The Pegula Ice Arena

University Park, PA

Technical Report I

September, 20 2012

Shane Marshall
The Pennsylvania State University
Department of architectural engineering
Construction Management Option

AE 481 W – Fall 2012
Faculty Advisor: Raymond Sowers

Executive Summary

This report is designed to assist with understanding the parameters in which the Pegula Ice Arena was constructed and it's scope of work. This report was completed by reviewing construction documents, specifications, estimates, schedules; and was accomplished through discussions with Mortenson, the construction manager, and Crawford, the architect.

The Pegula Ice Arena is a direct result of a sizable donation made on behalf of Terence and Kim Pegula. Terence Pegula, a former Penn State student and current alumni; is an avid Hockey fan and is the owner of the Buffalo Sabres. He wanted to bring hockey to Penn State and Penn State wanted hockey. Ice hockey is the only major sport that Penn State did not have a Division 1 program for. Knowing this, and that the Big 10 wanted to start a Division 1 ice hockey conference, Penn State jumped on the opportunity to build a state of the art collegiate hockey facility, through the Pegula's donation.

The Architect chosen to design the building was Crawford Architects. Unfortunately, since Penn State needed to have the new arena before the Big 10 aligned to create a Division 1 hockey conference, the design could not be completed before the building went out for bid. Because of this, Penn State decided to utilize a guaranteed maximum price contract. The job was awarded to M. A. Mortenson Company, who is serving as a CM at Risk while self-performing most of the concrete.

Basic building information, scheduling, and estimating are the focus of this assignment. The Pegula Ice Arena is a three story, 228,000 SF indoor ice arena; that can hold over 6,000 spectators and contains two ice rinks. The schedule for construction runs from January, 2012 until September, 2013. That is 20 months of construction. A square foot estimate was performed for this report to develop a baseline for the building cost. The number obtained was $27 million. This number came in much lower than Mortenson's estimated number which ran around $68 million. An indoor ice rink was utilized as the baseline using RS Means, however this did not size up to the standard and quality with which the Pegula Ice Arena meets. Additional square foot estimates were performed but nothing RS Means provided as a baseline came close in cost compared to what the Pegula Ice Arena costs.

Through doing Technical Report I many things have been learned and discovered that will help moving forward into Technical Report II and beyond. Continued research into scheduling and site planning will be done in order to most effectively learn how to construct a project. As well as continued research in cost estimates, in order to better understand fundamental design differences.

Table of Contents

Project Schedule Summary

Primavera Schedule

This schedule was broken down into design, preconstruction, procurement, construction, and project closeout. This schedule is not intended to show a critical path and does not have relationships between different trades but does give an overview of how the project is to be sequenced.

The project schedule is ultimately being pushed by the ice arena home opener October 11, 2013. This is the first men's Division 1 hockey game to be played in this state of the art collegiate facility. The penalty for delay was not disclosed but this is a must hit target date. Therefore, main components for the building are to be erected before August, which would allow for enough time to commission and furnish the building.

The Primavera Schedule can be viewed in full in Appendix A.

Construction Sequences

Excavation – The excavation for the building proved extremely difficult. Much of the soil was rock which required the use of blasting to remove the earth. This was a long process that was anything but cheap. After this, it was realized the western portion of the building pad was on loose soil. This required micropiles to be drilled throughout the western portion of the building pad; whereas the rest of the building needed minimal micropiles to rest on. This did cause a slight delay on the project but was minimized in part because the building was sequenced counter clockwise starting in the south.

Foundation- The foundation started with spread footers, which like the rest of the building moved in a counter clockwise sequence. Following the spread footings were the continuous footings. This process moved slightly slower than expected. This was due to the excavation in the south, east, and north quadrants; which need jack hammered out due to all the rock.

Structure – The steel erection began June 12, 2012. The floors are formed, rebared, and then poured, with cast in place concrete. Preliminary prep work has started with the roof trusses which span the width of the ice plus precast stadia. Topping off is set for December 7th, 2012.

Enclosure and Finishes – The enclosure is set to begin halfway through October, 2012. This consists of CMU, brick, and curtain wall with glazing. The interior finishes are also supposed to start in October. This will have drywall put in first followed by paint, carpet, and terrazzo as finishes.

Building Systems Summary

Table 1: Summary checklist

Building System Summary Checklist		
Description	Yes	No
Demolition Required	X	
Structural Steel Frame	X	
Cast in Place concrete	X	
Precast	X	
Mechanical System	X	
Electrical System	X	
Masonry	X	
Curtain Wall	X	
LEED	X	

Demolition

Demolition of existing materials was the first to take place. Existing on site was the former Penn State Lacrosse field. Underneath this was an advanced storm water drainage system, which was to minimize the amount of swamping and damage done to the field. These materials were disposed of as was bench seating located at the south end of the site.

There was also tennis courts located in the southeast corner of the site. The tennis courts as well as the shrubbery located around it were demolished. The asphalt parking lot located along University Drive was also demolished. The only items saved were the lacrosse field lights and the parking lot lights. On top of this any sports equipment was gathered and stored by the owner (i.e. goals, nets, etc.).

The utilities for the Pegula Ice Arena come from utilities lining Curtain Road (Reference Appendix E). Therefore, the parking lot adjacent to the Shields building was dug up in order to get the utilities underground to the ice arena. This is the demolition Penn State was most concerned with. Being that the utilities need to run so close to the building, overnight excavation was required as to not disturb the employees in Shields during the day.

Structural Steel Frame

The structural steel consists of a combination of moment and braced frames. There are W beams and columns located throughout the entire building. The roof consists of a combination of metal joists and trusses. Located on the south and north, of main rink, are roof joists as well as on the western side over the community rink. Over the main rink, there are to be trusses that span the width of the ice and seats. These trusses are being assembled in pieces. There are steel rakers that support the precast stadia, which are where the seats are located. Finally there are HSS columns located on the east curtain wall, facing University Drive, that were placed for aesthetic purposes.

The crane chosen to erect most of this steel is a Manitowoc 777 series 2. It has a capacity of 200 tons and for this job has a 180' main boom with a 40' fixed jib at a 15 degree offset. For this particular job the max radius required will be 170' with a factored load of 6,888 lbs. This will create a crane capacity of 65.6%. The maximum factored load for this project will be 14,039 lbs. with a radius of 60'. This will only create a crane capacity of 31.1%. The maximum crane capacity required is 73.6%. This will be due to a 11,928 lb. factored column, with a 136' radius created.

The steel is sequenced similarly to the rest of the building systems. It starts in the south, along grid line X9, and works counter clockwise around the building (SE 1). The crane and shakeout will be located inside the ice rink. The Manitowoc 777 is responsible for the main rink steel, while another crane will start work on the community rink roof joists (West 11 – 13), once sequence 8 has been erected. Once sequence 10 is finished the Manitowoc starts construction on the roof trusses. The crane operator will work their way out of the ice rink, exiting along section 16 which will then be erected from the outside of the building.

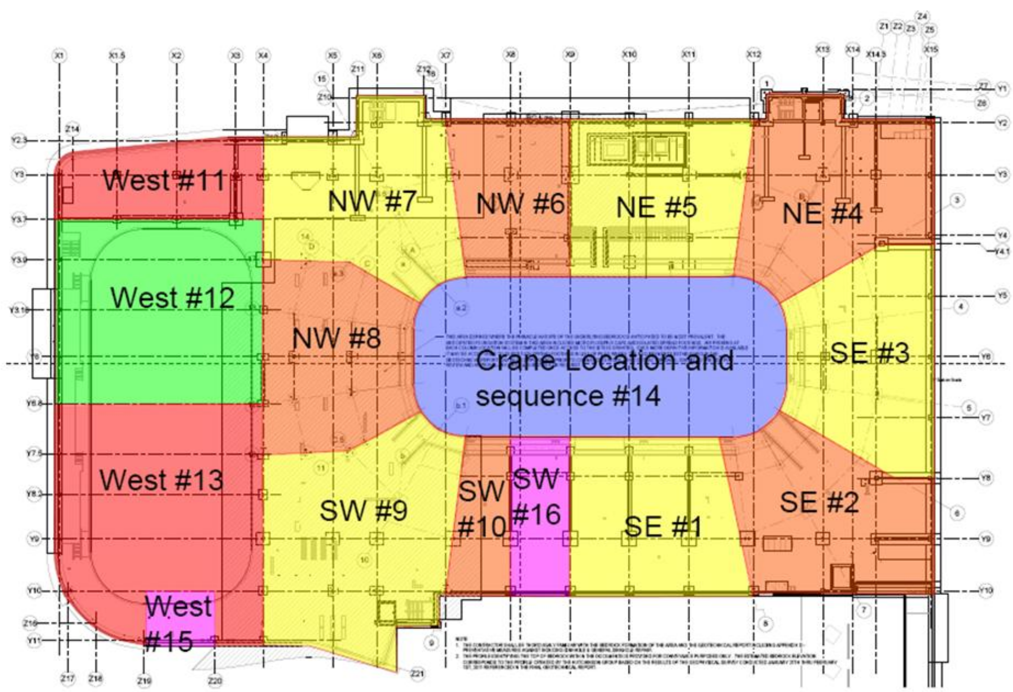


Figure 1: Steel Sequence

Cast in Place Concrete

The cast in place systems located throughout the building include micropiles, pile caps, column footers, wall footers, foundation walls, shear walls, a retaining wall, slab on grade, and slab on metal deck. The sequencing of the entire structure starts in the southern portion of the building in large part due to the need for micropiles. There are minimal micropiles located in the south, east, and north zones of the building. However there are many piles needed in the western portion of the building. Therefore, the sequence started in the south of the building to let the pile drillers as much time as possible to drill in the western zone of the building, without interfering with work going on throughout the rest of the building.

Lean fill was poured first below all of the spread and foundation wall footers. This was to provide a level surface for the footers as well as help distribute the load. This also allowed a very workable base to build the form for foundations.

Along the shear, foundation, and retaining wall, vertical formwork was built. The majority of the walls are of modular size which allowed for modular formwork to be set, with a crane, around the perimeter of the building. The only locations that needed to be specially formed were the north west and south west corners where the wall curves; and the retaining wall in the south east corner because it slopes downward. These forms also had built in slots for scaffolding at the top which allowed for quick and easy setup when scaffolding was needed to pour concrete.

Every cast in place concrete system utilized rebar. The micropiles and retaining wall utilized epoxied rebar with the expectation of high levels of moisture passing through. The flooring systems were also a rebar system instead of a wire mesh system with the SOG containing a vapor barrier beneath it.

There are three primary placement methods that were utilized in pouring concrete. One was a concrete pump. This was utilized along the entire foundation wall, SOG, and SOMD. The next system was direct chute. This was almost how all lean fill was poured and foundations when reachable. If the foundations were not reachable; then the crane and bucket placement method was used.

Below is the sequence method for foundation walls and the SOG. Remember, all construction starts at the south point near the center (gridline X9). The piles were poured first; then the pile caps; next were the spread and foundation wall footers; followed by the foundation, shear, and retaining wall; which preceded the SOG and SOMD.

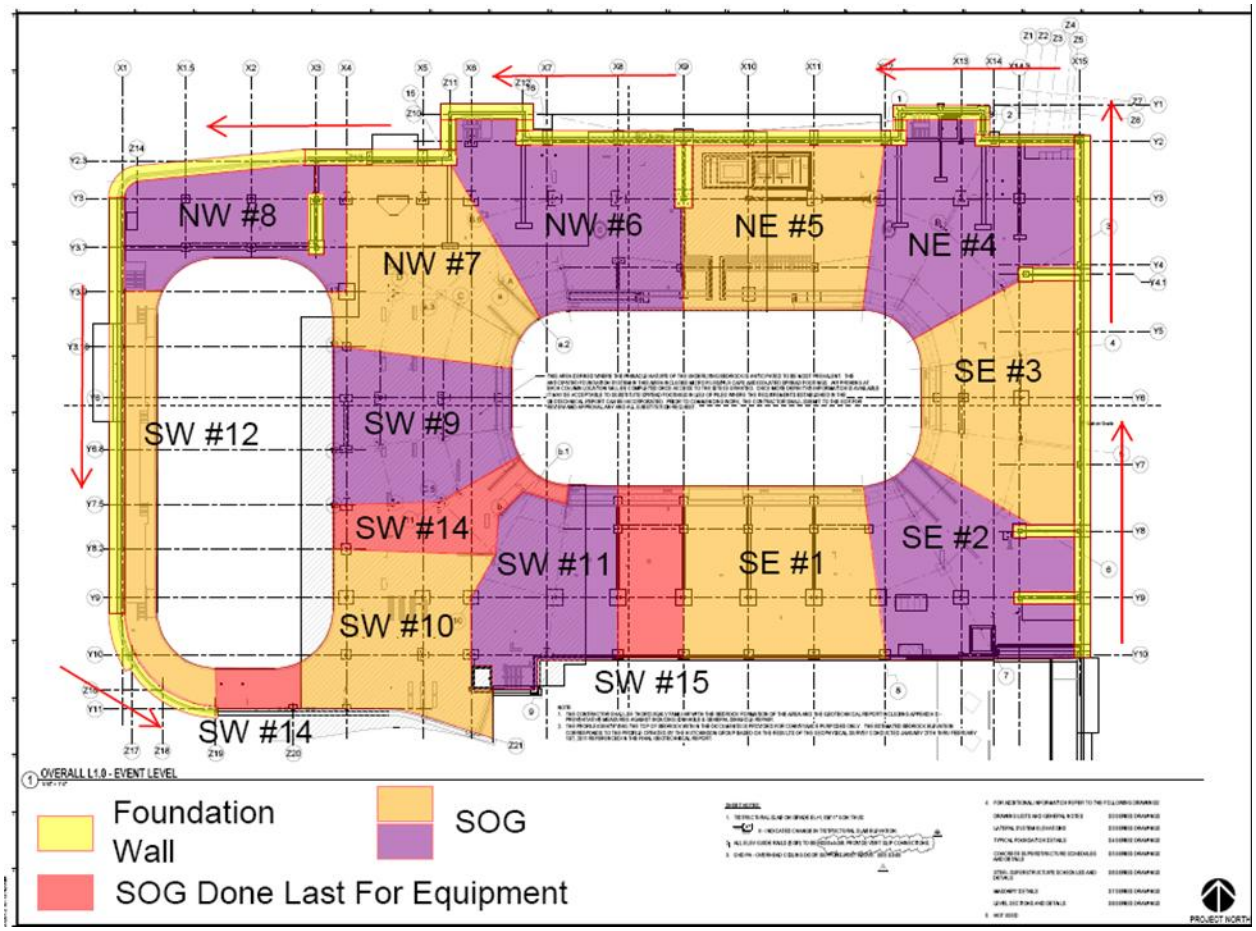


Figure 2: Foundation Wall and SOG Sequence

Precast

There are concrete precast stadia seats. These are being fabricated in Center Valley, Pennsylvania. This is a small town located just outside Allentown, PA. These sections are pre-stressed and get up to lengths of 30'. The precast stadia rest on 1" rubber pads which lie directly on the rakers. The precast stadia have pockets located on the face which allow the stadia to be bolted to the rakers. Once the nuts and bolts are in place caulking is applied to hide the bolt connection.

The precast seats are being installed during the night shift. This allows the same crane swinging the steel to be used for the precast stadia. Thus, the crane can obviously support the load, however the boom has to have a radius of 50' or shorter when placing the stadia. Along the ends, there are six, three on each side, locations for the crane to rig to the stadia. These are wire cables that are cemented into the concrete stadia, which get cut off after it is installed. Finally the gaps between the stadia are caulked with a preapproved color.

Photo 1: Precast Stadia | Courtesy of Mortenson

Mechanical System

The mechanical system incorporates 12 air handling units into its design. Most of these are located on the roof with the exception of one which is included in the event level with outside air running through duct to it. There are 6 AHUs that incorporate 100% outside air into their design, with 2 of those utilizing energy recovery wheels which should help push LEED certification and reduce energy costs. The other 4, of those 6, serve primarily as dehumidification units. Dehumidification is especially important within this building due to its primary function being ice hockey.

The mechanical system utilizes 25% glycol which is a refrigerant that is supposed to be more efficient as opposed to using just water. Finally, located along the curtain wall on the east side of the building; a radiant finned tube piping system is utilized. This is located at the base of the glazing and is meant to counteract any cold climate seeping through the window to make this area as comfortable as possible.

The mechanical room is located at the north west corner of the building and rests on the event level. Located in the mechanical room are multiple heat exchangers, variable frequency drives, and water pumps. There is also a sump pump among other items in the mechanical room.

The sprinkler system in the building is a wet pipe system. Per code the building is required to have a fire suppression system everywhere but over a floor area used for contest that is higher than 50'. The roof, from the ice is higher than 60', therefore no sprinkler system will be provided above the ice. Also, per code, standpipes are required at each level of an enclosed stairwell.

Electrical System

The electrical room is located on the event level in the north west corner of the building. There are three transformers all built up on concrete pads. Two service the building, while the third is in case of a system failure. The electrical conduit feeding from theses transformers carries 3000 amp, 480 / 277 volt, 3 phase, 4 wire service. The transformers themselves are oil filled, pad mounted transformers. Since they are oil filled they have to be set 15' back from the building in order to protect against a fire hazard.

Masonry

The masonry around the building is similar to much of the surrounding area. It is standard red brick utilizing a stretcher bond and jack on jack technique which can be seen in Figure 3. It encompasses most of the wall enclosure with the exception to some glazed curtain wall.

There is an initial layer of CMU that gets erected. Every other level has ladder reinforcement which is to help sustain lateral loads. These ladders are three point welded to allow brick ties to be installed. These then tie into the red masonry and are hidden with mortar. There are also locations where the brick is tying into metal framed panels, located on the outside of the building.

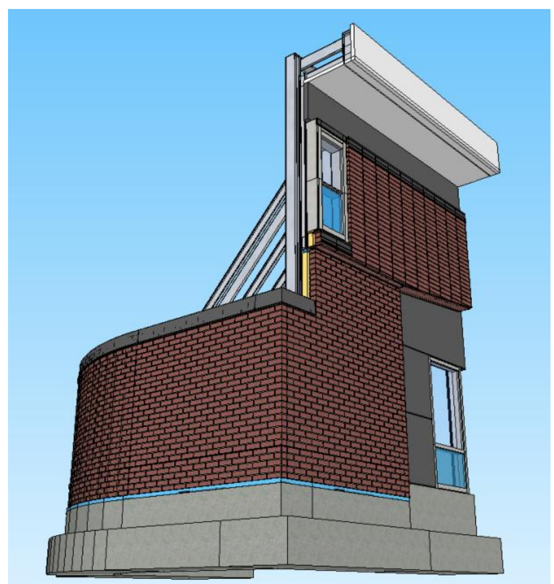


Figure 3: Mock Up of Brick Enclosure | Courtesy of Mortenson

The CMU blocks are not load bearing walls. Also scaffolding has not been officially chosen yet due to the fact that the exterior masonry has not yet started.

Curtain Wall

The most significant portion of curtain wall encompasses the entire east facade of the building and is visible along University Drive. The curtain wall will rest on an aluminum track frame which will house low e-coated insulating glass. The glass will be ultraclear with each glass lite a 1/4" thick and a 1/2" air space between each lite. Additional to this, each glass panel, along the east facade, will be approximately 11' x 4'.

Although Crawford Architects is the head architect, Bohlin Cywinski Jackson is the exterior façade consultant. They are behind the system, and are largely in charge of the design of the curtain wall.

LEED

Penn State buildings are required by the Office of Physical Plant to be LEED certified. Therefore, Mortenson has implemented many practices to help achieve LEED status. There are separate dumpsters set up for recycled materials. Mortenson also plans on using regional materials and a minimum of 50 % wood in accordance with the Forrest Stewardship Council. Mortenson also has a concrete washout station that is eventually being recycled for large aggregate. Finally, Mortenson plans on being extremely proactive in monitoring the indoor air quality by developing a management plan and performing a flush out of the ductwork systems.

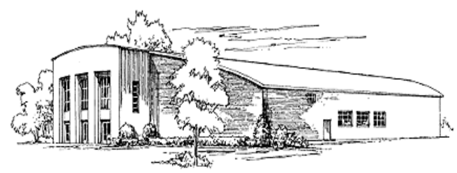
Project Cost Evaluation

Square Foot Estimate

Table 2: Square Foot Cost Breakdown

	Construction Cost	Total Project Cost	Architect Cost	Owner Cost
RS Means Square Foot	$ 27.0 M ($118 sf)	$ 33.5 M ($146 sf)	$ 2.3 M ($10 sf)	$ 35.8 M ($157 sf)
Actual Cost	$ 67.9 M ($297 sf)	$ 89.0 M ($389 sf)	NA	$ 102 M ($446 sf)

Estimate Name:	Untitled
Building Type:	Rink, Hockey/Indoor Soccer with Face Brick with Concrete Block Back-up / Steel Frame
Location:	STATE COLLEGE, PA
Story Count:	3
Story Height (L.F.):	65
Floor Area (S.F.):	228861
Labor Type:	Union
Basement Included:	No
Data Release:	Year 2012
Cost Per Square Foot:	$156.56
Building Cost:	$35,831,500



Costs are derived from a building model with basic components.

Scope differences and market conditions can cause costs to vary significantly.

Parameters are not within the ranges recommended by RSMeans.

Figure 4: RS Means Costworks Cost Estimating Report

The RS Means square foot estimate is significantly smaller than what the actual estimate is. The cost of construction, according to RS Means, came out to be $27 million. The estimated cost of construction done by Mortenson came out to be nearly $68 million dollars. There are many reasons why this large difference in cost exists.

For starters, the RS Means had limited information for an ice arena of this magnitude. As can be seen In Figure 5 there were many limitations put on the RS Means estimate. The three things that quickly grab the attention is the area, number of stories, and story height. RS Means modeled there data off a maximum building area of only 57,500 sf. The Pegula Ice Arena is approximately 228,800 sf. RS Means also has a maximum number of stories of one, and a maximum building height of 36 ft. The Pegula Ice Arena is three stories high and 65 ft high.

- Area (S.F.):
  8500 - 57500
- Perimeter (L.F.):
- Stories:
  1 - 1
- Story Height:
  10.00 - 36.00
- Contractor Fees:
- Architectural Fees:
- User Fees:

Include Basement:

Figure 5: RS Means Ice Rink Parameters

Another significant reason for the drastic difference in price is because the Pegula Ice Arena actually has two ice rinks. Certainly, RS Means did not factor this expectation into their data. The last reason for the huge difference in price is the fact that the Pegula Ice Arena is state of the art. It has two a skate rental shop, hydrotherapy space, gym space, offices, concession stands, a Tim Hortons, club sections fitted with kitchen space, and a general dining space for club members.

In order to ensure that a miscalculation did not occur, other building formats within RS Means, were utilized. The next closest building type found was a gymnasium which yielded an even smaller construction cost. There were no professional stadiums or arenas that were found within RS Means square foot estimate. Due to the large difference in square foot estimated costs and Mortenson's cost; a detailed estimate will be especially important which is to follow in upcoming reports.

At Mortenson's request, a detailed cost breakdown of certain fees, markups, contingencies, FF&E, and other soft costs are to be excluded. However, the estimated total cost of the GMP contract, is $89 million. Between some of the utility tie ins (to be funded by OPP), overhead, and design fees; Penn State is responsible for approximately $102 million worth of project costs.

A full square foot breakdown can be viewed in Appendix B.

Assemblies Cost Estimate

Table 3: MEP Assemblies Estimate

	Total	Cost per SF
Mechanical	$ 6,952,320	$ 30.40
Plumbing	$ 1,412,640	$ 6.20
Electrical	$ 6,703,796	$ 29.30
Total	**$ 15,068,756**	**$ 65.90**

Table three breaks down the different MEP assembly estimates. Mortenson has requested that I not detail their exact cost. However, I did come in below their number to some degree. This could be in part because they estimated it as a GMP, and therefore would protect themselves in case of particularly challenging design alterations.

A full square foot breakdown can be viewed in Appendix C.

Site Plans

Existing Conditions

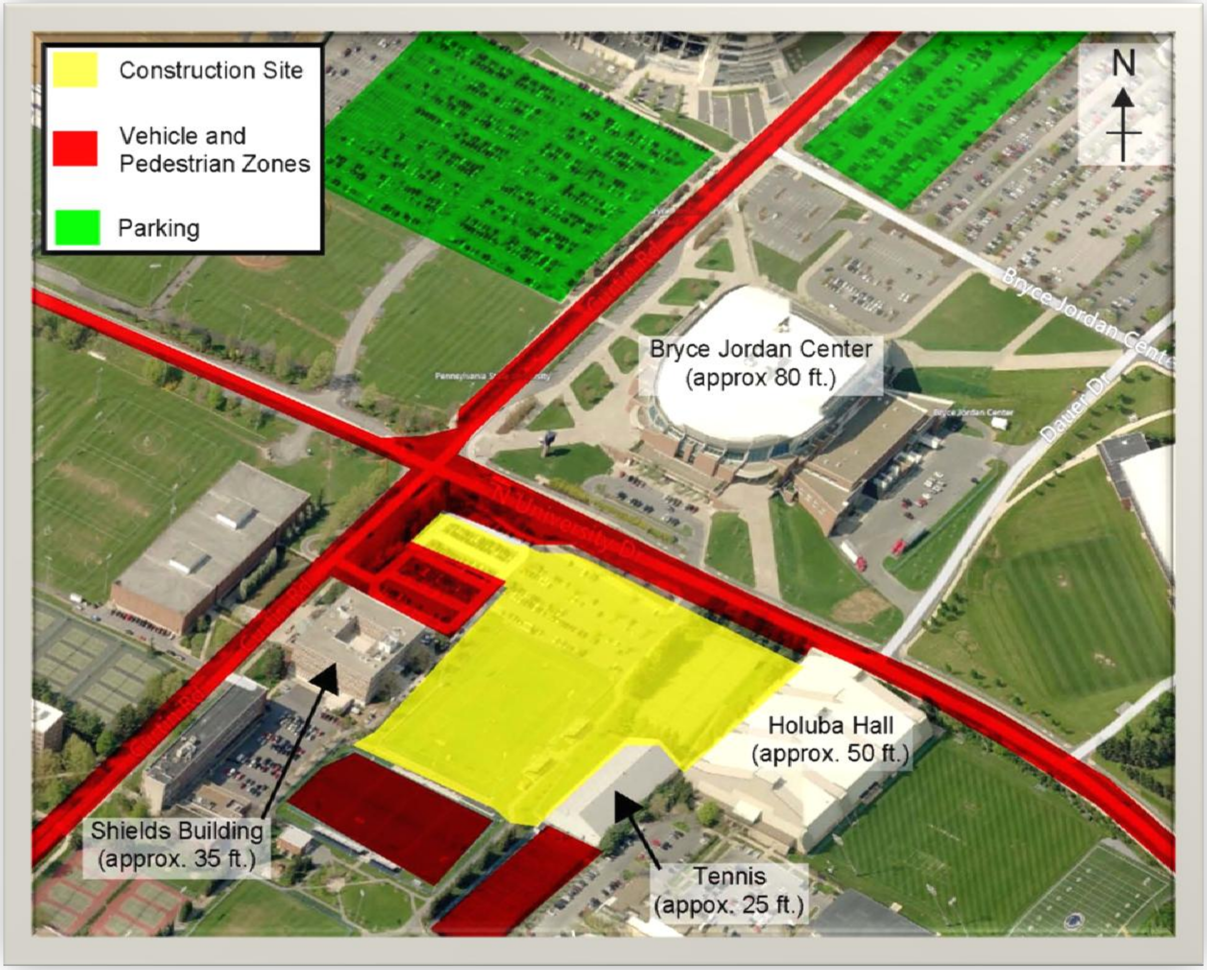


Photo 2: Existing Conditions

Photo 2 represents some of the existing conditions on site. As can be seen parking is in green and is relatively close to the sight, which can be seen in yellow. In red, are vehicle and pedestrian zones. The roadways near the site are two way streets. There are also many sports complexes located around the site. Therefore, high levels of student traffic are located around this area. Therefore, particular attention to safety must be done in order to ensure students are kept free from any danger. With that, the site perimeter must be checked frequently to ensure no student traffic can cross through the project site.

The general layout shows the building footprint, site perimeter, and where the project office trailers are to be located. The existing utilities plan shows the utility lines, light poles, fire hydrants, and bleachers.

Appendix D has the general layout plan and existing utilities plan.

Site Layout Planning

Excavation

Crew / Work

- Excavation / Removing Excavated Earth Offsite
- Micropiles
- Concrete for Micropiles

Temporary Facilities / Equipment

- Office Trailers
- Excavator
- Dump Trucks
- Concrete Trucks

Safety Concerns

- Blasting was Required (No one could be on site during blasting)
- Site Flagger needed at Construction Entrance for Dump Trucks

Foundation Wall and SOG

Crew / Work

- Formwork
- Rebar
- Crane Operator to Lift Formwork and Rebar
- Additional Concrete Trucks

Temporary Facilities / Equipment

- Hydraulic Boom Crane
- Storage Trailers
- Rebar Laydown Area
- Modular Formwork Laydown Area

Safety Concerns

- Daily Crane Inspections
- Daily Rigging Inspections
- Rebar Caps

Utility Tie In

Crew / Work

- Underground Utilities
- Excavation (Trenches)

Temporary Facilities / Equipment

- Excavators
- Dump Trucks
- Crane

Safety Concerns

- Additional Site Perimeter
- Road Closure
- Engineered Pick Plans for Precast Manholes
- Trench Boxes

Steel

Crew / Work

- Steel Erection
- Steel Finishing
- SOMD Form, Rebar, Pour

Temporary Facilities / Equipment

- Additional Office and Storage Trailers
- Crawler Crane with Latticed Boom and Jib
- Shakeout / Steel

Safety Concerns

- Daily Crane and Rigging Inspections
- Earth Beneath Crane
- Overhead Steel Swing Path
- Fall Protection (Retractables)
- Fire Watch for Welding

Interior Rough In

Crew / Work

- MEP Rough In
- Metal Stud Framing
- Drywall
- Fireproofing

Temporary Facilites / Equipment

- Additional Office and Storage Trailers
- Ductwork Staging Area
- JLG Lifts
- Fireproofing Staging Area

Safety Concerns

- MSDS on Fireproofing Material
- Leading Edge Training for Upper Stories

Exterior Enclosure

Crew / Work

- Masonry
- Curtain Wall
- Roofing

Temporary Facilities / Equipment

- Additional Office and Storage Trailers
- Grout Mix Station
- Scaffolding

Safety Concerns

- Daily Scaffolding Inspections
- Roof Perimeter / Leading Edge

Appendix E has site layout planning for different scopes of work.

Local Conditions

Soil

There were 31 boring samples done on site for the geotechnical report. Each bore had approximately 3 to 12 inches of topsoil. From here, the rest of the soils were classified into four principle strata. The stratum is fill, clay, sand, and rock. The general description of the soil was a pinnacled dolomite covered by a thin spread of clay.

Boring samples proved the soil would be suitable to build on. However, micropiles were to be utilized on the west where the top of rock was found to be at a lower elevation compared to the rest of the site. The rest of the site was capable of utilizing shallow spread footings. Unfortunately, the site was discovered to contain an underlain cover of a carbonate rock formation which is susceptible to subsurface erosion or sinkholes. Special precautions in design were taken because of this.

Water testing was done with each boring. There was no significant water found in any of the tests. It was implied however, that water seepage may occur during shallow foundations, but that static groundwater would not be encountered.

Recycling

The site contains multiple dumpsters for recycling. This was one of the many things Mortenson did as a project team to help achieve the goal of LEED certification. Adjacent to the dumpsters on site is a concrete washout. This is also going to be dug up at the end of the project and recycled to be used as large aggregate on future projects. Mortenson employees knew of no tipping fees, however, with research, it appears central Pennsylvania has an average tipping fee of $70 per ton.

Parking

The parking for the ice arena is fairly convenient. Most Penn State construction requires workers to park at the commuter lots along Beaver Stadium and the Bryce Jordan Center; and then bus over to the actual construction location. The Pegula Ice Arena is located directly across the Bryce Jordan Center which allows for workers to simply walk over to the construction site. This saves significant time and money for the construction process. The exact parking locations can be seen in Photo 2 under Existing Conditions.

The building is centered on two different zones. One is the college township and the other is the State College Borough. However, due to the fact that the site is located on University property the bylaws are regulated by the University Park District. The design of the building could not exceed 90’ and the minimum setback from University Drive is 50’.

Reference Site Plans (Photo 2) for parking map.

Client Information

The Pennsylvania State University is a public university with campuses and facilities located throughout Pennsylvania. The main campus is located in State College, Pennsylvania. It was founded in 1855 as an agricultural / farmers school.

The Pennsylvania State University is highly competitive in Division 1 athletics. There are multiple teams that compete for NCAA championship titles on a yearly basis. Some of these include football, baseball, basketball, wrestling and volleyball. It came to the attention of the Intercollegiate Athletics office, at Penn State, that hockey was the only mainstream sport that was not a competitive Division 1 program.

At this same time the Big 10 started actively seeking a competitive conference within collegiate hockey. It was decided that six teams would be needed to start a conference for hockey in the Big 10. Other schools such as Minnesota and Wisconsin had established teams but more needed to be added to make the Big 10 legitimate. For this reason, and the fact that ice hockey is a mainstream sport, Penn State decided to pursue a Division 1 Hockey program.

There were many hurdles to create a Division 1 hockey program; none larger than constructing a new facility. There is an existing ice arena, where Division 1 hockey will be played this year, but in order to legitimize the program they needed to build a new arena. The Pennsylvania State University primarily funds new construction by donations. Luckily for Penn State, they were able to receive one large donation to build the arena.

Terrence Pegula, and his wife Kim, donated 102 million dollars for the construction of a new ice arena at Penn State. The Pegula's are avid hockey fans and actually own the Buffalo Sabres. Terrence Pegula is a former Penn State engineering student. He founded East Resources, a natural gas drilling company, before selling it to Royal Dutch Shell for 4.7 billion dollars. Without the Pegula's generosity the Division 1 hockey program would not have been possible and the Pennsylvania State University is forever indebted them.

The 102 million dollars was to pay for construction and design of the building. Penn State required that construction be finished by the home opener for the 2013/2014 hockey year. This is because; this will be the official start of the Big 10 Division 1 hockey conference.

Penn State demands the highest of quality in design and construction. They demand construction be met on time and on budget. They expect these things with no sacrifice in safety.

Project Delivery System

Mortenson is the single prime contractor working on the Pegula Ice Arena. The contract held between Penn State and Mortenson is a Guaranteed Max Price. Mortenson was awarded this job as a CM at risk. In order to make their price as competitive as they could, they decided to self-perform the concrete and other miscellaneous items. This did give them some contractor responsibilities.

The GMP went for a total of $89 million. A GMP was appropriate for the Pegula Ice Arena due to where the building was it in design once negotiations started. The design was to be at only 50 percent completion when the bids were due. This made it impossible to pursue a lump sum bid. The reason Penn State could not wait for the design to be finished was because they had to have a new arena before the home opener in October 2013.

Standard retainage rates are being held by Penn State.

Penn State then has a separate contract with Crawford Architects and Bohlin Cywinski Jackson (BCJ). Crawford Architects is serving as the lead architect and BCJ is serving as the enclosure consultant. Penn State has a lump sum contract with possible additional fees if asked to do more work. Both of these contracts were held in compliance with the American Institute of Architects (AIA).

Penn State also held the initial contract with the geotechnical engineer Pennoni. On top of this, Penn State hired a third party testing agency, CMT, and their own commissioning agent, Aramark Engineering Solutions. All of these contracts were issued via lump sum.

Subcontractors were picked via Mortenson's decision following Penn State conditions. The subcontractors had to be prequalified by both Mortenson and Penn State. Initial bids had to be formerly submitted through Penn State. This was Penn State's way of ensuring Mortenson could not unfairly ignore certain subcontractor bids. From here, Mortenson utilized their company wide best value decision process. This incorporates the goals and expectations Mortenson has, more or less in a checklist, and whichever subcontractor has the highest score is to receive the award. This was possible because Mortenson was under a guaranteed max price contract. If it was a lump sum, Mortenson would most likely have to accept the lowest bid. Once Mortenson has made their best value decision, the results are sent into Penn State in order to ensure no negligence has occurred, and once approved, Mortenson can officially award a lump sum contract.

Appendix F contains the project organizational chart.

Staffing Plan

Mortenson is headquartered in Minneapolis, Minnesota. Mortenson has regional offices primarily focused in the Midwest, but also has a National Projects Group which is in charge of the Pegula Ice Arena.

Appendix G is the staff organizational chart for the Pegula Ice Arena. In orange are the directors in charge of the national projects group. Derek Cunz is the Principal in Charge. He was largely responsible for seeking out this job. Gene Hodge started out as Senior Project Manager for this job but got promoted to Construction Executive part way through the job. Therefore, he handled a larger amount of work and primarily became responsible for Penn State relations.

From Gene, the chart splits in two directions. The one side is the project management side. This starts with Steve Laurila, the current Senior Project Manager on site. From here, it splits off into four sections. On the far right is the office administrator. There are then two full time Integrated Construction Coordinators. They are responsible for all BIM applications regarding the project, and any model coordination that needs to take place. Adjacent to that, is Nate Mallory, who is in charge of quality as well as MEP systems on site. Heidi Brown is another project manager located on site full time. She is responsible for cost management as well as schedule oversight. Beneath Heidi and Nate are three field engineers whom are in charge of submittals and inspections on predefined scopes of work. Finally, I am still working part time primarily maintaining document control as well as helping out where needed.

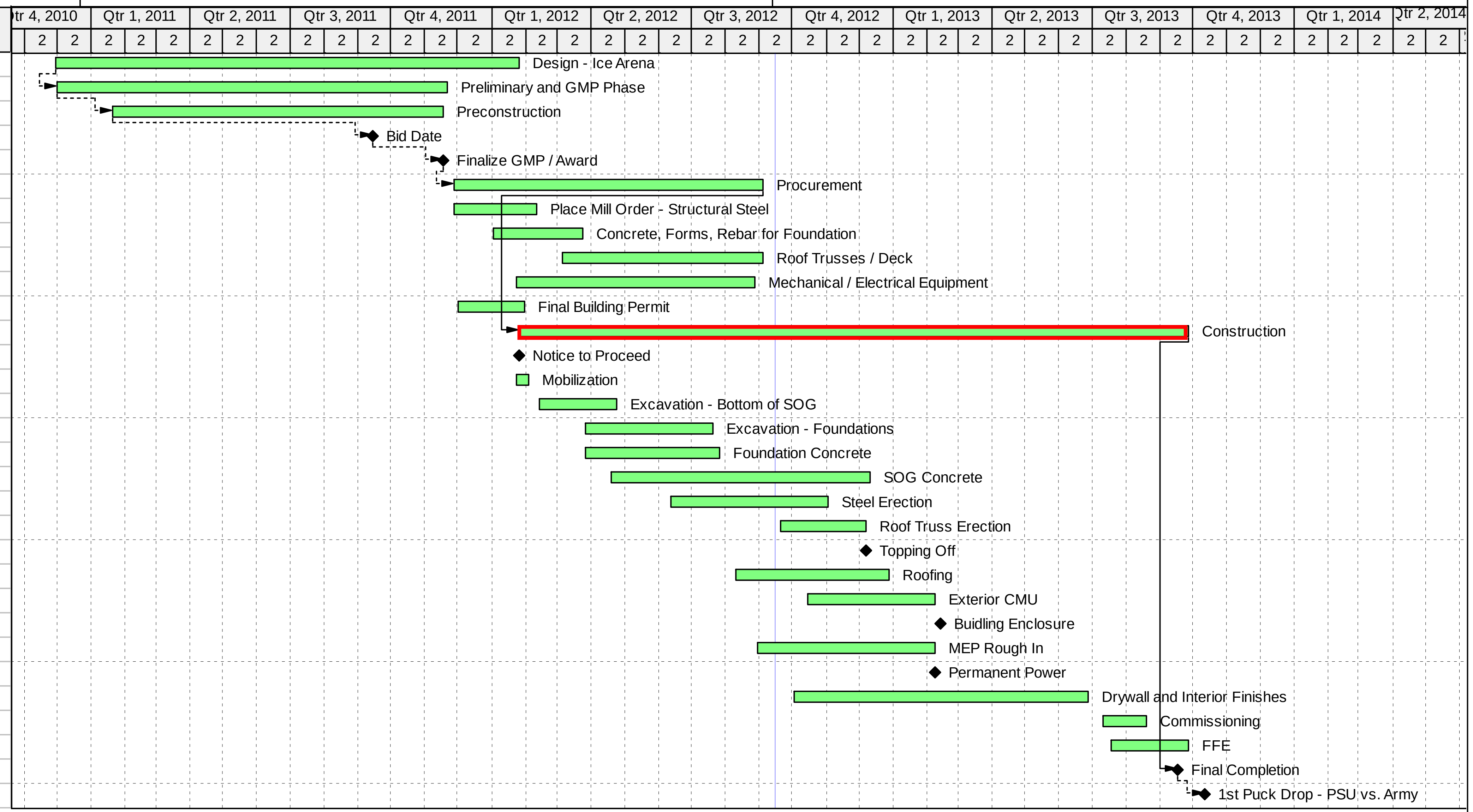
The other direction heading from Gene are the superintendents. There are three superintendents on site. Jason Brown is the Senior Superintendent who is in charge of the overall project supervision. Beneath the superintendents is Kyle Guenther. He is the full time Safety Engineer located on site.

Appendix G is the staff organizational chart for the Pegula Ice Arena.

Appendix A: Project Schedule Summary

The Pegula Ice Arena	Classic Schedule Layout	16-Sep-12 01:08

Activity ID	Activity Name	Original Duration	Start	Finish
A1000	Design - Ice Arena	295	30-Nov-10	26-Jan-12
A1010	Preliminary and GMP Phase	249	01-Dec-10	21-Nov-11
A1020	Preconstruction	214	20-Jan-11	18-Nov-11
A1030	Bid Date	0	15-Sep-11	
A1040	Finalize GMP / Award	0		18-Nov-11
A1050	Procurement	197	28-Nov-11	04-Sep-12
A1060	Place Mill Order - Structural Steel	53	28-Nov-11	10-Feb-12
A1070	Concrete, Forms, Rebar for Foundation	59	03-Jan-12	23-Mar-12
A1080	Roof Trusses / Deck	129	05-Mar-12	04-Sep-12
A1090	Mechanical / Electrical Equipment	155	23-Jan-12	28-Aug-12
A1100	Final Building Permit	41	01-Dec-11	30-Jan-12
A1110	Construction	427	26-Jan-12	26-Sep-13
A1120	Notice to Proceed	0	26-Jan-12	
A1130	Mobilization	10	23-Jan-12	03-Feb-12
A1140	Excavation - Bottom of SOG	51	13-Feb-12	23-Apr-12
A1150	Excavation - Foundations	82	27-Mar-12	20-Jul-12
A1160	Foundation Concrete	86	27-Mar-12	26-Jul-12
A1170	SOG Concrete	164	19-Apr-12	10-Dec-12
A1180	Steel Erection	102	12-Jun-12	02-Nov-12
A1190	Roof Truss Erection	56	20-Sep-12	07-Dec-12
A1200	Topping Off	0		07-Dec-12
A1210	Roofing	98	10-Aug-12	28-Dec-12
A1210.1	Exterior CMU	82	15-Oct-12	08-Feb-13
A1220	Buidling Enclosure	0		13-Feb-13
A1230	MEP Rough In	112	30-Aug-12	07-Feb-13
A1240	Permanent Power	0		07-Feb-13
A1250	Drywall and Interior Finishes	189	02-Oct-12	27-Jun-13
A1260	Commissioning	28	11-Jul-13	19-Aug-13
A1270	FFE	50	18-Jul-13	26-Sep-13
A1280	Final Completion	0		17-Sep-13
A1290	1st Puck Drop - PSU vs. Army	0	11-Oct-13	



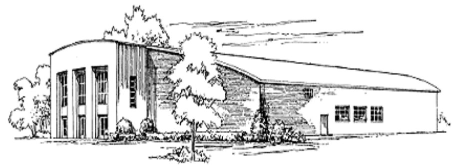
Construction Summary
Work

TASK filter: All Activities

Appendix B: RS Means Square Foot Estimate

Square Foot Cost Estimate Report

Estimate Name:	**Untitled**
Building Type:	**Rink, Hockey/Indoor Soccer with Face Brick with Concrete Block Back-up / Steel Frame**
Location:	**STATE COLLEGE, PA**
Story Count:	**3**
Story Height (L.F.):	**65**
Floor Area (S.F.):	**228861**
Labor Type:	**Union**
Basement Included:	**No**
Data Release:	**Year 2012**
Cost Per Square Foot:	**$156.56**
Building Cost:	**$35,831,500**



Costs are derived from a building model with basic components.

Scope differences and market conditions can cause costs to vary significantly.

Parameters are not within the ranges recommended by RSMeans.

		% of Total	Cost Per S.F.	Cost
A Substructure		**2.70%**	**$3.20**	**$733,000**
A1010	**Standard Foundations**		**$0.82**	**$188,000**
	6 KSF, 12" deep x 24" wide			
	KSF, 4' - 0" square x 12" deep			
	KSF, 5' - 6" square x 18" deep			
A1030	**Slab on Grade**		**$1.74**	**$398,000**
	Slab on grade, 6" thick, non industrial, reinforced			
A2010	**Basement Excavation**		**$0.05**	**$11,500**
	site storage			
A2020	**Basement Walls**		**$0.59**	**$135,500**
	12" thick			
B Shell		**40.40%**	**$47.64**	**$10,903,500**
B1010	**Floor Construction**		**$1.00**	**$229,500**
	Steel column, W8, 50 K, 16' unsupported length, 24 PLF			
B1020	**Roof Construction**		**$4.55**	**$1,042,000**
	57.5" deep, 40 PSF superimposed load, 65 PSF total load			
B2010	**Exterior Walls**		**$36.10**	**$8,261,000**
	thick, perlite core fill			
B2020	**Exterior Windows**		**$2.86**	**$655,000**
	three intermediate horizontals			
	Glazing panel, plate glass, 3/8" thick, clear			
B2030	**Exterior Doors**		**$0.84**	**$192,500**
	hardware, 6'-0" x 7'-0" opening			
	7'-0" opening			
	10'-0" opening			
B3010	**Roof Coverings**		**$2.06**	**$470,500**
	Roofing, single ply membrane, EPDM, 45mils, fully adhered			
	Insulation, rigid, roof deck, composite with 2" EPS, 1" perlite			
	Roof edges, aluminum, mill finish, .050" thick, 6" face			
	Flashing, aluminum, no backing sides, .019"			
B3020	**Roof Openings**		**$0.23**	**$53,000**
	steel, 165 lbs			
	operator			

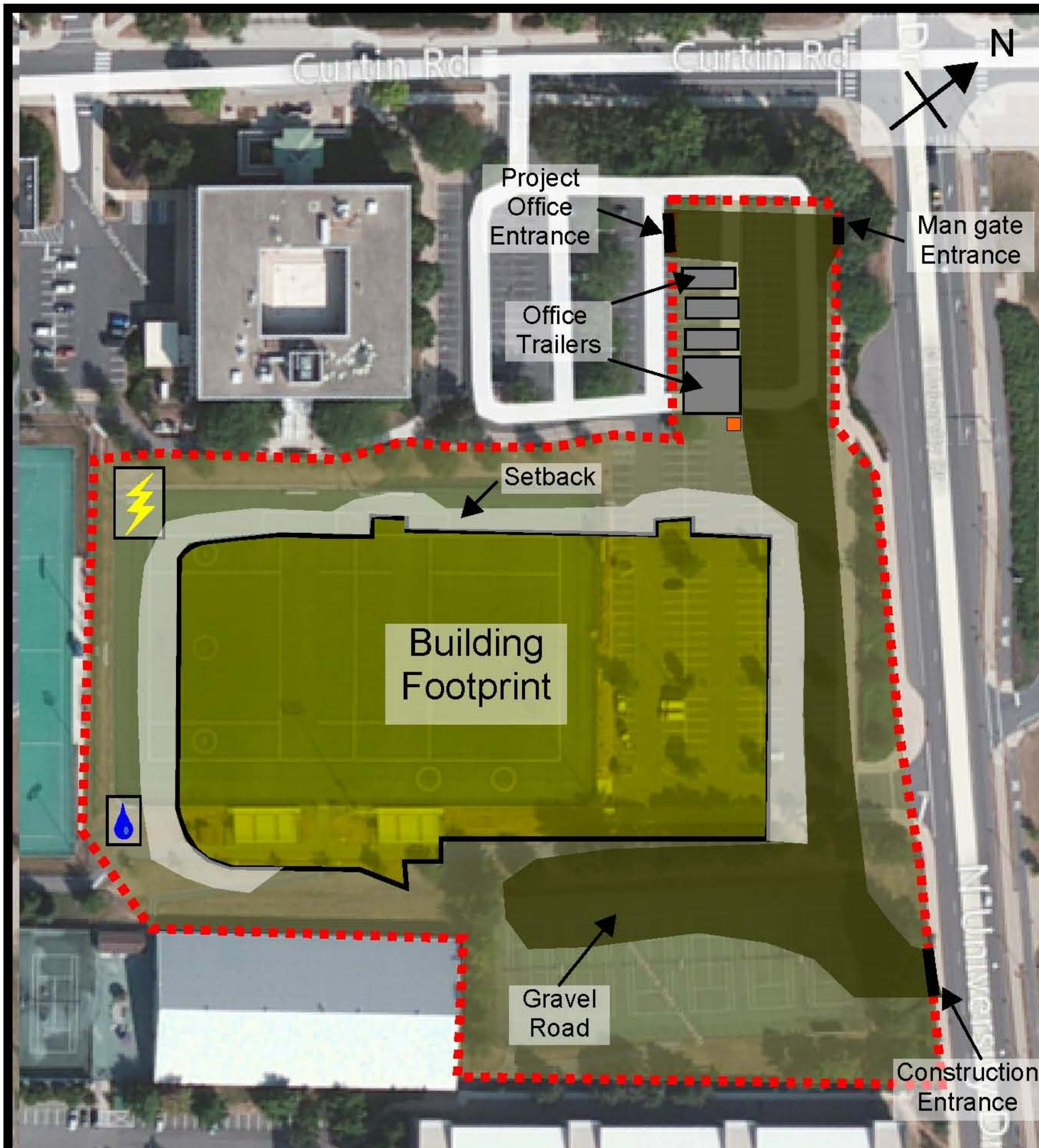
C Interiors		7.70%	$9.07	$2,075,500
C1010	**Partitions**		**$0.68**	**$155,000**
	Concrete block (CMU) partition, light weight, hollow, 6" thick, no finish			
C1020	**Interior Doors**		**$0.43**	**$98,500**
	flush, 3'-0" x 7'-0" x 1-3/8"			
C3010	**Wall Finishes**		**$3.64**	**$832,500**
	2 coats paint on masonry with block filler			
	Painting, masonry or concrete, latex, brushwork, primer & 2 coats			
C3020	**Floor Finishes**		**$3.72**	**$851,000**
	Concrete topping, paint			
	Vinyl sheet goods, maximum			
C3030	**Ceiling Finishes**		**$0.61**	**$138,500**
	channel grid, suspended support			
D Services		27.30%	$32.24	$7,377,500
D2010	**Plumbing Fixtures**		**$5.01**	**$1,146,500**
	Water closet, vitreous china, bowl only with flush valve, wall hung			
	Urinal, vitreous china, wall hung			
	Lavatory w/trim, wall hung, PE on CI, 19" x 17"			
	Kitchen sink w/trim, countertop, stainless steel, 33" x 22" double bowl			
	Service sink w/trim, PE on CI,wall hung w/rim guard, 24" x 20"			
	Shower, stall, baked enamel, terrazzo receptor, 36" square			
	Water cooler, electric, wall hung, dual height, 14.3 GPH			
D2020	**Domestic Water Distribution**		**$2.49**	**$570,500**
	GPH			
D3010	**Energy Supply**		**$0.83**	**$190,000**
	hot water, 10,000 SF bldg,100,000 CF, total, 2 floors			
D3050	**Terminal & Package Units**		**$11.61**	**$2,658,000**
	ton			
D4020	**Standpipes**		**$0.56**	**$128,000**
	floor			
	additional floors			
D5010	**Electrical Service/Distribution**		**$1.89**	**$433,500**
	phase, 4 wire, 120/208 V, 600 A			
	A			
	600 A			
D5020	**Lighting and Branch Wiring**		**$7.93**	**$1,814,000**
	with transformer			
	Miscellaneous power, 3 watts			
	Central air conditioning power, 4 watts			
	per 1000 SF			
D5030	**Communications and Security**		**$1.70**	**$390,000**
	and wire, sound systems, 12 outlets			
	detectors, includes outlets, boxes, conduit and wire			
	conduit			
D5090	**Other Electrical Systems**		**$0.21**	**$47,000**
	gas/gasoline operated, 3 phase, 4 wire, 277/480 V, 7.5 kW			

E Equipment & Furnishings		**0.00%**	**$0.00**	**$0**
E1090	**Other Equipment**		**$0.00**	**$0**
F Special Construction		**21.90%**	**$25.85**	**$5,916,500**
F1040	**Special Facilities**		**$25.85**	**$5,916,500**
	55 degree system, 5 months, 100 ton			
	polyethylene coated plywood			
G Building Sitework		**0.00%**	**$0.00**	**$0**
SubTotal		**100%**	**$118.00**	**$27,006,000**
Contractor Fees (General Conditions,Overhead,Profit)		**24.00%**	**$28.32**	**$6,481,500**
Architectural Fees		**7.00%**	**$10.24**	**$2,344,000**
User Fees		**0.00%**	**$0.00**	**$0**
Total Building Cost			**$156.56**	**$35,831,500**

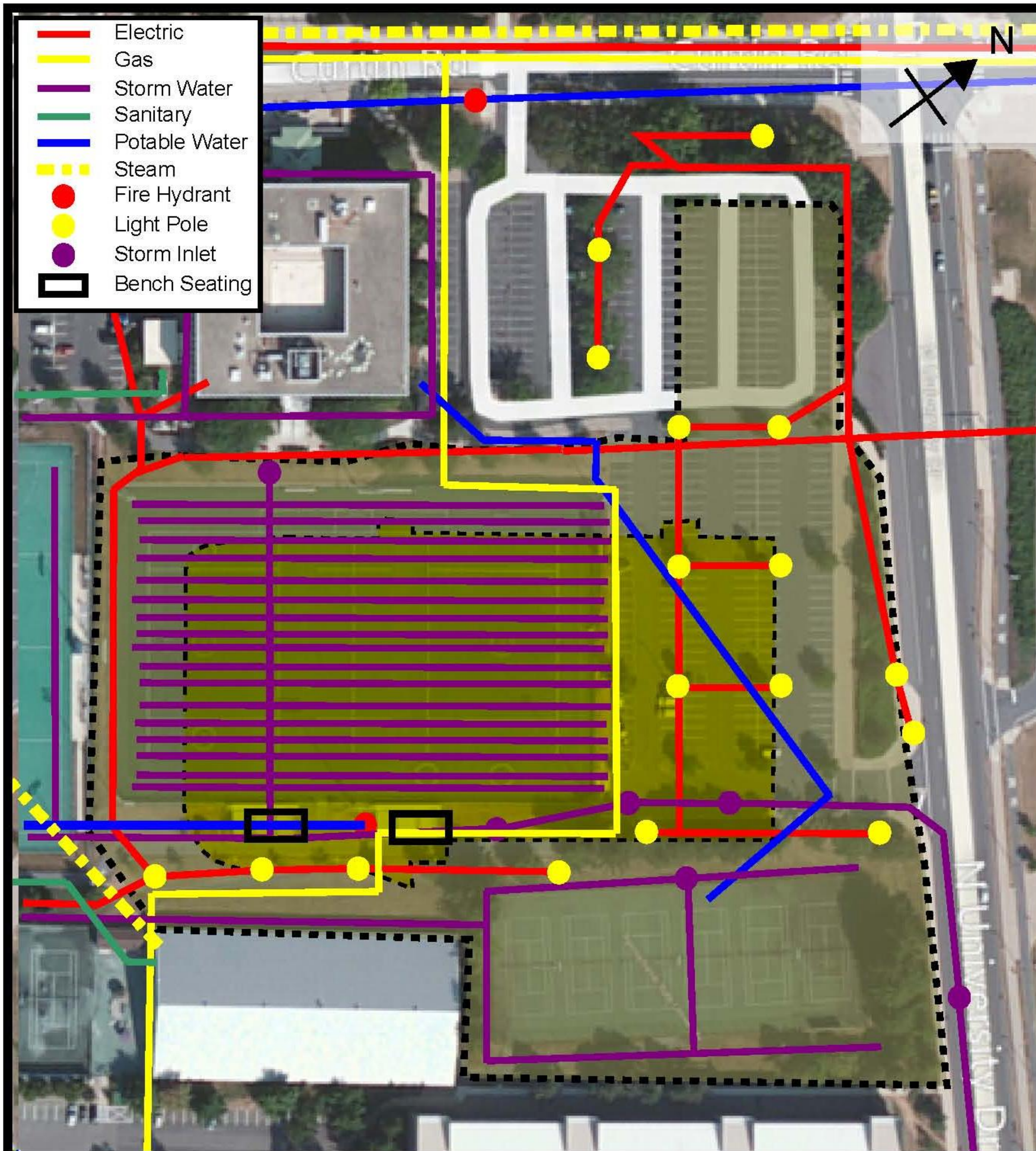
Appendix C: MEP Assemblies Estimate

Equipment	Quantitiy	Units	Material ($)	Installation ($)	Mat + Install ($)	Total
Mechanical						$ 6,952,320
AHU, Rooftop	11	EA	186000	21500	207500	$ 2,282,500
AHU, Indoor	1	EA	109500	51200	130700	$ 130,700
Fin Tube Radiation	15,000	SF	4.48	5.3	9.78	$ 146,700
Electric Radiant Heater	12,000	SF	15.9	12.7	28.6	$ 343,200
Cabinet Unit Heater	20,000	SF	15.9	12.7	28.6	$ 572,000
Fan Coil Unit (A)	20	EA	4000	7675	11675	$ 233,500
Fan Coil Unit (B)	24	EA	4650	10600	15250	$ 366,000
Plate and Frame Heat Exchanger	1	EA	160500	31600	192100	$ 192,100
Shell and Tube Heat Exchanger	2	EA	40500	17500	58000	$ 116,000
CWP (Pump)	1	EA	29700	9275	38975	$ 38,975
GCWP (Pump)	1	EA	29700	9275	38975	$ 38,975
GHWP (Pump)	2	EA	13400	4200	17600	$ 35,200
Exhaust Fan (800 CFM)	2	EA	1450	4300	5750	$ 11,500
Exhaust Fan (5000 CFM)	15	EA	5650	30600	36250	$ 543,750
Exhaust Fan (13,800 CFM)	11	EA	10500	57000	67500	$ 742,500
Contingency and Fee	20	%				$ 1,158,720
Plumbing						$ 1,412,640
Wet Standpipe	4	EA	7025	5325	12350	$ 49,400
Sprinklers	100,000	SF	2.82	2.44	5.25	$ 525,000
Roof Drain	22	EA	2250	2375	4625	$ 101,750
Toilet and Piping	114	EA	850	755	1605	$ 182,970
Unrinal and Piping	38	EA	640	785	1425	$ 54,150
Sink and Piping	102	EA	715	700	1415	$ 144,330
Shower and Piping	46	EA	1775	825	2600	$ 119,600
Contingency and Fee	20	%				$ 235,440
Electrical						$ 6,703,796
Service and Distribution	228,861	SF			4.95	$ 1,132,862
Lighting	228,861	SF			6.25	$ 1,430,381
Devices	228,861	SF			1.16	$ 265,479
Equipment Connections	228,861	SF			3.39	$ 775,839
Basic Materials	228,861	SF			5.17	$ 1,183,211
Fire Alarm and Detection	228,861	SF			1.42	$ 324,983
Sound System	228,861	SF			1.06	$ 242,593
Emergency Generator	228,861	SF			1.01	$ 231,150
Contingency and Fee	20	%				$ 1,117,299
Total						$ 15,068,756

Appendix D: Existing Conditions



Shane Marshall Construction Management	The Pegula Ice Arena University Park, PA	
	Technical Report1	*Site Layout Plan* *Start: NA* *End: NA*



Shane Marshall

Construction Management

The Pegula Ice Arena

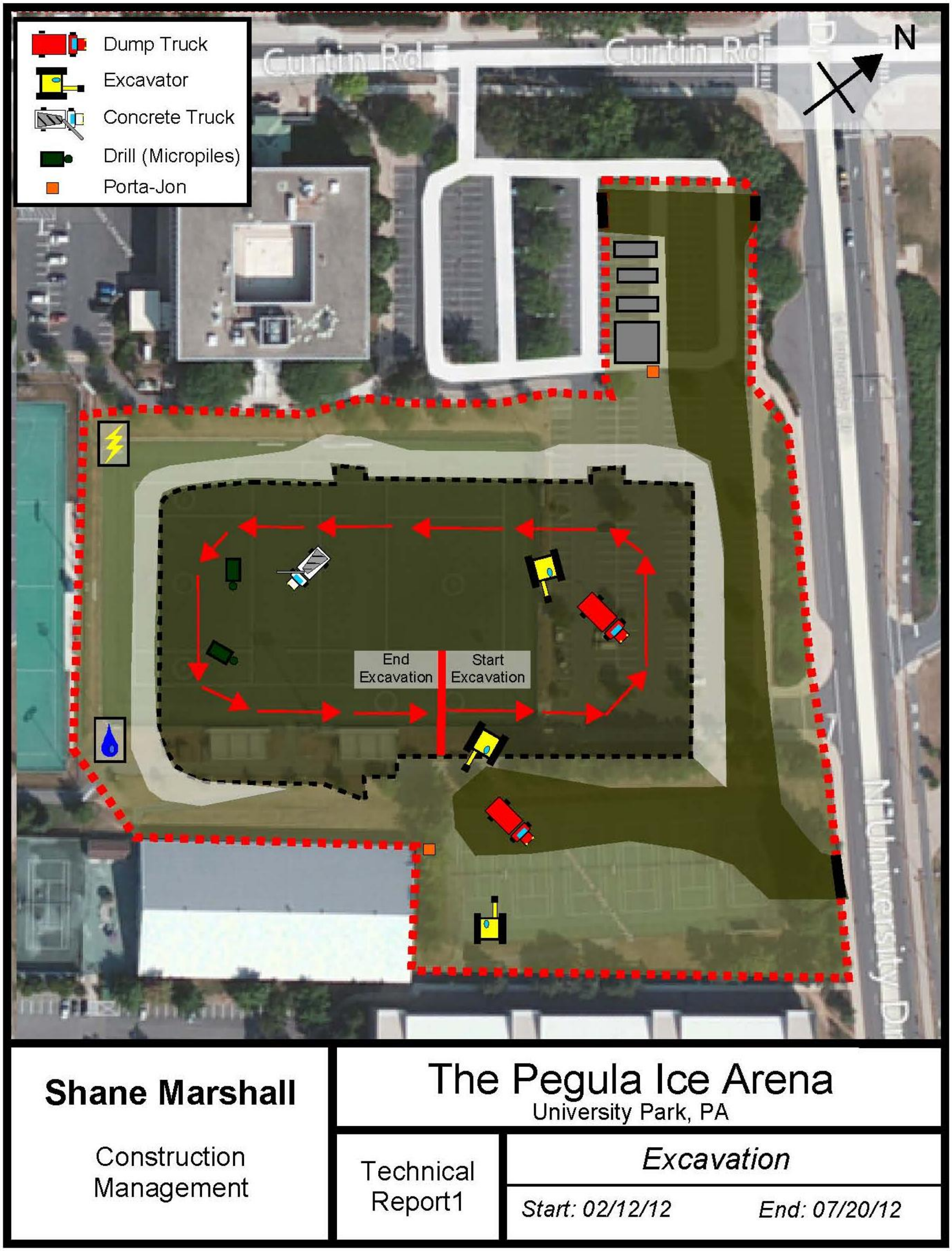
University Park, PA

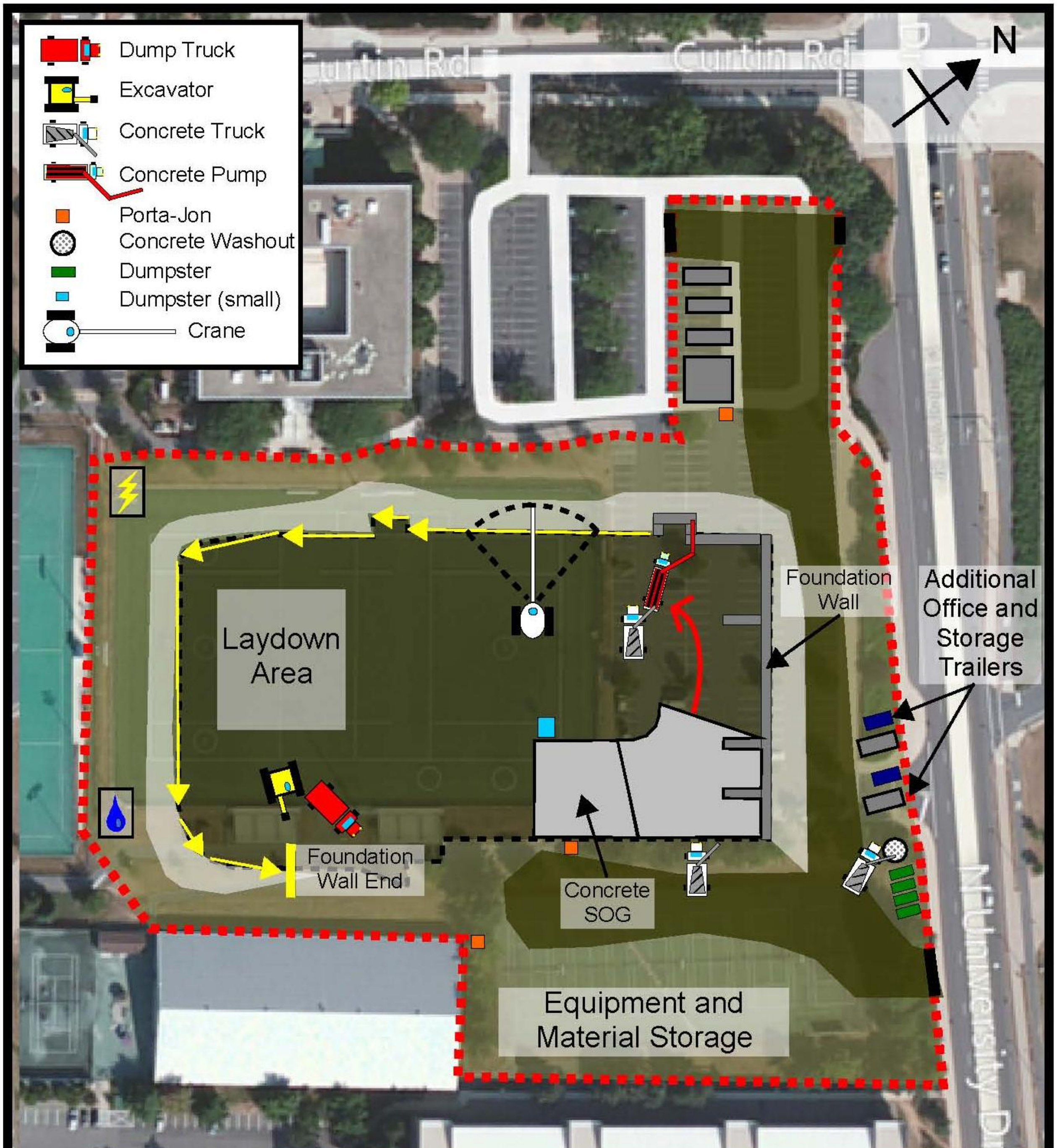
Technical Report1

Existing Utilities

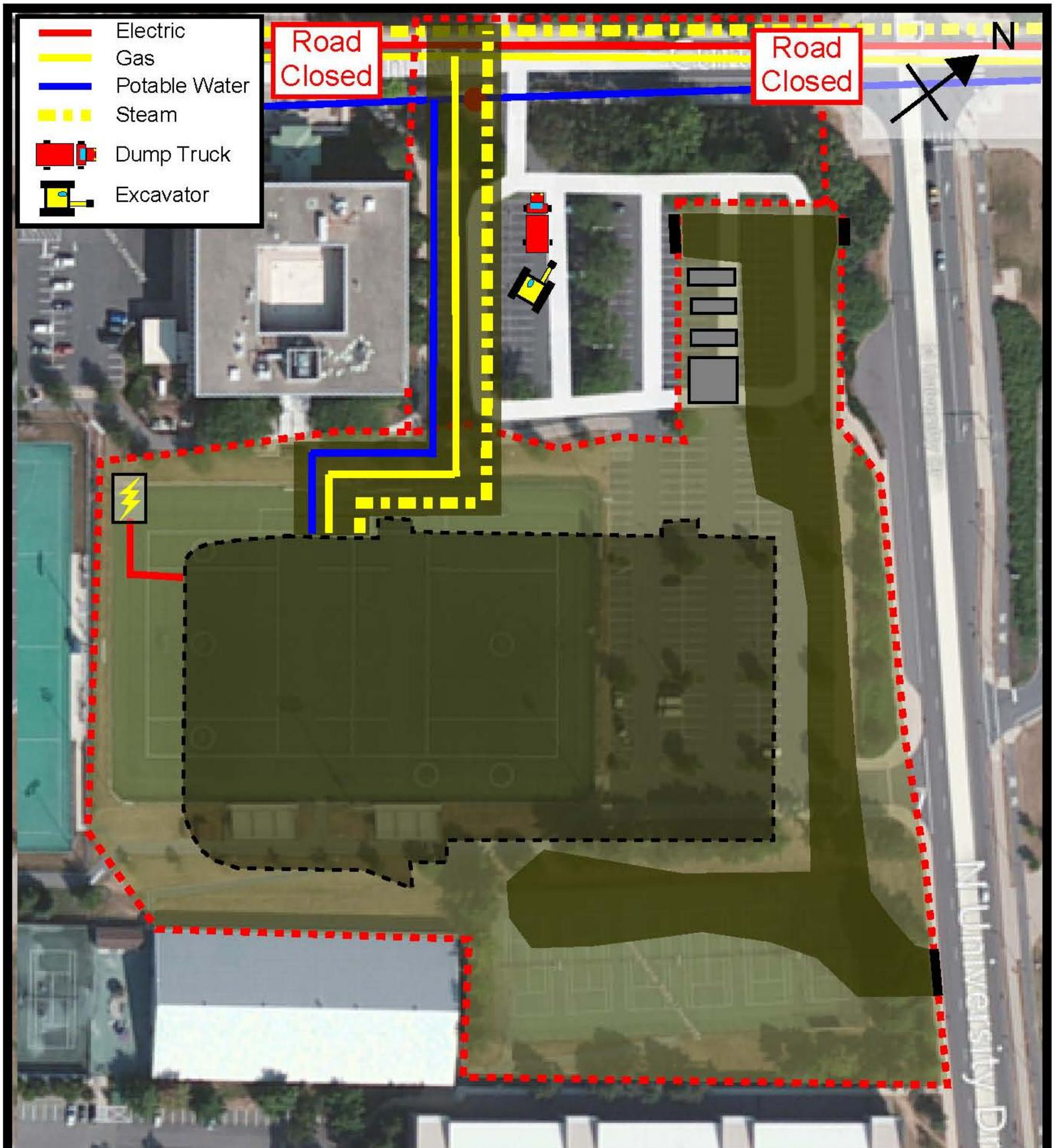
Start: NA *End: NA*

Appendix E: Site Layout


Dump Truck
Excavator
Concrete Truck
Drill (Micropiles)
Porta-Jon
Curtin Rd
Curtin Rd
N
End Excavation
Start Excavation
N University Dr
Shane Marshall
Construction Management
The Pegula Ice Arena
University Park, PA
Technical Report1
Excavation
Start: 02/12/12
End: 07/20/12



Shane Marshall Construction Management	The Pegula Ice Arena University Park, PA	
	Technical Report1	*Foundation Wall and SOG* *Start: 03/27/12* *End: 12/10/12*



Shane Marshall

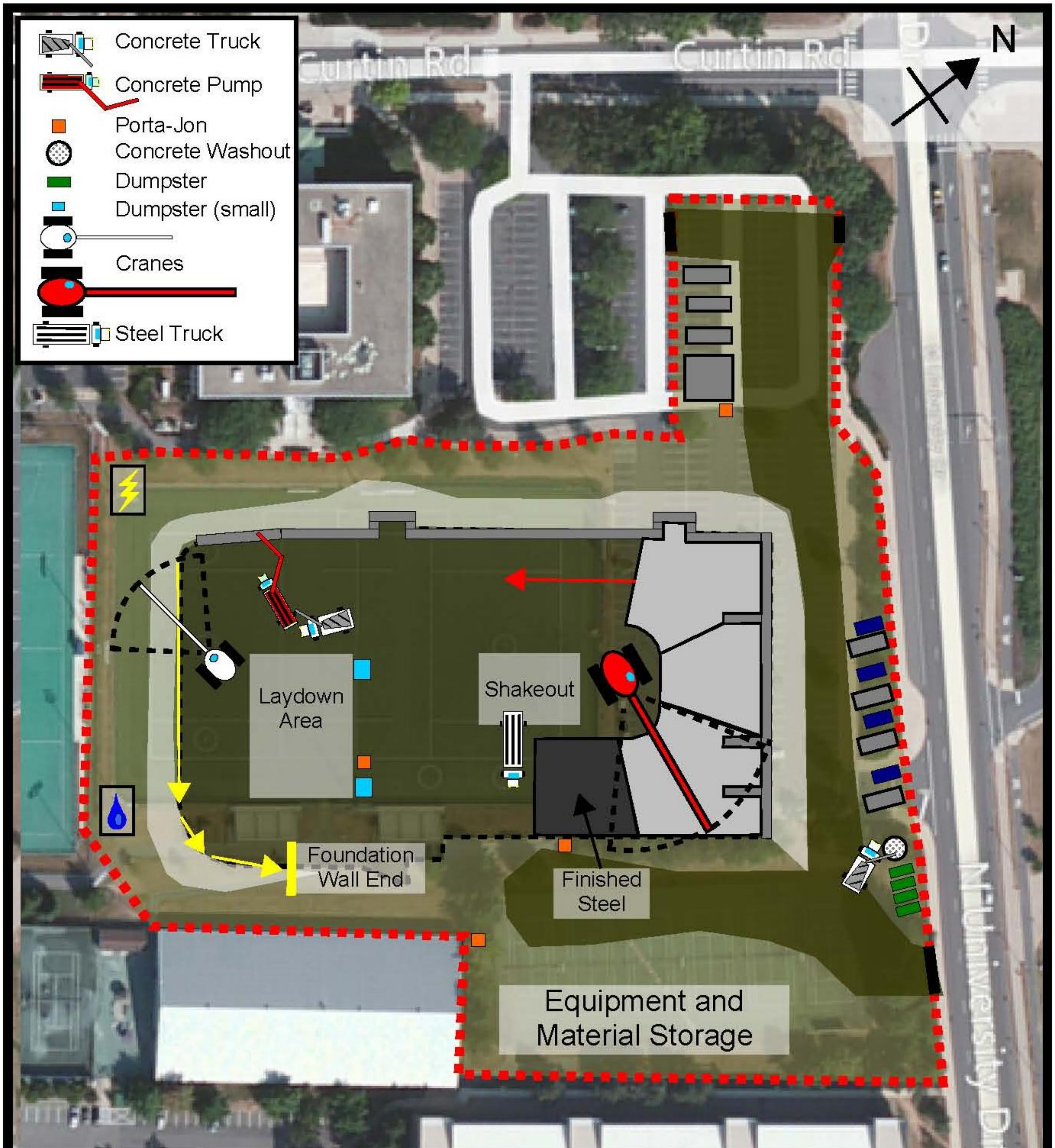
Construction Management

The Pegula Ice Arena
University Park, PA

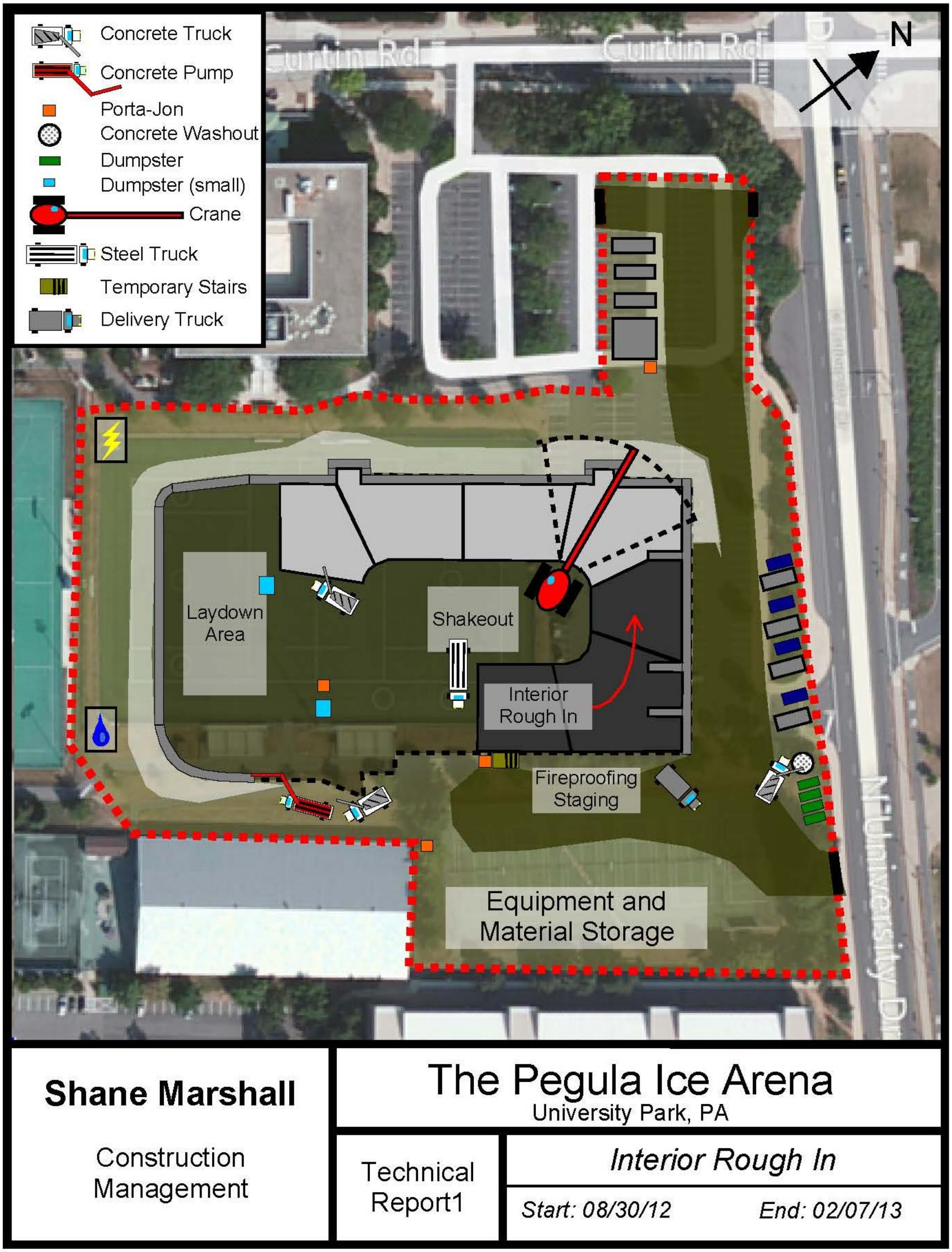
Technical Report1

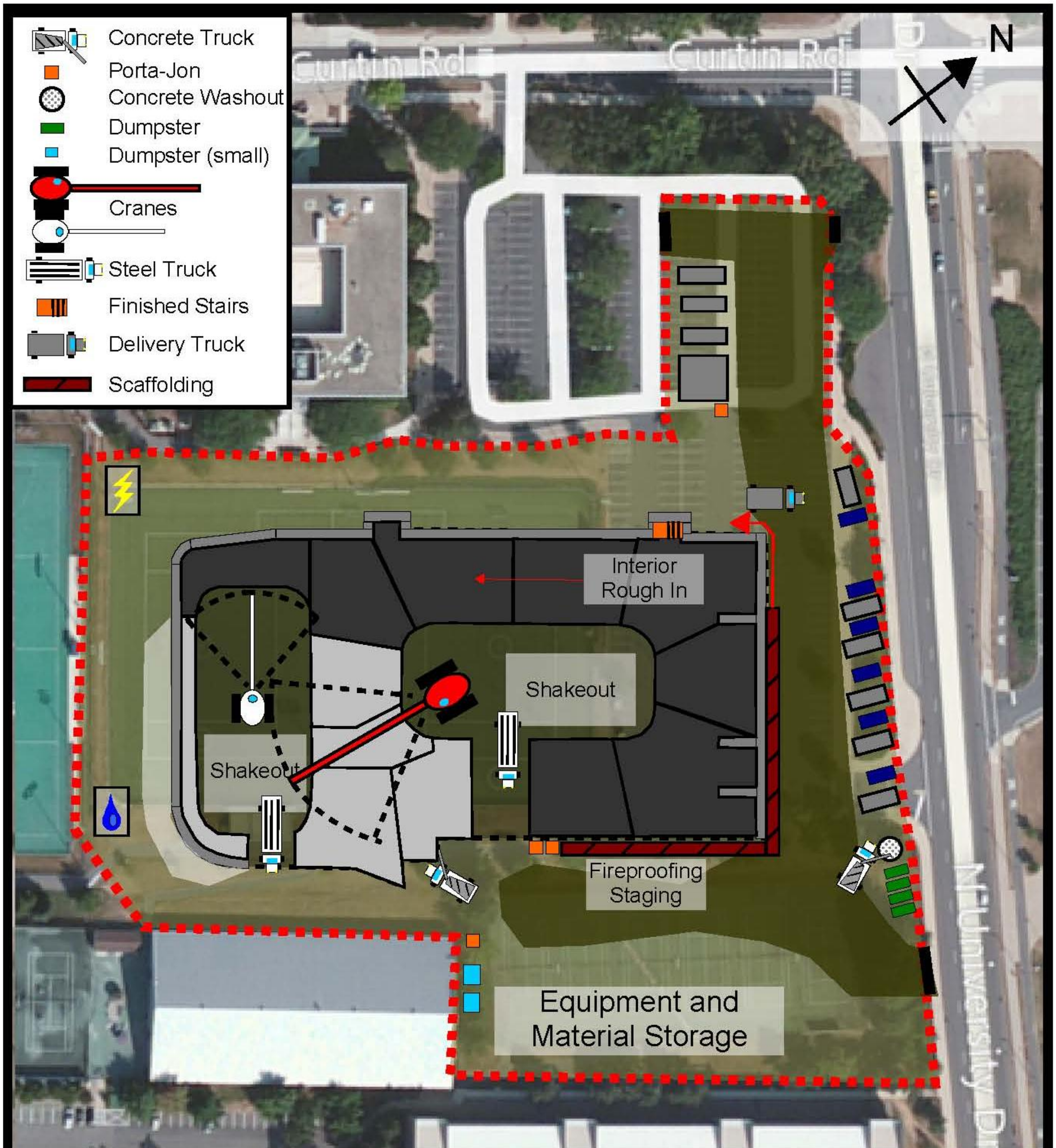
Utility Tie In

Start: 6/4/12 *End: 8/24/12*



Shane Marshall Construction Management	The Pegula Ice Arena University Park, PA	
	Technical Report1	*Steel* *Start: 6/12/12* *End: 12/07/12*


Concrete Truck
Concrete Pump
Porta-Jon
Concrete Washout
Dumpster
Dumpster (small)
Crane
Steel Truck
Temporary Stairs
Delivery Truck
N
Curtin Rd
Curtin Rd
Laydown Area
Shakeout
Interior Rough In
Fireproofing Staging
Equipment and Material Storage
N University Dr
Shane Marshall
Construction Management
The Pegula Ice Arena
University Park, PA
Technical Report1
Interior Rough In
Start: 08/30/12
End: 02/07/13



Shane Marshall

Construction Management

The Pegula Ice Arena

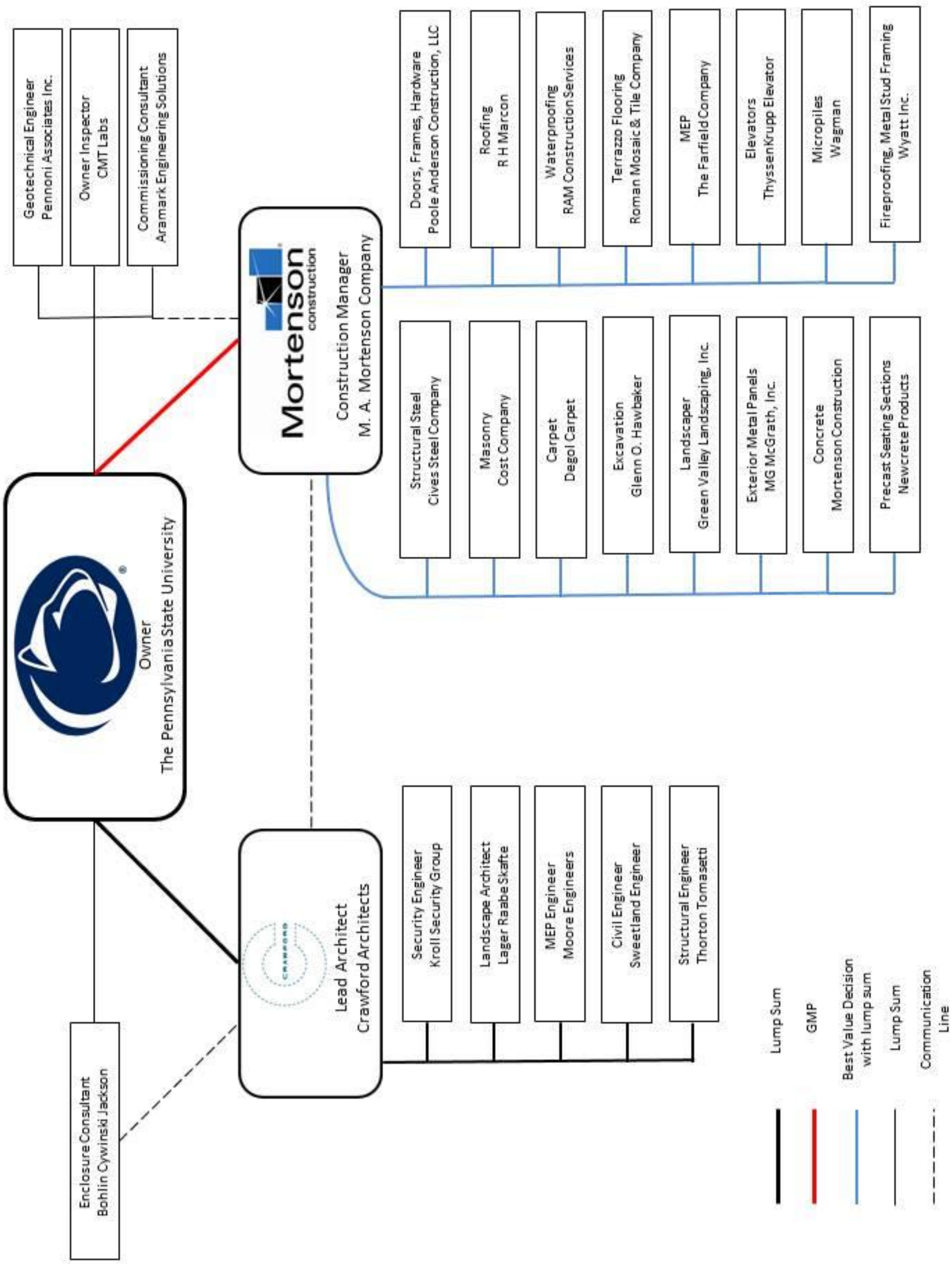
University Park, PA

Technical Report1

Exterior Enclosure

Start: 10/15/12 *End: 02/08/13*

Appendix F: Project Organizational Chart


Geotechnical Engineer
Pennoni Associates Inc.
Owner Inspector
CMT Labs
Commissioning Consultant
Aramark Engineering Solutions
Owner
The Pennsylvania State University
Mortenson construction
Construction Manager
M. A. Mortenson Company
Doors, Frames, Hardware
Poole Anderson Construction, LLC
Roofing
R H Marcon
Waterproofing
RAM Construction Services
Terrazzo Flooring
Roman Mosaic & Tile Company
MEP
The Farfield Company
Elevators
ThyssenKrupp Elevator
Micropiles
Wagman
Fireproofing, Metal Stud Framing
Wyatt Inc.
Structural Steel
Cives Steel Company
Masonry
Cost Company
Carpet
Degol Carpet
Excavation
Glenn O. Hawbaker
Landscaper
Green Valley Landscaping, Inc.
Exterior Metal Panels
MG McGrath, Inc.
Concrete
Mortenson Construction
Precast Seating Sections
Newcrete Products
Lead Architect
Crawford Architects
Security Engineer
Kroll Security Group
Landscape Architect
Lager Raabe Skafte
MEP Engineer
Moore Engineers
Civil Engineer
Sweetland Engineer
Structural Engineer
Thorton Tomasetti
Enclosure Consultant
Bohlin Cywinski Jackson
Lump Sum
GMP
Best Value Decision with lump sum
Lump Sum
Communication Line

Appendix G: Staff Organizational Chart

PSU Pegula Ice Arena Staff Organizational Chart