A Solar Powered Automated Public Transportation System

Civil and Environmental Engineering Team

San Jose State University

Mechanical Engineering Department

August, 2016

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Abstract

The main task for the civil team was to find our way around and outside San Jose. For its first phase, the project plans to be a fast and convenient way to link San Jose State University Main Campus and San Jose State University South Campus, where the soon-to-be renovated university's sports facility area is located.

The group worked by analyzing the current situation of the public transportation in the city of San Jose and identifying points of interest such as malls, airports and grocery stores in order to better understand where the less fortunate areas are and how to connect them with those places mentioned above. Along with that, the team also had a second major task, which was to design a test track layout for the site we had available.

By the end of our time in the project, we were able to come up with two solid solution plans for both our tasks and they will be presented and explained throughout this paper.

Acknowledgements

We thank the Institute of International Education and our sponsor CAPES for allowing us to be here. This experience has been very enriching and we are looking forward to giving it back to our home country.

The successful and final outcome of this assignment required a lot of guidance and assistance. We would like to thank Ron Swenson, Professor Burford Furman and Professor Kurt McMullin for giving us this opportunity and allowing us to learn and experience such great things in such a brief period.

Finally yet importantly, we would like to express our gratitude to our family and friends back home. None of this would have been possible without your continuous love and support.

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Executive Summary

It is always difficult to work in a different place and among people that you have never seen in your life. The civil team was composed by six students: five civil engineering students and one environmental engineering student. It was important for us to work together in order to get the work done.

The following report specifies all the work done by the Civil Team during the summer of 2016. The Civil Team started working in the end of May and kept working until the beginning of August. It is important to know that the tasks given to the Team were divided among all the civil and environmental engineering students.

The work done by the Team started with the possible routes to connect the San Jose State Main Campus and the San Jose State South Campus. During this first task, a lot of drawings using the program AutoCAD were done, to exemplify all the possible routes to connect the two campi. The two students working in this task found some problems on it. These problems are also discussed in this report. The team tried to let some information to help the future civil teams to work on it.

The other part of the work involves the south campus of the San Jose State University. The main concern about this are the stations, which would build in the parking lots. As the first task, some drawings were done to explain all the situation.

The civil team also worked with the Test Track, doing the first design of it. The test track was one of the main concerns for the civil team, so the students did a lot of effort on it. First of all, our team had a place where we would build the test track, but the place had a lot of problems and our team had to change the place where we would build it. The civil team just started the work and let the column and beam design for the future civil engineering teams. For

last, our environmental engineering student have done a precisely environmental study about the Spartan Superway Project.

The report have all the information that can be used by other teams, not just for future civil engineering teams, but any other team working in the Spartan Superway Project.

1. Introduction

When our team first arrived in the project we did not have much information from past civil teams so we basically just started working with the information we got from other teams. The main goal of the Civil Team is to connect the two campi of San Jose State University (SJSU): the north campus (main campus) and the south campus. The first one hosts all the academic facilities such as Engineering Buildings, labs and also student housing; the second one hosts all the sports facilities such as the Spartan Stadium, which was our main concern since it attracts an unusual amount of visitors on game days to the south campus.

The Spartan Superway is a green alternative for all the transportations problems that are common in big cities. As the capital of the Silicon Valley, San Jose should give new transportation alternatives to all other big cities in the world. The project also aim the students flow between the two campi, and maybe in the future it will be possible to extend the network. The ATN (Automated Transportation Network) will be a solution for the transportation problems, mainly the Solar-Powered ATN that is how this trains is moved by.

The project consists in a train moved by solar energy that tries to attend the flow, of not only students but also any civilians, between the two campi. 275 solar panels are to be placed all over the guideway. The guideway will be built over the street and it work together with the common traffic on the streets. It is also important to consider all the environmental problems that concern the new transport.

This report has the purpose of presenting the team's objectives and then outlining the requirements and specifications we had to meet. After that, it will present the solutions the civil team found while working this summer.

2. Background and context for the work of the sub-team

The Civil Team was in charge of four main tasks. The first task was the layout of three potential routes to connect the Main Campus to the South Campus; the second task was about building a test track for the pod car; the third task involves the route layouts inside the South Campus; and the last task was about researching and preparing a potential Environmental Impact Report (EIR) for the Superway Project. Each member of the team was in charge of one of the tasks, some tasks two civil students were working together.

3. Description of the Sub-team and Objectives

In the beginning three tasks were given to the Civil Team during the summer:

1. Layout three potential routes to connect the Main Campus of San Jose State University (SJSU) to the parking lot at the South Campus of SJSU on the 7th street. For this first task, three options were given to the Civil Team: Update the current layout along 7th Street, adjust the layout to use a tunnel bore under I-280 at 5th Street or adjust the layout to travel under I-280 at 3rd Street over the existing sidewalk and parking lane.
2. Develop a site plan and two potential layouts for a test track to be built at the land space provided by Ron Swenson at 7th Street. The two test tracks are to be one at full scale and a second at half scale;
3. Research and prepare a potential Environmental Impact Report (EIR) for the Skyway Project;

After the first week, Professor McMullin came up with another task:

4. Develop a layout route for a full-scale ATN transit layout for the new South Campus sports development. This system will connect the 7th Street parking lot, the Simpson Sports Center and each of the new sports fields. A potential extension will also connect the Downtown Ice facility, the Municipal Sports Field and Kelly Park.

4. Design Requirements and Specifications for the Sub-Team Work's Products

During the first week, the Civil Team received all the design requirements for the Test Track from Professor Kurt McMullin. According to what was passed to our team, traffic requirements must provide a clear passage of at least approximately 8.5 meters from the bottom of the pod car to the street; the pod car also has a height of 2.5 meters approximately, totalizing almost 11 meters. In addition, the columns will be placed on the sidewalks, 2 meters away from the guideway (both centerline of the guideway and the columns). The columns would be square 500 mm x 500 mm. To finish, the stations would be built on the sidewalks.

Every week, more specifically on Thurdays at 11 a.m., we had meetings with Professor McMullin to talk more about the week achievements. After analyzing the height and all the aspects that would interfere, our team realized that 8.5 meters is too high, so Professor McMullin decided to change the height, using another height of approximately 6 meters. This height would be used on the test track.

5. Description of the Design

5.1 Potential Routes

The project objective is to connect the two San Jose State University (SJSU) campi. In the figure below, the two campi are shown: the Main Campus in the north part and the South Campus in the south part.

Figure 01 - San Jose State Main and South Campus

As said before, groups were made to work on each task. Davi Cerqueira and Allan Oliveira were chosen to work on the first task, which is layout three potentials routes to connect the Main Campus and the South Campus. The main challenge of this group would be crossing the interstate highway that exists on the way to the South Campus. The previous idea was to cross the highway passing over it, but the pod car

would be too high, and maybe would not be safe for the people. The figure below shows the idea:

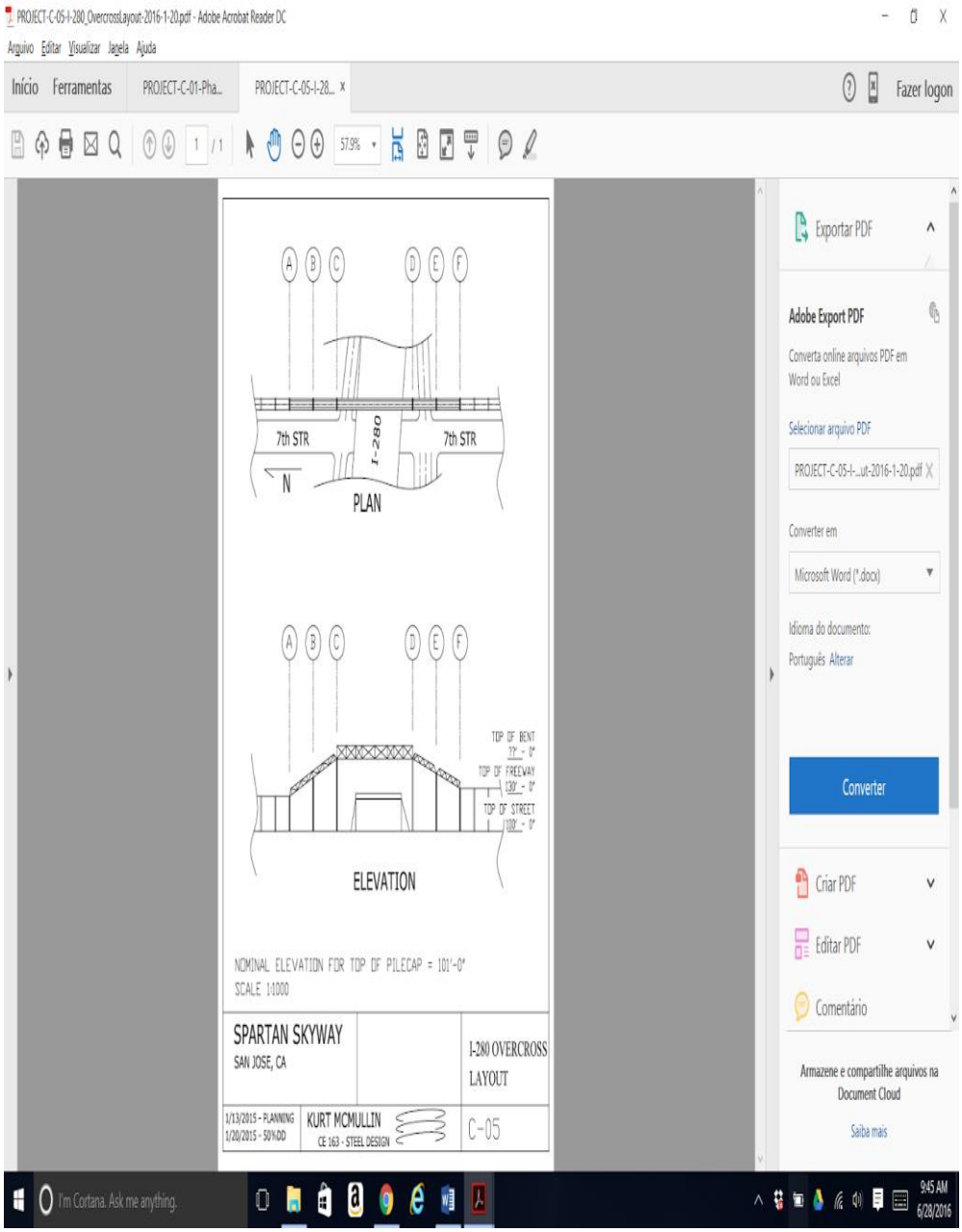

Figure 02 - Previous ideas to cross the highway.

At the beginning, five possible paths were identified to cross the highway as the next figure shows:

Figure 03 - The five paths

However, even identifying that there were others paths, the team thought that the paths using the alleys between the first and the second street, and the second and third street (Figure 04) were the best choice.

Figure 04 - Alleys between the 1st, 2nd and 3rd street.

After a while analyzing the possible paths to cross the highway, Allan and Davi found another path that presented better possibilities to reach the South Campus and build a “parking lot” for the pods once they were not been used. This path is located at the Coyote Creek Trail. As shown on figure 05:

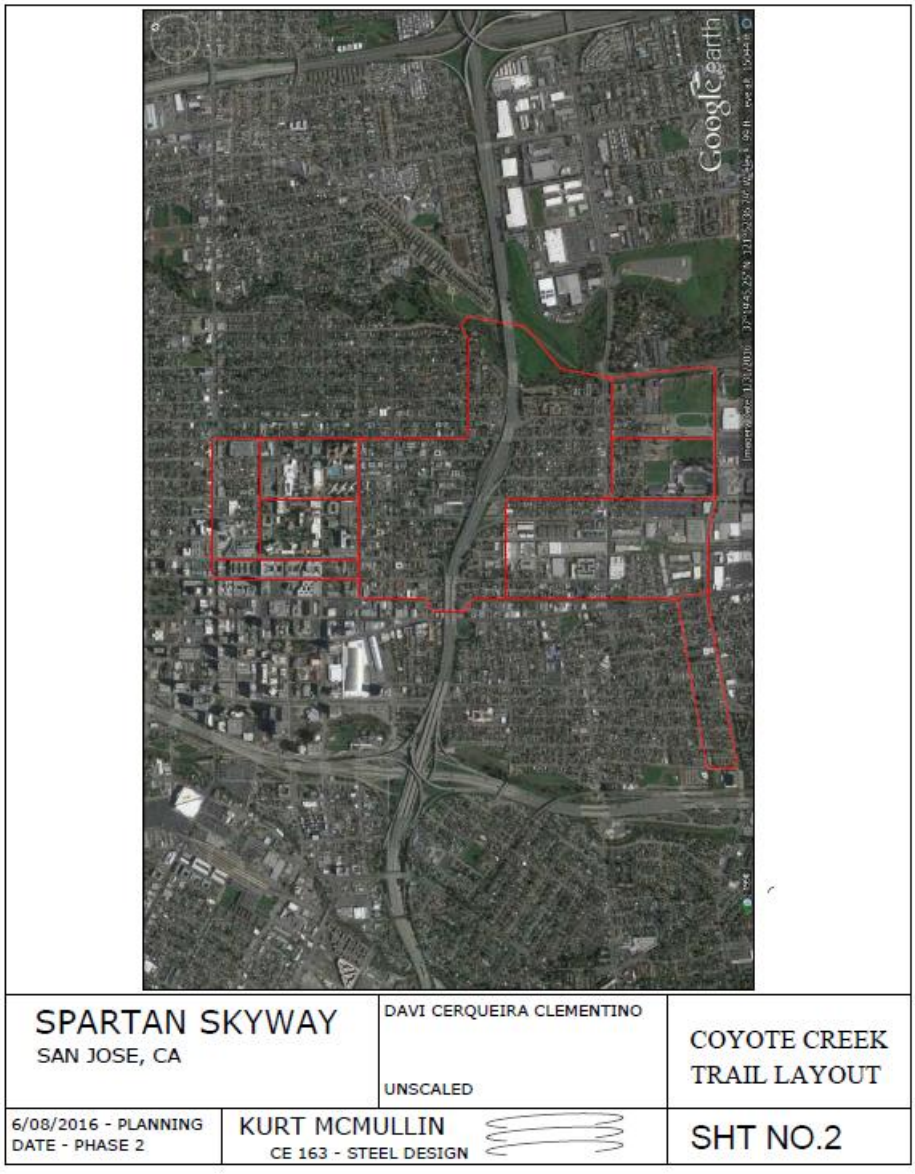

Figure 05 - The path using the Coyote Creek and the alley located between the first and second streets.

The civil team searched more possible spots for the track to cross the highway and we see the possibility to build the ones we already had found.

Figure 06 - The paths considered.

Considering the usable space in both sides of the possible spot at the 5th street, the team realized that wouldn't be possible for us to build the track passing there.

Figure 07 - The space before and after the highway on the 5th street.

At the next step, some sketches were made showing these possible spots and some other spots where some problems were found.

Figure 08 - The problem using two ways track and 30 meters radius.

The main problem identified on the Figure 08 is the impossibility of making turns without entering on particular proprieties and the distance that the tracks get between each other. The distance stayed less than four meters, which is unviable on our criteria. Once the Pod cars could be so close from another one in the opposite way that it would be uncomfortable for the people inside the vehicle.

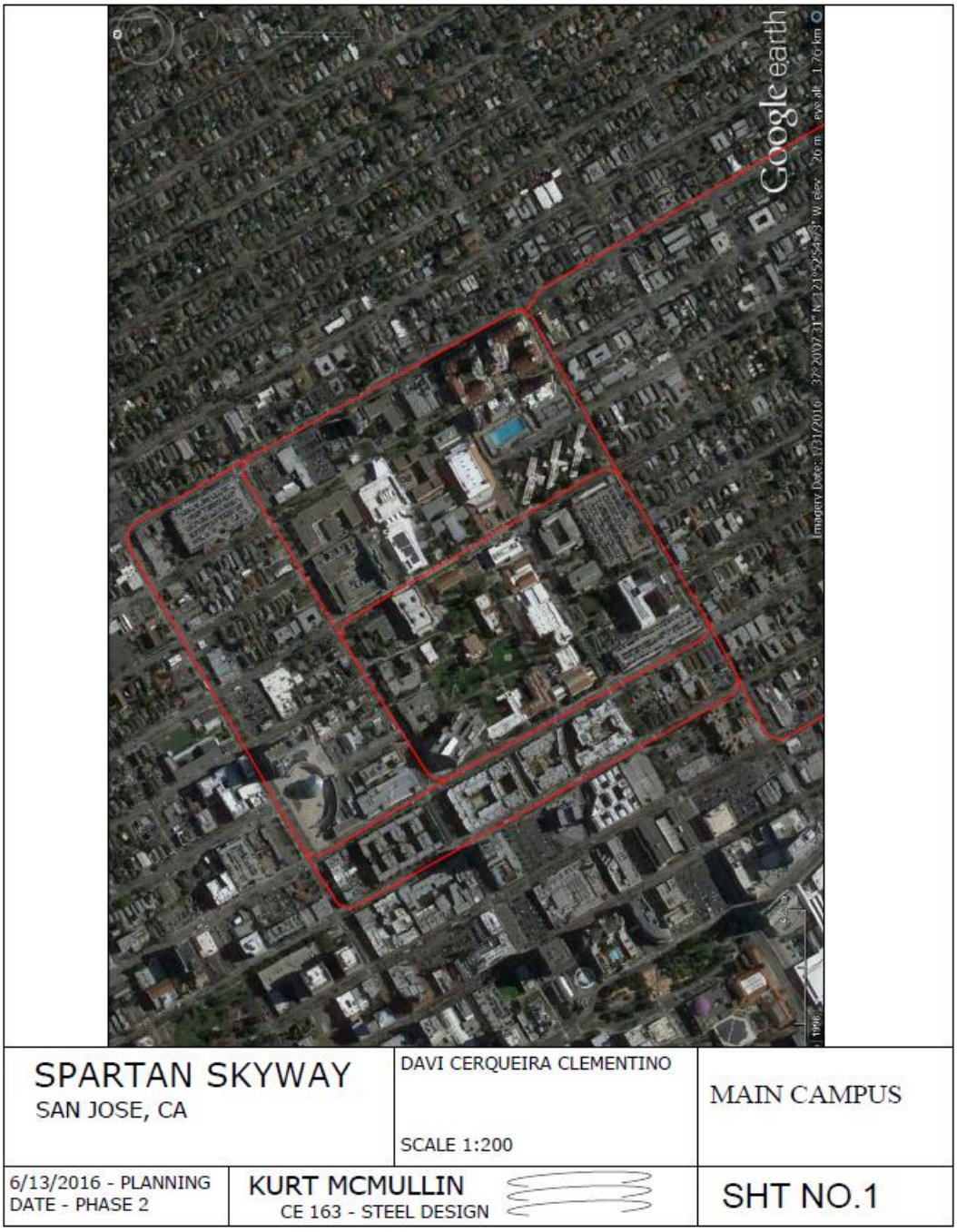

Figure 09 - A possible path for the Main Campus.

Figure 10 - Path under the 10th street.

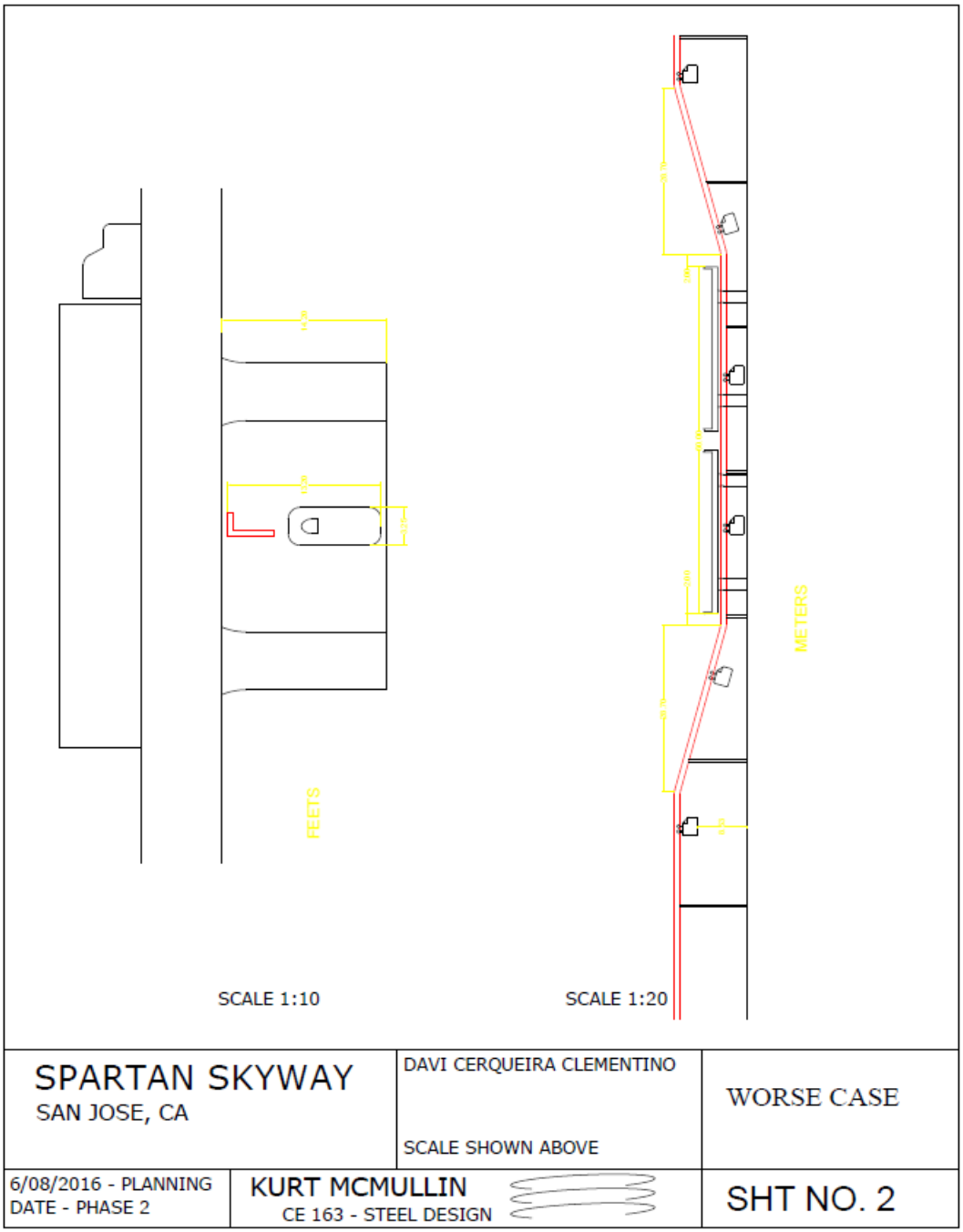

Figure 11 - The worst case under the highway.

Based on this work, the team thought that a different path could be the best option. Using the space on the 10th street and the Coyote Creek we could disturb less the population and still achieving our goals. So, this was the main route that we developed.

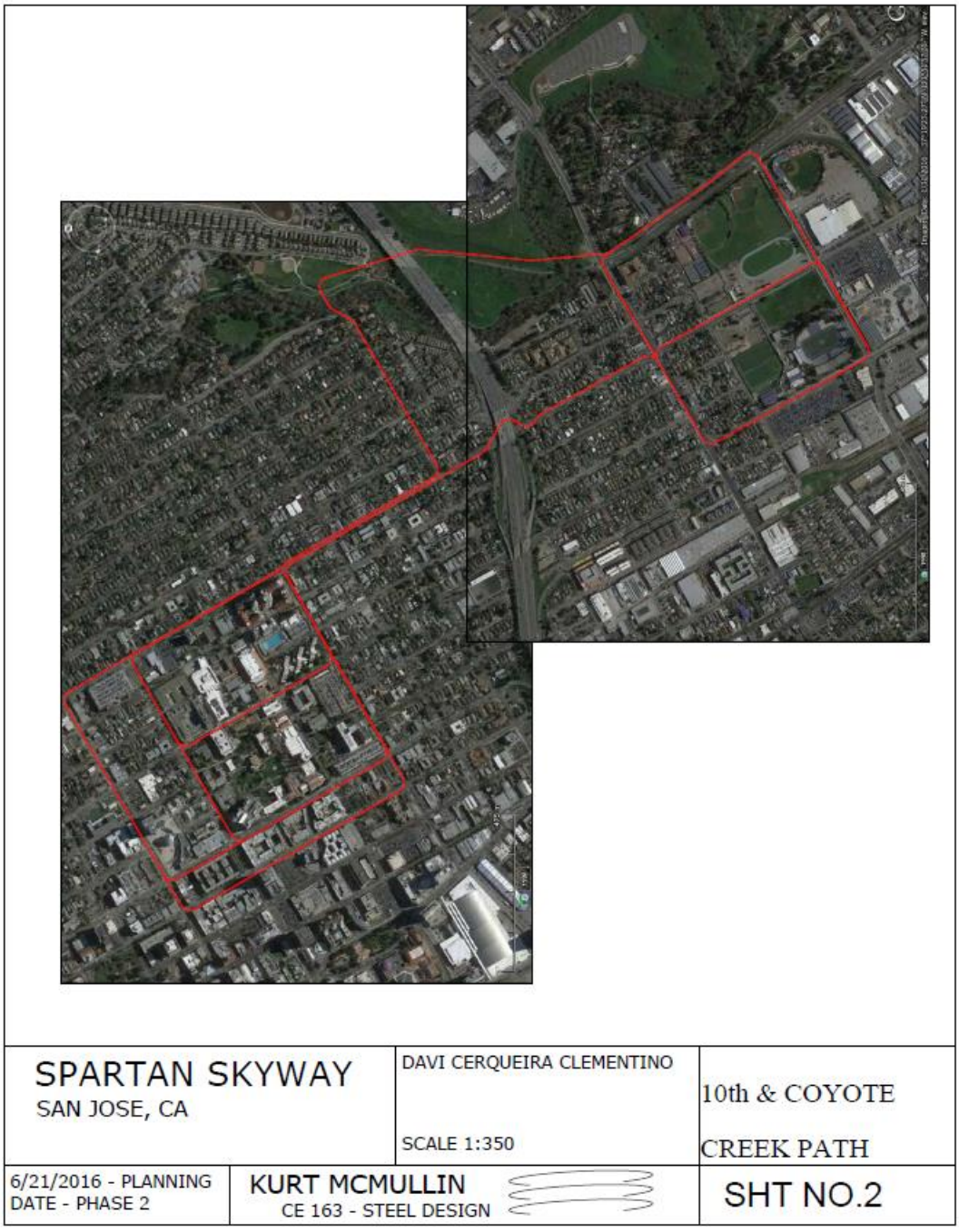

Figure 12 - The main path.

After having the route defined, the team focused on the stations that we would build. On the first analyzes we found some problems that we could have. One of the criteria proposed is that the stations should be on the ground level, once the stations must be accessible for

everyone. To build an elevated station it would be necessary the installation of an elevator to give access to handicap people.

However, after analyzing the distance needed to reach the ground level and to reach to the level that the Pods would ride (around 6 meters from the bottom of the Pod and the ground level) and using the maximum of 17 degrees slope, the team realized that the distance needed will be 72.4 meters. This distance is not a good number once the stations will be paced on the sidewalks. Therefore, any station built would block houses and garages of particular proprieties.

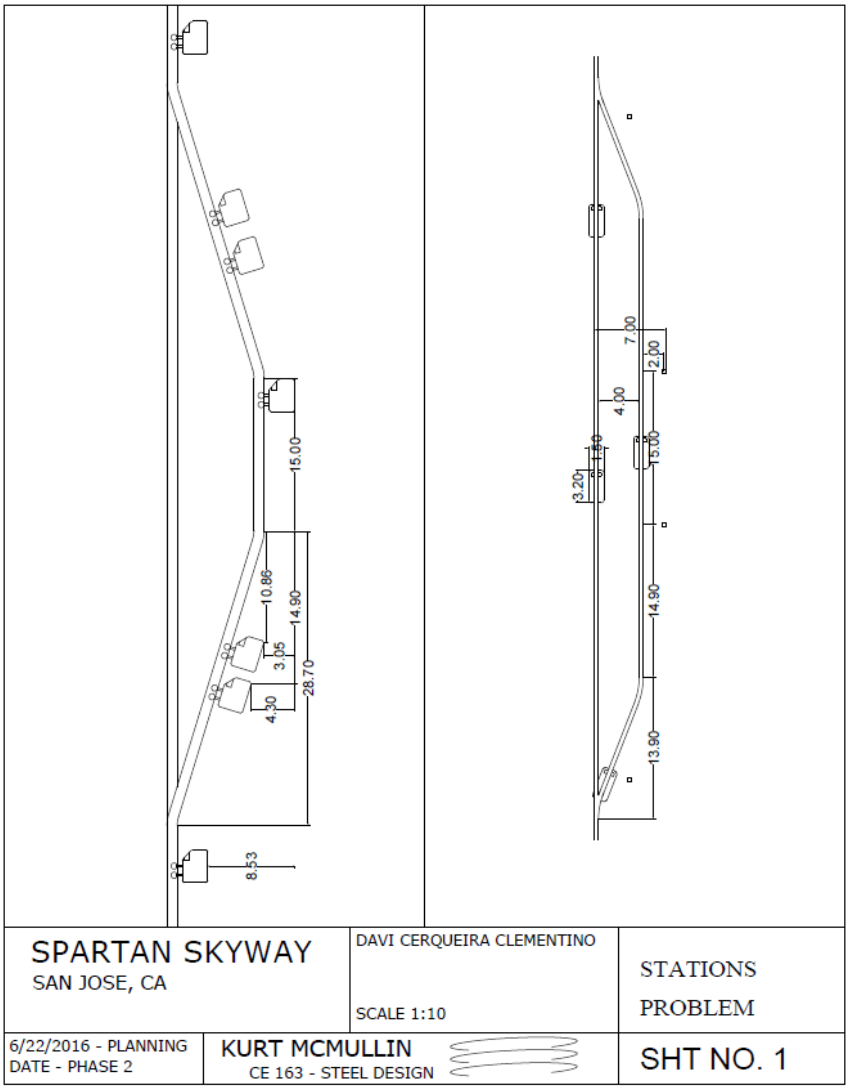

Figure 13 - Ground Station length.

After a meeting with professor Furman, a new idea of station was developed. A “Half high station” idea was developed. This kind of station would be elevated to a level where would be viable the construction of a ramp. Following there is a sketch:

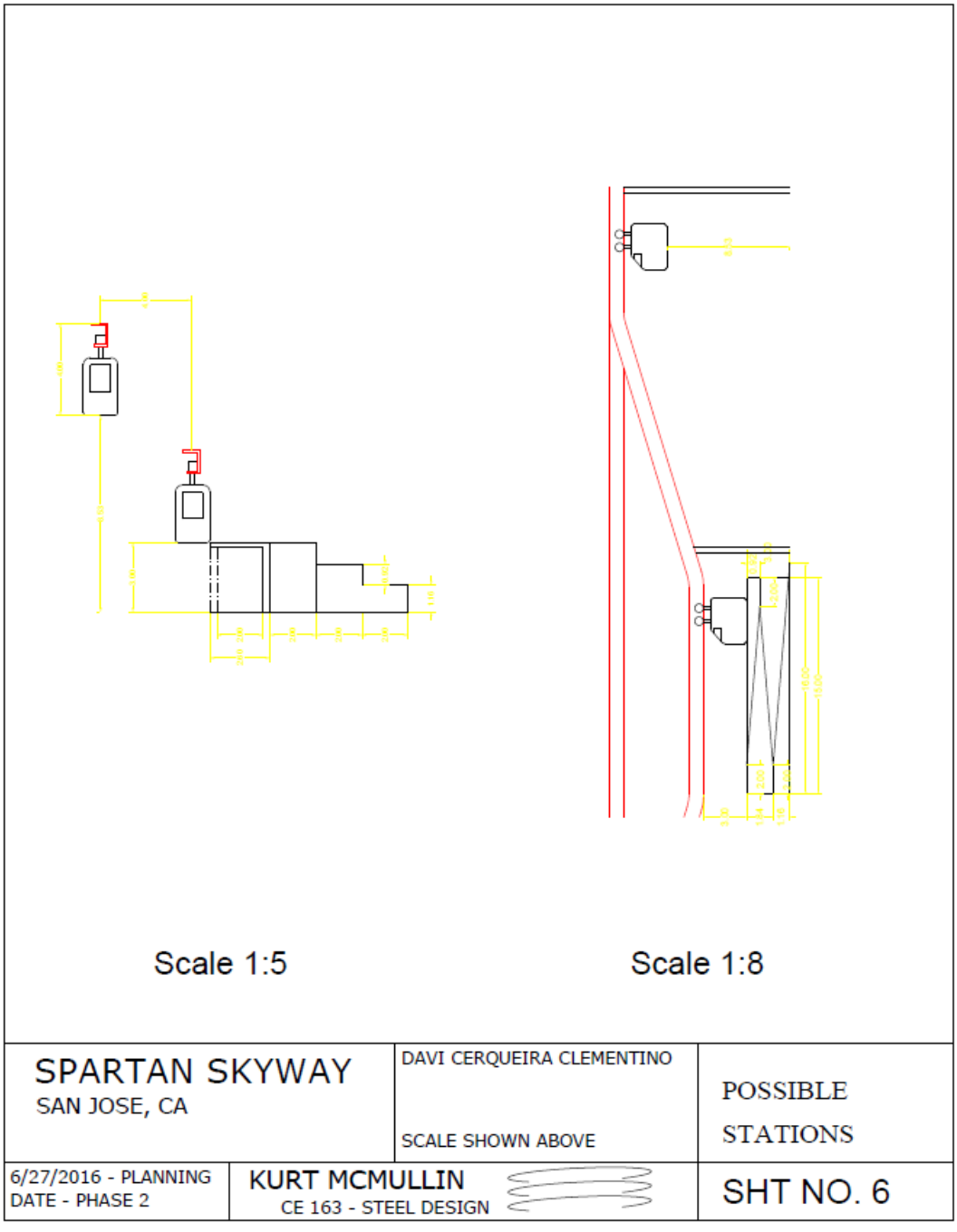

Figure 14 - Possible “Half High Station”

It must be remembered that the slope used on the ramp was 1:12, the maximum allowed to be useful to handicap people.

5.2 South Campus

Nayara and Kelvin were in charge of the San Jose State South Campus. The South Campus is a San Jose State sport facility located five minutes (about 1 mile) away from San Jose State University Main Campus. The main task in the South Campus was about searching the best spots to build the stations.

Figure 15 - Future Facilities in San Jose State South Campus

The first step to complete this task was to think about the people demand in the South Campus. The team realized that the biggest demand would be during football game days. Our first thought was building three stations, and we would use spaces inside the parking lots located in the South Campus. The first station would be built in the parking lot near the Football

Stadium; the second station would be built near the baseball training field; and for last, the third station would be built near the golf court.

Figure 16 - Parking Lots available for the stations

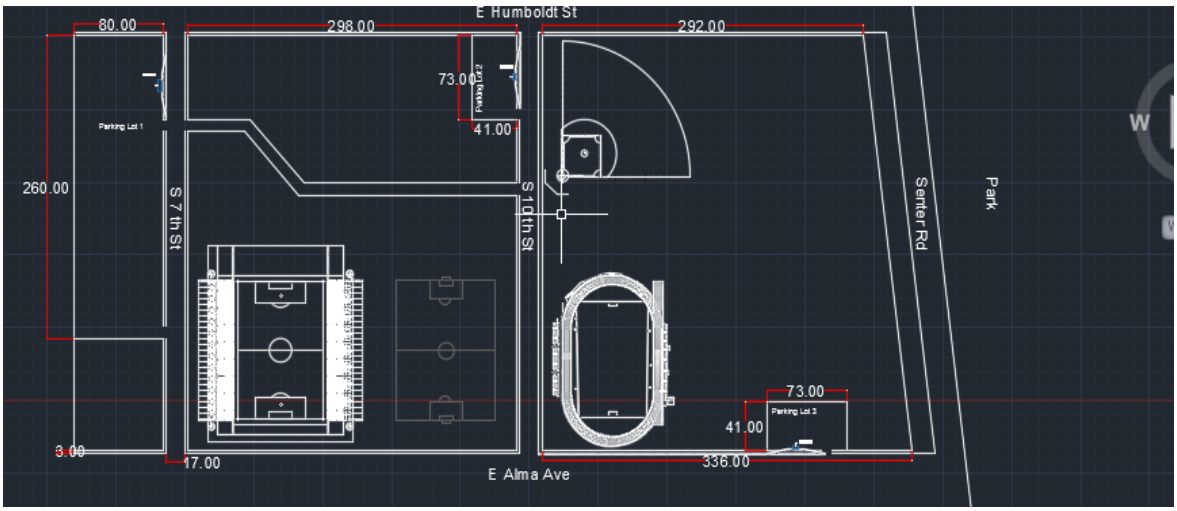

Figure 17 - South Campus Blueprint

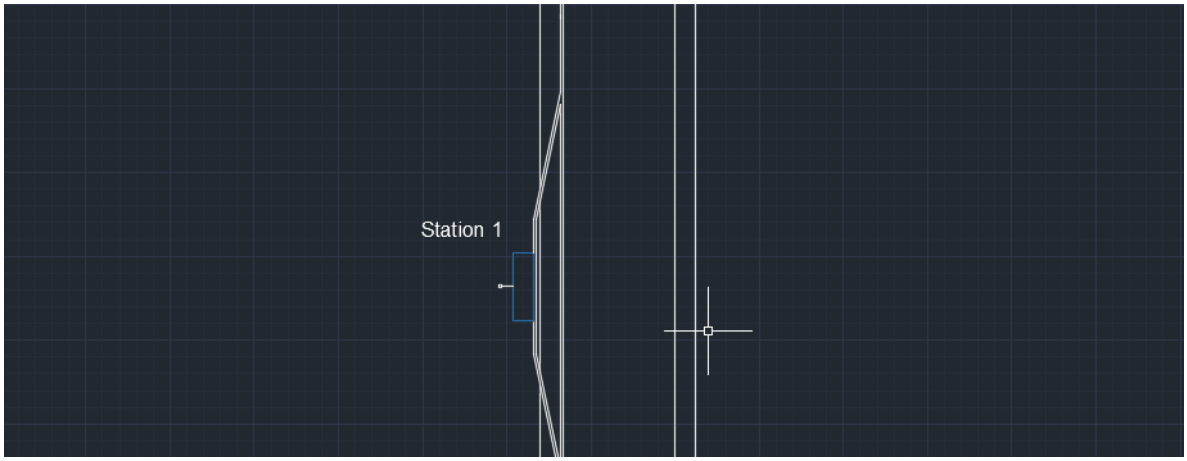

Figure 18- Station near the Football Stadium

It is important to know that the station near the golf court would also attend the demand to Kelley Park, located near campus.

5.3 Test Track Layout

For the test track, we were working on layouts of potential tracks. We had decided in the third week that we would focus just on the full scale test track, which will allow us to test more important aspects of the system.

We have an area located in 1555 S 7th street, near South Campus of SJSU. At the beginning of the summer, we were assuming the back area of the BSB building. We did some possible design for the available area. We found out that a track with the 30m radius curve (Figure 20) assumed in the first place wouldn't fit in the available area, so we decided to modify this parameter to 10m and use an alternative area (Figure 21), in a way that would disturb less the companies inside the site.

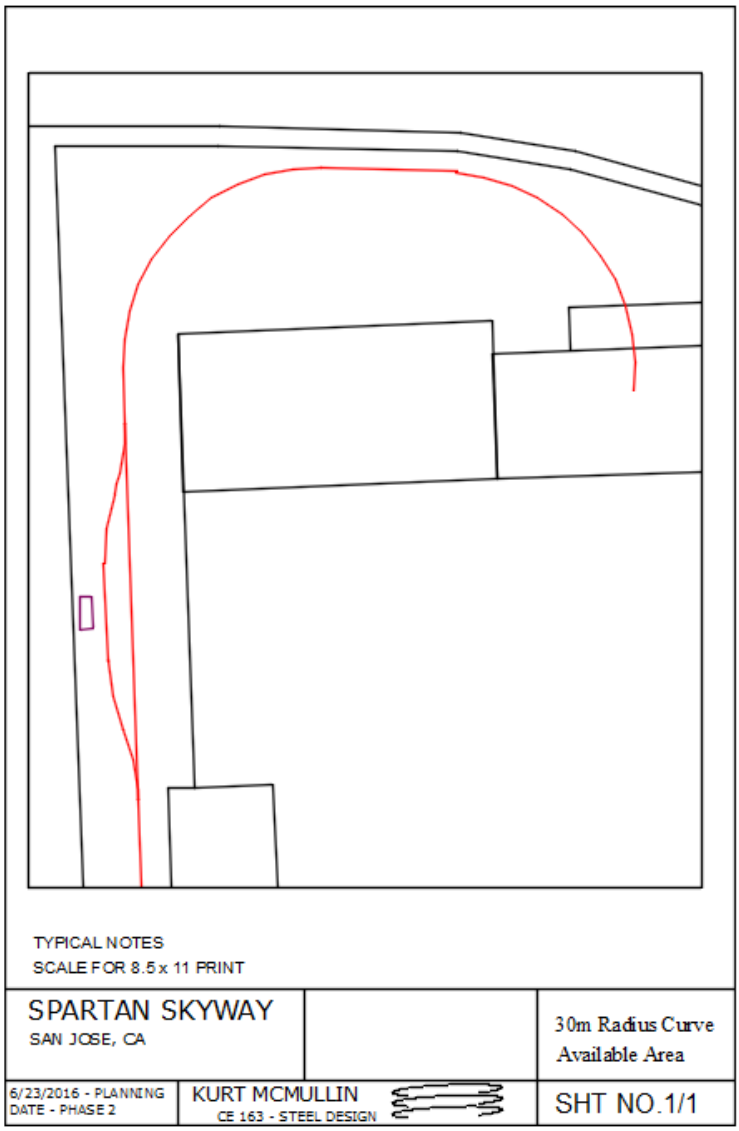

Figure19– Test Track design using 30 meters radius curve

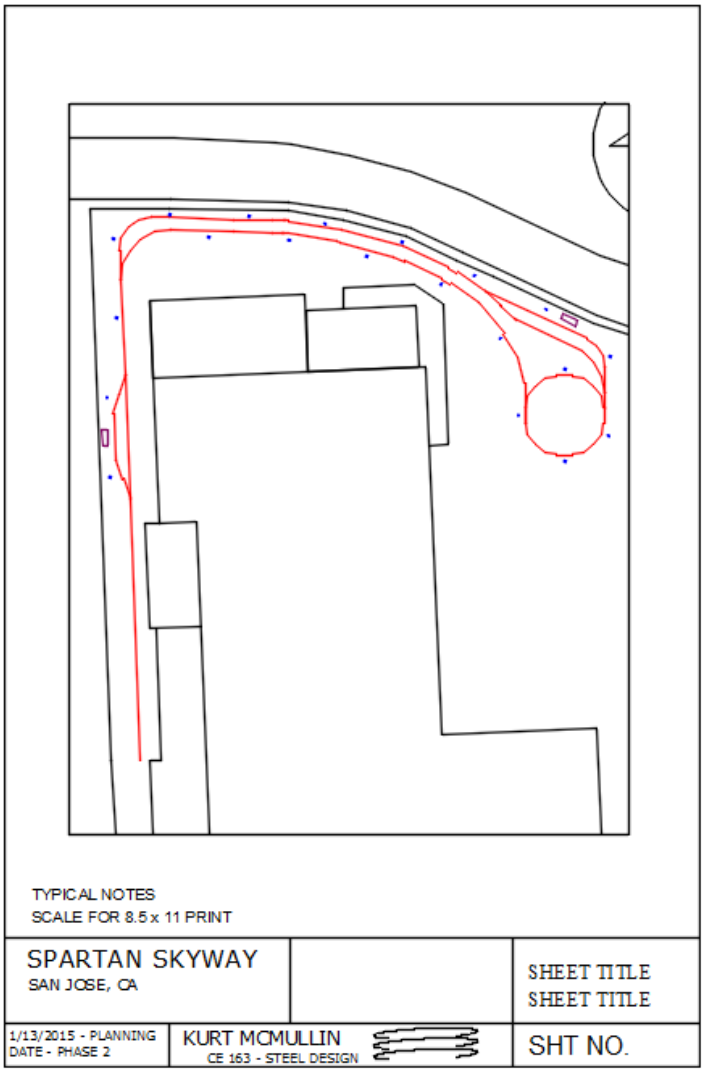

Figure 20 – Test Track design using 10 meters radius curve

On July 1st, we had a meeting with Tina, the vice-president assistant of the Barry Swenson Builder. We made a presentation giving an overview of the project and showing them our current idea for the test track in the area. After discussion, they recommended us to use another area in the site that is being negotiated with the City, which would be more convenient for the companies. Also, they provided the site plan of the facility (Figure 22) for help on the test track design.

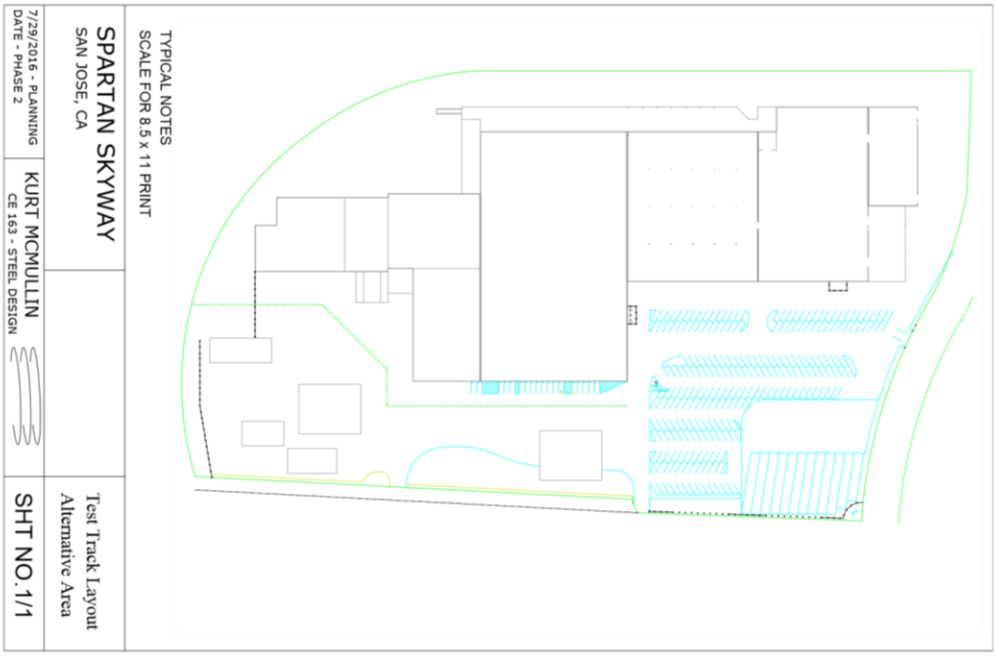

Figure 21 - Site Plan of the facility

We started to work with this new area. The first idea was to do a one-way track, with two loops on the beginning and on the end of the track (Figure 23). But, we realized that it would be necessary a reverse swift on the bogie, and it would be complicated to build.

Figure 22 – Test Track before BSB meeting

Therefore, after some meetings with Professor McMullin, Professor Furman and Ron, we decided to design a two-way test track (Figure 24). The new test track will have two stations, one on the ground-level and one elevated, to test all the possibilities of the stations. Also, it will have a slope, two sloops, at beginning and at the end, to change directions. We tried to incorporate all aspects that we think it will be necessary to test our project in the best possible way.

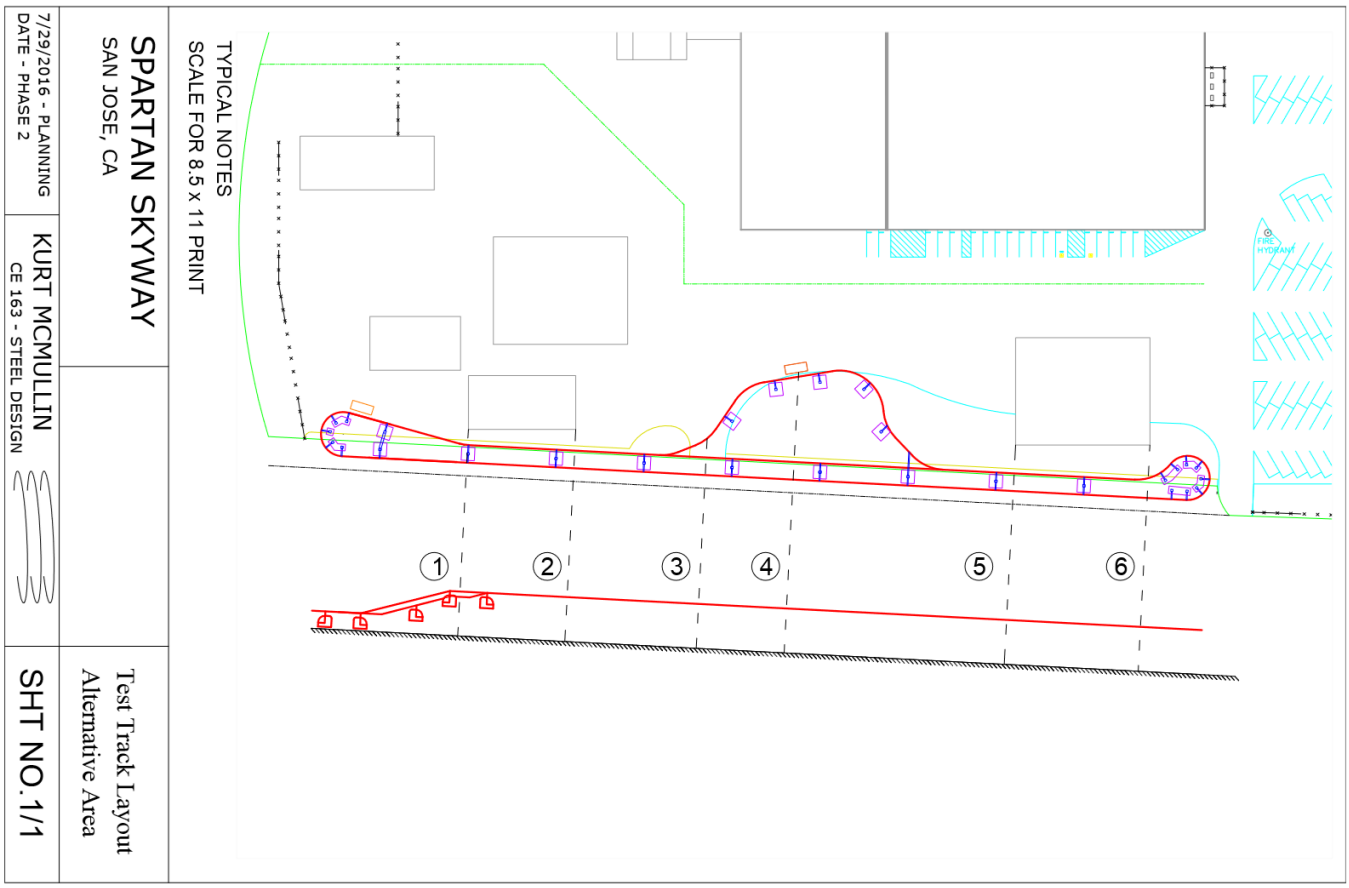

Figure 23 – New Test Track layout

We analyzed 6 sections for better understanding of the new layout (Figure 25, Figure 26, Figure 27, Figure 28, Figure 29 and Figure 30). The most concern section is Figure 25 –

Section 1, where the distance between the pod car and the building is 2.5 meters, approximately.

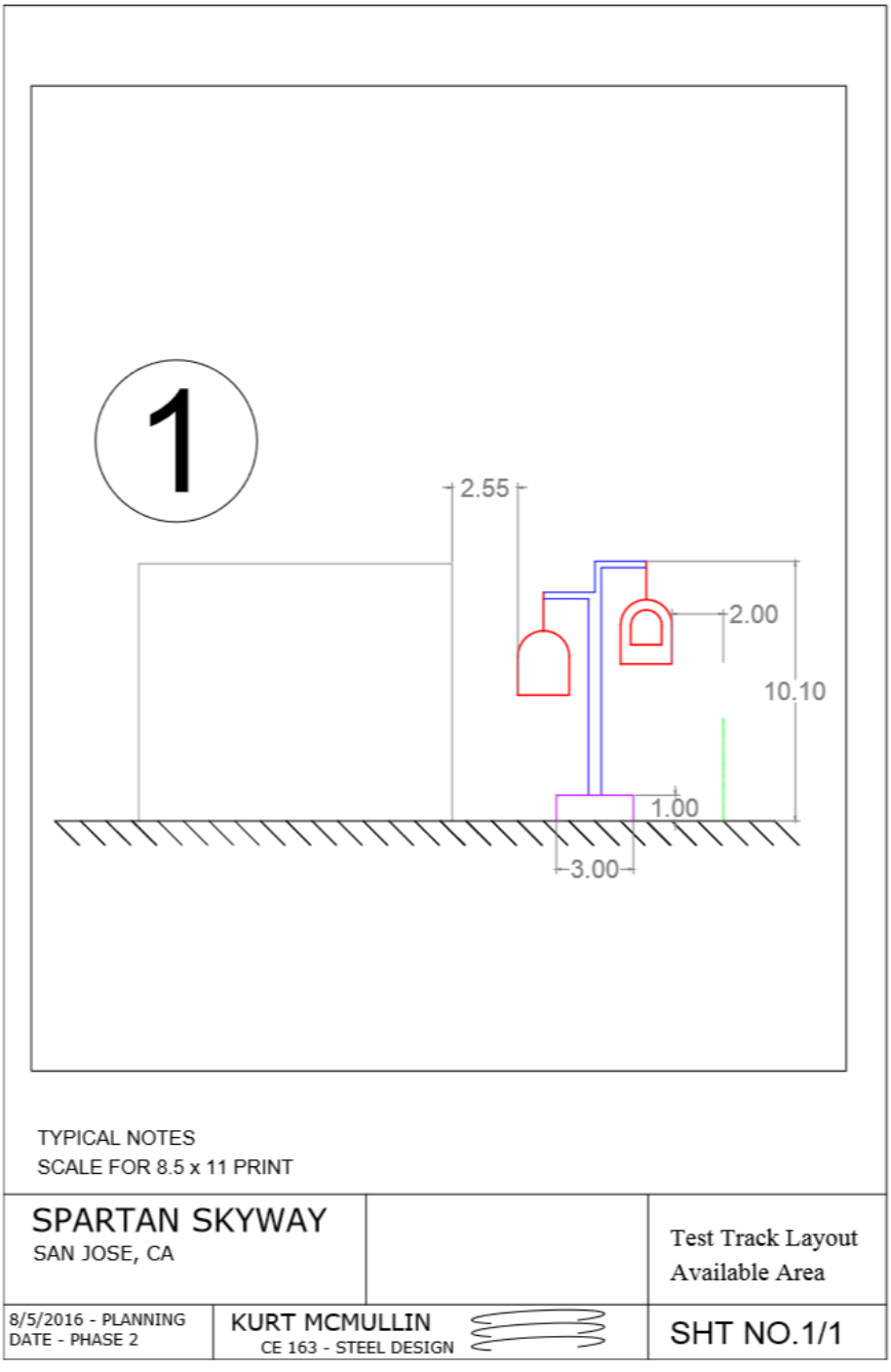

Figure 24 – Section 1 of Test Track

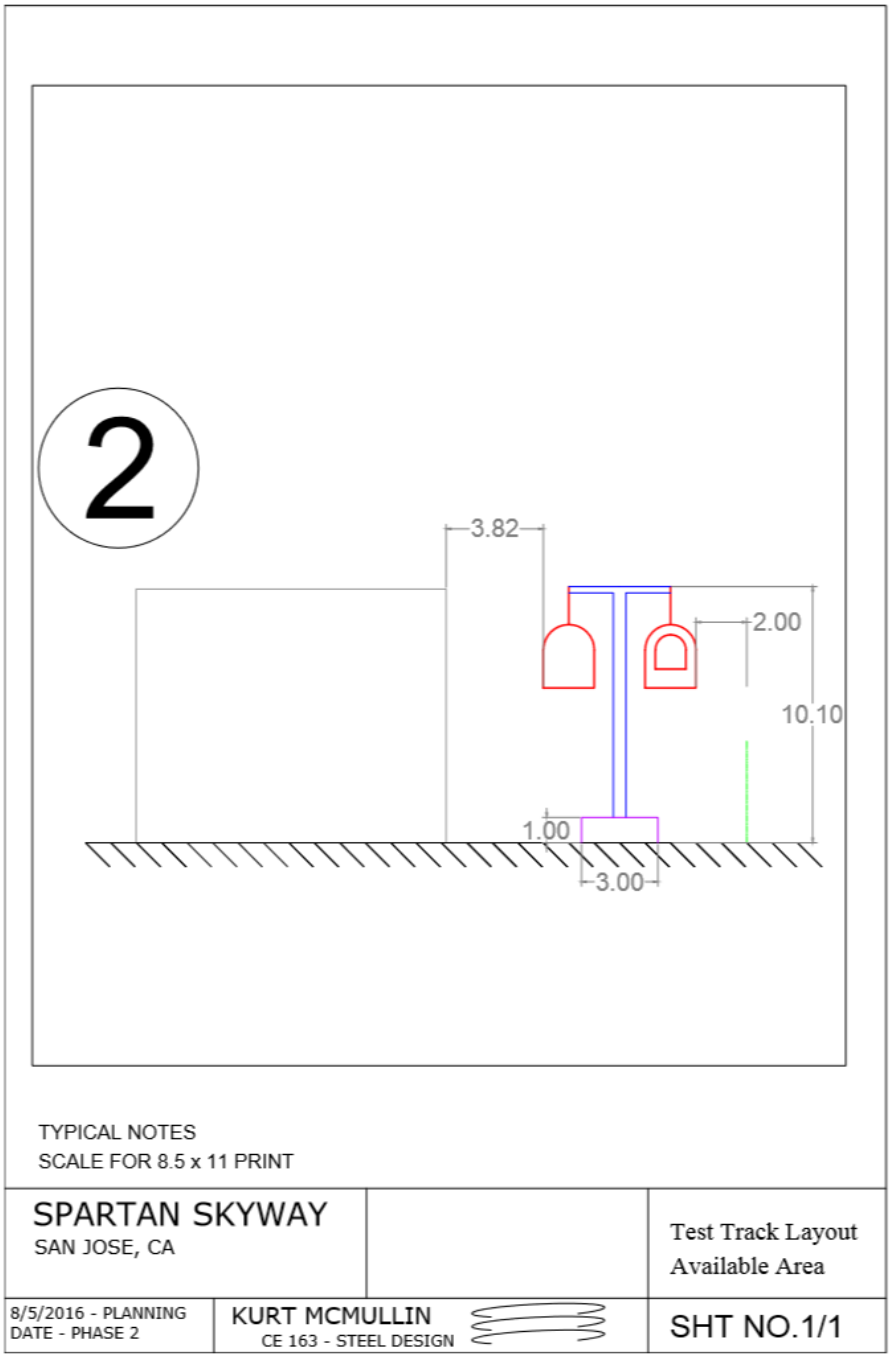

Figure 25 – Section 2 of Test Track

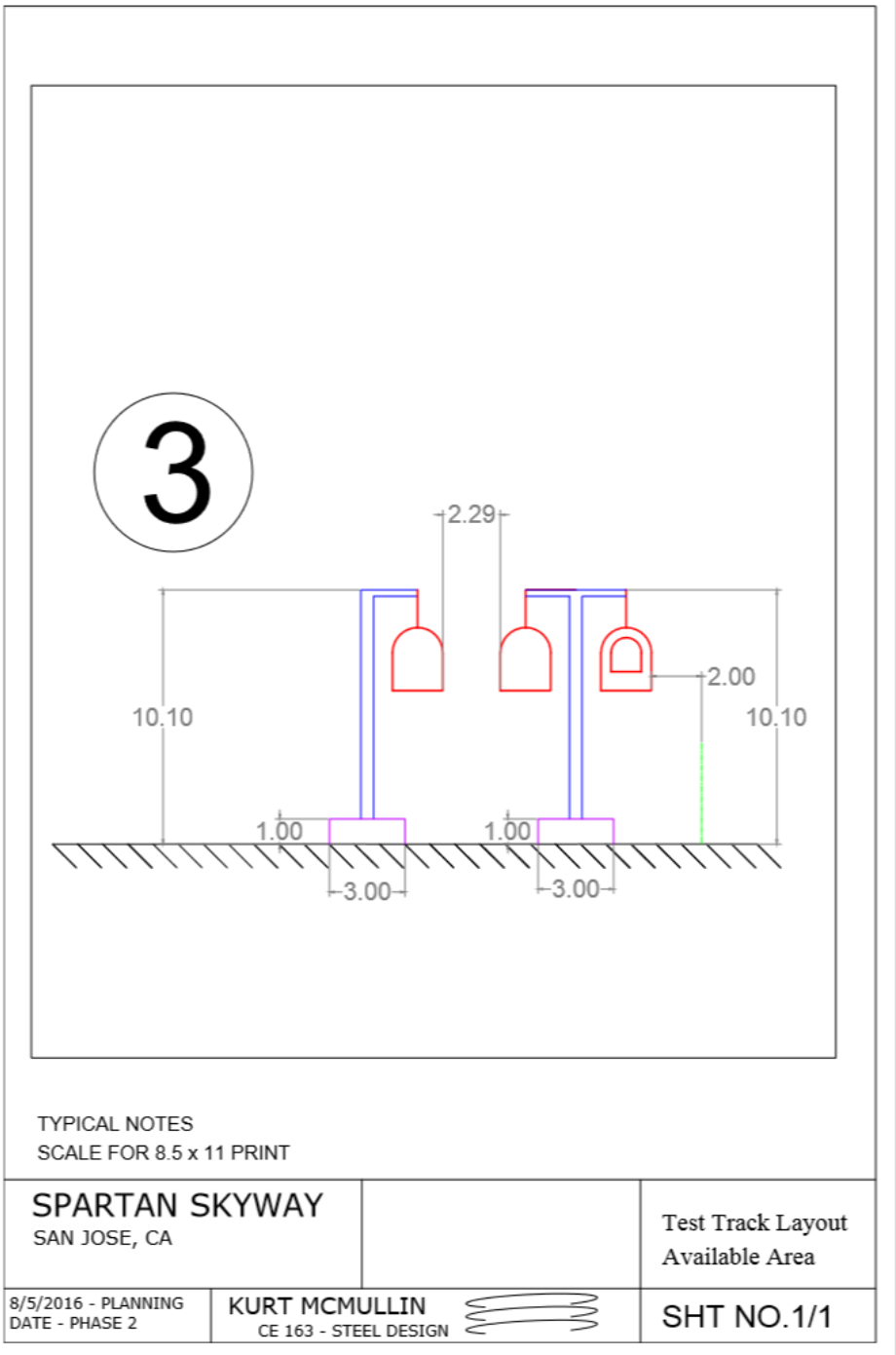

Figure 26 – Section 3 of Test Track

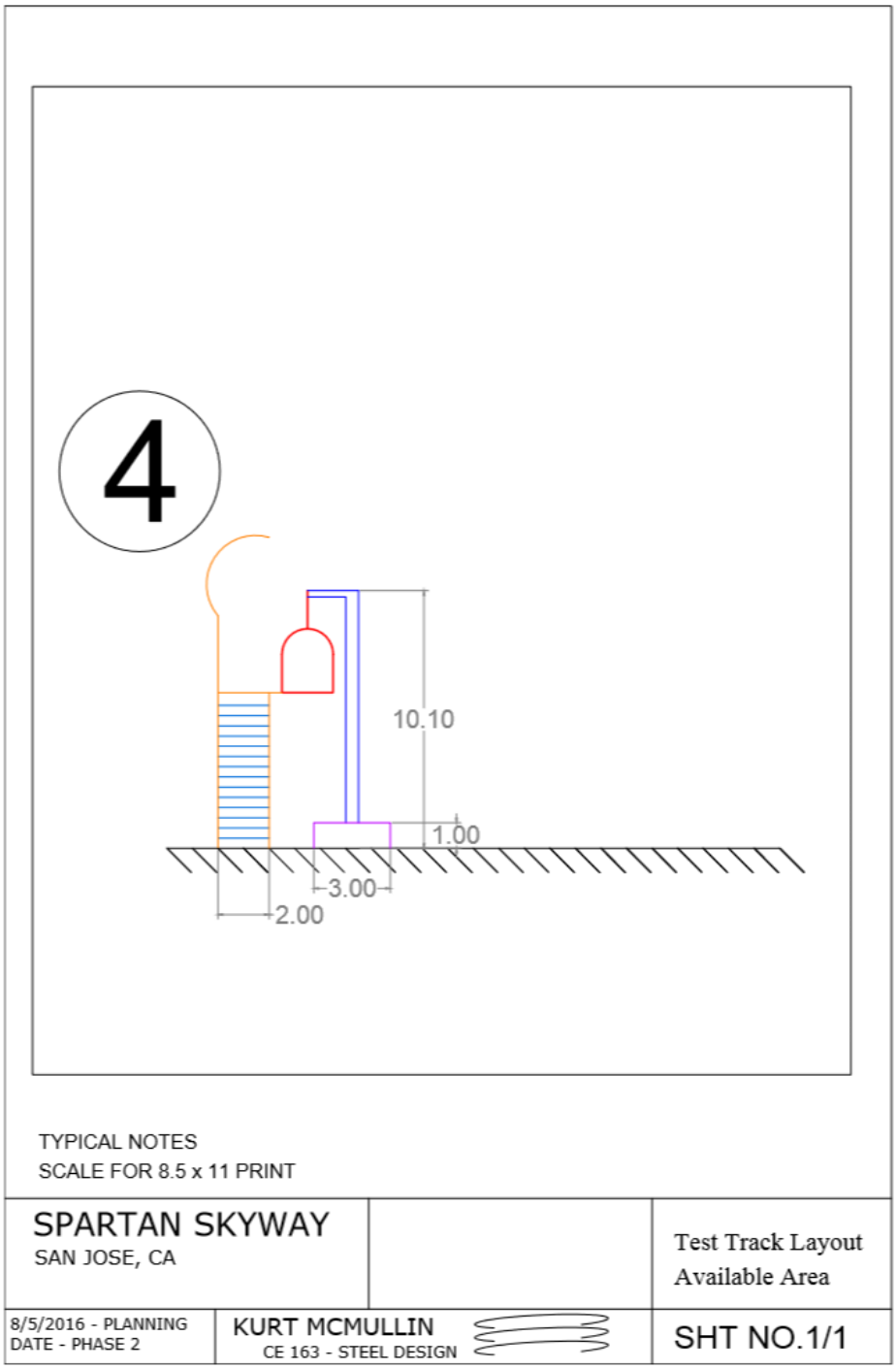

Figure 27 – Section 4 of Test Track

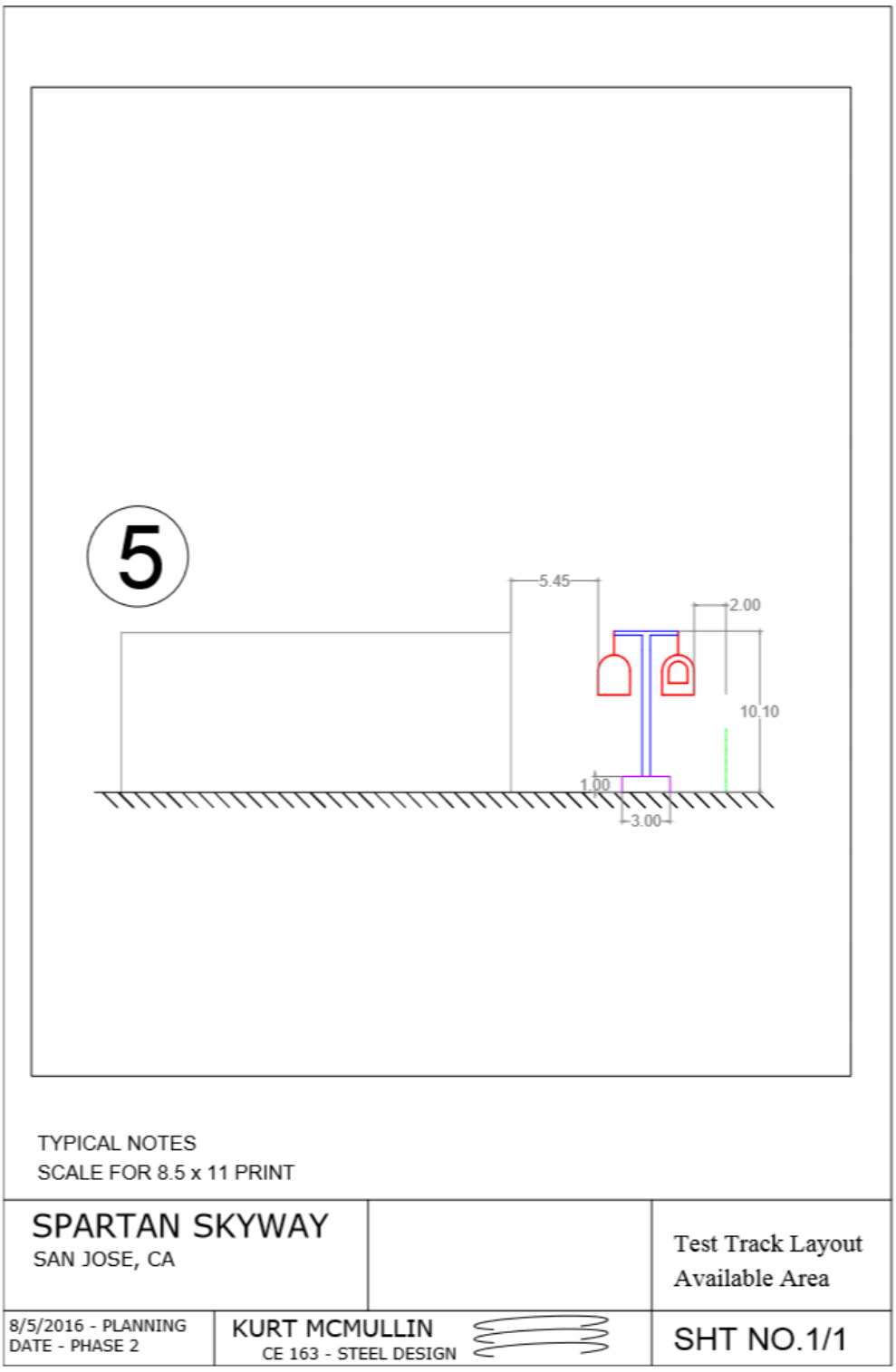

Figure 28 – Section 5 of Test Track

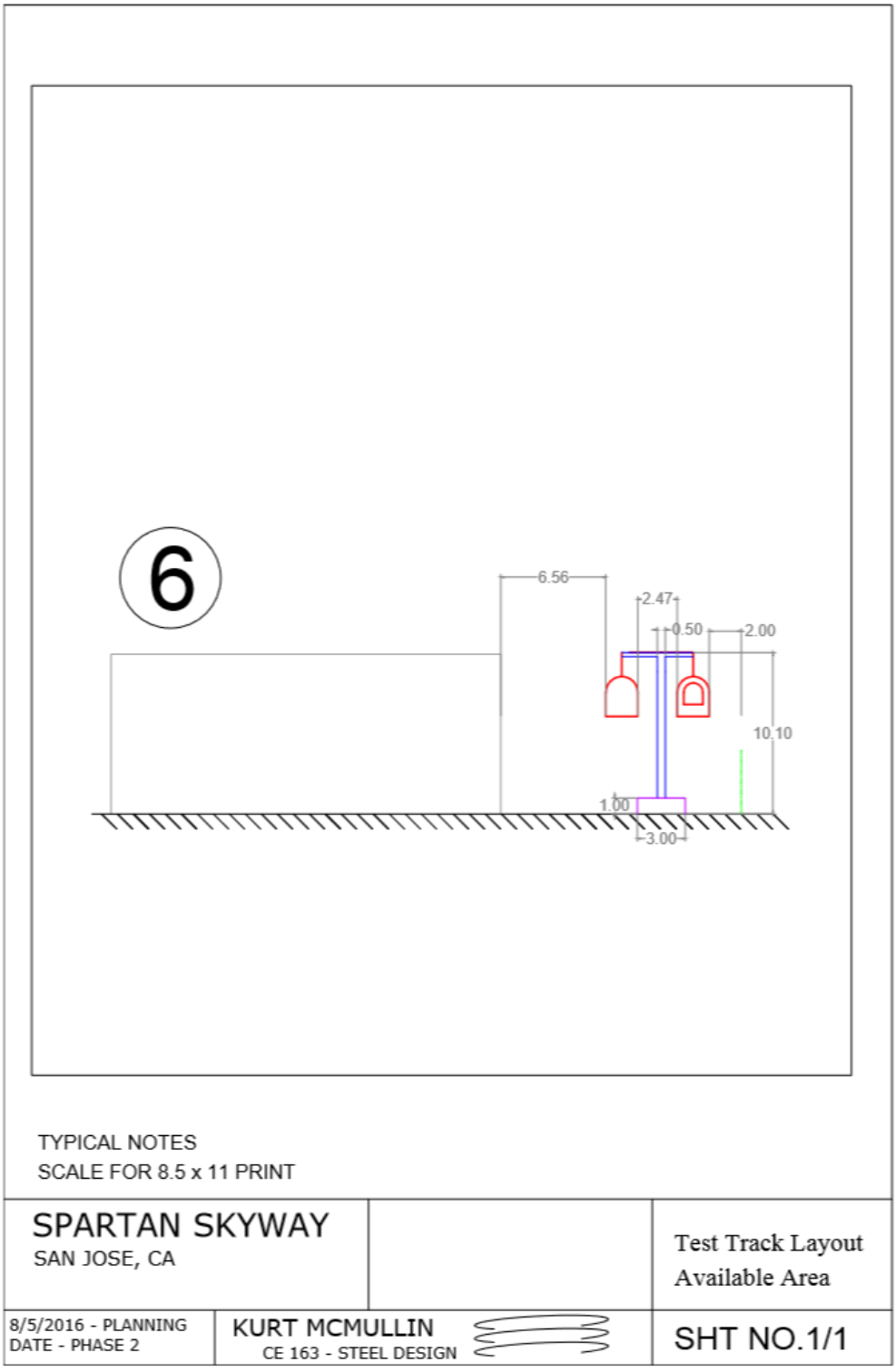

Figure 29 – Section 6 of Test Track

On the 3D-model designed on Solid Works (Figure 31, Figure 32 and Figure 33) , we can notice better the stations, the slope and how the test track is going to be. We still have to define the number of columns and how it will be located.

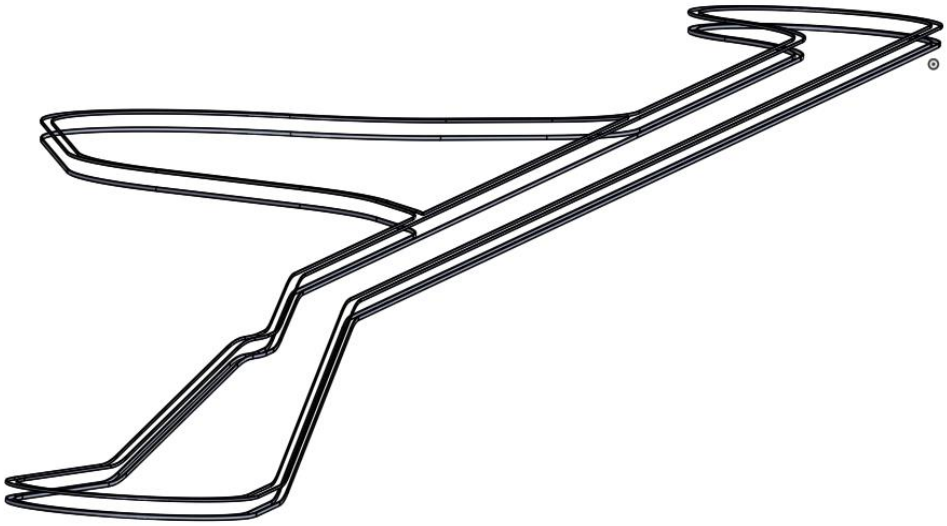

Figure 30 – 3D model of Test Track

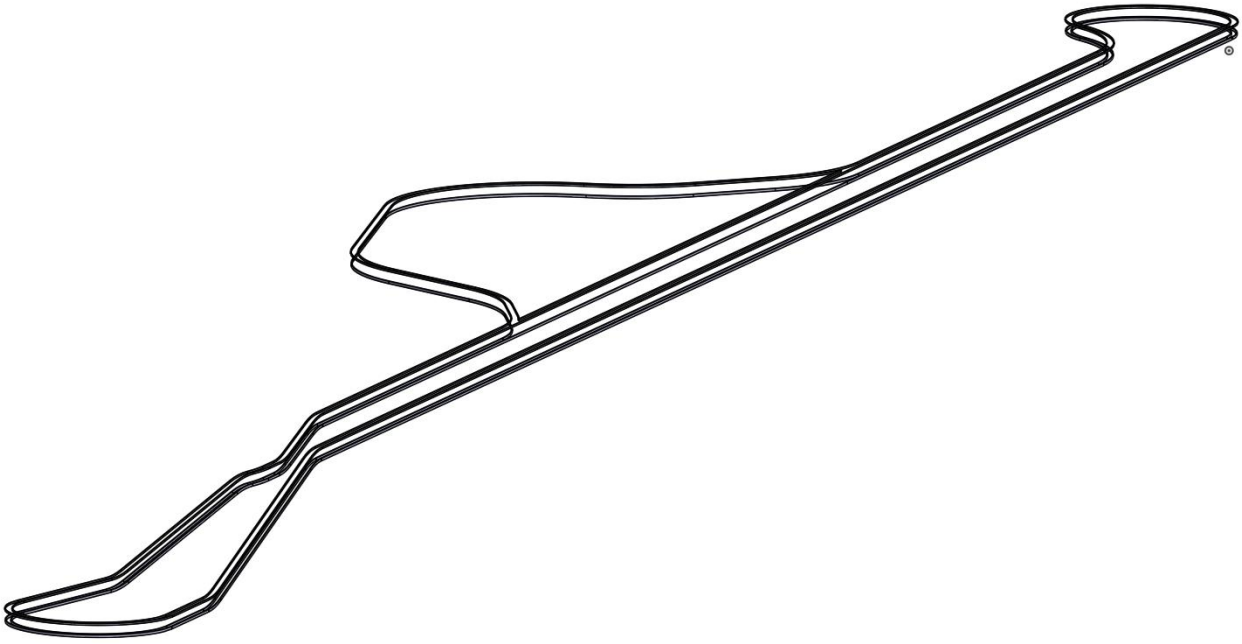

Figure 31 – 3D model of Test Track

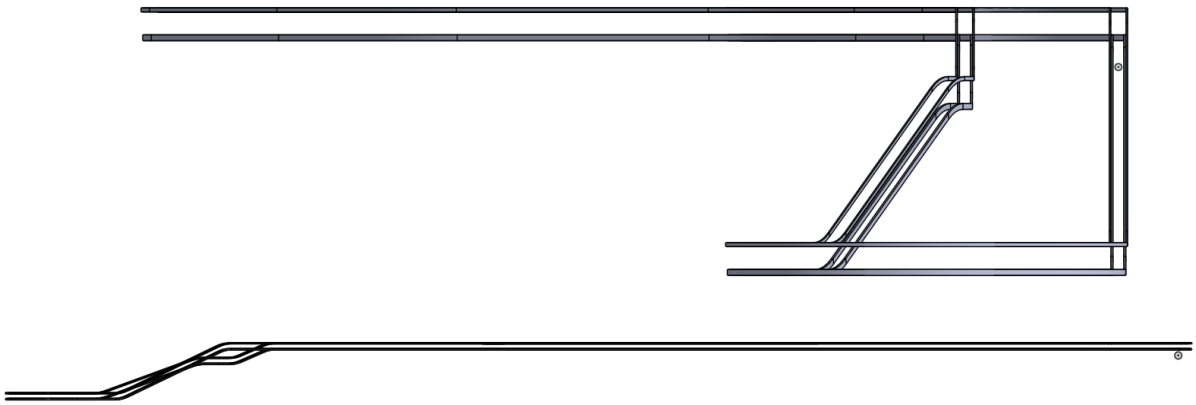

Figure 32 – View 3D model of Test Track

The considerations used to design the test track was:

- Distance between the centerline of the column and the pod car is 1 meter.

- Distance between the pod car and the fence of the property is 2 meters.

- Distance between the pod cars is 2 meters.

- Distance of the track guideline and the centerline of the column is 2 meters.

- Distance of the bottom of the pod car and the track guideline is 4 meters.

- The maximum distance between the columns is 10 meters.

- Dimension of the pod car is 2x3x2.5 meters.

- Dimension of the column is 0.5x0.5 meters.

- Dimension of the footing is 3x3x1 meters.

- The maximum height of the test track is 6.1 meters (20’).

- The radius of the curve is 10 meters.

- The radius of the two loops is 5 meters.

- The degrees of the slope is 17°.

- The length of the station is 10 meters.

- The distance for stabilize the pod car before and after the station is 5 meters each.

5.4 Environmental Studies

To start to compose the Environmental Impacts Report (EIR) for our project we need to consider some aspects. The organizations that we have to negotiate are the Department of Environmental of the City and CEQA (California Environmental Quality Act).

For the construction of our EIR, each section has to content a description of impacts that the project might cause. We must analyze and explain how the project will impact the environment and the population around it, indicating which level the impact is and proposing mitigation measures and monitoring plans for these impacts. The sections that we have to analyze are:

- Land use

- Aesthetics

- Population and Housing

- Transportation and Circulation

- Noise and Vibration

- Air Quality

To obtain approval for the EIR on CEQA, we must follow some requirements needed:

1- Notice of Preparation (NOP)

2- 30-day Comment Period

3- Public Scooping Meeting

4- Preparation of EIR Draft

5- Release of Draft EIR

6- 45-day Public Comment Period on Draft EIR

7- Preparation of Response to Comments

8- Final EIR

9- Release of Final Draft

10- Public Hearing

11- Certification of Final EIR

The main impacts that we must consider for this project are the noise and vibration, manufacture of the track and pod car, dust suspension of the installation process, refrigeration and cleaning of the track, surface runoff, storage of batteries, how it will be consist the energy conversion, land use, use of private land, aesthetics of the area used, location of the stations and birds migration.

For the construction of test track, we need a Use Permit to build it. On June 28th, we went to City Hall to ask them what the procedures for getting this permit are. They said that we need to show them a site plan of the facility, sections and the final draft of the test track.

We are still in discussion with owners of the area. We have to define all the terms and then come back to City hall for knowing about the requirements needed to construct the test track.

6. Conclusions and Suggestions for Future Work

The work done by the Civil Team in the Spartan Superway Project will continue with another team during the next summer. What the Civil Team have done with the routes, test track and San Jose State South Campus will be a reference not only for another Civil Team but also for other teams in the project.

It is important for the other teams to work with the routes our team have thought and also think about new routes that might be better. The problem to cross the highway needs to be in mind all the time.

The work with the test track have just started. The Civil Team have started working with the area and have done some drawings that will be useful for the next Civil Team. The next students will be concerned with the columns design and footing design.

The next steps for test track is to obtain the Use Permit with the City of San Jose. Therefore, the next team have to propose to them a final drawing of the Test Track Layout, with all aspects well defined, such as the type of columns, possible materials for build, the life-time of the test track and other considerations. They must go to City Hall with the site plan of the area, the elevation view and sections of the test track and ask them what the necessary requirements are for the construction of the test track.

San Jose State South Campus is another concern that cannot be forget. The team have already found the spots for the stations and next team will start the designs for these stations.

For the next teams, communication is very important. Our team talked a lot with the other groups and we learned a lot from them. Also, a good communication with the managements is a key for better results.

7. References

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- Keith A. McKenna, “Development and Construction of a Timber Composite Guide Way Beam and Steel Supporting Structure for a Full-Scale Prototype of an Elevated Transportation System” (2014), p. 1 - 92
- American Institute of Steel Construction, “Steel Construction Manual”, Fourteenth Edition.