Mechanical Breadth

Analysis 2: MEP & Utility Relocations with Regards to Basement Relocation

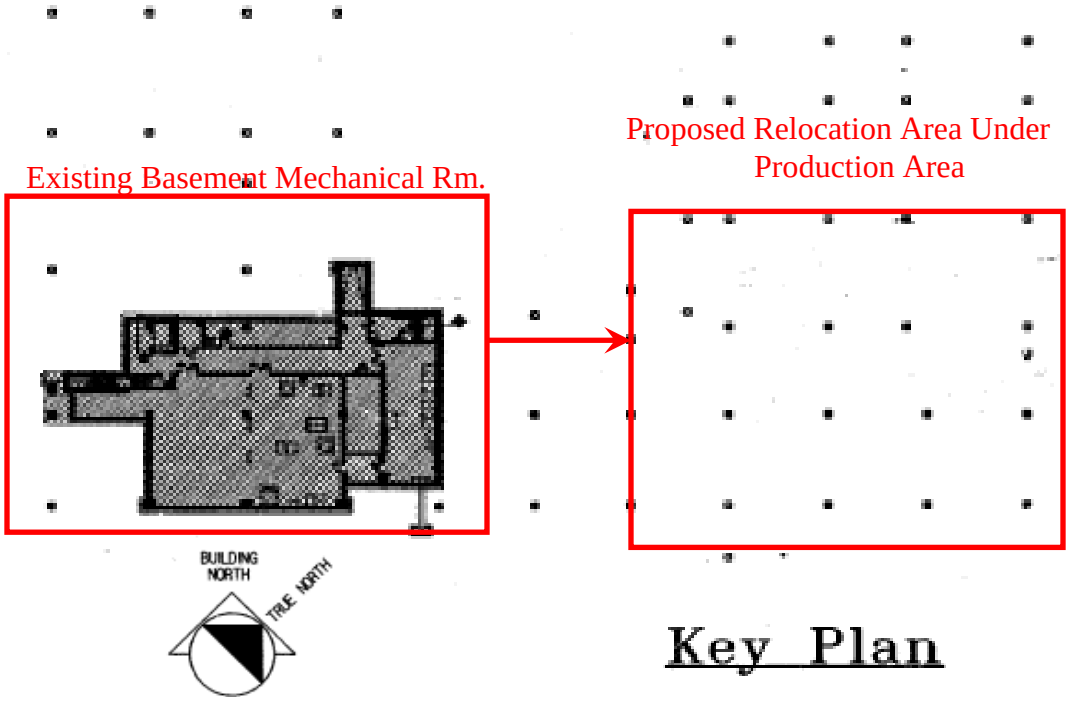
Background & Problem

The Production Area is a highly mechanically driven area of the building. A huge part of the sequencing and schedule delays was due to all of the rough-ins that had to occur in the slab-on-grade before pouring. This held up shoring, which held up structural slab that intern kept continuously pushing the schedule back for the Production Area. Additionally, the same situation occurred in the above structural slab area, although the rough-ins in this area contained an added factor. Due to the vast amount of conduit, pipes, and penetrations a close watch had to constantly be kept on the coverage and structural integrity of the concrete structural slab. All of this work was performed with the idea to keep the least amount of piping exposed in the Production Area itself. Thus, keeping the least amount of exposed piping hanging in the ceiling, the less of a chance there is for bacteria, etc. to grow up there. In spite of the design efforts there still ended up being a significant amount of piping exposed in the Production Area's ceiling. Also, all of the mechanical and electrical piping running in the Production Area ceiling meant that there needed to be time allowed in the schedule for this work to be done before flooring could begin. Intern, equipment installation, connections, and start-up could not begin until flooring is complete. Refer to the picture to the right showing a portion of the ceiling in the Production Area while current installation and construction in the area is not even complete.

The Food Science Building contains a partial basement level; meaning that only the west side of the building has a basement level below the first floor level. This basement area serves solely as the buildings mechanical and electrical rooms. A majority

of the services coming from this mechanical and electrical room serve the Production Area which is located at the opposite end of the building on the east side. Therefore, a lot of mechanical and electrical coordination was necessary to route all of the piping through the building to get it to where it was needed. As well, a good deal of extra piping was necessary to make these runs.

Refer to the figures below of the building layout to show the locations of the basement level mechanical room and the location of the Production Area.



Proposal

The proposal of this mechanical analysis will directly relate to structural analysis 1 performed earlier, relocating the basement mechanical and electrical rooms to the east side of the building under the Production Area. I will investigate all associated MEP relocations and conflicts that may arise with this relocation, positive and negative.

Analysis

Interior Piping

My initial considerations were that the relocation of the basement to the east side places all the starting points for the MEP's closer to the Production Area and closer to the mechanical shaft on the east side of the building. My thinking was that a majority of the runs from the basement ran to the Production Area and to the mechanical shaft nearby which would save a significant portion of piping.

The further I examined the drawings and pipe runs the more confused I became. The building houses a production facility, commercial labs, classrooms, teaching and food processing labs, and a retail area. Moreover, each specific type of facility was not organized into like clusters. Therefore, you had all different types of piping running back and forth across the entire building on each floor feeding all of the specific needs. Consequently, despite my earlier wish the amount of interior piping I was planning to save was not as significant as had hoped.

However, I was able to remove approximately 800 linear feet of piping due to the basement relocation. The basement now being directly next to the east mechanical shaft which feeds through the building to the penthouse, enabled me to remove many horizontal runs from the existing basement on the west side to the particular shaft. These include 6" low pressure steam supply and return lines, 8" chilled water supply and return lines, and 6" hot water perimeter supply and return lines along. In addition four 90^{o} elbows on each run were eliminated.

Using a pipe sizing and computational head loss chart from the ASHRAE Handbook I performed some calculations to determine the decrease in head pressure lost from removing the lines discussed above. Knowing the pipe size and pump size from the HVAC Schedule I was able to utilize the charts and find a head loss per unit length. In addition, a length of 30' was added to my run length for each 90^{o} elbow fitting encountered; from 'HVAC Analysis and Design, Fifth Edition'. The decreases in head pressures lost ranged from 10ft/100ft to 14ft/100ft. These losses were considered negligible and would only help to increase the efficiency of the pumps. Below find the take-off of the deleted pipe and associated costs:

Food Science Building

Interior Piping Take-Off

Description	Savings	Addition	Quantity	Cost		Total Cost
				Piping	Insulation	
Low Pressure Steam / Return						
4" LPS	X		120'	$2,520.00	$2,106.00	$4,626.00
4" LPR	X		120'	$2,520.00	$2,106.00	$4,626.00
4" 90° Elbows	X		4	$1,024.00	$0.00	$1,024.00
Chilled Water Supply / Return						
8" CHWS	X		120'	$5,700.00	$3,900.00	$9,600.00
8" CHWR	X		120'	$5,700.00	$3,900.00	$9,600.00
8" 90° Elbow	X		8	$5,200.00	$0.00	$5,200.00
Hot Water Permieter Supply / Return						
6" HWPS	X		120'	$3,960.00	$3,120.00	$7,080.00
6" HWPR	X		120'	$3,960.00	$3,120.00	$7,080.00
6" 90° Elbows	X		8	$3,440.00	$0.00	$3,440.00
Total Cost Impact					**Savings of:**	**$48,836.00**

Food Science Building

Utility Relocation Take-Off

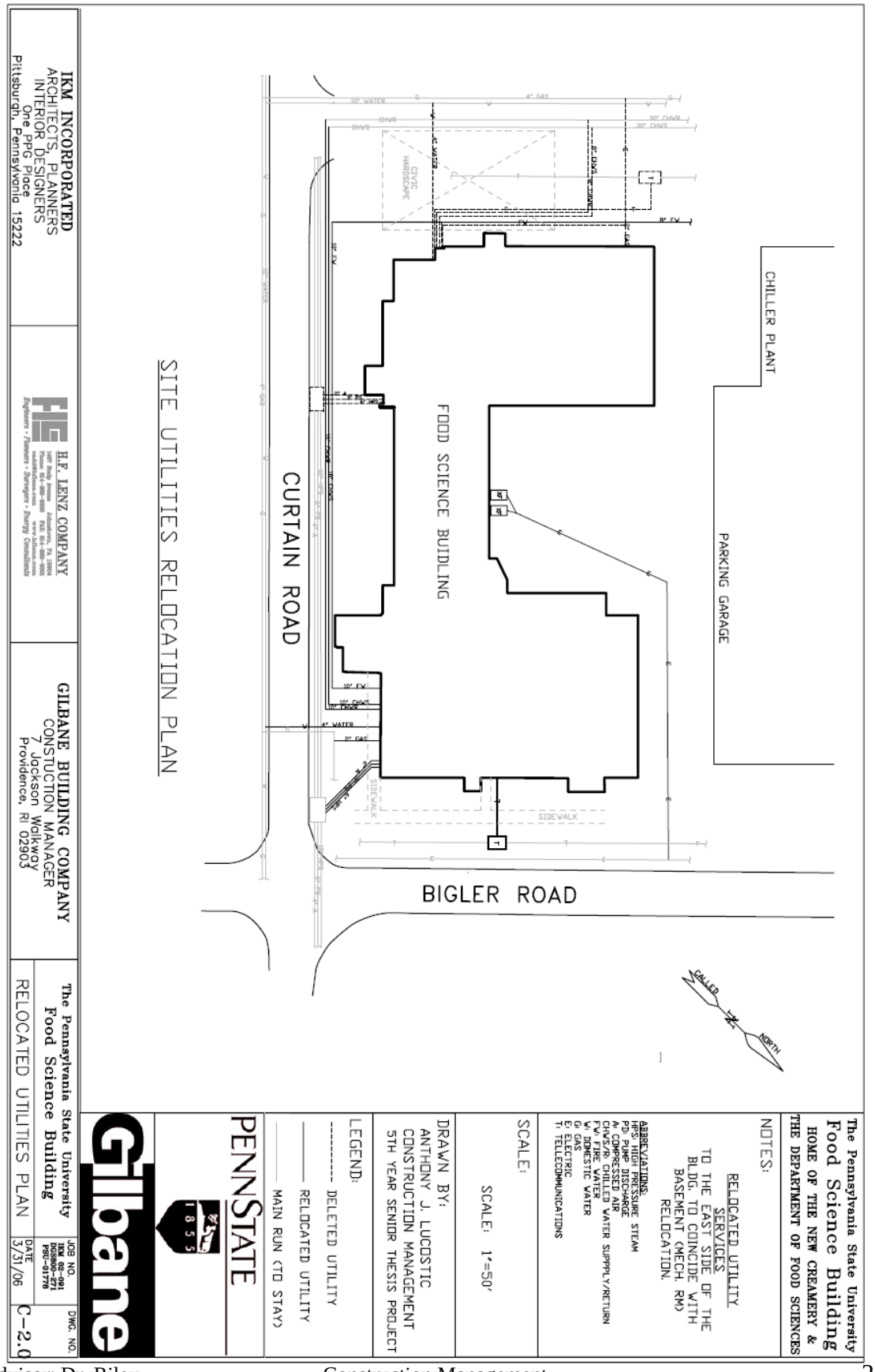
Description	Savings	Addition	Quantity	Cost		Total Cost
				Piping	Excavation	
Steam						
6" HPS (High Pressure Steam)	No Cost Impact		0	$0.00	$0.00	$0.00
3" PD (Pump Discharge,Condensate)	No Cost Impact		0	$0.00	$0.00	$0.00
2" A (Compressed Air)	No Cost Impact		0	$0.00	$0.00	$0.00
Chilled Water						
10" CHWS (Chilled Water Supply)		X	200'	$426.00	$1,088.10	$1,514.10
10" CHWR (Chilled Water Return)		X	200'	$426.00	$1,088.10	$1,514.10
10" 90° Elbow	X		2	$930.00	$0.00	$930.00
Fire Protection						
10" FW (Fire Water)		X	350'	$710.00	$2,176.20	$2,886.20
10" 90° Elbow		X	1	$465.00	$0.00	$465.00
Natural Gas						
2" G (Gas)	X		200'	$2,140.00	$1,088.10	$3,228.10
8" 90° Elbow	X		1	$256.00	$0.00	$257.00
Domestic Water						
4" W (Water)	No Cost Impact		0	$0.00	$0.00	$0.00
Electric						
E (Electric Ductbank)	No Cost Impact		0	$0.00	$0.00	$0.00
Telecommunications						
T (Telecom. Ductbank)						
4- 5" PVC Conduit	X		80'	$1,680.00	$627.75	$2,307.75
5" 90° Elbow	X		4	$314.00	$0.00	$314.00
Reinforcing Rods	X		1 Ton	$1,575.00	$0.00	$1,575.00
Concrete In Place	X		7 CY	$1,211.00	$0.00	$1,211.00
Total Cost						Savings $9,822.85
Total Cost						Addition $6,379.40
Total Cost Impact					**Savings of:**	**$3,443.45**

Utility Relocation

The exterior utilities would also need to be moved to accommodate the associated basement relocation. All utilities were considered when reviewing the tie-ins into the building and locations of the main runs. After review it was found that the following utilities needed to be routed to the basement: Steam, Chilled Water, Fire Water, Natural Gas, Domestic Water, Electric, and Telecommunications. Utilizing the existing site utilities plan I located the main runs for the services and also found some additional branch lines that might be of some use.

The drawing on the following page will show the placement of the existing utilities compared to the proposed relocation. You can see were the proposed utilities tap of the main compared to were they used too. The results found are shown in the table above with there associated costs to the project. The steam line, domestic water, and electric ductbank relocations were a zero cost impact because no length change was necessary. The chilled water was an added cost due to the 200 ft. of added line and the pipe increase from and 8” to 10” to maintain the correct pressure in the line due to the added length. Similarly, the same thing was found for the added 350 ft. of pipe for the fire water; and an increase from an 8” line to a 10” line was necessary. On the over hand, the natural gas line provided could be shortened by 200 ft. and the telecommunication’s ductbank could be shortened by 80 ft. The conclusion was that the utility relocation provided an overall savings to the project.

To determine the need for an increase in pipe size a similar calculation was performed as used in the interior piping above. The change in head loss from the existing run to the new proposed run was calculated. By increasing the pipe size of the new proposed line to a 10” from an 8” it was found that I could maintain the similar pressures that were needed. In addition, due to the fact that the chilled water and fire water are supplied from Penn State’s campus loops there is ample pressure necessary to boost it up if necessary.



SITE UTILITIES RELOCATION PLAN

The Pennsylvania State University
Food Science Building
HOME OF THE NEW CREAMERY &
THE DEPARTMENT OF FOOD SCIENCES

NOTES:

RELOCATED UTILITY SERVICES TO THE EAST SIDE OF THE BLDG. TO COINCIDE WITH BASEMENT (MECH. RM) RELOCATION.

ABBREVIATIONS:
HPS: HIGH PRESSURE STEAM
PD: PUMP DISCHARGE
A: COMPRESSED AIR
CHWS/R: CHILLED WATER SUPPLY/RETURN
FW: FIRE WATER
W: DOMESTIC WATER
G: GAS
E: ELECTRIC
T: TELECOMMUNICATIONS

SCALE:

SCALE: 1"=50'

DRAWN BY:
ANTHONY J. LUCOSTIC
CONSTRUCTION MANAGEMENT
5TH YEAR SENIOR THESIS PROJECT

LEGEND:

---------- DELETED UTILITY
——— RELOCATED UTILITY
——— MAIN RUN (TO STAY)

Gilbane
PENNSTATE 1855

The Pennsylvania State University Food Science Building	JOB NO. IKM 02-091 DGS800-271 PSU-01778	DWG. NO.
RELOCATED UTILITIES PLAN	DATE 3/31/06	C-2.0

IKM INCORPORATED
ARCHITECTS, PLANNERS
INTERIOR DESIGNERS
One PPG Place
Pittsburgh, Pennsylvania 15222

H.F. LENZ COMPANY

GILBANE BUILDING COMPANY
CONSTRUCTION MANAGER
7 Jackson Walkway
Providence, RI 02903

Conclusion

Relocating the basement mechanical and electrical rooms from the existing west side of the building to the east side under the Production Area will improve constructability, coordination, and maintenance. It will shorten some of your pipe runs while also reducing the conflicts that may occur along the way. Though, the most noteworthy benefit that will arise from relocating the basement will be that all of the rough in that had to go in the slab-on-grade below the Production Area could now be run overhead in the basement and stub-upped through the first floor slab. This will greatly ease constructability and future maintenance along with a huge schedule savings. The huge schedule savings will come because now the progress of the structural slab above is no longer in conflict with anything below! Additionally, the layout for all of the stub-ups for equipment that won't even be on-site for months to come is insignificant because you can now stub-up through the basement ceiling anytime, anywhere creating perfect layout the first time!

Overall, the mechanical relocations inside and out will provide a cost savings to the project of approximately $52,000 dollars with zero schedule impact to the project. In addition, with concern to the lines on the inside of the building anytime you decrease or remove the length of pipe run it is considered good practice. This decreases the chance of a leak occurring throughout these building systems just due to the fact that they are simply no longer there. Thus, creating lower maintenance cost in the future.