people on a trail, show different areas that Yosemite has to offer, help facilitate and increase tourism and improve safety. What motivates me to create a new trail is that trails can positively help people by possibly improving their health, improving their safety, and helping them enjoy and be immersed in nature, which can assist with improving mental health for some people.

The Yosemite region covers an area of 747,956 acres and is known for having the largest and the least altered habitat in Sierra Nevada. The acres are located on the central-western slopes of the Sierra Nevada mountain range. The park supports and maintains the diversity of plants, animals, flora, and fauna. This is shown by the park having five major vegetation zones: chaparral, lower montane forest, upper montane forest, subalpine and alpine. Additionally, 1,400 plant species exist within Yosemite. The geology of the Yosemite area is characterized by granitic rocks and remnants of older rock. It also contains massive granite domes, glacial features, and some of the largest granite monoliths on Earth. The terrain has U-shaped valleys, lakes, granite spires, waterfalls, rounded domes, moraines, and jagged peaks. There are also the Tuolumne and Merced rivers that are maintained here which contain geological, cultural, scenic, and recreational importance. Yosemite also has the headwaters of two of California's major watersheds, which help provide clean drinking water to the San Francisco Bay Area. The park has 5 structures that are national historic landmarks, and more than 600 that can be a part of the National Register of Historic Places. This includes 7 historic and 12 prehistoric archeological districts.

Environmental Mapping Engineering Group acknowledges that Yosemite National Park is on land that belonged to the Ahwahneechee people many generations ago and had deep and traditional connections to this land. We respect, recognize, and honor both the Miwok and the Ahwahneechee people of past and present, their sovereignty, culture, and their relationship and connection with the land.

ADA Specifications

The specifications defined by my client were to make the recreational trail at least 1 kilometer in length in the region of Yosemite and make the site have 2 ADA-compliant parking spaces. Additionally, an informational sign needs to be mapped along the route. Some restrictions or specifications I made needed to adhere to the standards of the Architectural Barriers Act (ABA). Here is a list of specifications. The surface of the trail needs to be firm and stable and very resistant to weather conditions and wear and tear. This is to prevent injuries or damage to people using the trail. If the trail was unstable and not resistant, then it could harm the people using the trail. The clear tread path width of trails has to be 36 inches minimum and trails with a clear tread width less than 60 inches have to provide passing spaces at intervals of 1000 feet maximum. The passing space also needs to be 60 inches minimum by 60 inches minimum. Passing spaces help people who use a mobility device to turn around and exit the trail easily. Tread obstacles on trails, passing spaces and rest intervals shouldn't exceed 1/2 of an inch in height. This is to prevent obstacles like rocks or tree roots from obscuring the trail which can result in people having a harder time navigating the trail. Openings on the surface of trails, passing spaces and rest intervals shouldn't allow the passage of a sphere more than 1/2 of an inch in diameter. 30% is the maximum of the total length of a trail allowed that should have a running slope steeper than 8.33%. The running slope of any segment of the trail cannot be steeper than 1:8 (12%). If the trail is steeper than 1:20 (5%), the maximum length of the segment is determined by a table with 200 feet, 30 feet, and 10 feet as categories for the maximum length of the segment. A resting interval must be at the top and bottom of each segment of the trail. Gradual running slopes are more usable by people with disabilities. If the trail has steeper running slopes, resting intervals are required more and if they are less severe, they can be put further apart. The cross slope can't be steeper than 1:48 and the length of the resting intervals should be 60 inches minimum. The width is at least as wide as the widest segment of trail tread leading to the resting interval and resting intervals shall have slopes that aren't steeper than 1:48. The resting interval should also have vertical alignment between the trail tread, and turning space which will be nominally planar. For any constructed objects on the trails, passing spaces, and resting intervals, all must have protruding objects that aren't hazardous or harmful to blind people. Trail information signs must have the length of the trail, surface type, typical and minimum tread width, typical and maximum running slope, and typical and maximum cross slope. These are all the ADA requirements that are regulatory requirements.

For the design of the two parking spaces, the accessible parking space has to be 8 feet wide. The access aisles near the parking spaces have to be 5 feet wide. The specifications I made were keeping my trail under 12% steepness to adhere to the ADA standards and I made it close to another trail. This is because almost all of the areas have a route or trail in it in Yosemite National Park. To use the underused areas of the national park, I had to design a new trail that is somewhat close to an older trail but goes in a different direction or path. I also wanted to create a restriction where the trail needed to be near a public road or NPS road, but other trails have been built in those areas which prevented me from creating this specification. These trails often took a lot of space and area near the roads which are why making a new one in those areas would mean the trails would be really close

to each other. This is because there is less area and space to use. Building a trail next to an existing trail and going in the same direction as that trail can make the experience less unique and doesn't show a different perspective or view of the park's beauty. This is why I chose an underused area because I wanted to show a different perspective or view of the park's beauty and didn't want to be limited by overused areas and other trails. Additionally, building trails near each other can bolster the problems of crowdedness and congestion that the park suffers from. This is why restricting myself to an unused area where people don't usually go is very important. The constraint of slope values as mentioned previously was also used to determine my trail location. I choose a route for the trail that has a slope value of less than 12 across the whole trail. This doesn't violate ADA standards and ensures the safety of the visitors. If it was more than 12, the higher steepness of the slopes could hurt or fatally wound a visitor, which is why it's important to use areas with lower steepness. A cultural constraint is I tried to avoid areas where the tribes previously lived on. This is because I wanted to preserve their cultural presence there and not remove or tamper with important Native history. Another constraint is I avoided areas that had endangered species like the Yosemite Toad to help preserve the existence of those species. Humans can possibly negatively affect the Yosemite Toad, so I wanted to keep humans and the endangered species away from each other. A specification I made is I wanted the route or trail to go to a location that has a point of interest. For example, the trail I designed goes to a lake called Lost Lake and there currently aren't any paths that lead there. The point of interest in this example is the lake. I also made my trail 2 km instead of 1 km to reach the lake from the point I started from. The specification I made about the color scheme is to make it color-blind friendly. This means avoiding colors like green or red so that people with color blindness can see the map and what the map is depicting. The specification for the parking lots was that they had to be 9 feet wide by 18 feet long and the space for drop-offs for disabled people was 5 feet wide by 18 feet long. These specifications adhere to ADA requirements.

National Park trails built before the ADA standards took effect are controlled by local governments and they are the ones who find ways to accommodate access and support for people with disabilities. If a local government decides to modify a trail and make it suitable for disabled individuals and there is more than one trail available, only some of the trails need to be accessible. This means that not all of the trails have to be ADA compliant if they were built before the ADA standards. It's their choice to upgrade the trails to be ADA compliant or not. Additionally, historic routes and certain different proposed routes in the wilderness don't have to be compliant. As I mentioned earlier this route should be built to mainly help alleviate one of the biggest problems that the park faces which is congestion and crowdedness. This would be done by giving the visitors more possible trail routes to go to and it helps disperse the visitors into numerous trails. This alleviates the congestion of the current existing routes and can help prevent the spread of diseases like Covid. This route should be more accessible and compliant with ADA because it prevents discrimination against people with disabilities by giving them more opportunities to enjoy Yosemite. This diversifies the trails in Yosemite since the majority of trails are in high-slope areas like mountains or hills. Having ADA-compliant trails will make the trail smoother and flatter and help attract more disabled people to the national park. Additionally, building a trail that is firm and stable, and resistant to weather conditions is important because it ensures the safety of

the visitors and prevents future lawsuits. A trail being firm and stable is an ADA requirement and isn't seen much in older trails that didn't need to be ADA compliant.

Datasets

The datasets I choose to help me pick an ideal place to put my trail are data regarding other trails, placenames, areas that have water, roads, and areas that have the Yosemite Toad species. The place names dataset labels the multiple areas like lakes, mountains, or points of interest in Yosemite National Park. The dataset with areas of water showed areas that have water like lakes or rivers in Yosemite National Park. The trails dataset shows all the trails in Yosemite National Park and is represented as dashed lines. The roads dataset shows every road in Yosemite. The Yosemite Toad dataset shows protected areas or habitats where the endangered species called the Yosemite Toad lives. The purpose of using the Toad dataset is to find areas to put a trail that doesn't negatively affect the endangered species and avoid areas that have the Yosemite Toad in them.

The datasets I created were for the newly created trail, an informational sign, and two ADA-compliant parking spaces. Metadata has tags, summary, description, credits, and use limitations. The description of the trail is that the trail is roughly 2 km and goes from the middle of the John Muir trail to the Lost Lake in Yosemite National Park. This is built in an unutilized part of Yosemite National Park and has slopes that are ADA compliant. This trail also was strategically built away from a popular endangered species which is called the Yosemite Toad. For the summary part, the trail is intended to be constructed and designed in the Yosemite region and has to be ADA compliant. The use limitations of the trail are that the data and design are meant to be only used by UC Merced or Yosemite National Park. This data is not available to the public, since a private company hired our organization. This data and design are not public domain. The credits for this trail are to Jason Gates for designing the trail. The tags of this trail are Yosemite, national park, and trails. The description of the informational sign is that it is a point on the map at the entrance of the proposed trail. For the summary, the informational sign is intended to give information about the trail like the length, rest stops, and insight on terrain. The use limitations of the informational sign are that the data and design are meant to be only used by UC Merced or Yosemite National Park. This data is not available to the public, since a private company hired our organization. This data and design are not public domain. The credit for this sign is to Jason Gates for designing the informational sign. The tags are Yosemite, national park, trails, trail length, rest stops, and information. Lastly, the description of the two ADA-compliant parking spaces is that the parking spaces are next to the proposed trail and are 9x18 and the space for unloading is 5x18. These parking lots are shown on the map as polygons shaped like rectangles. In summary, the parking lots are intended to be places where visitors can leave their cars and it also accommodates people with disabilities by having extra space for them. The use

limitations of the parking lots are that the data and design are meant to be only used by UC Merced or Yosemite National Park. This data is not available to the public, since a private company hired our organization. This data and design are not public domain. The credit for these parking lots is to Jason Gates for designing the parking lots. The tags for the parking lots are Yosemite, national park, parking, parking lots, and disability accommodation. The projection of each dataset is NAD 1983 UTM Zone 11N.

The uncertainty in the datasets is present in the trail and the parking lot. For the trail, I am uncertain that the trail is the best spot for a new trail because it connects to the middle of an already existing trail called the John Muir trail. This means that visitors need to walk and hike the John Muir trail to access the proposed trail. This may seem like an intimidating task for newcomers and can limit newcomers' attempts to use the trail. However, veterans or experienced hikers who want a challenge would most likely use the trail. There are also no roads or NSP roads near the area of the trail which makes me uncertain if it's the best location. Additionally, more people will go onto the John Muir Trail since it is connected to it which can cause congestion and crowdedness. This is a uncertainty and I am concerned that it will increase crowdedness. I think that this helps alleviate the crowdedness in the other multiple trails and the long length of both the trails can help lower the crowdedness. This is because people will come back at different times when finishing the trails which means there will be less of a crowd overall. Roads can be built near the area, but they'll most likely be very expensive and time-consuming to build. This also connects to my uncertainty about the parking lots because the parking lots are being built at a place where there are no roads. Building a parking lot without roads would be an inefficient use of time and money. The parking lot is essentially useless in this scenario. I propose that roads be built first before building the parking lots. The dataset originally used to decide where my trail should be located based on the slope could possibly be inaccurate because of possible horizontal and vertical errors that may have occurred during the data collection of the slopes. This dataset is the output_be file. This would mean my trail can possibly touch or be on a steeper part of Yosemite than intended. However, I accommodated this error by making sure no parts of the trail touched the width and length of the horizontal error and vertical error. This ensures the accuracy of my trail and resolves the uncertainty of the trail being located in high slope areas. The selection of suitable sites section goes into more detail about this.

The trails, areas of water, names of places, and roads datasets were found on ArcGIS Hub and the datasets it used were originally from the National Park Service Data Store. The National Park Service is a reliable and credible source because they are known for collecting data about their national parks across the United States and using them for a variety of things like finding areas where animals live or tracking the number of buildings built on a national park. The toad dataset was found on Arcgis Hub and the user who posted it didn't share how he got the data. I assume the user tracked the movements of the toads to collect data and to eventually find out the general area where the toads inhabit. The metadata was blank for all of the datasets and all the datasets don't give any insight into how they collected data. The Yosemite Toad dataset might not be reliable or credible, since the information about the user and how the person collected the data is very limited. For the trails, areas of water, names of places, and roads datasets, I assume that they had a person collect data by using previous maps of the locations of these three or they sent a person around the park to get the length, shape and distance of the roads, areas with water or trails. Additionally, using previous GPS data could've also helped when collecting the data. The projection of the roads dataset was originally transverse mercator and its projected coordinate system was originally NAD 1983 UTM Zone 11N. The projection of the trails

dataset was originally transverse mercator and the projected coordinate system was NAD 1983 UTM Zone 11N. The projection of the name of places and areas with water datasets was originally transverse mercator and the projected coordinate system was NAD 1983 UTM Zone 11N. The toad dataset was originally using a geographic coordinate system called WGS 1984. All projected coordinate systems and projections were converted to be the same to prevent projection issues. Some uncertainties about the roads, areas of water, names of places, and trails datasets are that they were published on January 2, 2019. Road work could've been done or newer roads were built which could make this dataset inaccurate. Areas with water could have shrunk due to climate change and drought. Evaporation could have occurred which would make the areas with water look different and make the dataset inaccurate. For names of places, new points of interest could have been made or built which would make it inaccurate. Additionally, points of interest could have been removed or repositioned to another location. Lastly, the park could have increased or decreased the length of trails or even added or removed some trails. The toad dataset was published on June 19, 2019. This means that the dataset can possibly be an inaccurate depiction of where the toads reside. The toads could've possibly migrated to different areas in Yosemite or the areas or boundaries of the areas depicted in the data where the toads reside would have grown bigger (toads spread more) or decreased (toads stayed in an area for longer). The datasets I ended up using in the actual map are the trails, names of places, and areas of water. The Yosemite Toad and roads dataset was used as a reference and helped me exclude areas where trails wouldn't be possible. This led me to use specific areas because of these constraints. For the uncertainty of the other trails, placenames, areas that have water, roads, and areas that have the Yosemite Toad species datasets, there might have been errors in how they collected data. The datasets that were provided to me were output_be, Yosemite boundaries and CA10_Zimmer_metadata.txt Output_be helped find slope values in terrain in Yosemite. Output_be is a 1 bare earth LiDAR DEM file and shows terrain in Yosemite. Yosemite boundaries show the section of Yosemite National Park and separate the land from the others. Output_be and Yosemite boundaries don't have metadata. CA10_Zimmer_metadata.txt provides horizontal accuracies and vertical accuracies which are used in the selection of suitable sites section to determine possible errors in the map or datasets. It is created by the National Center for Airborne Laser Mapping and the author named Zimmer. There seems to be no metadata in this either. These three were provided to me by my co-workers and aren't classified as datasets that I took time and effort to find online. The proper citations for the datasets found on the internet are in the reference section of this report. This is done to be organized and not mix references with information about the datasets. The dataset citations are the 7th and 8th citations in the references section.

For the trails, roads, names of places, areas of Yosemite Toad, and areas of water datasets, they were acquired from the ArcGIS Hub website. The Yosemite Toad dataset was acquired by using ArcGIS Hub and searching Yosemite Toad in the search bar. The purpose of this dataset is to inform the people who own the land about the Yosemite Toad and the areas it lives in. This is to prevent the species' extinction and the author advocates for the conservation of the species. The trails, roads, names of places, and areas of water datasets were acquired by googling Yosemite National Park GIS data and clicking on the second main link. These four datasets are a part of a minimum essential dataset and are meant to be used for search and rescue operations. The authors of all these datasets didn't give any

information or metadata regarding how they gathered the data, so I provided information about how I gathered their data.

Methods

For data management, I made all the layers have unique names so that I can easily identify them and not mix them up with other datasets. When I used geoprocessing tools like clip, I deleted the original to make sure the project's layers look organized and not confusing. I also made sure the layers overlapping each other on a map looked decent and made sure it didn't look cluttered or block any important data. For map projection, I converted all the layers and datasets to NAD 1983 UTM Zone 11N. One of the main reasons I used this projection is because a good portion of the datasets was this projection and I would rather convert fewer datasets than more datasets. This method saves a lot of time. NAD 1983 UTM Zone 11N is also good for locations in North America. It can be used in the west coast areas like California and Washington. Yosemite National Park falls in the 11N zone of the transverse mercator which also indicates that the NAD 1983 UTM Zone 11N projection would be ideal to use. All the data sets use a transverse mercator as their projection. Since we are involving the terrain and slope of Yosemite National Park to make a recreational trail, we need to use a transverse mercator because it is efficient at representing the topographical mapping of an area. For geoprocessing tasks, I used feature class to feature class to help me edit and exclude null trail values. The original trails dataset didn't let me edit and would only let me view the dataset. This is why I used feature class to feature class so that I can be able to edit and exclude irrelevant or incorrect data. For the same reason, I used feature class to feature class for the roads dataset. The new output for trails had trails and routes outside of the national park boundary, so I used the geoprocessing tool called clip to make all the trails in the area or boundary of Yosemite National Park. The Yosemite layer was used and depicted the boundaries of the park. The new output for roads had the roads and routes also outside of the national park boundary. I used the geoprocessing tool called clip to exclude roads that weren't within the boundaries of the national park. I also used the Yosemite layer which depicted the boundaries of the park to help me use the clip tool. For the Yosemite Toad areas dataset, I used the project tool to convert it from WGS 1984 to NAD 1983 UTM Zone 11N. Once I converted it to a proper coordinate system, I inputted it and used the clip geoprocessing tool to exclude areas that weren't within the boundary of Yosemite National Park. This was done using the Yosemite layer which helped the clip tool. Finally, I used the slope geoprocessing tool on the output tif file. The tif file depicted the elevations of an area in Yosemite National Park. The slope tool outputs slope_output1. Slope_output1 showed the different levels of slopes and steepness in each area which is crucial to deciding where to put a trail in Yosemite that fulfills ADA requirements. To check if the trail accommodates possible errors, I used the geoprocessing tool called buffer on the trail with a buffer of 12.7 cm.

Workflow Diagram

Selection of Suitable Sites

When we make and design a trail, we need to consider the errors and uncertainty that can occur. Errors and uncertainty can occur, since tools used to map the world and its terrain can be inaccurate or less precise. The tools can interpret the terrain as a different visualization than how it actually looks. There are two types of error and uncertainty and they are vertical and horizontal. Vertical accuracy is the height difference between the modeled height and the actual height of the land. Horizontal accuracy is the difference between the planimetric coordinates of ground points with the coordinates of the same points from a source of higher accuracy. The errors are most likely systematic errors. The steps taken to reduce errors and uncertainty are to calculate the horizontal error and vertical error. Horizontal accuracy can be calculated by solving the equation 1/5,500 times the altitude. The altitude referenced has two different altitude values, so we calculate it for both of them to prevent possible excluding a correct measured value. Multiplying 1/5,500 by 700 or 600 leads to 0.127 meters and 0.109 meters. Converting them to centimeters gets 12.7 centimeters and 10.9 centimeters. For vertical accuracy, the reference that was created by Zimmer states that to expect a 5 to 30 cm error. This is our range of errors based on the system. Using the RMSE equation and plugging the values in gets us 10.9 centimeters for vertical error. Some steps taken to reduce error is to accommodate for these errors while creating the trail. This means making the trail have enough space for the 12.7 horizontal error and 10.9 vertical error. The trail needed to be adjusted to make sure the horizontal error and vertical error doesn't reach high slope values. To check if the trail accommodates errors, I used the geoprocessing tool called buffer on the trail with a buffer of 12.7 cm. This shows errors and uncertainty if the trail was 12.7 cm wider or if the trail was 12.7 cm less in width. With the buffer, the trail doesn't touch any areas that have a higher slope or higher steepness values. This ultimately shows the accuracy of this trail and how it accommodates for errors and uncertainty. Even with errors accommodated with the trail, it doesn't reach very steep areas. In this instance, this is for the horizontal error. If there is no accommodation for the errors in the trail, the errors could influence the trail's location to be in a steeper area than intended. The buffer is shown along with the trail on the map. For vertical error, a lower RMSE value is better and indicates a better fit. Since the vertical error is at 10.9, this is a substantial error and indicates that it isn't the best fit. The lower the RMSE value, the more accurate it is. The RMSE gives increased weight to outlier errors, so a lower value is ideal for accuracy. It is also known as the standard deviation of the prediction errors and is a pessimistic approach in statistics. My attempt to accommodate the vertical error was to adjust the slope values to better represent the vertical error value of 10.9. This would better represent the errors and differences in height and elevation. Adjusting the slope values by 10.9 cm or 0.109 m could represent the vertical errors better in my trail. I added 0.109 to all of the slope values to better represent the vertical error in the map. The trail can accommodate the possible height difference between the modeled height and the actual height. Implementing this onto my trail shows that it still doesn't negatively affect the trail's positioning in the specific area I chose.

The uncertainty of the DEM data used for finding the slopes could be from how the DEM data was gathered. For example, the DEM data could have had problems with the sensor and helicopter, issues with being measured in an inertial measurement, human error, and problems with the data in post-processing. These possible problems can all cause uncertainty and inaccuracy for the DEM data. There could also be errors in vertical accuracy

and horizontal accuracy. The vertical accuracy and horizontal accuracy mentioned above can also affect the credibility and reliability of this DEM dataset and can also be applied to this dataset. Slope values of a mountain in real life could be different and misinterpreted in the DEM data. If the DEM data is wrong or inaccurate, then that makes the slope data inaccurate. The uncertainty can also stem from the DEM data's age. Data is known to change every day and needs to always be updated. If the terrain changed by weather conditions or erosion, then the DEM data would be inaccurate and the slope values made through the DEM data would also be inaccurate. If this DEM data is old, there should be some inaccuracies to be expected. On the contrary, if the DEM data is recent, then there is a higher chance that it is still accurate and an accurate representation of the terrain. This would affect the ADA compliance of slopes and steepness in the trail. The trail can possibly end up not being ADA compliant. It would essentially mean that the trail I designed would be built on inaccuracy and uncertainty. This trail would possibly be dangerous for visitors and could be very dangerous to people with disabilities. This is why it is important to make sure the DEM data is as accurate as possible or it could possibly lead to risking the safety of the visitors. It can also waste the time and effort of the person who designed the trail. It would also make any analyses of why the trail should be positioned in a certain area become inaccurate and incorrect. The datasets used to justify why the trail should be in that area would also have to be adjusted and fixed to accommodate the error in the DEM.

The criteria of selection were I wanted the trail to be in an underutilized location and near a point of interest. I used the names of locations dataset to help me find suitable points of interest that were in underutilized locations. This is where I found the Lost Lake area. The Lost Lake was the point of interest and was suitable for me to use. Another criteria is I wanted the trail to not be close to another trail to prevent congestion and crowdedness. The area I picked is only close to the John Muir Trail but is in the middle section of it. This means more people will use the John Muir Trail to get to the trail but will eventually disperse to either the proposed trail or continue on the same trail. This alleviates some crowdedness and congestion by having another route or trail to go to while on the John Muir Trail. However, I understand that people who want to go to my proposed route and people who want to use the John Muir Trail will be using the same trail, which can contribute to congestion or crowdedness. My counterargument to this is that the congestion and crowdedness will disperse once they get to the entrance of the trail. Since my trail is long, it will take a long time to complete which gives more time for the people on the John Muir trail to finish and go back to the entrance. Crowdedness and congestion are still lowering in this case. Additionally, this trail is a decent distance away from the other trails and helps alleviate the crowdedness in those trails by having another trail be built in a location that is isolated from the majority of trails. In this location, the trail needed to be accessible to people and couldn't start in the middle of the wilderness, so I put it near a trail. I propose building roads near the proposed trail to make it more accessible by making visitors have the decision to drive there and adding another entrance that doesn't start at the John Muir Trail. Adding another entrance can help alleviate crowdedness, but a road needs to be built near it so it can be accessible to the public. The next criteria is that it shouldn't overlap with other trails and shouldn't affect endangered animals. The trail isn't affecting the Yosemite Toad and doesn't interfere or overlap with other trails. Another criteria was that the trail shouldn't interfere with places that have water like lakes or ponds. The trail I made doesn't cross or go into places with water like lakes or ponds. However, this trail doesn't have any campgrounds or any bathrooms which is why I propose that these things be built near the trail in the future. Since it is underutilized land, Yosemite National Park hasn't used the land

to build these amenities in this area. I propose once the trail is built, the national park should build bathrooms and campgrounds near the trail to ensure ADA rules and keep the visitors happy. My design of the trail didn't revolve around restrooms or campgrounds, so I didn't consider areas with these features. However, I do know restrooms and campgrounds aren't present in this area because the area is unutilized. Another criteria is it shouldn't go over the slope value of 12 which fulfills the ADA slope criteria. This ensures the safety of all who visit and doesn't discriminate or endanger the lives of disabled people. With higher slopes, people are more likely to be in more danger and this is especially true for disabled people. This is why using land that has low slope values ensures the safety of people and disabled people. The surface of the trails is also on flatter land and not rough terrain which also ensures the safety of the visitors and fulfills ADA surface criteria.

A suitable site for a trail is a trail in the underused area between Glacier Point Road and Pohono Trail. A point of interest that can attract visitors could possibly be Illilouette Ridge. They won't be able to see the ridge up close due to steepness constraints, but they can still see it from a distance. It also isn't in the area of the Yosemite Toad which helps keep the endangered species alive. There are also roads and trails near it. Any site that has a wide area of low slope and low steepness values is advisable, but I recommend choosing a route in an unutilized area to prevent congestion and in an area that doesn't affect endangered species.

My ranking scheme for design solutions is that accessibility is a top priority, path curvature is the second priority, user experience is the third priority and conservation is the last priority. Accessibility is the top priority because I believe the trail shouldn't discriminate against people who are disabled and anyone should be able to enjoy the trail. Accommodating for accessibility also leads to the trail becoming safer and structurally sturdy for visitors. This prevents visitors from endangering themselves. Safety is something that should come first. Path curvature is connected with accessibility. This is because the design of the path and how it is shaped are influenced by accessibility and ADA. The slope can't be 12 or more which influences how the trail is shaped. The trail can only go onto areas that have a slope or steepness value less than 12 which indicates that it is less steep. Building on areas with less or smaller steepness ensures the safety of the visitors. If you use steeper areas, it endangers both normal visitors and visitors that need accommodations. The curvature path was also influenced by the ADA's rules which advocate for accessibility. It avoids areas with higher steepness values and goes to areas with lower steepness values. User experience is also important because, without the visitors, there would essentially be no national park. Visitors are essential and having no visitors will severely hurt the national park. This is why appealing to the visitors and keeping the visitors happy is very important. Building a new trail in a new unseen and unutilized area can bring in more visitors and keep them satisfied with the park. This is because they get to see new sights and see a new side to Yosemite's beauty. The informational sign would give the visitors information about this trail to keep the visitors happy and not confused. It would help them better enjoy the park and the trail. User experience is also connected with accessibility and path curvature. With a trail that discriminates against disabled people, the visitors will most likely respond negatively, which can lead to decreased numbers of visitors. With path curvature, visitors need to be safe, and if they get injured the visitors will think negatively about the park and can possibly sue the park for endangering their visitors. This is why the trails have to be ADA compliant, sturdy and resistant to prevent lawsuits and ensure the safety of the visitors. Conservation is important, but our objective is to build a trail and a trail utilizes land. Regardless of how the trail is shaped and how it looks, conservation of land would still be

impacted and land would still end up being used. Land needs to be used to keep the users or visitors happy with the national park and land needs to be used to help accommodate disabled people. The aspect of conservation that is important to me is conserving the population of the endangered species in Yosemite by making the trail away from their habitats. My final design puts accessibility first, path curvature second, user experience third, and conservation last.

The condition for the informational sign that was evaluated was that it needed to be on an area that had a small slope or steepness value. I put the information sign in an area with little to no slope because putting it in a location with higher steepness can most likely lead to the sign being damaged and is not at the most ideal point where most people will see it. Putting it at the beginning on flatter or less steep land is ideal because there is a significantly less chance of the sign being damaged and more people will see it. Additionally, having the sign on flatter land makes people with disabilities have less difficulty when approaching the sign.

Ethical Considerations

An engineering-specific consideration is upholding the rule that engineers shall hold paramount the safety, health, and welfare of the public. The trail shouldn't negatively affect the community or any visitors and shouldn't harm or damage any visitors. The trail is sturdy and resistant to weather conditions is essential and these features have to be constantly maintained. Building the trail in very steep places with high slopes discriminates against disabled people and is also very dangerous for anyone using it. Maintenance can be expensive, but I think it's a good investment to prevent future lawsuits or future damages and ensure that all civilians are safe.

Another engineering-specific consideration is upholding the rule that engineers shall not aid unlawful practice of engineering by a person or firm. Designing the trail could possibly harm or disrupt habitats and animals. Building a trail in or near a habitat can possibly alter the migration and movements of animals. Yosemite National Park has endangered species and if a trail is built in a protected habitat or area where endangered species roam, this would violate federal and state laws that are enacted to protect endangered species. For example, it would violate the California Endangered Species Act, since the trail would be a threat to the lives of the endangered species. People visiting the trail could possibly hurt or be damaged by the animals. Breaking endangered species laws may lead to imprisonment and a huge fine which is why it is advisable to avoid putting a trail in a habitat with endangered animals. It's important to strategically put a trail away from animals or place them in areas of a habitat where animals don't frequent. Ensuring the safety of the people using the trails is top priority. This also connects to the rule from the Code of Ethics that was previously mentioned.

Final Recommendations

I recommend placing the path away from the other trails on unutilized land to prevent the congestion problem that Yosemite faces from growing and to give alternative trails to people when there are weather conditions affecting other parts of Yosemite. Having trails away from each other separates people and prevents an abundance of people from being on a trail at one time. The separation of trails is also important because it prevents diseases like Covid from spreading. If the trails were closer to each other, it would lead to more congestion in areas where the trails are near each other and can lead to possibly the spread of disease. Weather conditions like smoke or haze are common and alternative trails away from other trails can give people another route to go to if one of the trails has haze or smoke covering the scenic views. I recommend the path I chose because it accommodates for possible errors and uncertainties in positioning and fulfills the ADA requirements along with my personal requirements stated above. However, this is a basic ADA compliant trail and doesn't have resting intervals. If you use my proposed route, I recommend putting resting intervals at areas of the route with high slope values and also recommend building roads and essentials like restrooms and campgrounds. Building roads will make the parking lot useful. The parking lot is next to the trail and can be used to help get more people to visit this new trail. The land is unutilized, so roads have not been built there yet. This is why I propose building a road next to the parking lot so that more people can come and access the trail. The parking lot also fulfills ADA requirements and is positioned in an area with little to no slope. It isn't too far or too close to the trail and there is space in between them. The location of the sign is in front of the trail because the sign and the information need to be seen by everyone. This is to ensure that all visitors know all important information about the trail which can ensure their safety and maximize their enjoyment of the trail. The general content of the informational sign should include the distance the trail reaches along with a map, information about rest stops and restrooms, and information about the terrain and wildlife. Additionally, the sign should include accessibility information and where parking lots are. These pieces of information are essential to the sign because it helps people better understand the trail and can help them have an enjoyable time at Yosemite National Park. Knowing where rest stops and restrooms are can help people restore their stamina and give them time to recover. Knowing the terrain and wildlife can help people maintain their safety by being aware of the possible animals near the trail and the steepness of each part of the trail. Knowing the distance of the trail will show people when the trail ends. People with disabilities need to know how accessible the trail is to them and any accessibility accommodations the trail has for them. This maintains the disabled people's safety and doesn't discriminate against them. The map also helps guide visitors and prevents visitors from getting lost or going off the trail. I wanted to include areas with scenic or pretty views and the history of the specific area, but it would make the informational sign seem overwhelming and overbearing. This is because the sign already has a lot of information on it. I made trade-offs for accessibility and excluded the trail traveling in sensitive areas. This is because I believe safety and being inclusive to others is important. If we place the area on sensitive areas, it discriminates against people with disabilities and excludes them from being able to see the scenic terrain of Yosemite. Additionally, sensitive areas have high slopes and higher steepness values which can be very dangerous for anyone to traverse. I avoided the sensitive areas to ensure the safety of all the visitors and to not discriminate against people with disabilities by accommodating them and their physical needs.

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Final Visuals

Production Quality Map #1:

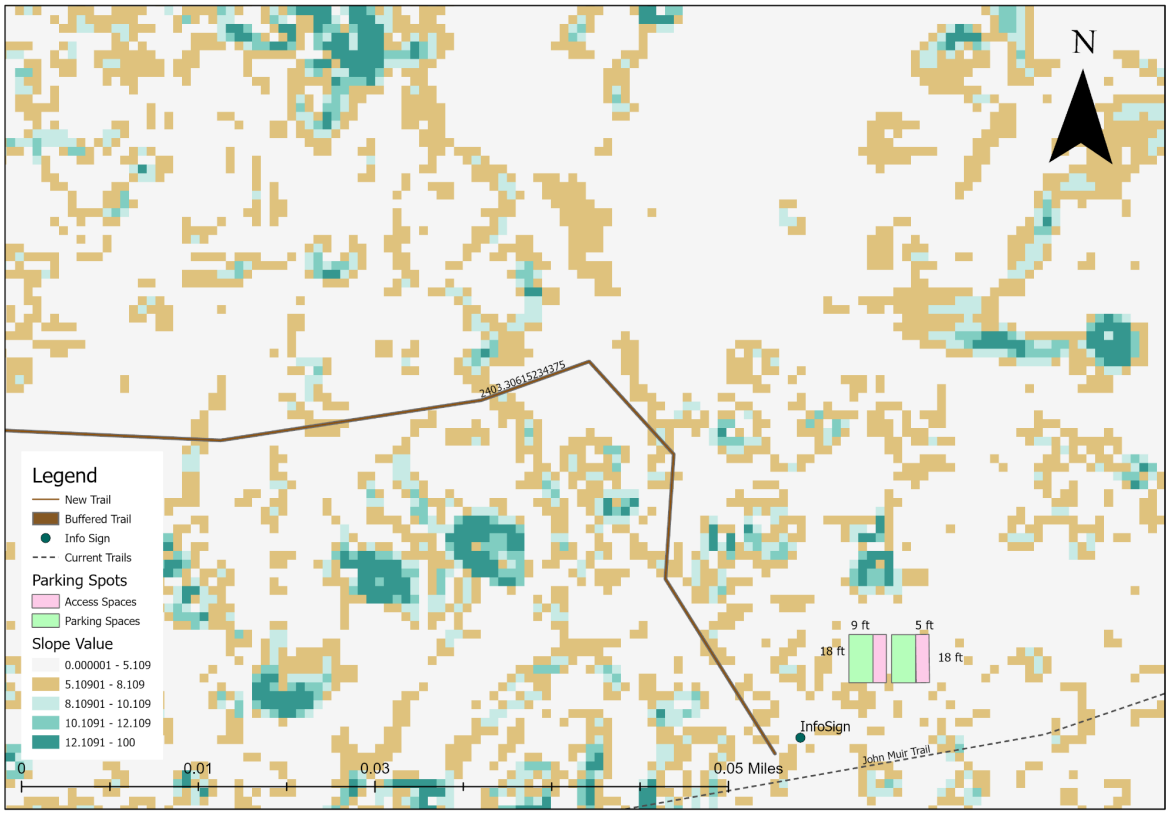
Proposed Trail and its Slopes in Yosemite National Park

Made by Jason Gates (6/25/2022)

Production Quality Map #2:

Proposed Parking Lots Near New Trail in Yosemite National Park

By Jason Gates (6/28/2022)



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