TECHNICAL REPORT I

A Campus Project
Northeastern US

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Executive Summary

This Campus Project, located in the northeastern US, is a multi-building, multi-use project, built to serve as a community and cultural gathering place. It consists of five unique buildings, an underground parking garage, and a geothermal well field. The five buildings are the Turkish Bath, Convent/Monastery, Mosque, Cultural Center, and Fellowship Hall, as labeled in **Figure 1** below. This document will introduce the project and its details, including schedule, building systems, cost, existing conditions, delivery method, and staffing plan. The project will serve as a place for religious practice, while also providing dining and lodging accommodations for visitors.

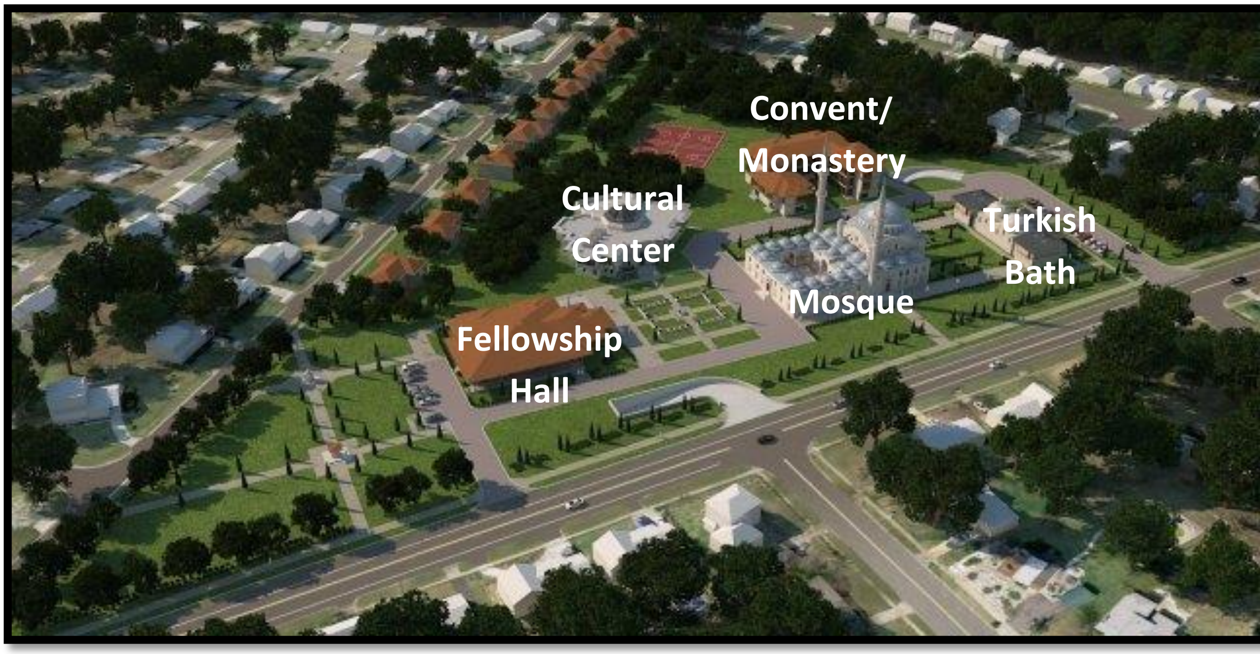


Figure 1. *Overall Site (courtesy of Balfour Beatty)*

The project delivery method, found on page A-1, is design-build. Initially, the design was developed by Hassa, a foreign architecture firm. Then the owner searched for a US team to bring the design to 100% completion and permit level. They did this by coordinating through their operations within the US and by bringing on their own representative, Transtech. Balfour Beatty was awarded the contract for design and preconstruction fees, which constituted Phase 1 of the project. After bringing the drawings to 100% with the help of Fentress Architects, the owner decided that Balfour Beatty was well suited to continue the project kept them on for Phase 2. They were awarded a $69.5 million GMP. Balfour Beatty contracted with Fentress Architects and Capitol Design Development, Inc. via lump sum to utilize their design services. Additional consultants were contracted with as applicable. Over 10 different subcontractors hold lump sum contracts with Balfour Beatty in order to complete the work for the project. Contractors and subcontractors were chosen through a combination analysis of best quality and lowest price.

The owner of the project is primarily interested in quality, schedule, and safety. Quality is of interest because of the high amount of handcrafted work which needs to follow certain cultural specifications, such as water closets not facing mecca. In addition, there is a $20 million allowance provided, signifying the owner's desire to ensure quality. Sticking to the schedule is important to deliver the project on time and will require allotments and considerations for cultural requirements and religious practice. Religious holidays, such as Ramadan, need to be observed to respect cultural beliefs. They will also need to be recognized in order to ensure worker safety, so that the combination of fasting and intense labor does not jeopardize worker health. Site safety protocols require that all personnel complete a safety briefing in order to be on site. In addition, a translator is kept on site to ensure proper communication with foreign workers. Most importantly, in order to ensure owner satisfaction, the team needs to include the owner in decisions and incorporate input from Hassa, the foreign architecture and construction team. Many of the elements of design are religious or cultural in nature and cannot or should not be changed. During the design development process, drawings were reviewed by Hassa to ensure they followed the desired cultural aspects of design.

Balfour Beatty's staffing plan for the project is shown on page A-2. The staff includes people in both the office and on site. The varied team with its strong background will be more than capable of fulfilling every need required on the project. The Assistant Project Engineer, Bhavin Patel, has served as the primary point of contact on site. The owner's representative serves as a close contact to the project team to answer any and all questions.

The project takes place in two phases. Phase 1 involved design services that took contract drawings to permit level in the US. This began in May 2012 and lasted approximately four months. During this time, Balfour Beatty partnered with Fentress Architects and Capitol Design Development, Inc to produce 100% contract drawings. After their completion, a second bid was conducted for Phase 2 (Construction) of the project. Balfour Beatty was awarded Phase 2 and was given the Notice to Proceed on September 19, 2012. Construction of all of the buildings takes place concurrently, maximizing efficiency. Excavation and foundations last approximately 10 months for all buildings, and are typically phased. For example, the Parking Garage is completed in four overlapping stages so that the time from start to finish is shorter. The majority of time consuming activities are interior and exterior finishes. In most cases, this must be completed or installed by Hassa, due to owner and cultural requirements. These finishes involve very ornate detailing, including stone veneer and wooden lattice work. The entire project is scheduled to be completed on September 18, 2014, approximately two years later. Considerations for religious practice must be taken into account for the schedule and are encouraged by the project staff. However, they are also kept in mind in order to ensure worker safety and to diminish delays to the schedule.

The project site can be seen on page A-3 to the right. The surrounding buildings and landscape are residential units and neighborhoods. Site utilities enter the project from two locations. Gas and sanitary lines enter at the southeast end of the garage before distribution to each building. Domestic water, sprinkler, and electric enter the Turkish Bath at the east end of the parking garage. Minor demolition of two existing buildings and a retaining wall is required on site. Once these are demolished, excavation, primarily of red clay soil, can take place. This type of soil does not require extensive bracing or setbacks, but when necessary, wall tiebacks and sheet piling are used to support the soil. In many cases, the excavated walls can remain nearly vertical.

Structural systems include steel, cast in place concrete, and CMU walls. Steel is used for the Fellowship Hall, the above ground floors of the Convent/Monastery, the roof of the Cultural Center and the cones at the top of the minarets of the Mosque. CMU walls form the structure in several locations, such as the structure of the minarets or under the deck of the Fellowship Hall. Stone veneer is typically anchored to the CMU to provide aesthetically pleasing exterior. The most commonly used structural element is cast-in-place concrete. Reinforced beams, columns, and slabs are present in almost every building, and are used extensively for the Parking Garage, the Mosque, and the Turkish Bath. Post-tensioned beams are used over the pool and auditorium of the Turkish Bath and over the library and exhibition hall of the Cultural Center. The spans here are very large, requiring the extra strength provided by post-tensioning.

Two tower cranes provide the reach and lift required to place these structural elements. Each has a boom length of 246 feet; together they cover the length of the parking garage from the Turkish Bath to the Fellowship Hall. Typical concrete pouring methods are crane and bucket or concrete pump. Because of the huge amount of cast-in-place concrete required on site, a large amount of formwork was kept on site. Facchina, the concrete subcontractor, kept tens of thousands of square feet of flying and table formwork on site to support the concrete pours. Handmade wooden forms are used in more unusual locations such as the arches of the Mosque or the changing shape of the minarets. Large Styrofoam hemispheres are used to form the smaller domes of the Mosque and required specially built screeds to ensure a smooth surface.

The MEP systems of each building are connected via runs through the parking garage, and are centered around the HVAC Control Plant in the basement of the Mosque. This plant features a modular chiller/boiler unit that regulates and distributes all of the water lines throughout the project. To alleviate some of the energy load required, there is a geothermal well field to the north of the Convent/Monastery. A network of 250 wells connect to a geothermal vault that directs condensate water lines to the control plant via 8” pipes. From the control plant, a loop of piping is fed through the garage to distribute the services to the project. Each building has its own mechanical system to support the loads within. Typically, VAV systems provide the air handling for each building, with the number of units dependent on the requirements of that building. For example, the Turkish Bath has three units: one for the pool, one for the auditorium, and one for the above grade spaces. Fan coil units and cabinet heaters are used to provide additional occupant control in certain spaces. There are nearly 50 of these units in the Convent/Monastery, so each guest room has its own environmental controls. Radiant floor systems are used in the ground floor of the Mosque and in the spa lounges and warm rooms of the Turkish Bath.

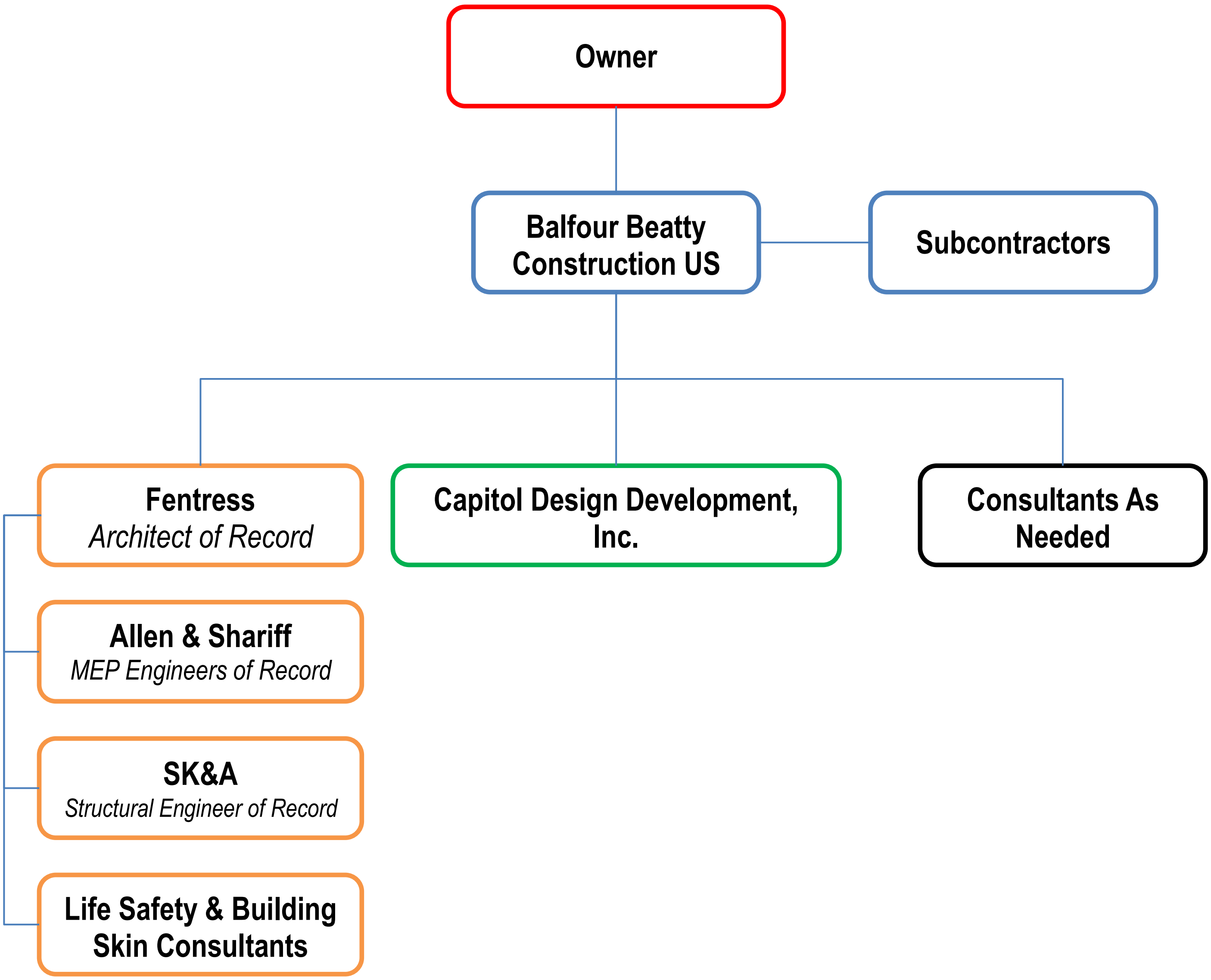
Fire protection systems consist of dry and wet sprinkler systems. Dry systems are used where possible, such as in the Parking Garage and for below grade floor levels. Fire company connections to both systems are present on the front façade of the Turkish Bath. Inside the Mosque, sprinklers are wall mounted along the base of the dome and are triggered by a heat sensor located at the apex of the dome. This technique limits the architectural intrusion by the sprinklers. The Electrical System is distributed from a project electrical room and a generator room located near the entrance ramp to the garage. It is sized at 4000A for 208V and 3000A for 480V. Electrical distribution panels range in sizes from 50A to 1200A, and each building has appropriate transformers to adjust the electrical power as necessary. Five backup generators provide emergency power when needed. Three generators provide 208V and two generators provide 480V. They are connected to a 2500 gallon fuel tank for prolonged activity and two 150 gallon fuel cubes, each lasting a day.

The total cost of the project is $89.5 million. This includes Balfour Beatty's GMP plus a $20 million allowance. The table below breaks down the costs further, including the cost per square foot. A square foot estimate was conducted using RS Means, tailoring the estimate to match the building data as well as possible, primarily by using multiple estimates for each building to reflect different occupancy uses.

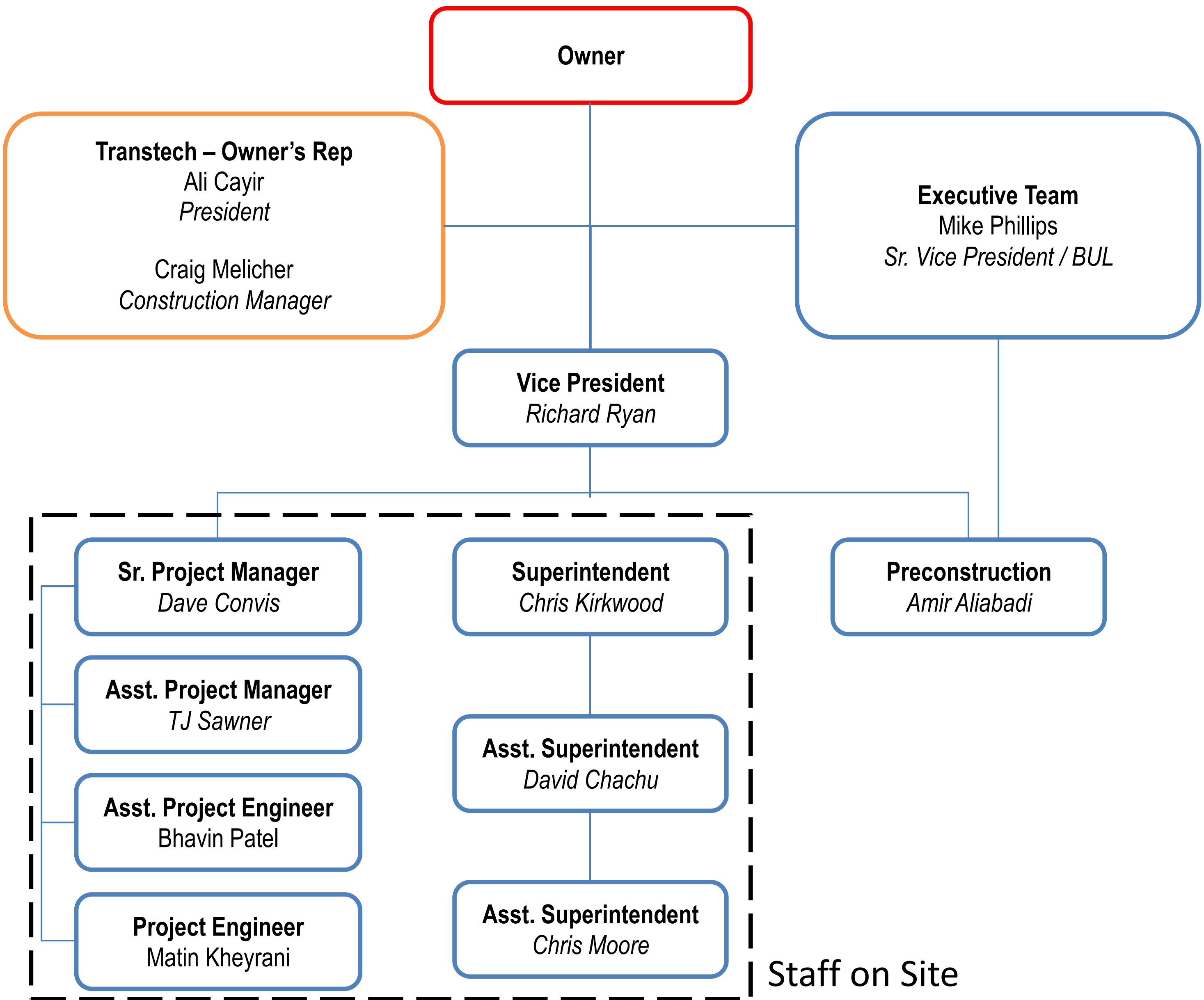
The difference between the square foot estimate and the actual building cost can be attributed to the inaccuracies of RS Means. The uniqueness of the buildings makes it almost impossible to find an RS Means data sheet that matches those specifications. Much of the work on the buildings is also hand crafted work, which would greatly increase the cost due to specialty labor and materials. For example, the difference between the actual cost and the square foot estimate of the Mosque was nearly $10 million. The façade of the Mosque features extensive hand crafted stone veneer and ornamental windows, which would constitute a large portion of the cost. Furthermore, there is no adjustment or option to accurately represent the minarets, domes, arches, or other unique shapes that form the exterior.

Appendix

Item 1: Project Delivery Method



Item 2: Balfour Beatty Staffing Plan



*Note: Staff in **blue** are Balfour Beatty employees.

Item 3: Enlarged Site Plan