JSNN

The Joint School of Nanoscience and Nanoengineering

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Construction Management

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2907 E. Lee Street
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Proposal Report

JSNN

Joint School of
Nanoscience and Nanoengineering

UNCG

Executive Summary Prepared by Aubrey L. Fulton

Several innovative ideas have been drafted for the Joint School of Nanoscience and Nanoengineering (JSNN) to present to the general public. While the building has already been constructed and turned over to Gateway, these ideas can be used on the future complexes that JSNN plans on building for Gateway Research. All four analyses look to improve the facility and focus around the owner's goals and expectations. The biggest concerns on JSNN were to focus on the maintenance and operations of the facility post construction and to ensure the quality of the facilities installed such as the level five clean rooms.

The first analysis places an emphasis on the total cost of ownership for the building. While a complete total cost of ownership is not being analyzed, the total cost of ownership for the laboratory equipment will be looked at to show the owner the amount of funding that will be needed over a period of time to determine the effectiveness of the equipment for the owner's benefit. In some cases, the results may show that an alternative manufacturer or piece of equipment will produce better results. The second analysis is the Aquatherm piping system. Aquatherm is a polymer plastic that requires no insulation because the material of the pipe has an internal R value of 1. The piping is faster, easier to install, and has a life expectancy that will outlast any copper, cast iron, or steel piping. The purpose of the Aquatherm analysis is to install a system that will aid in the 3D coordination efforts on the project and to help the owner attract more researchers to the project by having a system that advertises that JSNN and Gateway Research is as innovative as the research it conducts. The third analysis brings back the focus to the construction aspect by suggesting a material storage warehouse to be placed on site for the subcontractor and project team's use. A material storage warehouse will help the team stay on schedule by having a facility on site to store materials for early delivery. The warehouse will also be accessible to the contractor to use to prefabricate parts on site for the mechanical equipment and different activities on the project. The final analysis looks at the wetland and environmental protection on the jobsite. This analysis will tie into the third analysis because the goal is to use sustainable materials on the warehouse that can be used to help protect the wetlands and recycle the materials. It also looks at a way to use the storm water retained on the temporary pond on the construction site by designing a filter system so that the storm water may be reused.

Analysis II and III house the mechanical and structural breadth respectively. The Aquatherm system will be looked at from the mechanical design efficiency aspects whereas the warehouse will be the structural focus of how the warehouse will support a 10 ton MRI for a period of time.

GATEWAY UNIVERSITY RESEARCH PARK

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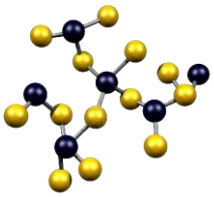


Analysis I – Total Cost of Ownership of Laboratory Equipment

Problem

When a university is looking to build, install, fabricate, invest, or embark on a new idea, there are costs associated that will hinder or advance the idea. In the case of JSNN, A&T and UNCG are looking to expand Gateway Research Park and the facilities it offers to researchers. The Nanosciences and Nanoengineering courses require costly pieces of equipment to run and operate the experiments the students want to conduct. From a construction standpoint, the purchasing of these types of equipment makes planning a difficult task. Most of the time the owner wants to hold off on making the decision until it's absolutely necessary to ensure that they are purchasing the latest and greatest equipment. Gateway University Research is a non-profit organization that is set up to manage the facilities. Gateway, A&T, UNCG are working together to attract new researchers who are interested in giving the funds to conduct certain experiments. Having the best equipment available is a huge priority of JSNN. In the same way, having the best equipment can be costly if the funds do not support the overall cost of the building especially with maintenance of the different laboratory equipment.

Research

Total cost of ownership (TCO) is looking at the direct and indirect costs of an expense to the owner over period of time. The time period is considered the period of ownership for that item. The item can be anything from people, to finishes in a building, technology support, or in the case of JSNN, laboratory equipment. The universities decided to purchase several large pieces of equipment and several high-tech microscopes for the laboratories. The cost of an MRI machine is anywhere between $1 million - $3 million depending on the make and type, and the cost of an NMR is approximately $10,000. With these two pieces of equipment, JSNN is looking to make the most use of the MRI and NMR because these are two of the several feature pieces of equipment that will bring researchers into JSNN. Analyzing the TCO of the pieces of equipment will layout an expected income that JSNN will need to maintain ownership and operate the equipment throughout its period.

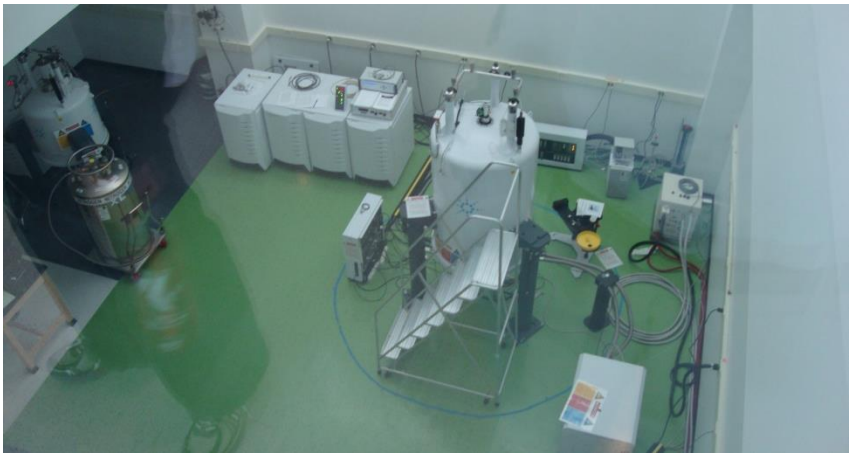


FIGURE 1.1 NMR FOR JSNN, PHOTO PROVIDED BY A.FULTON

Solutions

By running a total cost of ownership calculation on the laboratory equipment, JSNN will have a better knowledge background of the amount of research that needs to be brought in. Laying out the procedures and guidelines for completing a TCO will be a beneficial tool that JSNN and Gateway can use in the future for the eight other complexes that the university wants to build. The goal is to have TCO calculations become a religious practice for JSNN to use on its future facilities. Any university that is looking to expand has to understand the period of investment and outreach for funding.

Protocol

1. Determine the pieces of equipment that need to be considered for the TCO.
2. Derive exact cost for equipment.
    a. Facility manager's input and John Merrill's input
3. Determine a period of ownership for the types of equipment based on specifications of equipment
4. Compile TCO report.
5. Delineate a budget and expected income for each fiscal year.

Predicted Outcome

Value Engineering is a huge key to a project being executed as best as possible. Cost is a variable in value engineering that leads most people to believe that cutting cost is the focus of

value engineering. Total cost of ownership for JSNN will help take that stereotype away from skeptics. The TCO for the lab equipment will prove that cost is a variable because there are instances where cost will decrease the value of a piece of equipment no matter what type of quality the piece of equipment has. JSNN and Gateway need to consider the maintenance and operations costs associated with the type of equipment they have. These costs will dictate if the purchase was a worthwhile investment for the universities and Gateway.

Analysis II – Aquatherm

Problem

During the coordination efforts for JSNN, there were several design issues on the MEP side that arose due to the amount of different types of plumbing that had to be run throughout the building. Ceiling plenums were jammed packed with piping that was in tight with the duct works and sprinkler piping. While 3D coordination was conducted on this project, it was still a cumbersome task to get the MEP equipment installed in the ceilings. Post construction, a design issue slipped through that was not caught in the design development stages of the project. In the plenum space above the clean room, there are p-traps connected to the floor drains in the penthouse that collect condensation from the mechanical equipment see Figure 2.2. Red circles in Figure 2.2 represent the location of the floor drains in the penthouse. In the design and specifications, the p-traps were never given insulation to be put around them. The condensation that would go through these traps would condensate on the outside and the water would drip down onto the ceiling of the clean room. The water drips down over fan filters that have rusted overtime. The owner has had to replace the fan filters multiple times since the building has been turned over.

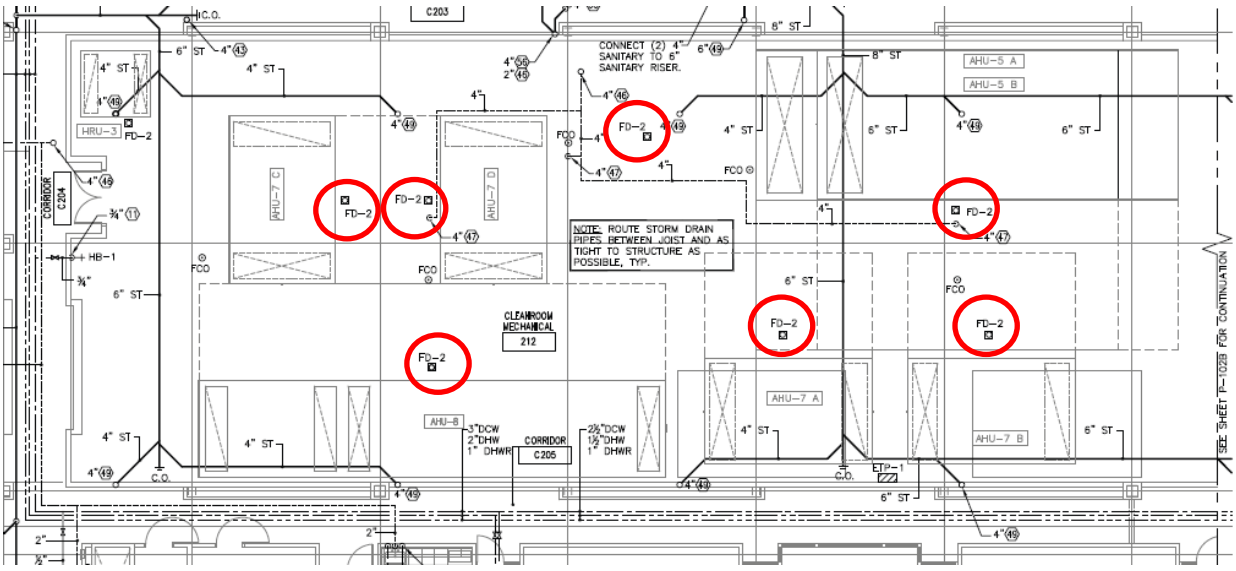


FIGURE 2.2 LOCATION OF FD-2 DRAINS OVER CLEANROOM PLENUM, P-102A

Research

Aquatherm piping is a type of piping that was developed in Germany. It is a thermoplastic piping composed of polypropylene-random (PP-R). This type of piping comes pre-insulated. It

has been tested and proven to hold an R-value of 1. Aquatherm does not require any insulation over the material. It is also lightweight and is pieced together using heat of fusion. Heat of fusion is a method of chemically fusing the piping together. When it bonds, there are no paths for leaks or blow-outs left behind after the fusion takes place. The piping will outlast any other type of piping because of its chemical make-up and method of bonding during. If JSNN were to have been aware of this type of piping prior to construction, then the issues in the coordination effort could have been reduced by the amount of issues that were caused by insulation. Several Aquatherm case studies have been conducted and success stories created in the US. Aquatherm was used on Lawrence Livermore National Laboratory in Livermore, CA where the project saved $2 million dollars by using the blue piping.

FIGURE 2.1 AQUATHERM BLUE PIPING. PHOTO PROVIDED BY AQUATHERM.COM

Solutions

By performing this analysis, it is expected to show a savings in time, and quality in piping throughout the building. The research should also prove a savings in linear footage of piping over copper piping and process piping for the building. Because of using heat of fusion to bind the pipe together, there is an added benefit of a safer means of constructing. The piping is lighter and applies less stress to the workers when they are working overhead.

Protocol

1. Research case studies similar to the construction of JSNN.
2. Interact with an Aquatherm representative for costs associated with the linear footage and different types of piping.
    a. Provide data for the piping in the form of a specification.
3. Calculate the cost per square foot of using Aquatherm over the cost per square foot for the MEP system as installed.
4. Show a savings in the schedule for using Aquatherm over typical soldering and the reduced safety incidents associated with rough in piping.
5. Determine lead times for piping to be manufactured and delivered.

Predicted Outcome

Due to the quality of the piping and its unique features, it is a very likely scenario that this piping will be the innovative answer that JSNN is looking for when trying to attract researchers to their facility. With A&T and UNCG looking to expand the research facilities, the implementation of Aquatherm is going to further be an asset to the universities being able to receive research funding because of its newly integrated building parts. From the construction standpoint, there are reduced safety risks for using Aquatherm and there should be a reduction in the mechanical and plumbing piping for the building.

Analysis III – On site material storage warehouse

Problem

In the submittal process, there are instances where the approval process is slowed because of the time lapse on the project being physically ready for installation of that product or the lead times needed for the product to be manufactured and shipped out to the jobsite. Typically, jobsites are not equipped to house materials that need to be in a warehouse setting until they are shipped to the jobsite. This is because the jobsites are usually pinched for space available for building a miniature warehouse to store the products or equipment that need the conditioned space prior to arriving on site. The construction schedule for JSNN sequences its activities and milestones around the cleanrooms. Some activities are on hold and some are accelerated to balance the schedule for completion. The clean rooms have sensitive construction and protocol that require a continued focus throughout the project when deciding on how to sequence activities and areas of JSNN. When the air handler for the penthouse level had to be set, there were issues where they could not place the air handler due to the massive size they were and could not fit them into the section of the enclosure that the team left unconstructed.

Research

The project team was blessed with the vast amount of space available on the farmland they were building JSNN. Since there are no site constraints outside of the adjacent 3 story office building and the beginning of the wetlands, JSNN has the space available to construct an on-site material storage facility for multiple uses. The first use of the warehouse is to use it to prefabricate aspects of the facility. For example, when clean room construction is underway, there are levels of protocol that require the area when the clean rooms are being built to be free of particles and debris. To reduce the amount of debris accumulated on site, items such as drywall, tile and metal studs can be precut or sawn in the warehouse before taken into the clean room area. The other means for prefabricating in the warehouse is by having the set up ready for the aquatherm piping and any other piping that will happen on site. Since the aquatherm piping is an easy set-up, pieces can be fused together at any time and set aside for the installers to put up when it's ready on site. Another benefit for having the warehouse is the early arrival of materials ready to be put in place once the job site is ready for installation of them. Once laboratory equipment finishes the submittal process for items such as hoods, cabinets, countertops, etc., the team can have them brought to site as soon as they are ready to store them.

Solutions

The conditioned warehouse is a luxury to have for a jobsite, but in the case in JSNN, the warehouse is arguably a necessity due to the constraints for the cleanrooms and the laboratory equipment that arrive onsite. The clean rooms need to have debris free areas when the rooms are being closed in. At that stage of construction, special suits have to be worn while working in them. To make sure that there is a reduced amount of particles and debris, the team can have the contractors utilize the warehouse to cut and size the drywall and tile pieces and take them into the cleanroom space. Another solution the warehouse provides is the ability to store materials and have them read for immediate install. Numerous times on site there will be one item or one material that was not ordered on time or not delivered to site on time to install the minute the team was ready to put it in. By having the material or products ordered as soon as it's ready, there is a reduced amount of time lost in the project by having the product stored on site waiting for the contractor to put it in.

Protocol

1. Design the ware house and locate it on site.
    a. Reference Structural breadth
    b. Derive cost for the warehouse to present to owner.
2. Draft a layout plan for space occupied in warehouse
3. Design a deconstruction plan
4. Research ways to recycle or use parts of warehouse in project to prevent excess construction waste.

Predicted Outcome

After seeing the benefits from having the warehouse on site, the goal is to encourage the owner to put the money towards the cost of the warehouse as an added benefit to ensuring the quality of the cleanrooms will be directly associated with the success of the warehouse. In addition to the cleanroom success, the construction schedule will have fewer delays and upsets. It is expected that because the material will always be available to pull from the warehouse there will be no hindrances to the schedule from material deliveries or laboratory equipment not being available on site. The schedule will have fewer revisions and updates because it will maintain the schedule that was originally drafted by the construction team.

Analysis III – Wetland Preservation

Problem

Before the construction team for JSNN was to begin breaking grounds, the team was confronted with the EPA telling them that there were violations from the previous contractor that needed to be resolved before they could start working. The site work plan would not be approved until the erosion control issues were cleaned up. Clean up was put on Barton Malow and Samet to resolve. Gateway was going to have to pull the cost for cleaning this up out of their design contingency. The cost was approximately $13,000 to run a pipe extension to Lee Street and clean up the issue.

Research

To effectively protect the wetlands that the project team will be responsible for during the excavation stages of construction, there are several different ways the team can use recycled materials on the project to prevent erosion from being an issue. For example, hay bales and silt fencing is the best means of preventing run off from going into the wetland non-encroachment area as seen in Figure 4.1.

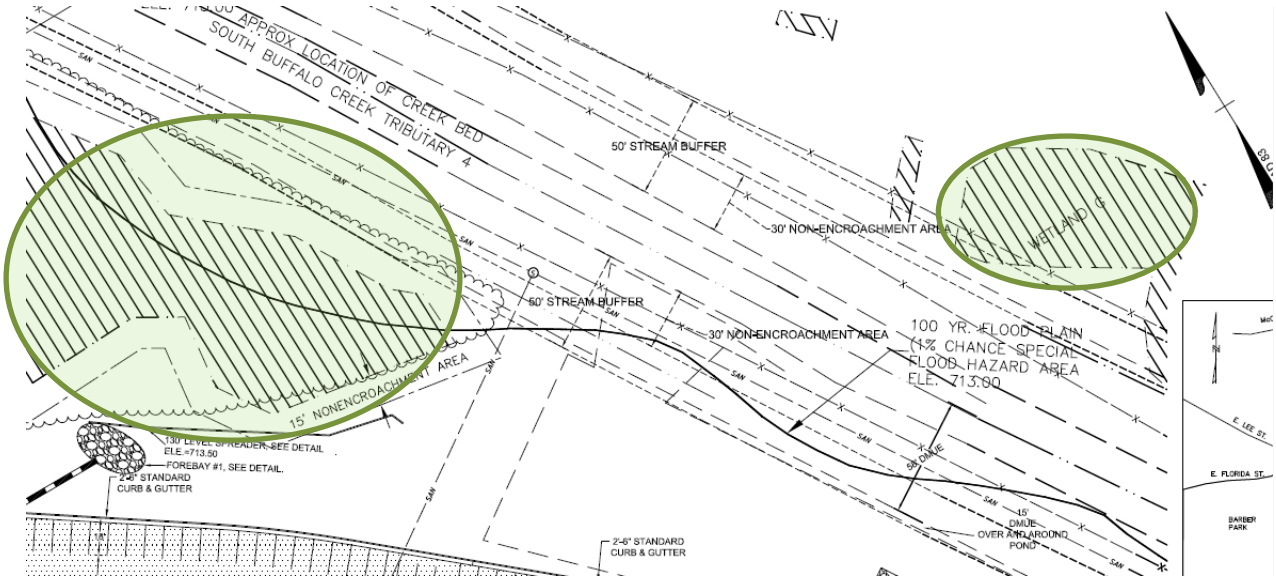


FIGURE 4.1 WETLAND PRESERVATION, C-300

The hay bales can then be reused when it comes time to landscaping and growing the grass on the turf. While the wetlands are a natural filter for fresh drinking water, there needs to be a filtration system so that the wetlands so not receive any toxins to the water. Silty clays and soils have tendency to spread and muddy an area very quickly when saturated from a rain storm.

The suggested means of draining the site is to install a perforated pipe that will collect the silt and clay and filter them into a pond that is controlled to an area of the jobsite. The project team built a temporary pond to collect the storm water that is collected from the 18" diameter pipe that they installed on site to help control the water and soil management that will be a common occurrence for the team as they work on the project through the seasons.

FIGURE 4.2 EROSION CONTROL USING HAY BALES, PHOTO PROVIDED BY GOOGLE

Solutions

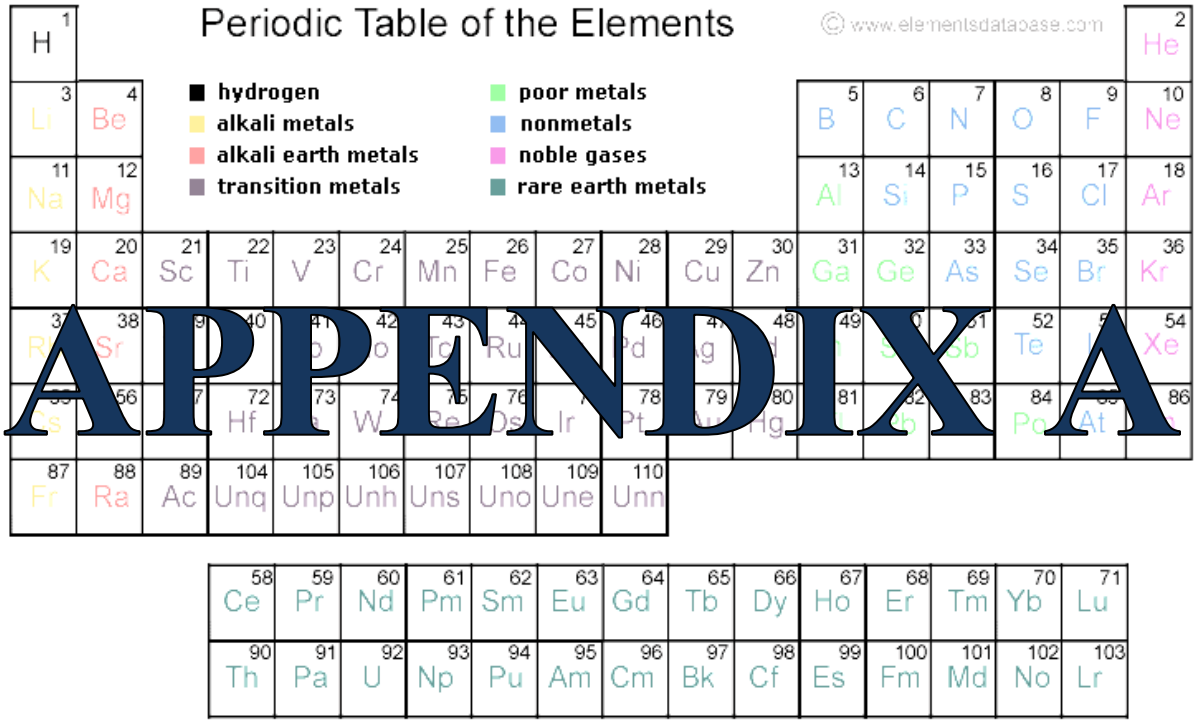
To save the owner and the project team the added cost and time from the issues left behind from the previous contractor, there are several different creative ways to save the time and the money. Some of these savings can come directly from the on-site warehouse and the materials used to build the facility. If the storm water is collected and filter out, then the water can be reused for construction purposes such as wash-out and cleaning throughout the building.

Protocol

1. Research case studies about materials used in erosion control and storm water collection.
2. Develop plan to route perforated piping around jobsite.
3. Show treatment to reuse collected storm water on site for construction purposes.
4. Confirm legitimacy with North Carolina Department of Environment and Natural Resources.

Predicted Outcome

While little detail is usually given for ways to gain back from erosion and environmental control, there are several solutions to add to the sustainability of JSNN and incorporate the third analysis in this process. Several instances of recycling the materials used between the environmental control aspects and material storage warehouse will help to provided continued support to the wetlands surrounding JSNN. Recommendations from the North Carolina Department of Environmental and Natural Resources (NCDENR) will also be considered when looking at the research outcomes. Controlling the storm water pond that is built by the project team can provide a shared source of water for the subcontractors.


Periodic Table of the Elements
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hydrogen
alkali metals
alkali earth metals
transition metals
poor metals
nonmetals
noble gases
rare earth metals
APPENDIX A

Breadth Requirements

Mechanical

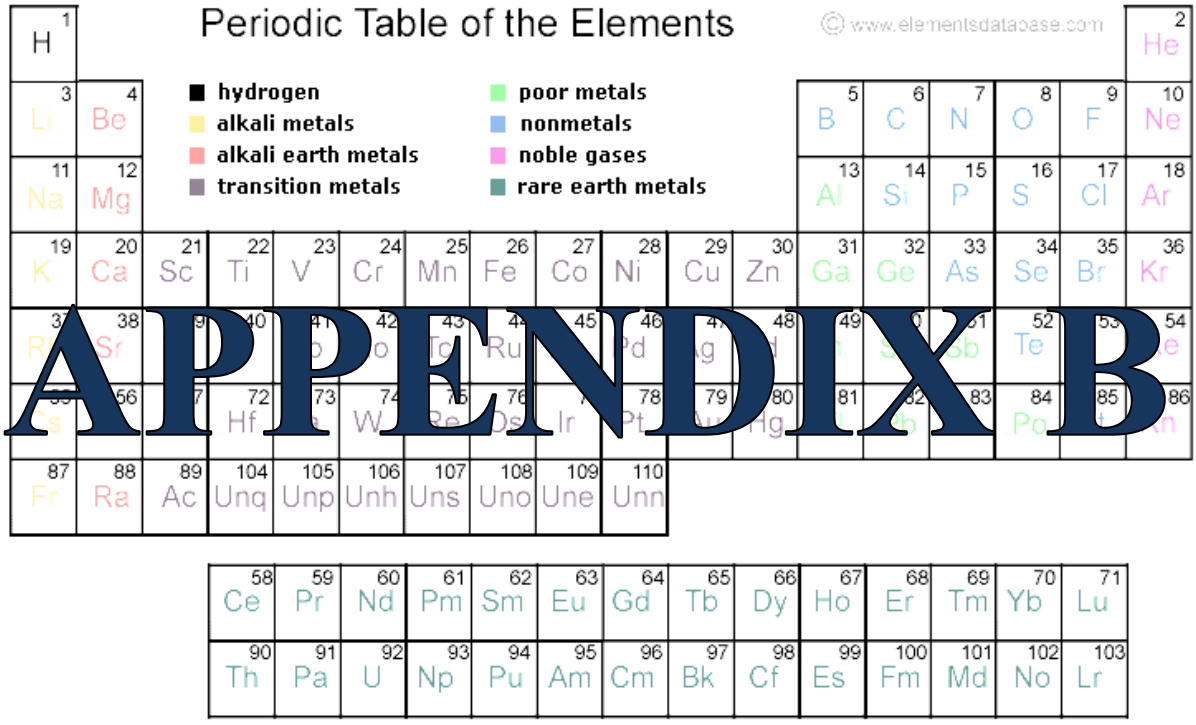
Analysis II, the use of Aquatherm, is the analysis that will directly relate to the mechanical breadth. The breadth will focus on the technical aspects of installing the Aquatherm pipe and look at improved flow rates since the pipes are a polymer material. The longevity of the Aquatherm system is expected to outlast the any copper, cast iron, or steel piping that is installed in the building. The innovative use of the system is an attractive feature to JSNN and its modernized facilities. Within this analysis the cost of the system over the cost of a typically domestic and potable water system will be analyzed.

Structural

Building the on-site warehouse will require research to be done on the construction of the warehouse because of the weight that some of the materials will put on the structure. For example, if the project team wanted to use the warehouse for storing the NMR or MRI for the time being, then the facility has to able to hold the weight of the machinery. The MRI alone will weight approximately 10 tons. The structural breadth will require a design plan to show the construction of it and the type of material that will be used. A goal for the construction of the facility is to use materials on JSNN that can be recycled back into the building instead of becoming construction waste.

Conclusion

The Joint School of Nanoscience and Nanoengineering will reap many benefits from the research and analyses that are proposed. Analyses I and II look to benefit the owner for future research and post construction benefits. The III and IV analyses are intended to aid the construction team and to take advantage of the site and materials they are investing in for the owner. The strengths of the analyses come from the dynamics of JSNN. A nanoscience and nanoengineering complex proves that the construction of such a highly sensitive facility is going to need highly sensitive construction. The protocol for the analyses will be followed upon given consent to proceed with the research.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alkali metals
alkali earth metals
transition metals
poor metals
nonmetals
noble gases
rare earth metals
H
He
Li
Be
B
C
N
O
F
Ne
Na
Mg
Al
Si
P
S
Cl
Ar
K
Ca
Sc
Ti
V
Cr
Mn
Fe
Co
Ni
Cu
Zn
Ga
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Se
Br
Kr
Sr
Ru
Pd
Sb
Te
Hf
W
Re
Os
Ir
Pt
Hg
Po
Fr
Ra
Ac
Unq
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Dy
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Pa
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Np
Pu
Am
Cm
Bk
Cf
Es
Fm
Md
No
Lr

APPENDIX B

aquatherm

Aquatherm Environmental Benefits at a Glance

✓ Excellent
❍ Sometimes
- Not Recommended

	PP-R	Stainless Steel	Copper	Steel	PEX	CPVC
Hygienic purity						
Zero impact on taste	✓	❍	❍	-	❍	❍
Zero impact on smell	✓	❍	❍	-	❍	❍
Opaque, microorganism free	✓	✓	✓	✓	❍	❍
No leaching into water	✓	✓	❍	-	✓	❍
Longevity and performance						
Resistant to abrasion and corrosion	✓	✓	❍	-	✓	✓
Resistant to chemical breakdown	✓	✓	❍	-	✓	-
Resistant to fitting leaks and failures	✓	❍	❍	❍	-	-
Strong structural integrity	✓	✓	✓	✓	-	-
Resistant to scaling and electrolysis	✓	❍	-	-	✓	✓
Tolerant to freezing	✓	-	-	-	✓	-
Engineered for 50 year life cycle	✓	-	-	-	-	-
Low production impact						
Does not require extraction	✓	-	-	-	✓	-
Does not require steel or copper mills	✓	-	-	-	❍	✓
Does not require chlorine	✓	✓	✓	✓	✓	-
Toxin-free material						
No lead	✓	❍	-	❍	❍	-
No copper	✓	✓	-	✓	❍	✓
No iron	✓	-	✓	-	✓	✓
No PVC	✓	✓	✓	✓	✓	-
No dioxins	✓	✓	✓	✓	✓	-
No BPA	✓	✓	✓	✓	❍	❍
No VOCs	✓	❍	❍	❍	✓	-
Minimum foreign materials						
No toxic glues or solders	✓	✓	❍	✓	✓	-
No gaskets	✓	❍	❍	❍	❍	❍
No corrosion inhibitors for pipe	✓	❍	❍	-	✓	✓
Environmental responsibility						
Recyclable	✓	✓	✓	✓	-	-
No hazardous waste	✓	✓	✓	✓	✓	-
Safe combustion by-products	✓	✓	✓	✓	✓	-

aquatherm

Aquatherm's Polypropylene (PP-R) Piping System
with Fusion Connections
✓ Check out the Performance Benefits ✓

Nearly 40 years experience in over 70 countries and backed by a 10 year warranty covering material, labor and incidental damages

PIPE MATERIAL	PP-R	Stainless Steel	Copper	Steel	PEX	CPVC
Impact resistant	✓	✓	✓	✓	-	-
Chemically resistant*	✓	✓	❍	❍	❍	-
Abrasion resistant	✓	✓	-	-	❍	✓
Scale resistant	✓	✓	-	-	❍	❍
No toxic metals or plastics	✓	❍	-	-	❍	-
Corrosion resistant	✓	✓	-	-	❍	❍
Non-toxic	✓	❍	-	-	❍	❍
Non-toxic combustion products	✓	✓	✓	✓	-	-
Resists chemical leaching into water	✓	✓	✓	✓	-	-
50-year system rating	✓	-	-	-	-	-
Controlled thermal expansion	✓	✓	✓	✓	-	-
Recyclable	✓	✓	✓	✓	❍	-
Opaque to block algae and bacteria	✓	✓	✓	✓	❍	❍
Self insulating	✓	-	-	-	❍	❍
Quiet	✓	-	-	-	✓	✓
Does not easily sweat	✓	-	-	-	❍	❍
Stable competitive pricing	✓	-	-	-	✓	✓
Environmentally friendly system	✓	-	-	-	❍	-
Potential LEED Innovation Credits	✓	-	-	-	-	-

CONNECTIONS AND FITTINGS	Fusion	Weld	Gasket**	Solder	Gasket**	Weld	Gasket**	Crimp/ Compression	Glue
Leak-proof connections	✓	❍	-	❍	-	❍	-	-	-
No foreign materials	✓	❍	-	-	-	❍	-	❍	-
Joints stronger than pipe	✓	❍	-	❍	-	❍	-	-	-
Saddle or other low cost branches	✓	✓	-	❍	-	✓	-	-	-
Low Cost Connections	✓	-	-	-	-	-	-	-	❍
Non-toxic connections	✓	✓	❍	❍	❍	-	-	❍	-
No open flames	✓	-	✓	-	✓	-	✓	✓	✓
Connections usable in < 1 hour	✓	✓	✓	✓	✓	✓	✓	✓	-
Full Range 1/2" to 24"	✓	✓	-	❍	-	✓	-	-	-

✓ Excellent
❍ Sometimes
- Not Recommended

** Please provide details of intended application including chemical(s), concentrations, pressures and temperatures, to verify compatibility*
*** Includes pressed and grooved fittings*

aquatherm • 500 S 500 W, Lindon, UT 84042 • 801-805-6657
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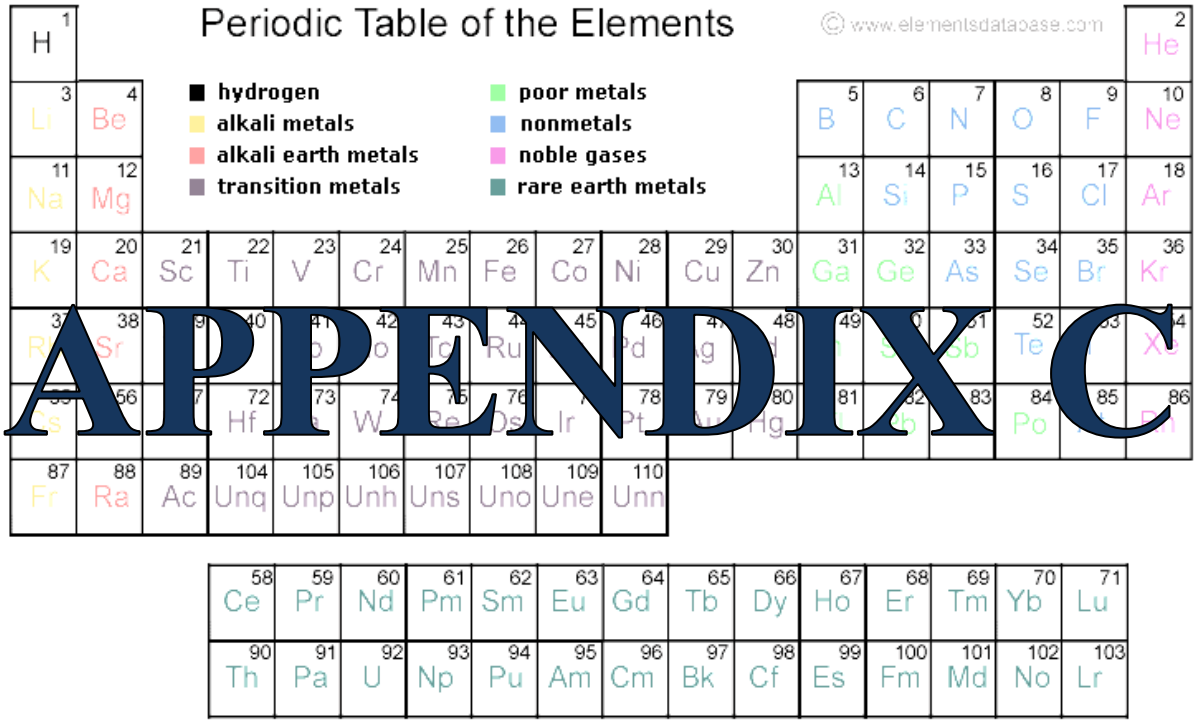
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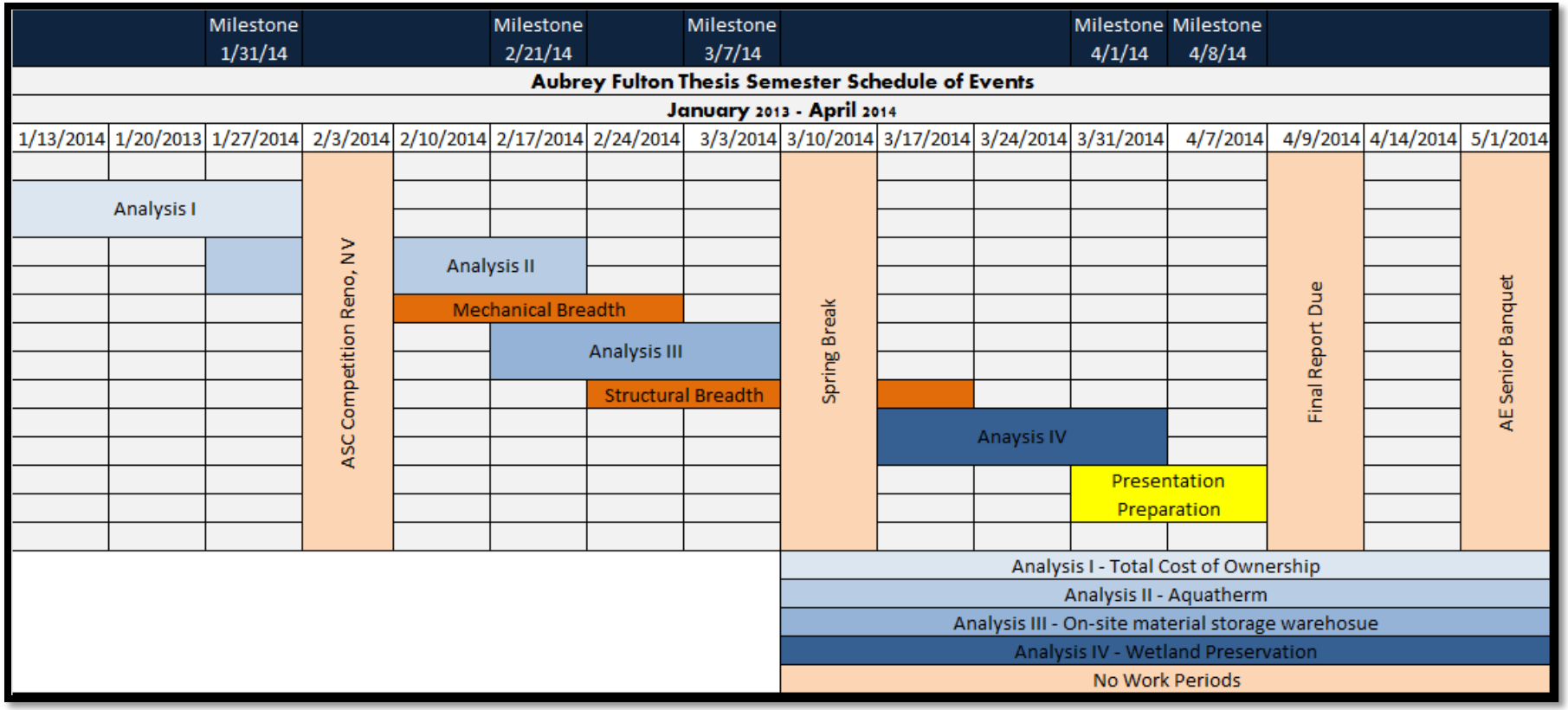
APPENDIX C


Milestone 1/31/14
Milestone 2/21/14
Milestone 3/7/14
Milestone 4/1/14
Milestone 4/8/14
Aubrey Fulton Thesis Semester Schedule of Events
January 2013 - April 2014
1/13/2014
1/20/2013
1/27/2014
2/3/2014
2/10/2014
2/17/2014
2/24/2014
3/3/2014
3/10/2014
3/17/2014
3/24/2014
3/31/2014
4/7/2014
4/9/2014
4/14/2014
5/1/2014
Analysis I
ASC Competition Reno, NV
Analysis II
Mechanical Breadth
Analysis III
Structural Breadth
Spring Break
Anaysis IV
Presentation Preparation
Final Report Due
AE Senior Banquet
Analysis I - Total Cost of Ownership
Analysis II - Aquatherm
Analysis III - On-site material storage warehosue
Analysis IV - Wetland Preservation
No Work Periods