Fresno F.C. Soccer Stadium

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Fresno Professional Soccer Consortium has tasked the design team of Central Valley Engineering with a new, professional soccer stadium located in Downtown Fresno. The city has formed a professional soccer team, the Fresno Football Club (F.C.), which needs a new home. Therefore, Fresno Professional Soccer Consortium requested a stadium designed to seat more than 15,000 people, structures to hold luxury suites and concessions stands, parking for 3000 spaces, and water systems to satisfy the stadium attendee's needs.

Grandstands, which are the main seating area and usually covered, command the best view for spectators at events. The task of designing quality grandstands was difficult. Determining the loads the structure would experience and ensuring that collapse would not occur were the primary design goals; however, this wasn't enough to deliver a quality fan experience. For this, the perspective of the spectator had to be considered. "Is there enough leg room for the guy who keeps getting up to walk past me comfortably?" "Is the sun in my eyes?" "Can I get to my seat easily?" These are the things that will make or break the fan experience. It was a high priority to get this right. In order to provide adequate leg room, visits to current stadiums were made to get measurements and see how they performed. A large sun shade was designed to cover nearly the entire section from the afternoon sun that can be hot in Fresno summers. Multiple access rows were incorporated to make seats accessible. By considering the fan experience, this will not only attract new fans to Fresno F.C. but also make sure to keep the ones already established.

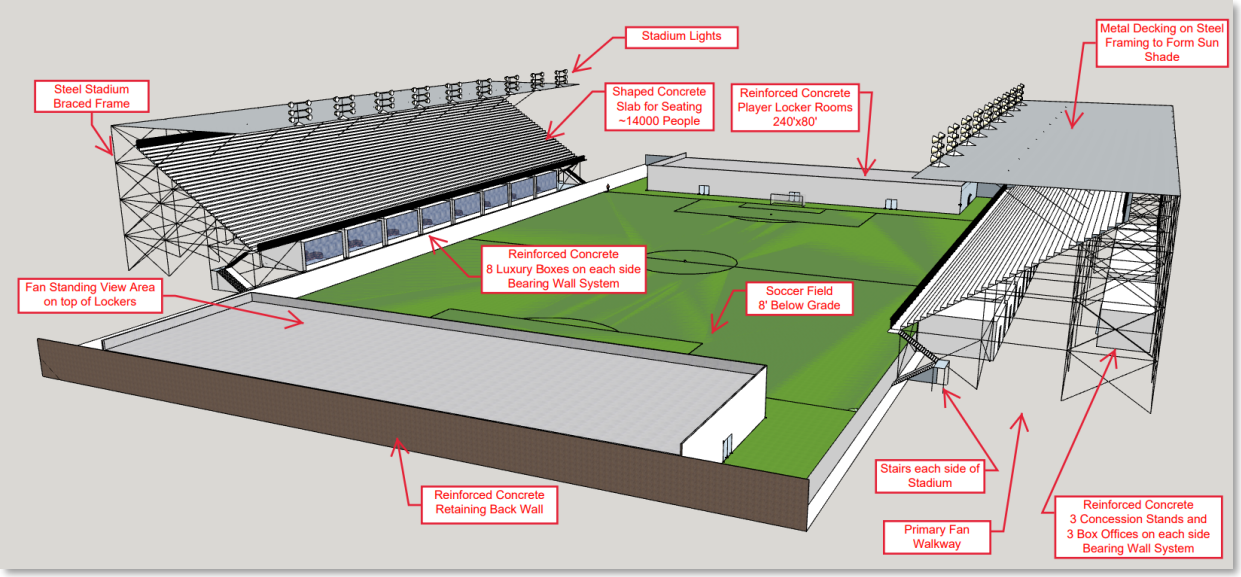

Figure 1. 3-D Rendering of stadium

Structural design was aided by computer software to double check all calculations and designs so the fans can feel protected from collapse even in the highest row of the grandstands. Lastly, the stadium was designed to be sustainable. Recycled steel is specified for the entire structural system and a plant-based sedum roof is utilized on the sun shade to create more oxygen as well as minimalize any heat island effect on the stands.

The luxury suites and concession stand structures are single-story with a height of 12-feet, composed of reinforced concrete.

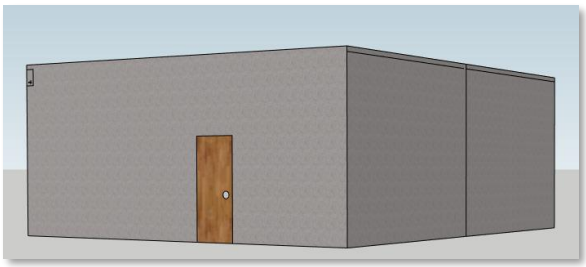

Figure. Exterior view of luxury box

The luxury suites are 840 square feet and will have shear walls, which support live, wind, and seismic forces acting on the structure for three of the structure's four walls. The fourth wall will be two 15-foot window openings facing the soccer field.

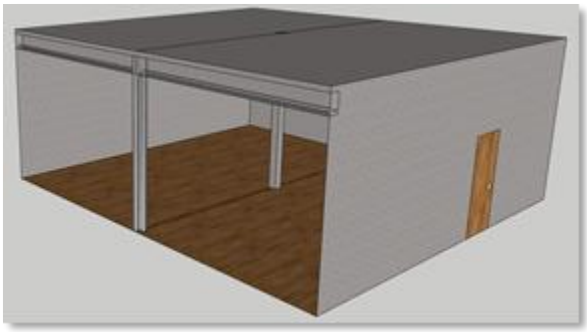

Figure 2. Interior view of luxury box

The 600 square feet concession stands will have three outer shear walls with the fourth consisting of three windows, each being 6-feet in width. This one-story structure will also include an interior shear wall in the center to separate the service room from storage.

Figure 3. "Fire Squad" march at a Fresno FC game. Photo by: Michael Massoudi

The soccer stadium has two buildings that provide services to the players, referees, media, and groundskeepers and provide more viewing options to the fans. The players have private locker rooms with a separate room containing massage tables. The locker rooms have their own restrooms and shower areas. The players are provided with an indoor warm-up area. The referees too have their own area that is provided with private restrooms. In addition, there is a medical area that could provide care to both injured players and injured referees. The media have their own room and private restrooms. The media room does not have direct access to the players' area. The two buildings have a groundskeepers' room with its own private restrooms. Both the media room and the groundskeepers' room have direct access to the soccer field to facilitate moving needed equipment in and out of the rooms. Lastly, the fans are able to stand on the roof of the two buildings and watch the game.

Historically, the San Joaquin Valley has been an area of relatively low seismic activity. There are no known

Fault Name	Approximate Distance to Site (miles)	Maximum Earthquake Magnitude
Great Valley 12	40	6.4
Great Valley 11	40	6.6
Great Valley 13 (Coalinga)	40	7.1
Great Valley 14 (Kettleman Hills)	45	7.2
Great Valley 10	45	6.5
Great Valley 9	50	6.8
Ortigalita	60	7.1
San Andreas	65	7.9

Table 1. Seismic information

active faults in the project vicinity. The eight closest active faults are summarized in the table above (all distances are approximate). The site is not within a currently established State of California Earthquake Fault Zone for surface fault rupture hazards. No active faults with the potential for surface fault rupture are known to pass directly beneath the site. Therefore, the potential for surface rupture due to faulting beneath the site during the design life of the soccer stadium is considered low.

The site is not located within a State of California Seismic Hazard Zone for liquefaction. Soil liquefaction is a state of soil particles suspension caused by a complete loss of strength when the effective stress drops to zero. A seismic hazard, which could cause damage to the proposed soccer stadium during seismic shaking, is the post-liquefaction settlement of the liquefied sands. The site has a low potential for liquefaction, because of the depth to groundwater, the fines content of the soil, the apparent density of the soil, and the seismicity of the region,

The purpose of the Geotechnical Design Team was to compile the results of a Geotechnical Engineering Investigation for the site of the proposed Fresno F.C. soccer stadium. Central Valley Engineering (CVE) is working on the completion of a geotechnical engineering investigation with the purpose to observe and sample the subsurface conditions encountered at the site and provide conclusions and recommendations relative to the geotechnical aspects of constructing the project as presently proposed.

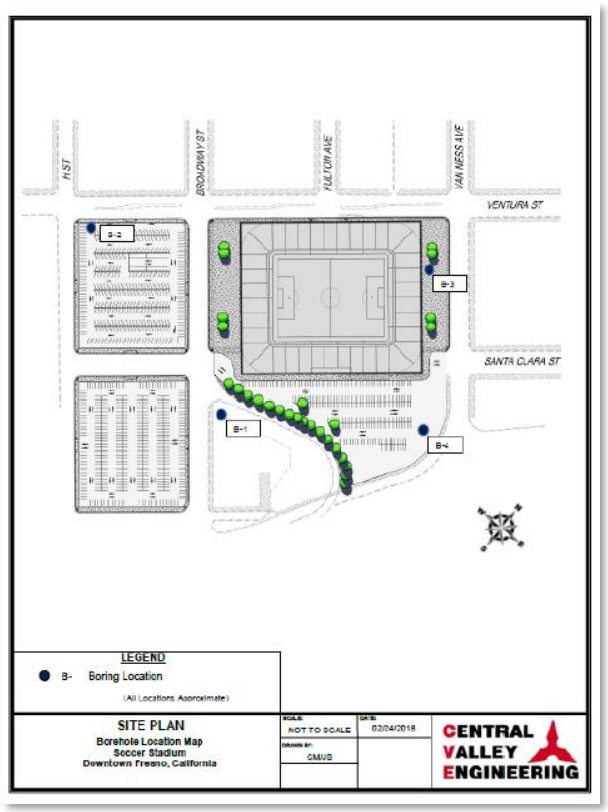

Figure 4. Site plan with bore hole locations

The scope of this investigation included a field exploration, laboratory testing, engineering analysis and the preparation of a report. Field exploration was performed and included the drilling of four soil borings to a maximum depth of 5 feet at the site.

Laboratory tests were performed on selected soil samples obtained during the investigation to evaluate pertinent physical properties for engineering analyses. The recommendations presented herein are based on analysis of the data obtained during the investigation and experience with similar soil and geologic conditions.

A new soccer facility meant to accommodate 15,000 people has its challenges regarding water distribution. These challenges include analyzing peak demands, minimum demands, sizing pipes, and an efficient pipe layout throughout the site. The total domestic water demand for the stadium was calculated using various analytical methods in order to obtain the demand value that best represented the proposed stadium. The value is 520 gallons per minute. A six-inch PVC water pipe looped throughout the stadium is being proposed on site shown in the figure below.

The peak septic demand for the system was considered to be one hundred percent of domestic demand. Some important criteria to address is minimum and peak flows inside of the sewer pipe. Another challenged faced in this project is the fact that the stadium pitch and locker rooms are eight feet underground. Although sanitary systems normally function through gravity, a lift station pump would be used in order to push sanitary waste out of the site. In order to accommodate the various waste structures throughout the site, there will be a twelve-inch sanitary sewer pipe looped underneath the project with a lift station (pump) attached to the system shown in the figure below.

The storm drainage system will be comprised of a series of concrete valley gutters, street gutters, and ductile iron pipe. The runoff will be conveyed into the Fresno Metropolitan Flood Control District (FMFCD) storm drainage system. Once in the FMFCD system, the runoff is directed towards an infiltration basin located to the southwest of the site. The soccer pitch is located 8 feet below grade, so it will include an underground drainage system that pumps water into the FMFCD system.

The site facilities are designed for a typical storm in Fresno with a 2-year return period.

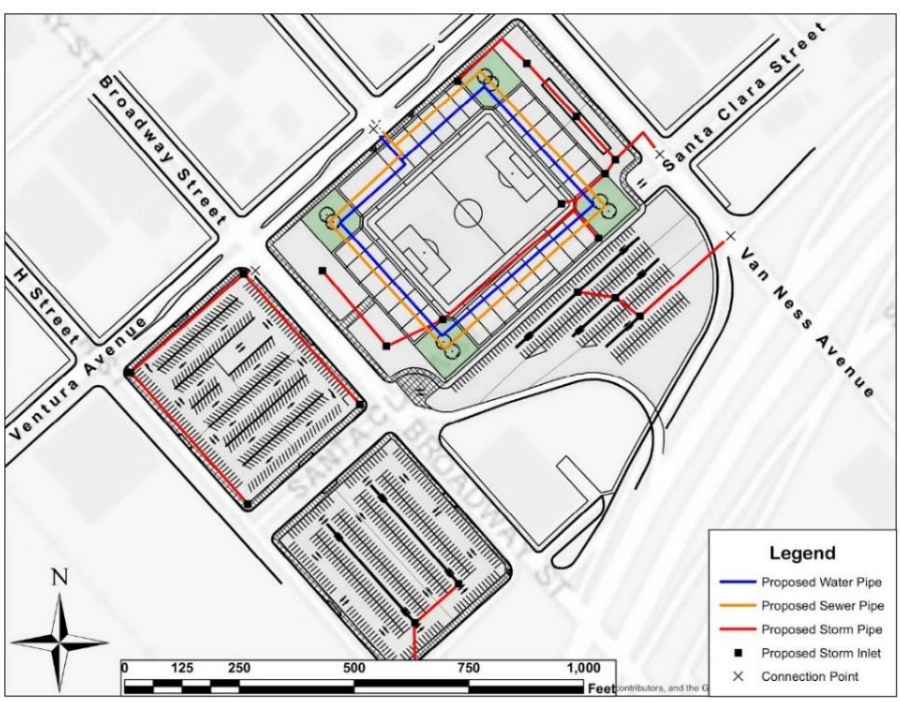

Figure 5. Map of all water systems

The soccer pitch drainage is designed with a 100-year, 5-minute storm in mind. Grate inlets are used to collect runoff on the surface. The site is graded so that the land slopes between 0.15% and 2% towards the inlets in all places. The figure to the left shows the proposed pipe layout and inlet locations. The design accounts for 3,600 feet of new pipe, 19 grated inlets, and 4 connections to the FMFCD storm drainage system. The pipes are sized between 4 and 18 inches and are set at slopes between 0.10% and 0.18%. The storm runoff, for a 2-year design storm, prior to the development of the stadium is 20.54 cubic feet per second (cfs). After development, discharge is expected to increase to 23.0 cfs; this is a 12% increase in runoff. The imperviousness of expected development will cause this. The maximum discharge for a single pipe is 3.4 cfs. All the pipes will be designed so that peak velocity does not exceed 6 feet per second.

Water supply for the stadium will be sufficient enough for domestic, fire, and irrigation uses following the California Building Code, California Plumbing Code, and City of Fresno Standard Specifications and Drawings. Using these specifications, the stadiums sufficiency will adequately provide water distribution in which domestic water requirements will be met at peak hour demands and fire demand will be pressurized in case there is a fire emergency. Two points of connections will be made. One will be for domestic water and one for fire distribution, in accordance to City of Fresno Specifications. The design will then be looped around the stadium. The fire connection will loop around connecting four fire hydrants in every corner of the stadium and also loop around for the sprinkler system. The fire sprinklers will assist concession stands, stadium stands, and the building for locker/media rooms. A visual design of the pipe network is provided that will distribute water to the stadium. Irrigation is also vital for the field to be in near perfect condition, so games can be efficiently played.

Event centers, such as this stadium, pose a unique challenge in the task of managing traffic. Attendees will generally arrive within an hour or two before the game and depart shortly after finishing, causing congestion on the surrounding roadways. Sporting events typically occur in evenings and, if occurring during weekdays, may coincide with peak vehicle volumes – when people are leaving work and heading home. By understanding existing traffic behavior on the roadways around the stadium and creating a simulation modeling vehicle and pedestrian movement, a better analysis the surrounding network and proper planning for how best to manage traffic movement during these most critical times can be conducted.

Traffic counts of the key intersections were manually recorded during the PM peak hour. These totals are then compared amongst each other. This gives a sense of typical movement patterns and which routes are most frequented. To better understand when fans are arriving to the game and by what mode, a survey was conducted with a random sample of Fresno F.C. fans during a home game at Chukchansi Park in Downtown Fresno. The results can be found in the table below.

Time of Arrival			
Before 5 PM	5 PM to 6 PM	6 PM to 7 PM	After 7 PM
18%	47%	32%	3%
Mode Choice			
Car	Drop Off/Pick Up	Bike	Walk
78%	13%	6%	3%

Table 2. Survey results taken during a Fresno FC home game.

Fans mostly arrived within two hours of game time (7 PM) and largely traveled by personal vehicle. The mode choice percentages were then used to help determine trip generation.

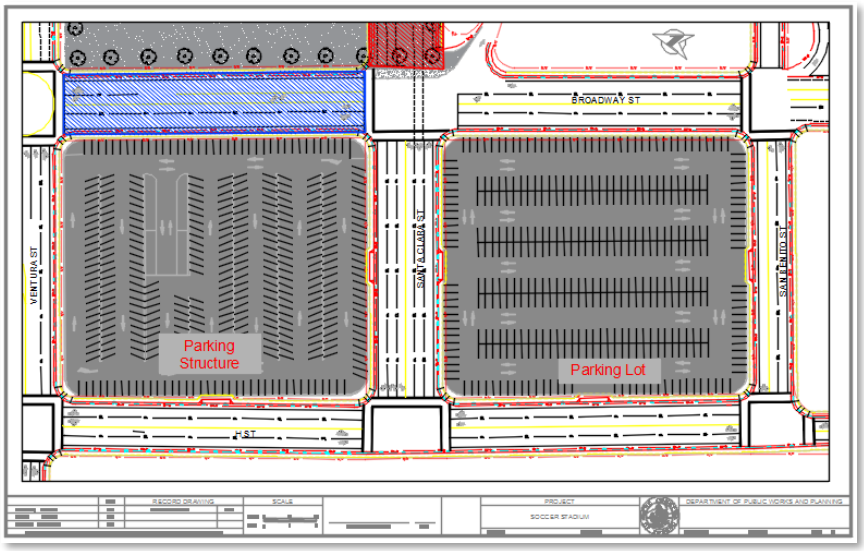

Figure 7. Transportation improvements

The Level of Service (LOS) of the roadways and intersections and the quality of traffic flow were measured with the assistance of applications such as Highway Capacity Software. The A (best) through F (worst) ranking measures the delay experienced by users with a rank of "D" regarded as acceptable, though not ideal, on major streets.

Taking the traffic analysis and generated trips, a simulated model of the roadways around the stadium was created using the PTV Vissim software. This application allowed the transportation team to map the roadways and input volumes, route behaviors, and signal timing to simulate both vehicle and pedestrian movement. This allowed the transportation team to see how its roadway improvements would affect the network, compare LOS against a no-build scenario, and determine ways of how the network could be best optimized. The model includes both a before-event scenario where traffic is guided into queues through signage, as well as an after-event scenario where special event traffic handling is implemented to efficiently move traffic out of the area.

The Transportation team will be improving upon red outlined area in the figure above. These include: H St, Broadway St, Santa Clara St, and San Benito St. The improvements will include the addition of bike lanes per City of Fresno planning, re-striping of roadways, ADA curb ramps and sidewalks, San Benito St realignment, and added signage to guide travelers to parking locations. A parking garage and lot are to be constructed to supplement the existing parking facilities in the Downtown area. These improvements will offer better and safer routes for vehicles, bicycles, and pedestrians. To the left is a cross-section of H St which visualizes the addition of bike lanes and a two-way left turn. These improvements were designed per City of Fresno Standard Plans. Existing landscaping will be maintained where possible.

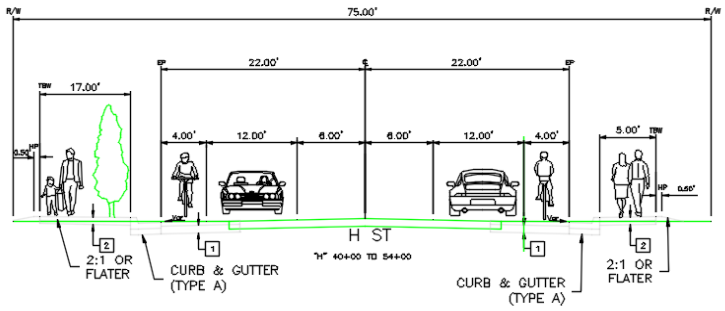

Figure 6. H St. cross section

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CENTRAL VALLEY ENGINEERING

The Central Valley Engineering team is composed of the Project Manager and transportation designer, Michael Massoudi. The team Secretary and structural designer, Diana Rosas. The rest of the structural team includes Derek Anderson and Jabran Samaan. The water resources team consists of Christian Gonzalez, Mikel Meneses and Jagdeep Mandair. The geotechnical team is composed of Carlos Montero and Jasdeep Sangha. Lastly, the transportation team also includes Manmeet Singh.

Figure 8. CVE Team