PATTON TOWNSHIP, PENNSYLVANIA

GEISINGER GRAY'S WOODS AMBULATORY CARE CAMPUS PHASE I

FINAL SENIOR THESIS REPORT

ERICA CRAIG

CONSTRUCTION MANAGEMENT

SPRING 2008

DR. RILEY

Geisinger Gray's Woods Ambulatory Care Campus Phase I

Patton Township, Centre County, Pennsylvania

STATISTICS

Size	64,350 SF
Levels	Two Above Grade
Building Cost	$17 Million
Construction Dates	April '07 - June '08
Delivery Method	CM Agency

PROJECT TEAM

Owner	Geisinger Health System
Construction Manager	Alexander Building Construction, LLC
Architect/Engineer	EwingCole
Civil Engineer	Sweetland Eng. & Assoc., Inc.

STRUCTURAL

CIP Concrete Pier Footers, Grade Beams and Slab-on-Grade

Aluminum Curtain Wall System supported by Metal Studs

Brick Masonry and EIFS supported by CMU or CIP Concrete Walls

3 1/4" Concrete Slab-on Deck on 2" Composite Metal Decking

EPDM Roofing on Concrete Slab and Composite Metal Decking

Metal Roofing System and Skylights supported by Metal Studs

FUNCTION

OBGYN Practice, Pediatrics, Family Medicine, Cardiology, Urology

ARCHITECTURE

Pursing LEED Certification

Each floor comprised of waiting areas and check-in kiosks as well as exam rooms, nursing stations, pharmacy, laboratories, and procedure rooms

Lobby features prominent stairway with a running water feature

Third floor expansion considered in design

Comfortable and welcoming interior

MECHANICAL

400-Ton Cooling Tower

Water-Cooled 250-ton Electric Chiller

Three 19,000 CFM Modular Rooftop Air-Handling Units

Gas Hot Water Boiler

ELECTRICAL

2500A, 480/277 V Service

250 kW, Diesel-Driven Emergency Generator

T8 Lamps, Compact Fluorescent, Occupancy Sensors

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http://www.engr.psu.edu/ae/thesis/portfolios/2008/elc159/

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April 9th, 2008
Final Report
Dr. Riley

TABLE OF CONTENTS

Acknowledgements 3

Executive Summary 4

Project Overview ..... 5 - 15
- Client Information 5
- Site Plan & Existing Conditions 6
- Project Team 8
- Project Delivery Method 8
- Building System Summaries 9
- Project Cost Summary 10
- Project Schedule Summary 11

Analysis 1 – Green Roof Design ..... 16 - 30
- Problem Statement 16
- Proposed Solution 16
- Methodology 17
- Resources and Tools 17
- Existing Conditions 17
- Architectural Impacts 20
- Mechanical Impacts 24
- Cost Analysis 27
- Conclusions and Recommendations 29

Analysis 2 – Floor Sub Systems 31-40
- Problem Statement 31
- Proposed Solution 31
- Methodology 32
- Resources and Tools 32
- Existing Conditions 32
- Structural Impacts 34
- Cost Analysis 37
- Conclusions and Recommendations 40

Analysis 3 – Approvals & Permits ..... 41 - 46
Problem Statement 41
Proposed Solution 41
Methodology 41
Resources and Tools 42
Geisinger Gray's Woods Conditions 42
Permitting History 42
Permitting in Areas of Central Pennsylvania 43
Other Current Permitting Processes 44
Conclusions and Recommendations 46

Appendix A ..... 47 - 48
Detailed Project Schedule 48

Appendix B ..... 51 - 53
Building Sections 52
Detailed Building Sections 55

Appendix C ..... 61 - 75
Green Roof Materials 62
SHGF and CLTD Charts 69
Mechanical Calculations 71

Appendix D ..... 76 - 77
Structural Tables 77

Appendix E 78- 86
Survey Materials 79
Seattle, Washington Research 85

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R. H. Marcon

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Altoona Pipe and Steel Supply Co.

CMC Joists and Decking

I would also like to thank my wonderful family and friends for their love and support throughout my college career at Penn State University.

EXECUTIVE SUMMARY

This thesis report is intended to provide technical breadth studies on the Geisinger Gray's Woods Project and to provide further research on an issue facing the construction industry today. The breadth studies deal with how a proposed change with effect the building systems. Further analyses of the breadth studies include a cost analysis as well as a recommendation of the success or failure of the proposed change.

The goal of the first analysis is to investigate the effects of relocating the current green roof on the boiler/chiller building to the sloped front roof of the building. Building envelope calculations along with solar radiation calculations will be used to evaluate the effects on the mechanical equipment. Additionally, building sections and renderings will provide the aesthetics of the relocation of the green roof. It was found that by implementing a green roof system on the sloped front roof, the cooling load on the building can be reduced by 7% each year cutting back nearly $1,000 on utility costs. By selecting the Xero Flor Green Roof System, the Owner can additionally save an initial $26,000. Selecting this system would have little effect on the project schedule due to the metal roof having intricate detail connections and requiring a substantial amount of time to begin with. It is recommended that the Xero Flor Green Roof System be implemented on the front slope roof so long as the aesthetics of the building façade are still acceptable.

Second analysis objectives include lowering the total building costs through value engineering the concrete slabs and still maintaining the structural integrity of the medical office building. With the comparison of the concrete slabs, the structural steel design will need to be re-evaluated for the normal weight concrete as well as a cost comparison. With over 60,000 SF of lightweight concrete being used for the slabs, the lower material costs of normal weight concrete could have substantial impacts on the project. In addition, an investigation of a form deck slab construction on steel joists will be completed for value engineering. This option would require even heavier girders than the normal weight concrete option because they will no longer be composite girders, but form deck construction can be less expensive. It has been found that the form deck system for the typical bay areas reduces the project costs by about $16,000 if the current system of composite beams is used for all other areas. Joists, however, would affect over head installation scheduling and coordination but not add any additional time to the structure erection.

Through continuing education of the ICC codes and increasing the amount of plans examiners within each municipality, tension created between code officials and project members could be greatly reduced. Furthermore, initial project delays from approvals and permits could be greatly reduced. After surveying several municipal code officials from central Pennsylvania, the need for continuing education for the designers is apparent as well as the importance of preliminary meetings with code officials early in the design process. Studying other permitting offices, such as the Department of Planning and Development in Seattle, Washington could bring their success to other regions.

Erica L. Craig
Construction Management
April 9th, 2008
Final Report
Dr. Riley

PROJECT OVERVIEW

Located in Patton Township, Centre County, Pennsylvania, the Geisinger Gray's Woods Ambulatory Care Campus Building Phase 1 demonstrates Geisinger Health System's growth and expansion to provide better health care to rural areas. The building will offer multi-specialty outpatient services as well as an OB/GYN practice, pediatrics, and family medicine. For the 64,000 SF, two-story facility, Geisinger has hired Alexander Building Construction, LLC to provide construction management services. Also teamed with EwingCole Architects, and Engineers and Sweetland Engineering Associates, Inc., this $17 million project is aiming for LEED certification. Construction started on April 23rd, 2007 and substantial completion is planned for June 8th, 2008.

Client Information

As the owner of the project, Geisinger is a physician-led health care system that spans over 40 counties in Central Pennsylvania to serve 2.5 million people. Their vision and values are based on four themes: quality, value, partnerships, and advocacy. With their main focus and drive now on growth, the Gray's Woods Ambulatory Care Campus facility is a step towards expanding the best care to rural areas.

Overall, cost, quality and schedule are all equally important to Geisinger for this project. Set and approved by Geisinger's Health Care Board, the cost of the project cannot exceed the budget due to the fact that the Board will not re-negotiate a new cost. Quality for any health care project is high and is held at the optimum level. Scheduling of the project, more specifically completion, is vital to Geisinger to gain revenue off the project. If owner occupancy is delayed, money will be lost.

Gray's Woods Ambulatory Care Campus is the first of four phases planned by Geisinger and EwingCole Architects/Engineers on the 52 Acre site. Phase 2 of the facility, scheduled to begin 5-10 years after Phase 1, includes an addition on the South side of the building and a parking garage. Phase 3 and 4 will entail a traffic light, a 3rd floor expansion, and other additions.

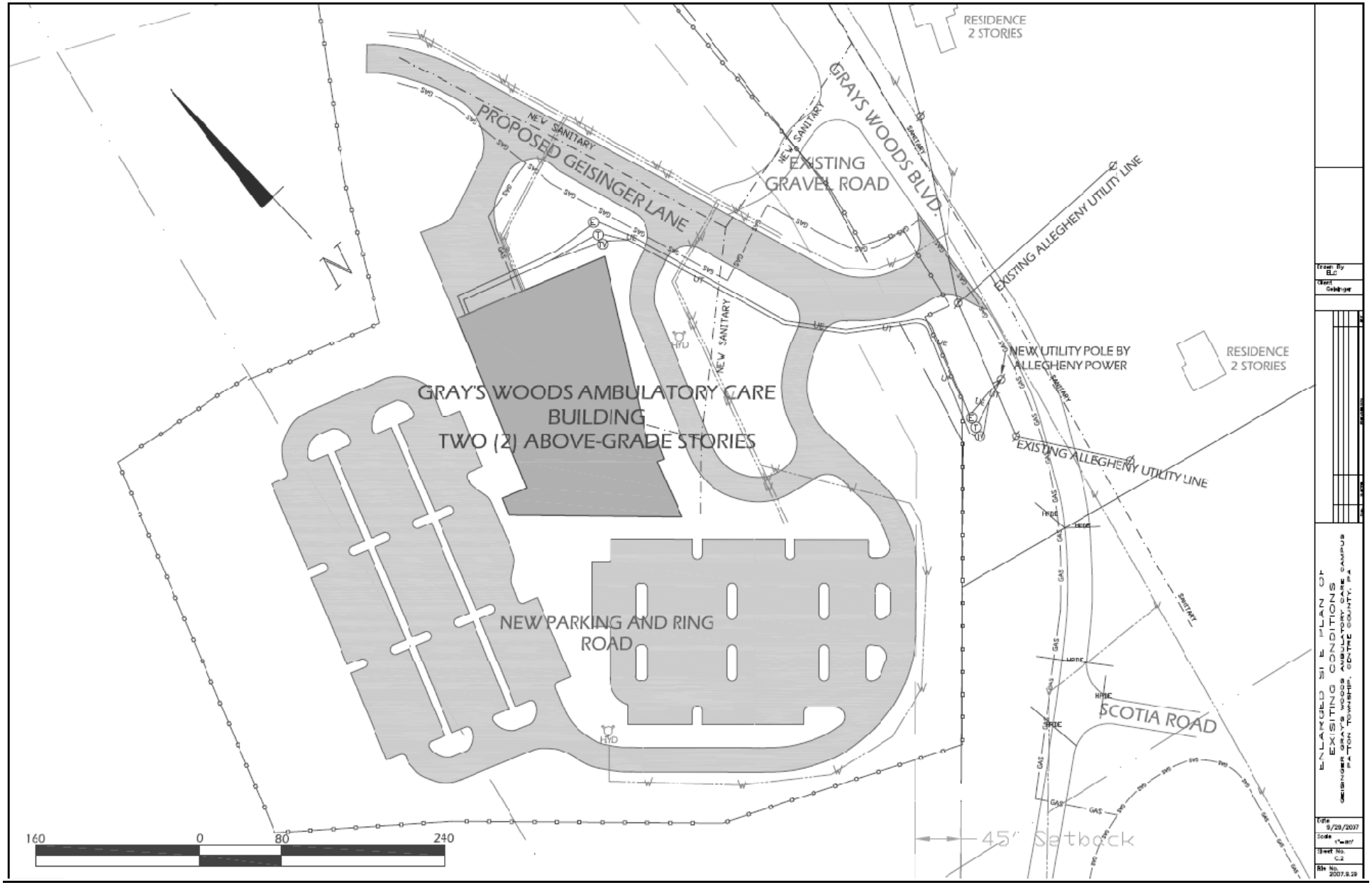
The key to completing the project to the owner's satisfaction is not only completing the project on time, under budget, and with high quality, but also to maintain a flow of communication through all parties involved. As stated as a theme, Geisinger Health System values partnering between Architects, Construction Managers, Engineers, and Subcontractors.

Site Plan and Existing Conditions

Geisinger Gray's Woods Ambulatory Care Campus is located on a 52 acre lot in Patton Township, PA. With US Route 220/322 directly connected to Gray's Woods Boulevard, the project allows for easy access by construction equipment and employees. The site only has one entrance on the east side of the lot. Truck delivers are not hindered by only having one entrance due to having a front entrance drive loop and two large parking lots completed first for easy truck turn-around.

Arial View of Gray's Woods Site off of US Route 220/322

The site plan on the following page shows the layout of the existing conditions for the project. This includes parking, access roads, hydrants, utility locations, neighboring buildings, and traffic patterns. The plan also shows the Gray's Woods building's footprint. The predominant soil on site is sandy loam and the groundwater level is well over 100 feet below land level which allows for easy shallow excavation on the project.


RESIDENCE
2 STORIES
GRAYS WOODS BLVD.
PROPOSED GEISINGER LANE
NEW SANITARY
EXISTING
GRAVEL ROAD
EXISTING ALLEGHENY UTILITY LINE
NEW UTILITY POLE BY
ALLEGHENY POWER
RESIDENCE
2 STORIES
GRAY'S WOODS AMBULATORY CARE
BUILDING
TWO (2) ABOVE-GRADE STORIES
NEW PARKING AND RING
ROAD
EXISTING ALLEGHENY UTILITY LINE
SCOTIA ROAD
45' Setback
N
160
0
80
240
ENLARGED SITE PLAN OF
EXISTING CONDITIONS
GEISINGER GRAY'S WOODS AMBULATORY CARE CAMPUS
PATTON TOWNSHIP, CENTRE COUNTY, PA

Project Team

Owner – Geisinger Health System
Architect – EwingCole
Mechanical Engineer – EwingCole
Structural Engineer – EwingCole
Construction Manager – Alexander Building Construction, LLC / Butz Enterprises, Inc.
Civil Engineer – Sweetland Engineering & Associates, Inc.

Project Delivery Method

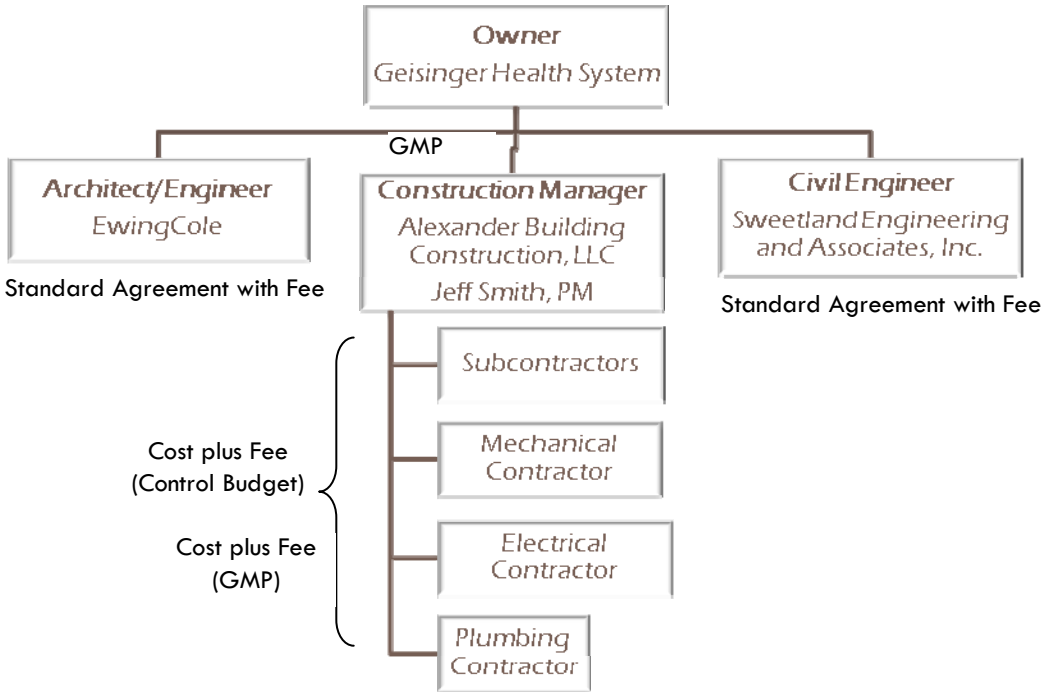
The Gray's Woods project is being delivered with a construction manager. This approach was chosen because Geisinger Health System values relations and communication. In addition, using a construction manager allows for constructability and design to collaborate early in the design process. For this delivery type on this specific project, the Construction Manager will hire subcontractors to perform the work, hold Owner's and Subcontractor's meetings to manage the cost and schedule of the project and to keep communication flowing between all parties involved, and is not liable for any risk with the project. The subsequent page organizational chart demonstrates the key project parties and the types of contracts held between these parties.

Geisinger holds a standard agreement with a fee contract with both the Architect/Engineer and the Civil Engineer. An Architect/Engineer standard agreement ensures a common vision for the project is present and requirements and expectations of the project are understood.

The type of contract held between the construction manager and Geisinger is a GMP (guaranteed maximum price) with no risk to the construction manager. A GMP contract allows for any savings on the building to revert back to the owner. Typically the contractor would pay the difference if the project went over budget, but for this specific project with Geisinger, the Construction Manager does not hold any risk. Having a construction manager allows critical parties to become involved early in the construction process after agreeing to set fees. Using GMP contracts allow the Owner to see a cost for the building that creates some sense of assurance.

The cost plus fee (control budget) contracts (held by the construction manager) with the Mechanical, Electrical and other subcontractors sets a fixed profit amount. If project costs exceed the budget, the Owner will reimburse the contractor's actual costs, regardless of the amount, and if the project costs are lower than the budget, the Owner will gain these savings. Furthermore, the Owner will pay a negotiated fee not based on project costs. Similarly, Alexander holds a cost plus fee (GMP) with the Piping Contractor for the project. For this contract, the Piping Contractor will be

compensated for a fixed amount if the project is under budget and they have set a maximum cost that the project cannot exceed.



Gray's Woods Project Organizational Chart

Building Systems Summary

Architectural Design/Function

The Ambulatory Care Campus features an expansive 'glazed' glass front elevation with a sloped roof to bring the building to scale with the surroundings. With the building being adjacent to a two-lane interstate highway, design professionals developed an eye-catching unique shape and vision. Multiple skylights can be found on the sloped roof and canopy entrance. A new entrance and two parking lots allow easy access for patients and medical staff. The mostly brick and aluminum window façade is supported by a metal stud system. Interior Architecture creates a space that is welcoming and calming for patients and their families. Interior space features a prominent stairway with a running water feature below, comfortable and spacious waiting areas and a coffee bar area.

Geisinger Health System along with EwingCole is pursing LEED certification for the Ambulatory Care Campus. Focus and attention has been made to the glazed glass to maximize energy saving and reduce interior lighting, the use of recycled and locally obtained building materials, and

incorporating especially efficient heating and cooling systems and advanced lighting control system. A third story future expansion was also considered in the design.

Building Envelope

Each elevation has a portion of the aluminum curtain wall system with vertical mullion caps which is supported by metal studs. Other façades include brick masonry on the West, East and North elevation and an EIFS wall system on the South elevation. Brick masonry and the EIFS wall system are supported by either grouted CMU or a cast-in-place concrete retaining wall. The roof is comprised of rigid insulation on a lightweight concrete slab on galvanized composite metal decking with welded wire fabric. The sloped roof portion is covered by a metal roofing system and skylight windows

Electrical

A 1000A, 480/277V underground service in a concrete reinforced ductbank through Allegheny Power will be provided for Geisinger Gray's Woods to a 1000A, 480/277V Service Switchboard to serve all Main Building loads as well as space and spares for future 3rd floor loads. Electrical rooms are provided on each floor to house electrical distribution equipment. A 208/120V distribution will be used for appliance loads while a 480-208/120V transformer will be provided on each floor to serve the appliance panels. The 250 kW emergency generator will be outdoor packaged. This generator will serve a 400A, 480/277V Emergency Main Switchboard located in the Main Emergency Electrical Room. The main emergency electrical room on the first floor will also house a 150kVA modular UPS Emergency Power and equipment. Electrical distribution will use copper conductors, wiring devices will be hospital grade and receptacles will be tamper-proof. Additionally, transformers will be type TP-1 energy saving while emergency wiring will be installed in metallic conduit.

Mechanical

On the North-West corner of the building, a boiler/chiller building will house a boiler, chiller, pumps, and space for future equipment. The design of the boiler/chiller building is to support the first 3 phases of the project. Additionally, there are 3 rooftop units that include an economizer cycle. Distribution for the VAV (variable air volume) system is through ductwork that includes single duct VAV boxes and hydronic reheat coils. Return air is through the plenum ceiling. For LEED certification, the system is designed for demand control ventilation and heavily commissioned. LEED credits for "Optimize Energy Performance" and "Carbon Dioxide Monitoring" have been included. The system also incorporates a stand alone DDC control system with a workstation in the boiler/chiller building.

Structural

A shallow foundation system of pier footers, grade beams and a slab-on-grade was designed to support the 2-story, 64,350 SF Geisinger Gray's Woods building. Pier footings are spaced on an approximately 30' by 30' grid. The footers range from 6' by 6' to 17' by 17' in size and the deepest footing is 3' thick. All of these elements are to be cast-in-place concrete and require a minimum design strength of 3,000 psi (slabs) to 4,000 psi (foundation).

Grade 50 ASTM A992 structural steel creates the skeletal system for the building. Column sizes range from W10x39 to W10x77 while the typical steel beam size is W16x26. Bracing along four grid lines, running East-West and North-South, occurs both on the exterior of the building and through interior column lines. HSS steel tubing provides inverted 'V' bracing with gusset plate welded connections to beams and columns. Exterior facades are supported by 6" structural metal studs.

The second floor is comprised of a 3 ¼" lightweight cast-in-place concrete slab on 2" composite metal decking and is reinforced with welded wire fabric. Similarly, the majority of the roof is comprised of a 3 ¼" lightweight cast-in-place concrete slab on 2" composite metal decking and is reinforced with welded wire fabric. The rest of the roof consists of a metal roofing system and skylights which are supported by structural steel W8x18 and 6" metal studs.

Telecommunication

In accordance with Geisinger's Information Technology department's standards, a main telecommunication room and satellite telecommunication rooms will be strategically designed for each floor to limit the amount of wiring required for each workstation. Also in the building, nurse call stations in accordance with Geisinger requirements and AIA Guidelines for Hospitals and Health Care Facilities will be provided. The low voltage communication systems in the building include a public address (PA) and Program (Music) Distribution System, a CATV system, and a Security system.

Project Cost Summary

The 64,350 SF Gray's Woods medical office building has a budgeted building cost of $15 million dollars, $233/SF. Geisinger Health System has set the total project cost, including land and permits, to a budget of $35 million, $543/SF. Bid packages were made for subcontractors by Alexander Building Construction, LLC, the construction manager. Below is Alexander's most current schedule of values for the project. An approximate value was given to additional building costs to adjust to the total building cost of $15 million dollars.

BUILDING SYSTEM COSTS			
Division		SF Cost	Budgeted Cost
1	General Requirements	-	1,212,760
2	Sitework	42.4	2,727,500
3	Concrete	18.7	1,201,464
4	Masonry	4.7	302,000
5	Metals	20.2	1,297,243
6	Wood & Plastics	10.5	673,640
7	Thermal & Moisture Protection	12.3	793,594
8	Doors & Windows	15.4	992,673
9	Finishes	30.9	1,986,755
10	Specialties		-
11	Equipment		-
12	Furnishings		-
13	Special Construction	1.7	109,454
14	Conveying Systems		-
15	Mechanical	61.7	3,973,512
16	Electrical	37.5	2,414,054
	BUILDING COST	$218/SF	$14,108,649
	Additional Building Costs	15.5	1,000,000
	TOTAL BUILDING COSTS	$233/SF	$15,108,649

Gray's Woods Building Systems Costs

From the above schedule of values, and additional $1 million was added to adjust for general liability insurance, contingency, construction management fee and elevator costs. The entire project costs ($35 million) include land, permits, FF & E and other soft costs on the project.

Project Schedule Summary

After Geisinger and EwingCole progressed through the design phase of the project, on-site construction began on April 23rd, 2007. Substantial completion of the project is set for June 6th, 2008 and the Owner anticipates moving in on July 22nd, 2008. Please refer to Summary Schedule on the subsequent pages for further explanation of the project schedule. The attached summary schedule has been broken down

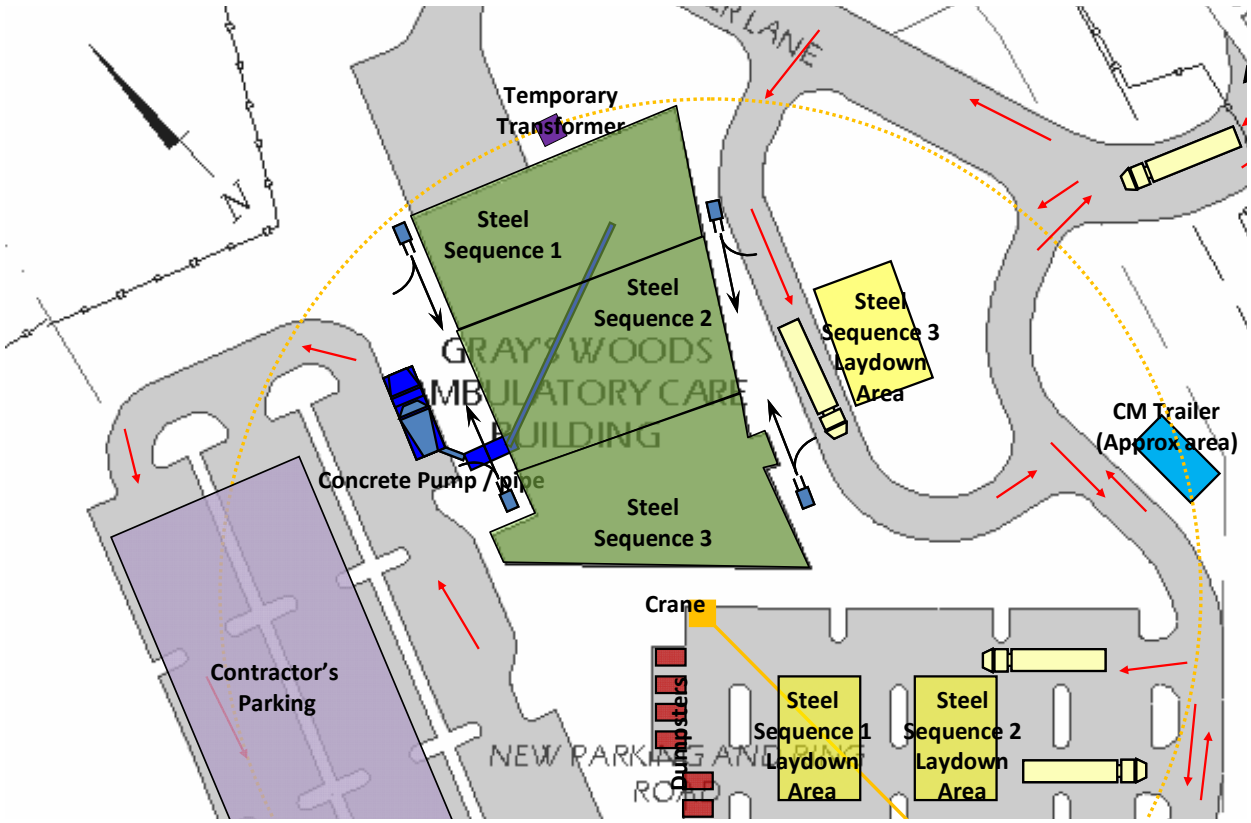
into 5 portions: Design, Sitework, Shell & Enclosure, Interiors, and Completion & Closeout. Below are details of the foundation, structure and finishes sequencing for the project.

Foundation

The foundation system for the Gray's Woods project consists of cast-in-place concrete pier footings and grade beams. There are no below-grade stories. The West side of the building will require a cast-in-place concrete foundation/retaining wall.

Structure

Structural steel erection is planned to be done in three phases. The building will be broken into three sections, from North to South, with erection of the steel starting on the North side of the building. After metal decking for the second floor is in place, the concrete floor can be placed for the first two sections. Following, the last section of the second floor concrete will be place with the first section of the slab-on-grade floor. Similarly, the roof concrete slab will first have two sections poured, and to finish, the last section of the roof and the last two sections of the slab-on-grade will be placed. To recap, concrete for slabs will be placed for two sections at a time.



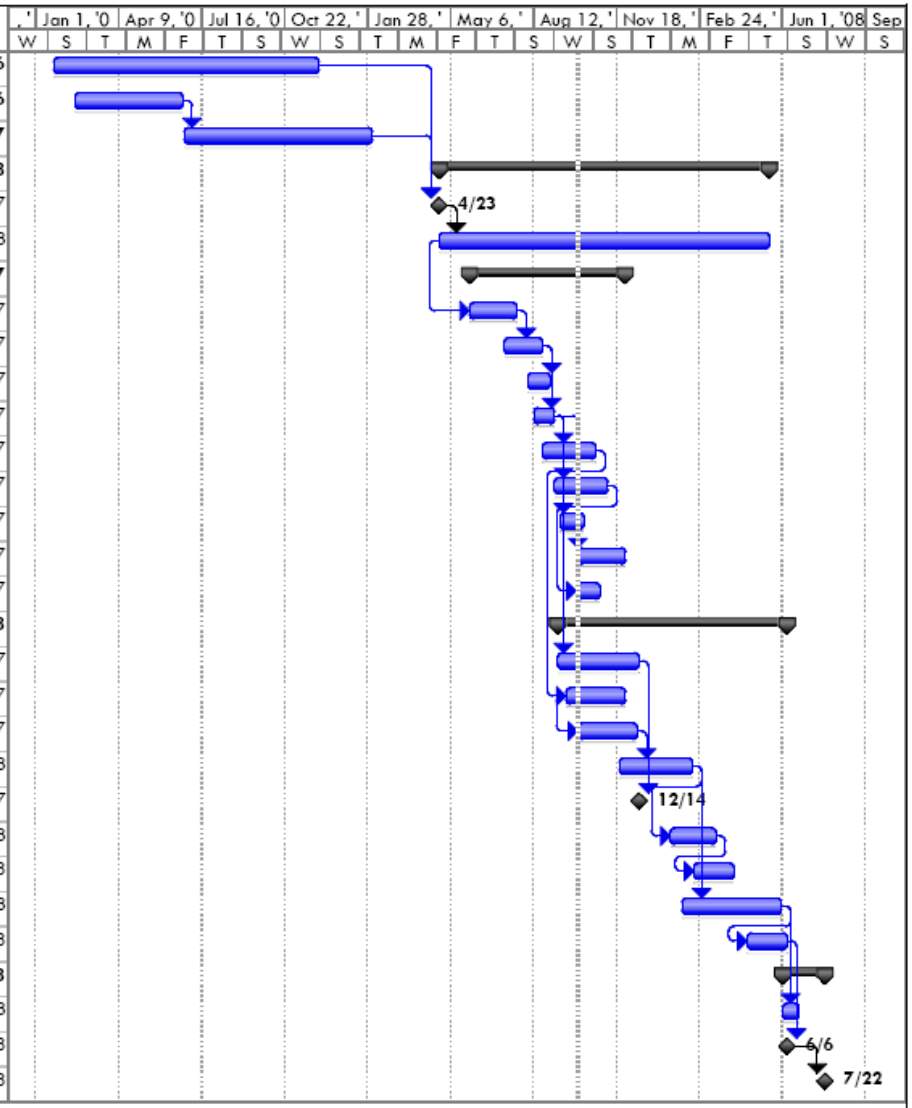
Site Layout Planning – Structural Steel Erection Construction Phase

Finishes

After the building is enclosed, interior finishes may begin. Interior finishes will be completed in the same sequence as steel erection. Subcontractors will progress through the building in the following order:

- Hang Ductwork
- Metal Studs
- MEP Wall Installation
- Drywall/Painting
- Epoxy Terrazzo
- Ceramic Tile
- Ceiling Grid
- Millwork
- Plumbing Fixtures
- Light Fixtures
- Doors

ID	Task Name	Duration	Start	Finish
1	**APPROVALS/PERMITS**	**225 days**	**Mon 1/23/06**	**Fri 12/1/06**
2	**DESIGN DEVELOPMENT**	**91 days**	**Fri 2/17/06**	**Fri 6/23/06**
3	**CONSTRUCTION DOCUMENTS/GMP/PROCUREMENT**	**160 days**	**Mon 6/26/06**	**Fri 2/2/07**
4	**SITEWORK**	**280 days**	**Mon 4/23/07**	**Fri 5/16/08**
5	Mobilize on Site	0 days	Mon 4/23/07	Mon 4/23/07
6	Sitework	280 days	Mon 4/23/07	Fri 5/16/08
7	**SHELL & ENCLOSURE**	**132 days**	**Tue 5/29/07**	**Wed 11/28/07**
8	Foundation Concrete	40 days	Tue 5/29/07	Mon 7/23/07
9	Steel Erection Sequence 1-3	33 days	Mon 7/9/07	Wed 8/22/07
10	Underground Plumbing	20 days	Mon 8/6/07	Fri 8/31/07
11	Concrete SOG, 2nd Floor, Roof	18 days	Mon 8/13/07	Wed 9/5/07
12	Exterior Stud Framing	45 days	Thu 8/23/07	Wed 10/24/07
13	Brick Masonry & EIFS	45 days	Thu 9/6/07	Wed 11/7/07
14	Metal Roof	20 days	Thu 9/13/07	Wed 10/10/07
15	Aluminum Curtain Wall	40 days	Thu 10/4/07	Wed 11/28/07
16	Aluminum Windows	20 days	Tue 10/2/07	Mon 10/29/07
17	**INTERIORS**	**195 days**	**Mon 9/10/07**	**Fri 6/6/08**
18	Boiler Room Mechanical	70 days	Mon 9/10/07	Fri 12/14/07
19	Interior Metal Studs	50 days	Thu 9/20/07	Wed 11/28/07
20	MEP in Wall	50 days	Thu 10/4/07	Wed 12/12/07
21	Drywall	62 days	Thu 11/22/07	Fri 2/15/08
22	Permanent System for Temporary Heat	0 days	Fri 12/14/07	Fri 12/14/07
23	Epoxy Terrazzo & Ceramic Tile	40 days	Mon 1/21/08	Fri 3/14/08
24	Plumbing Fixtures	35 days	Mon 2/18/08	Fri 4/4/08
25	Ceiling Grid, Light Fixtures & GRDs	85 days	Mon 2/4/08	Fri 5/30/08
26	Floor Finishes	35 days	Mon 4/21/08	Fri 6/6/08
27	**COMPLETION & CLOSEOUT**	**36 days**	**Mon 6/2/08**	**Tue 7/22/08**
28	Testing & Air Balancing	15 days	Mon 6/2/08	Fri 6/20/08
29	Substantial Completion	0 days	Fri 6/6/08	Fri 6/6/08
30	Owner Move-In	0 days	Tue 7/22/08	Tue 7/22/08



Project: Geisinger Gray's Woods Ambulatory Care Campus Phase 1
Summary Schedule

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary
Deadline

ANALYSIS 1:
GREEN ROOF DESIGN

Problem Statement:

With the majority of the buildings flat roof designed as a cool roof, the boiler/chiller building's roof was designed to have a green roof. Located on the northwest corner of the building and separated from the rest of the building, design may be questioned as to why the green roof was used. Being located behind the building, only those who park in the back parking lot as well as only a few offices on the second floor will be able to see the green roof. In addition, with the boiler/chiller building not needing to be cooled or heated as much as the main building, the thermal benefits of a green roof have been lost.

View of Geisinger Gray's Woods Ambulatory Care Campus from Gray's Woods Boulevard. Personal Photo.

Proposed Solution:

The goal of this analysis is to investigate the effects of relocating the current green roof on the boiler/chiller building to the sloped front roof of the building. Building envelope calculations along with solar radiation calculations will be used to evaluate the effects on short term and long term effects on the mechanical equipment. Additionally,

building sections and renderings will provide the aesthetics of the redesign and relocation of the green roof. Various green roof systems will be researched to find the optimal system for the steep sloped roof.

Methodology:

The first step will involve researching the varying green roof systems currently used for steep sloped roofs after initially analyzing the current roofing systems. These systems will be evaluated by cost, schedule impacts, and the constructability of the system. A proposed green roof will then be selected.

With the best system selected, Architectural drawings will be produced using AutoCAD. To demonstrate the differences between the current system and the proposed system, building sections, section details, and renderings will be used.

Lastly, the thermal effects of the proposed green roof will be determined using an Microsoft Excel Spreadsheet. The mechanical equipment energy savings converted to dollar savings will show both initial and life cycle costs with the new system.

Resources and Tools:

Architect and HVAC Engineer – EwingCole

Roofing Subcontractor – R.H. Marcon, Inc.

AutoCAD

Microsoft Excel

Professor Robert Holland

Professor James Freihaut

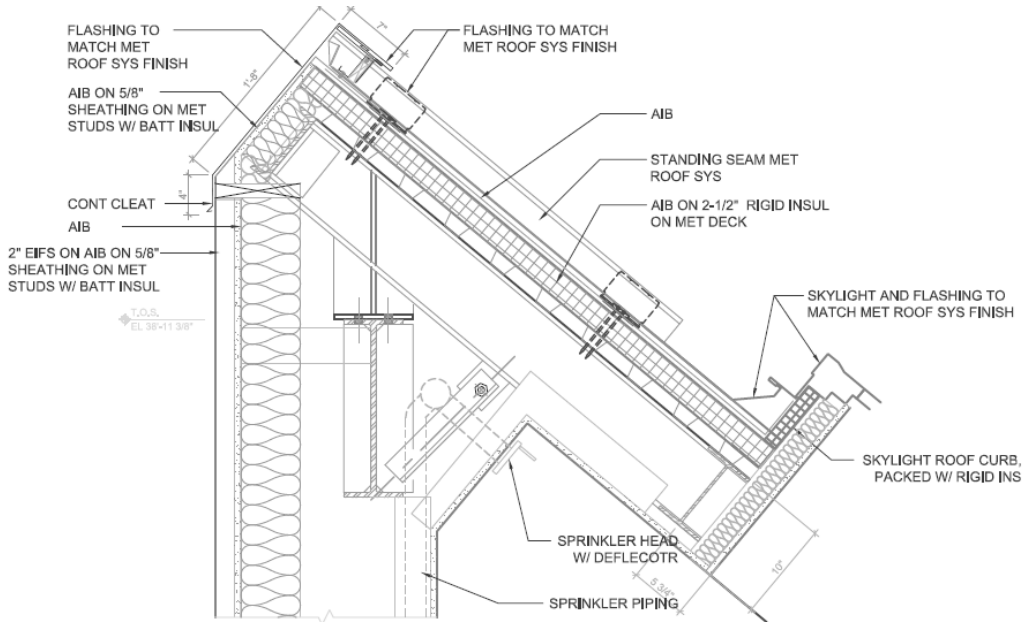
Green Roof Manufacturer – Xero Flora America, LLC

Existing Conditions:

The Gray's Woods Medical Office Building's main entrance and curtain wall system are orientated to the south to allow for the maximum amount of daylighting for the building. The roof over the curtain wall consists of a metal and skylight system that creates a dramatic façade while providing shading during the summer months.

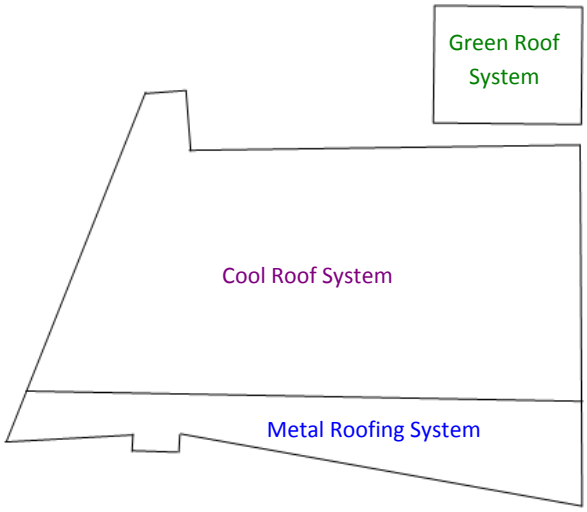
Rendering of Geisinger Gray's Woods Medical Office Building.

With the building striving for LEED Certification apon completion, the roof systems used played a key part in earning additionaly LEED points. First, the sloped metal roof is highly insulated, locally available and is specified to have a long life span.



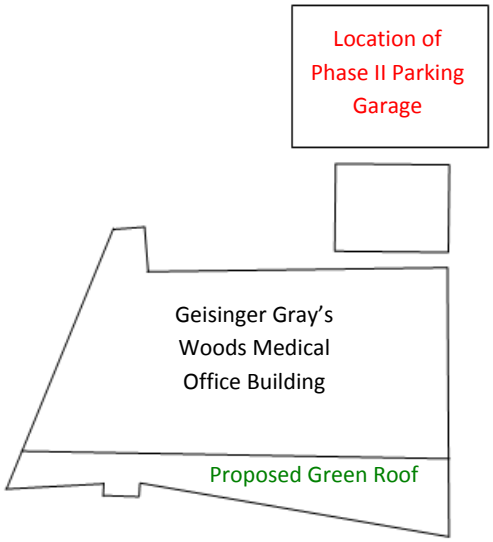
Section Detail at Roof Slope of Metal Roofing System. Additional Building Sections and Section Detail Drawings in Appendix A.

Next, the main area of the roof consists of once again a thick layer of insulation, and has a "cool roof" membrane to reduce the heat island effect. Lastly, the boiler/chiller building which is detached from the rest of the building, is designed to have a green roof system with additional insulation.



Plan of Different Roofing Systems Used.

Green roofs are known to have many benefits for the building and the surronding environment. In Gray's Woods case, the two main reasons they used a green roof on the boiler/chiller room is for stormwater management, and to increase the aesthetic value of the building. After Phase I – the medical office – Phase II of the project consists of a parking garage adjacent to the boiler/chiller building.



Plan with Future Parking Garage.

Owners and Architects felt strongly about veiwing the green roof from the green roof from the parking garage – instead of just a typical black commercial roof – due to it's design success at one of Geisinger's Danville, PA locations.

Architectural Impacts:

When proposing to relocate the green roof from behind the building to the front façade, a stronger impression is created by the building. Being located in a non-urban area, it is important to restore and preserve the portion of the natural habit destroyed by the buildings foot print.

Rendering of Geisinger Gray's Woods with the proposed Green Roof.

Geisinger's approach to creating sustainable and environmentally friendly offices is an asset to the entire community. Although it seems by placing the green roof where only future clients parking in the parking garage can see their contribution, they are not completely supporting the "Green Movement". By relocating the green roof more than just the small percentage of people parking in the "not yet" parking garage will see the green roof. Then, all those passing by on Gray's Woods Boulevard as well as the adjacent US 322 Highway will see and know what Geisinger stands for thus creating more community attention and support.

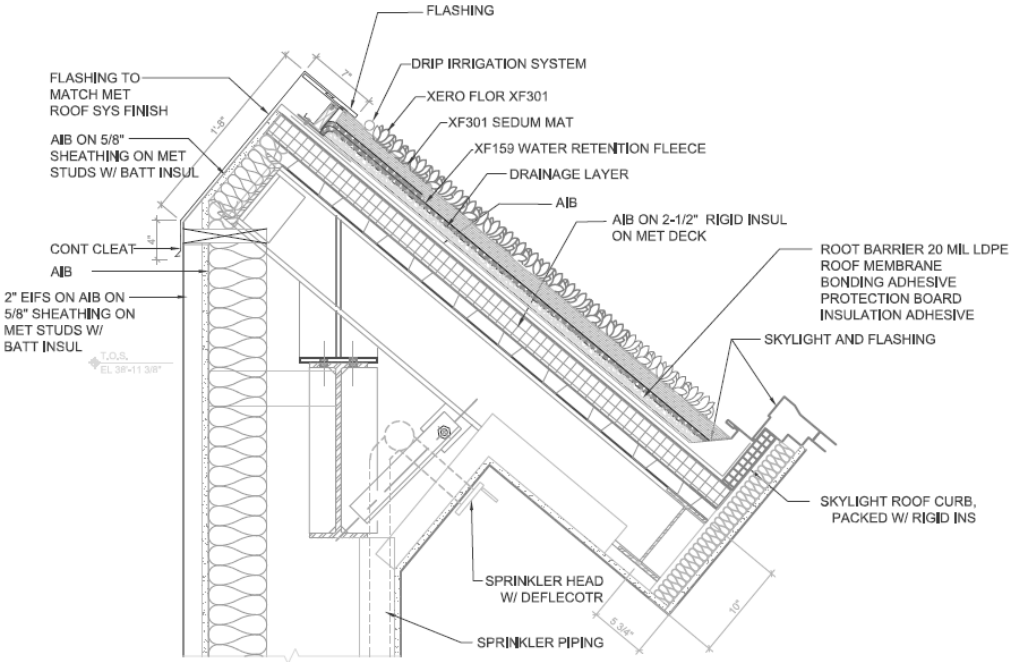
Xero Flor Green Roof System

The XF301 System is a lightweight extensive green roof system containing a special blend of Sedums and other succulents. The Xero Flor green roof mats are tolerant of the extreme conditions of rooftops. The plants used are naturally drought resistant and low profile so they require very little maintenance. The textile-based carrier design is easier assembly and less waste than injected-plastic trays and the pre-vegetated mat design can accommodate steep slopes angles such as the one on Gray's Woods.

System Profile of the Xero Flor Extensive Green Roof Mats.

While keeping the same amount of roofing insulation, the metal roofing system can simply be replaced by the Xero Flor green roof system with very little additional materials. First, a typical waterproofing roofing membrane is necessary. To keep the plants at the peak of the sloped watered and green, a drip irrigation system and additional layer of water retention fleece is required. The water necessary for the irrigation system could be obtained from a small rainwater collection. Additionally, a vertical taking strip spaced about 40" on center is necessary to anchor the mats to the steep slope.

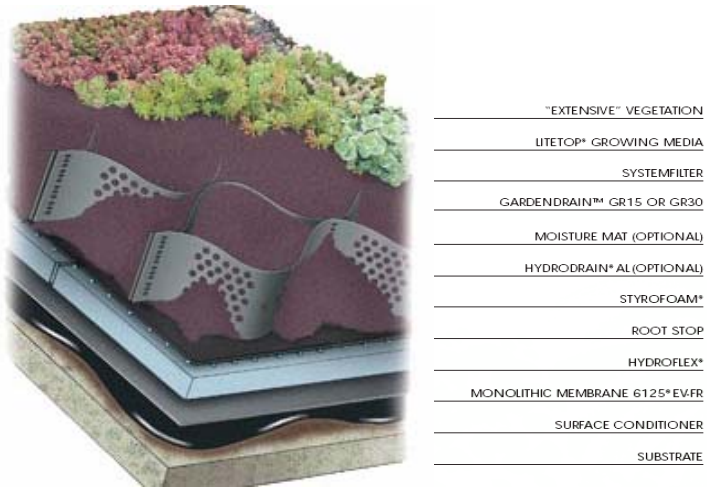
Tacking Strips and Rolled Mats Used on Previous Project.



Section Detail at Roof Slope of Xero Flor Green Roof System. Additional Building Sections and Section Detail Drawings in Appendix A.

American Hydrotech Green Roof System

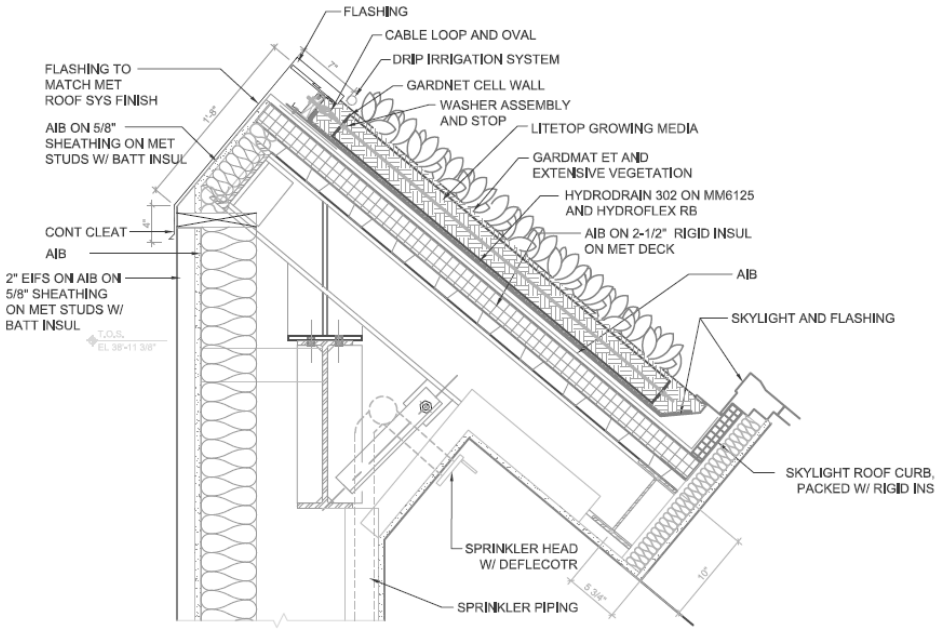
The American Hydrotech's Garden Roof Asembly is a lightweight and low profile extensive green roof system. Suited for locations that will receive little or no maintenance, the soil mixture is comprised of mineral materials mixed with organic matter. Recommended plants include sedum, herbs, and grasses.



System Profile of the American Hydrotech Extensive Green Roof System.

While keeping the same amount of roofing insulation, the metal roofing system can easily be transformed into the Garden Roof System with few additional materials. First, a typical waterproofing roofing membrane is necessary. To keep the plants at the peak of the sloped watered and green, a drip irrigation system similar to the system used for the Xero Flor System is required. To keep the system in place, the sloped application includes a soil stabilization system. The following photo shows the soil stabilization system as used on a previous sloped project.

Gardnet Soil Stabilization System



Section Detail at Roof Slope of American Hydrotech Green Roof System.
Additional Building Sections and Section Detail Drawings in Appendix A.

Mechanical Impacts:

For low rise buildings, roofing systems can have substantial impacts on the mechanical equipment loading. To calculate to environmental loading on the equipment, the building envelopes thermal resistance is typically measured as well as the roofs solar absorption. Both of these features combine to reduce the Urban Heat Island Effect.

For this analysis, only the area of the slope roof has been considered since the rest of the building envelope system will not change.

To begin, with additional mass and resistance, green roof systems can reduce thermal loading on mechanical equipment. Roof materials are given an R-value (hr*ft^2°F/Btu) which is the resistance of one square meter of the material to a one degree temperature change. Appendix C contains the thermal resistance calculations for all three roofing systems. Below is a chart demonstrating the R-values for each roofing system.

Table 1: Total R-Values of Varying Roof Systems

	Metal Roof Current Design	Xero Flor Roof	Hydrotech Roof
R-Value	21.83	23.48	23.34
Difference from Current Design		-1.65	-1.51

From these values, the heat flow rate (Btu/hr) for the roof system can be calculated using the following equation:

$$\text{Heat Flow Rate} = \frac{\text{Area of Roof x Cooling Load Temperature Difference (CLTD)}}{\text{R-value of Roof System}}$$

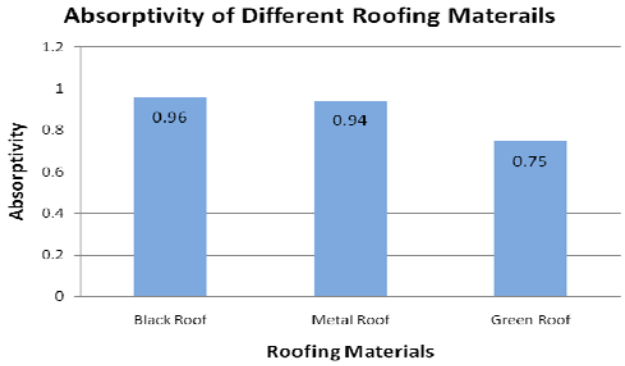
The design temperature change was found by taking the indoor design temperature (70°) and subtracting it from an extreme outdoor temperature (130°). The heat flow rate could then be multiplied by the degree days to find the about of Btu's per year (load on the mechanical equipment). This load is only a portion of the entire thermal load on the mechanical equipment since only the slope roof area was considered. Below is a table of the thermal loads on the equipment for each roofing system from the thermal resistance of the roofing systems can be found.

Table 2: Btu/Year Based on Thermal Resistance of Varying Roof Systems

	Metal Roof Current Design	Xero Flor Roof	Hydrotech Roof
Btu/Year	543,191,351	505,019,898	508,049,152
Difference from Current Design		38,171,454	35,142,200

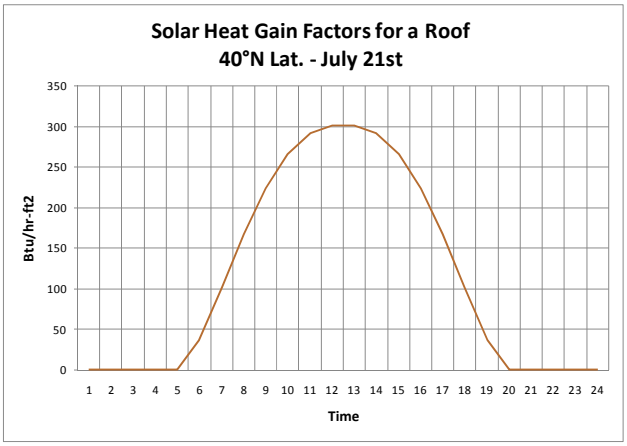
Based on the calculations, with the higher R-value systems, the amount of heat gain per year is reduced. Specifically, both the Hydrotech Green Roof System and the Xero Flor Green Roof System provided about 7% heat gain reduction for the Geisinger Gray's Woods Building.

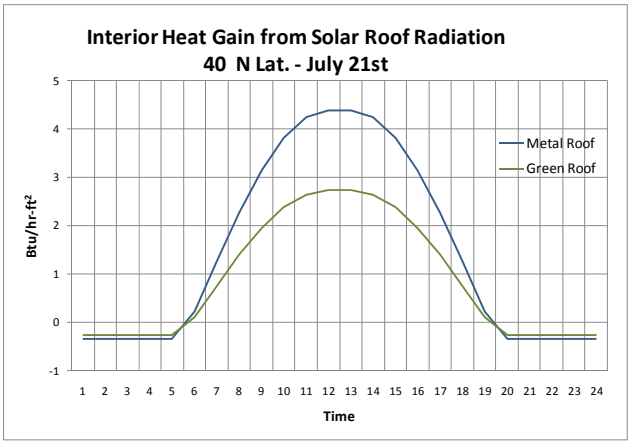
To complete the mechanical analysis, the roof systems solar absorption was considered as well. Depending on the absorptivity of the roof material, a portion of the solar heat gain is absorbed into the roof itself and is eventually radiated into the interior of the building proportionally. Below are the absorptivity values of three typical roofing materials.



Absorptivity Values of Different Roofing Materials.

After obtaining the solar heat gain factors (Btu/hr-ft^2) for 40°N Latitude for July 21st, the actual incident solar radiation on the roof was found my multiplying the solar heat gain factors by 1.15. The solar heat gain factors chart can be found in Appendix C. By multiplying the roofs absorptivity value by the actual incident solar radiation, the amount of heat gain radiated into the interior of the building can be calculated. Below are two charts demonstrating the solar heat gain and interior heat gain for the July 21st date.



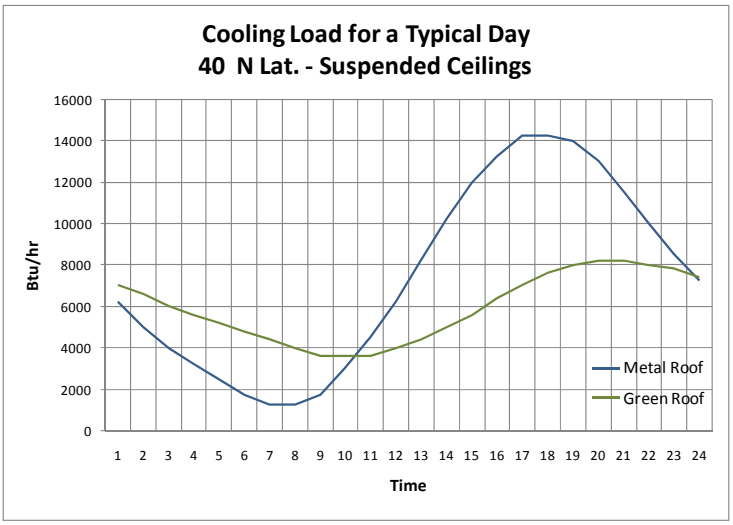


From these charts we can see that a green roof will absorb less heat then a metal roof and thus have less heat to radiate into interior spaces of the building.

To find the cooling loads on the building from the solar radiation heat gain, the following equation can be used:

$$\text{Cooling Load from Heat Gain} = \frac{\text{Area of Roof x Cooling Load Temperature Difference (CLTD)}}{\text{R-value of Roof System}}$$

A chart of the CLTD numbers for different roofing systems with a suspended ceiling at 40°N latitude can be found in Appendix C. Since a green roof has a higher R-value and a great absorptivity, the CLTD numbers for a green roof will be lower and delayed as compared to a metal roof system. The following graph demonstrates this.



When taken into consideration for an entire year, each hourly Btu for a typical day is added and multiplied by the number of sunny days for the region. This results in a final Btu/year for both systems as demonstrated in the table below. Further calculations can be found in Appendix C.

Table 3: Btu/Year Based on Solar Radiation of Varying Roof Systems

	Total Btu/Day	# of Sunny Days Per Year	Total Btu/Year
Metal Roof	177,250	215	38,108,750
Green Roof	142,000	215	30,530,000

Comparing these numbers to the Btu/year for the thermal resistance, the solar radiation load plays a small role. When combining both thermal resistance heat gain and solar

radiation heat gain for cooling loads, the following has been calculated for each system with the difference from the current design showing that the green roof systems reduce the cooling load by 7% per year.

Table 4: Btu/Year Based on Thermal Resistance & Solar Radiation of Varying Roof Systems

	Metal Roof Current Design	Xero Flor Roof	Hydrotech Roof
Btu/Year	581,300,101	535,549,898	538,579,152
Difference from Current Design		45,750,204	42,720,950

Cost Analysis:

Initial costs of the varying building constructions include the components used in each roofing system. All roofing systems include the standard components (roofing membrane, insulations, and adhesives) unless otherwise noted. Other components added include additional materials for the green roof systems.

All cool roof, metal roof, current green roof, and sloped Hydrotech green roof systems costs have been obtained from the roofing subcontractor – R.H. Marcon, Inc. The roofing subcontractor has also supplied the additional building material costs – roofing membrane, insulation, irrigation system, and plants for the green roofs. The Xero Flor green roof systems costs and shipping costs were obtained by Xero Flor America, LLC. All costs include labor and installation.

The current design of the all roofing systems costs a little over $422,000. Below is a Microsoft Excel spreadsheet of the current roofing systems costs.

Table 5: Green Roof, Cool Roof, Metal Roof (Current Design of Building)

Current Roofing Systems					
	Amount		Cost		Total
Green Roof - Boiler Room	3290	SF	25	$/SF	82,250
+ Plants for Green Roof	3290	SF	5	$/SF	16,450
Cool Roof - Flat Main Roof	24200	SF	10	$/SF	242,000
Metal System	5105	SF	16	$/SF	81,680
				PRICE	***$422,380***

When moving the green roof to the sloped area with the Hyrdotech green roof system, the priced is increased to about $466,000. In this case, the boiler/chiller building now has a cool roof system. The top of the next page shows a table of the green roof relocation using the Hydrotech green roof system.

Table 6: Cool Roofs, Hydrotech Green Roof System

Relocation of Green Roof - Hydrotech					
	Amount		Cost		Total
Cool Roof - Boiler Room	3290	SF	10	$/SF	32,900
Cool Roof - Flat Main Roof	24200	SF	10	$/SF	242,000
Green Roof - Sloped	5105	SF	32	$/SF	163,360
+ Irrigation					2,500
+ Plants for Green Roof	5105	SF	5	$/SF	25,525
				PRICE	***$466,285***

When moving the green roof to the sloped area with the Xero Flor green roof system, the priced is reduced to about $396,000. In this case, the boiler/chiller building now has a cool roof system. Below is a table of the green roof relocation while using the Xero Flor green roof system.

Table 7: Cool Roofs, Xero Flor Green Roof System

Relocation of Green Roof - XeroFlor					
	Amount		Cost		Total
Cool Roof - Boiler Room	3290	SF	10	$/SF	32,900
Cool Roof - Flat Main Roof	24200	SF	10	$/SF	242,000
Green Roof - Sloped	5105	SF	13	$/SF	66,365
+ Shipping Costs	5105	SF	0.25	$/SF	1,500
+ Roofing Membrane & Insulation	5105	SF	8	$/SF	40,840
+ Tacking and Accessories	5105	SF	2	$/SF	10,210
+ Irrigation					2,500
				PRICE	***$396,315***

From this analysis, the initial cost differences can be found of all three design variations. Below is an estimated table (Table 4) of the cost of each system for all roofing systems with the difference of cost from the current design. The difference was found by subtracting the current systems cost from the proposed systems cost.

Table 8: Initial Cost Comparison of All Three Roofing Systems

	Current Roofing System	**Relocation with Hydrotech**	**Relocation with XeroFlor**
Initial Cost	$422,400	$466,300	$396,300
Difference		$43,900	-$26,100

By changing the design to use a cool roof on the boiler/chiller building and the flat main roof with the Hyrdrotech green roof system on the front sloped roof the cost of the project is greatly increased – about $43,900 more than the current design. In this situation, the Hydrotech system is more costly than the metal roof system and the difference between the current green roof and the cool roof replacement.

As seen in the table, the owner can initially save around $26,100 dollars by using a cool roof system on the boiler/chiller room building and the main flat roof and by using the Xero Flor green roof system on the front sloped roof. In this situation, the Xero Flor system is less costly than the metal roof system and the difference between the current green roof and the cool roof replacement.

Additional consideration has been given for the yearly costs savings related to the energy savings of each design. First, the thermal resistance and solar heat gain loads on the varying designed roofs were translated into a yearly energy cost on the mechanical equipment. Based on the current average cost of electricity (per kWh), the heat flow rate of all three systems can be converted to the operating costs of the mechanical equipment for a portion of the building envelope cooling loads. Appendix C contains the operating costs calculation for all three systems. Below is a table of the yearly operating costs of the mechanical equipment for all three systems. The table also demonstrates the difference in costs from the current design.

Table 9: Yearly Mechanical Equipment (Partial) Operating Costs (Thermal and Solar)

	Current Roofing	Relocation with Xero Flor	Relocation with Hydrotech
Yearly Operating Costs	$15,680.00	$14,530	$14,480
Difference		-$1,150	-$1,200

By redesigning the slope roof with either green roof system, the operating costs of the mechanical equipment can be reduced each year by about $1,000 dollars.

Conclusions and Recommendations:

From the stand point of the Owner, Geisinger Health System may feel hesitant in making roof on the front façade green and in reality, the decision is theirs to make. The aesthetics and architecture of the building create the image of Geisinger so moving the green roof may be risky in the eyes of the Owner. Financially, the Owner can select the most cost effective solution – the Xero Flor Green Roof System – and save a substantial

initial amount ($26,000 savings), and they would incur slightly lower utility costs per year ($1,000 savings).

In regards to the project schedule, all of the roofing systems analyzed would either require extra training time for green roof installers or require extra time during installation for the intricate metal detail connections. Additional time to install a green roof may be necessary for the irrigation system installation and connections to a collection system.

Structurally, the Xero Flor System has a greater weight (by about 8 psf) and may require a slight redesign of the structural beams and columns below this portion of the roof. However, this structural redesign was not completed for this analysis.

With little technical information available regarding green roofs, it becomes difficult to give the best thermal and solar analysis possible. Conceptually, green roofs should reduce cooling loads dramatically from evaporation, radiation, and conduction, but calculating the evaporative cooling to exact numbers is very challenging.

ANALYSIS 2:
FLOOR SUB-SYSTEMS

Problem Statement:

Top of the line mechanical and electrical systems are vital for LEED certification and the longevity of the building. The interior finishes are important to keep the quality of the Geisinger medical office to their higher standard. In an attempt to lower building costs, the next most costly system – the metal and concrete structural system – should be re-evaluated. The metal and concrete systems account for 16% of the building costs while the mechanical (26%), electrical (16%), and finishes (13%) account for over half of the building costs.

Proposed Solution:

While providing information comparing the benefits and drawbacks of the three slab systems, the objective is to lower the total building costs through value engineering the concrete slabs and still maintaining the structural integrity of the medical office building.

Although both lightweight and normal-weight concrete can fulfill the same structural function, there is a significant cost premium for lightweight concrete. With the comparison of the concrete slabs, the structural steel design will need to be re-evaluated for the normal weight concrete as well as a cost comparison. With over 60,000 SF of lightweight concrete being used for the slabs, a lower material cost could have substantial impacts on the project.

	Unit Weight (lbs/ft^3)	Strength (psi)	Material Costs ($/SF)
Normal Weight Concrete	145 – 150	3,000 – 5,000	1.85
Lightweight Concrete	90 – 115	2,500	2.20

Lightweight and normal weight concrete comparison. Costs from RSMeans 2007.
(2 ½ " thick floor slab including finish, no reinforcing.)

In addition, another floor system will be analyzed. An investigation of a form deck slab construction on steel joists will be completed for value engineering. This option would require even heavier girders than the normal weight concrete option because they will no longer be composite girders, but form deck construction can be less expensive.

Methodology:

To begin this analysis, an evaluation of the current system is required. Consisting of LW concrete on 2" decking, the floor system is supported by structural steel beams, girders, and columns. Also considered is the amount of spray-on-fireproofing required for the building.

From here, two suggestions were made to reduce cost by pin-pointing the more costly components: lightweight concrete and the decking with structural steel beams. Redesigning the structural systems and providing a cost analysis will then be done using Microsoft Excel.

Lastly, to complete a thorough investigation, a constructability review and any changes that the varying systems may have on the project schedule will be discussed.

Resources and Tools:

Dr. Andres Lepage

Microsoft Excel

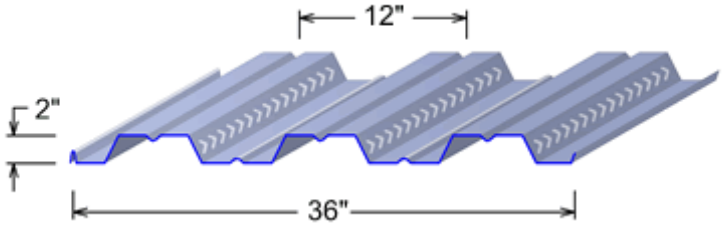
Structural Steel Manufacture/Installer – Altoona Pipe and Steel

Decking Manufacturer – United Steel Deck, Inc.

Structural Engineer - EwingCole

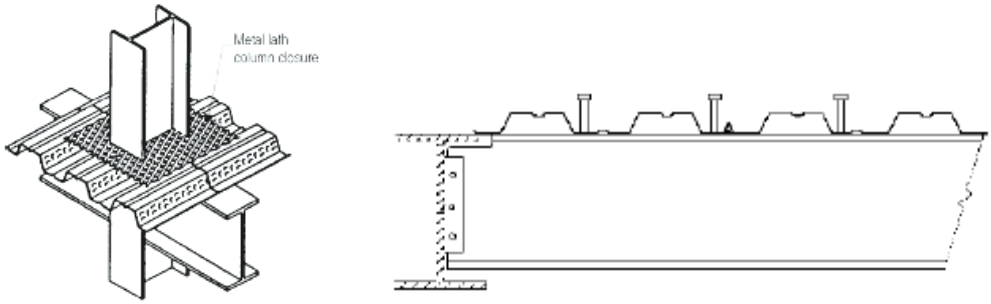
Existing Conditions:

As stated previously, the current structural design consists of LW concrete on 2" decking and structural steel beams, girders, and columns.



2" Composite Decking

Typically throughout the building, 3 ½" of lightweight concrete is placed on 2" LOK composite decking for the floor and roof slabs. Steel beams, girders, and columns (W 16x26, W 24x55, and W 10x68 respectively) build the frame of each 30' x 30' bay. Beams are spaced at 10'. This system is typically called composite beam decking.

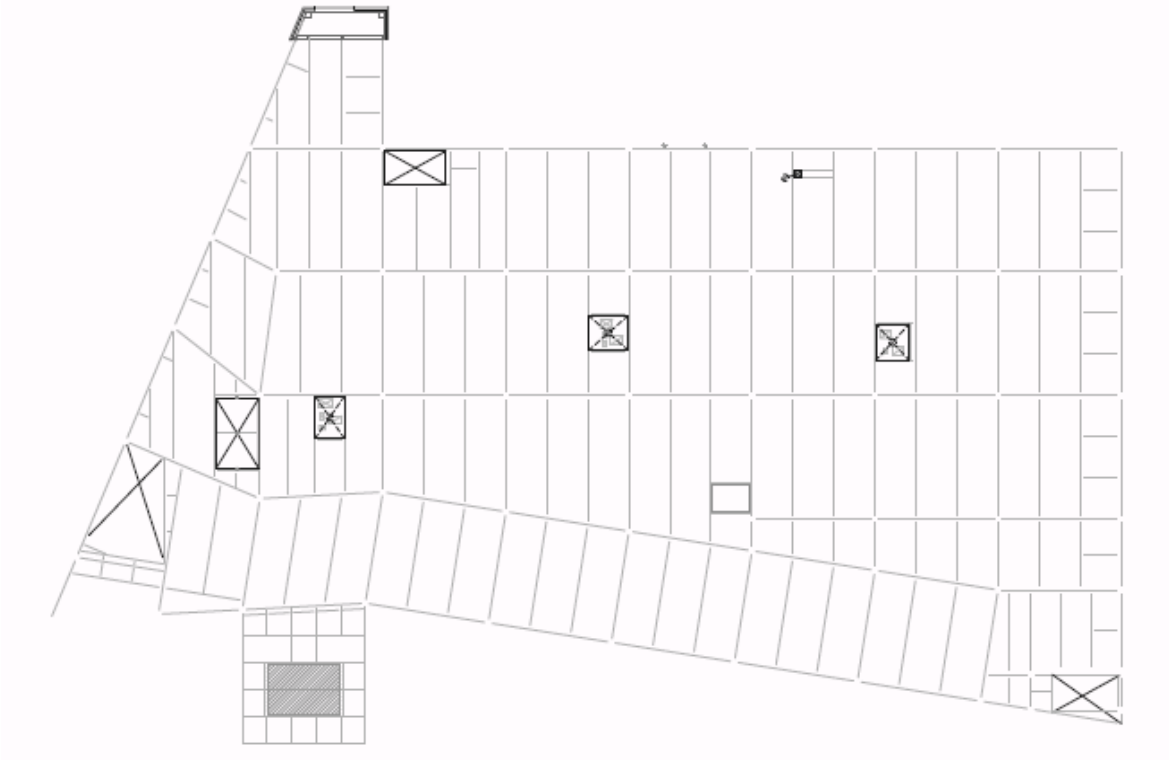


Typical Details of Composite Floor Deck Slabs

Overall, there are twenty-six (26) 30' x 30' bays within the first and second floors while other areas (south and west perimeters of the building) are not consistent with this bay size. The structural steel system designed for the building was initially chosen for two reasons: lightest floor system for the required fireproofing necessary and to have the least amount of vibrations for the medical equipment in building.

View from first floor of structural bays during construction.

With Alexander Building Construction's concrete division alongside Centre Concrete Company completing the concrete work, Altoona Pipe and Steel Supply, Inc. provided the structural steel for the project. Spray-on fireproofing for the elevator and stair shaft areas was completed by the fire protection subcontractor – Preferred Fire Protection.



Basic Second Floor Structural Drawing of current structural system design.

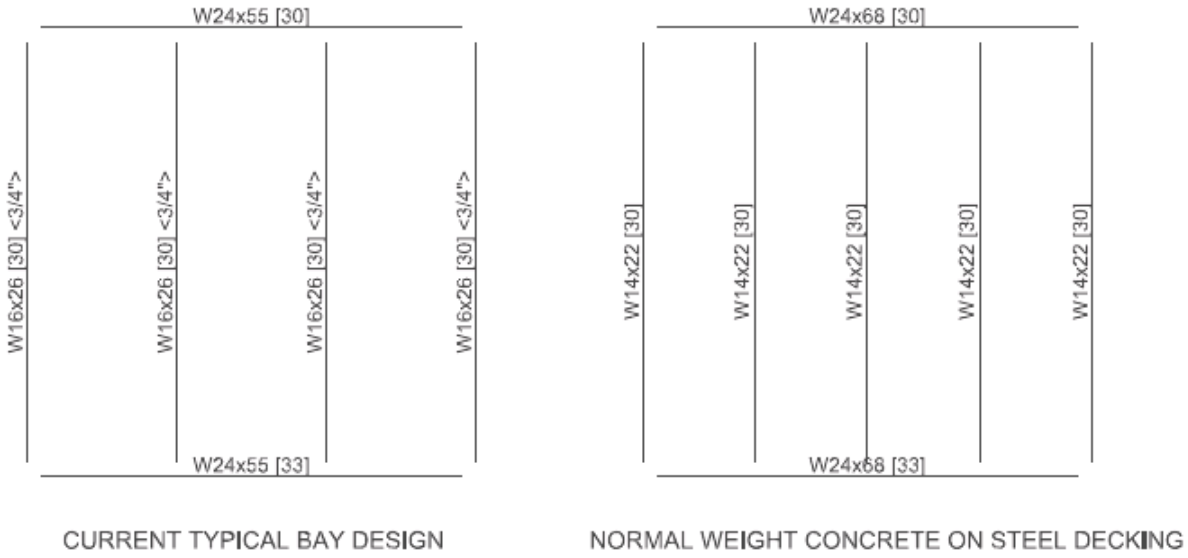
Structural Impacts:

Lightweight Concrete to Normal Weight Concrete

When redesigning the structural system to normal weight concrete, the typical bay size (30' x 30') was kept constant so it would not interfere with column spacing and interior architectural layouts. In order to have adequate fireproofing (only needed for the elevator, mechanical, and stairway shafts), the redesign includes a 4 ½" normal weight concrete slab on the same 2" LOK decking for the second floor and roof.

2" Composite LOK Decking

With a heavier concrete slab, beams will now be spaced at 7'-6" and will be W14x22s with the same shear connections. Additionally, girder sizes will increase to W24x68s for each typical bay. Steel column sizes also increase to W10x88.



Lightweight concrete and Normal Weight Concrete Typical Bay
Structural Drawings.

Changing the light weight concrete to normal weight concrete adds a beam (per bay) but the beam is slightly lighter now. Regardless, this comes out to be about ½ ton additional steel per bay and only about 3 more cubic yards of concrete. Steel connections would be the same for both systems.

CURRENT DESIGN	Size	
LW Concrete	3.5"	
Concrete Placing	< 6" thick	
Steel Decking	2" LOK	
Steel Beams	W 16x26	3
Steel Girders	W24x55	1
Steel Columns	W10x68	2
Fireproofing		

NW CONCRETE	Size	
NW Concrete	4.5"	
Concrete Placing	< 6" thick	
Steel Decking	2" LOK	
Steel Beams	W14x22	4
Steel Girders	W24x68	1
Steel Columns	W10x88	2
Fireproofing		

Light weight concrete and normal weight concrete composite beam system comparisons for a typical 30' x 30' bay.

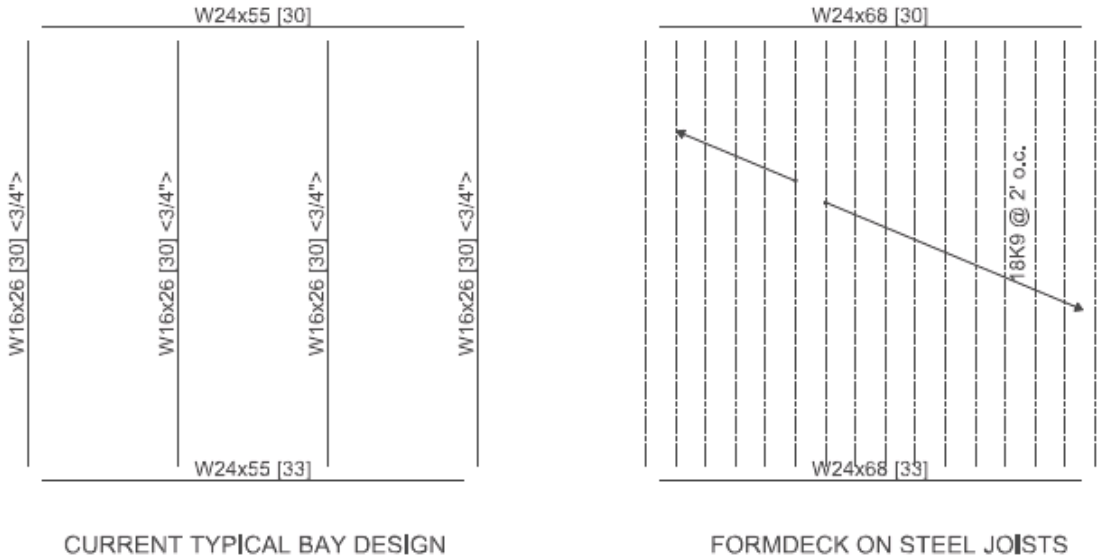
Composite Beam Decking to Form Decking

Similar to the last analysis, the bay size was also kept constant for the form decking analysis so to not interfere with the column spacing and interior architectural layouts. With a redesign of 3" normal weight concrete on 9/16" form decking for the second floor and roof slabs, spray-on fireproofing is still only prescribed for the elevator, mechanical, and stairway shafts.

9/16" Form Deck

Typically form deck systems include structural steel joists and joist girders. For the typical 30' x 30' bay of Gray's Woods Medical Office, 18K9 joists spaced at 3' on center will be used with W24x76 steel girders. Steel column sizes also increase to W10x88.

Form deck is the common name of deck products that are mainly used as stay-in-place forms for structural concrete slabs. The deck can act as a diaphragm both with and without concrete and provides resistance to lateral loads caused by wind or earthquake.



Composite Decking and Form Decking Typical Bay Structural Drawings.

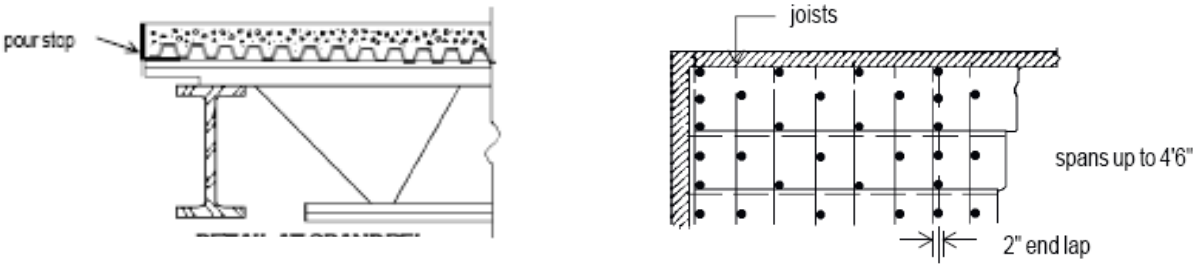
When using the form deck and joist option, steel girders are slightly heavier because the girders can no longer be composite girders. The three rooftop air handling units will now need to sit on steel dunnage for more support. Another design issue would be that the form deck and joist system may cause design problems for the atypical bays on the south and west perimeters, although it is capable of being done. As mentioned earlier, on the south and west perimeter of the building, the building geometry and grid becomes complicated. For the form deck option, about a ½ ton of steel is added to each bay but the amount of concrete needed is reduced by 3 cubic yards.

CURRENT DESIGN	Size	
LW Concrete	3.5"	
Concrete Placing	< 6" thick	
Steel Decking	2" LOK	
Steel Beams	W 16x26	3
Steel Girders	W24x55	1
Steel Columns	W10x68	2
Fireproofing		

FORMDECK	Size	
NW Concrete	3"	
Concrete Placing	< 6" thick	
Steel Decking	9/6" FD	
Steel Joists	18K9	10
Steel Girders	W24x76	1
Steel Columns	W10x88	2
Steel Dunnage		
Fireproofing		

Composite beam decking and form decking comparisons for a typical 30' x 30' bay.

Connection details and welding patterns will be slightly different with the form deck option due to the decking being different and the use of steel joists.



Typical Details of Form Deck Slabs.

Cost Analysis:

There are many different components considered for the structural system budget. For this analysis, the following areas were taken into account: concrete material and placement, all structural steel (including connections), and fireproofing.

All concrete material costs were obtained from Centre Concrete Company with concrete placement from RSMeans 2007. United Steel Decking Inc. supplied the decking prices, while all steel W-shapes and joists prices are from RSMeans 2007 and Altoona Pipe and Steel Supply (steel subcontractor on project). The project manager from Alexander Building Construction supplied the fireproofing costs.

The current design of the building costs a little over $13,300 per 30' x 30' typical bay. Below is a Microsoft Excel spreadsheet of the current structural system. Prices include the cost of labor.

Table 1: 2" Decking with Lightweight Concrete (Current Design of Building)

2" Decking with LW Concrete						
	Size		Amount		Cost	Total
LW Concrete	3.5"		12.5	CY	142 /CY	1,775
Concrete Placing	< 6" thick		12.5	CY	29 /CY	363
Steel Decking	2" LOK		0.09	100 Sq	16,000 /100 Sq	1,440
Steel Beams	W 16x26	3	30	Ft	40.5 /Ft	3,645
Steel Girders	W24x55	1	30	Ft	88 /Ft	2,640
Steel Columns	W10x68	2	15	Ft	103.23 /Ft	3,097
Fireproofing			900	SF	0.47 /SF	423
					PRICE	***$13,382***

With the redesign of lightweight concrete to normal weight concrete, the price per typical bay increased greatly. For a normal weight concrete system, a typical bay costs about $14,700. Below is a table of the normal weight concrete system costs. Prices again include the cost of labor.

Table 2: 2" Decking with Normal Weight Concrete

2" Decking with Normal Weight Concrete						
	Size		Amount		Cost	Total
NW Concrete	4.5"		15.3	CY	97 /CY	1,484
Concrete Placing	< 6" thick		15.3	CY	29 /CY	444
Steel Decking	2" LOK		0.09	100 Sq	16,000 /100 Sq	1,440
Steel Beams	W14x22	4	30	Ft	35 /Ft	4,200
Steel Girders	W24x68	1	30	Ft	97 /Ft	2,910
Steel Columns	W10x88	2	15	Ft	127 /Ft	3,810
Fireproofing			900	SF	0.47 /SF	423
					PRICE	***$14,711***

Redesigning the system to a form deck system, however, results in a slight decrease of cost per typical bay. For a form deck system, a typical bay costs just over $12,700. Additional costs for steel dunnage were added for the typical bay, but would only actually be used on the roof slabs (half of the typical bays). Prices also include the cost of labor. Below is a table of the form deck systems typical 30' x 30' bay.

Table 3: 9/16" Form Decking with Normal Weight Concrete

9/16" Formdecking w/ NW Concrete							
	Size		Amount		Cost		Total
NW Concrete	3"		8.3	CY	97	/CY	805
Concrete Placing	< 6" thick		8.3	CY	29	/CY	241
Steel Decking	9/6" FD		0.090	100 Sq	9500	/100 Sq	855
Steel Joists	18K9	10	30	Ft	229	/Ea	2,290
Steel Girders	W24x76	1	30	Ft	108	/Ft	3,240
Steel Columns	W10x88	2	15	Ft	127	/Ft	3,810
Steel Dunnage			900	SF	1.2	/SF	1,080
Fireproofing			900	SF	0.47	/SF	423
						PRICE	***$12,744***

To compare all systems equally, each systems typical bay cost has been multiplied by 26 (the amount of typical bays in the building). The remaining areas (south and west perimeter) that have not been included would have effects on the complete cost of the system. For this analysis, these additional areas have been assumed to have the same price for each system. Below is a table of the cost of each system for all of the typical bays with the difference of cost from the current design. The difference was found by subtracting the current systems cost from the proposed systems cost.

Table 4: 2" Decking with Lightweight Concrete (Current Design of Building)

System	Cost	Difference
2"Decking with LW Concrete - *Current Design*	$347,942	-
2" Decking with NW Concrete	$382,481	$34,538
9/16" Form Decking with NW Concrete	$331,339	-$16,604

As seen in the table above, by changing the light weight concrete to normal weight concrete it results in a more expensive structural system – about $34,500 more. Although the concrete costs of this system are less than the current design, the fact that you need about ½ ton more steel per bay greatly increases the systems costs.

Also developed from the table above, by changing the composite decking to form decking, the cost of the structural system was only slightly lower – about $16,600 less. With the concrete slabs for this system being cheaper and the costs of joist systems being less than steel beams, the typical bays of a form deck system cost less than composite decking. However, when looking at the areas not included in the analysis, having a complicated grid that does not comply with a joist construction, these savings may be lost to accommodate a more complicated design.

Conclusions and Recommendations:

Redesigning the structural system with normal weight concrete does not result in any costs savings for the project. However, by using the form deck system, a small savings can be gained. So as there is no visible difference to the exterior and interior finishes, the form deck option should be used for the typical bays (to gain savings) and the other area should be designed using the composite beam and decking option. Therefore the calculations conclude that by using both the form deck and composite decking designs together, the project can save over $16,000 to either be returned to the owner or used in another design area of the building.

Negligible time would be added to the project regarding the structural portion. However, with the formdeck system with floor joists, additional time may be added during the overhead MEP installation for additional coordination due to the reduced plenum space.

ANALYSIS 3:
APPROVALS & PERMITS

Problem Statement:

With scheduling and project completion continually being a main focus for new construction projects, it is important for industry members to evaluate where time and money are being wasted to improve the process of project design and construction. For Geisinger Gray's Woods Ambulatory Care Campus, numerous approvals and permits delayed the design and early construction phases of the project for three months – so far the most costly delay on the project. At such an early stage of the project, it becomes frustrating and aggravating to owners, design professional, and construction managers to not see their vision become a reality. I have found that many other new commercial construction projects throughout the US have experienced this same problem, and at times, encounter even larger delays from approvals and permits.

Proposed Solution:

Through continuing education of the ICC codes and increasing the amount of plans examiners within each municipality, tension created between code officials and project members could be greatly reduced. Furthermore, initial project delays from approvals and permits could be greatly reduced.

Methodology:

Preliminary research began with researching the permitting and approval process used on the Geisinger Gray's Woods project as well as other municipalities in Central Pennsylvania. A short survey generated from knowledge gained from research was then sent to several municipality code officials. A copy of this survey can be found in Appendix E. The survey was sent by email and was either returned through email or a phone interview of the questions was completed. Completed surveys can also be found in Appendix E. Further research was then completed on successful permitting processes – more specifically Seattle, Washington's process. The results from both research and interviews were then compiled to produce a recommendation.

Resources and Tools:

Plan Review Officials

Geisinger Gray's Woods Construction Manager – Alexander Building Construction

Centre Region Code Administration

Geisinger Gray's Woods Conditions:

For the Geisinger Gray's Woods Medical Office Building, the permitting and approval process delayed the start of construction on the project. During the permitting and approval period, the project team was involved with six permitting/approval agencies to get the project started. Of these included the National Pollutant Discharge Elimination System (NPDES), PennDOT, Patton Township, Department of Environmental Protection (DEP), Centre Region Code Administration, and the Sewer Authority.

Overall, the permitting and approval process took over a year – 13 months. Site drawings were completed March 27th, 2006 with construction originally scheduled for December of 2007; however construction did not actually begin until April 23rd, 2007 – a four month delay.

Permitting History:

The International Code Council, ICC, founded in 1994, is responsible for developing the codes used to design and build commercial and residential buildings. It was created by combining Building Officials and Code Administration International, Inc. (BOCA), International Conference of Building Officials (ICBO), and Southern Building Code Congress International, Inc. (SBCCI). ICC is a non-profit organization.

After the ICC was enacted, cities, counties, and states slowly started adapting the new codes. With over fourteen ICC publications and an impressive inventory of codes, commercial project teams can now work with a consistent set of requirements throughout the entire United States. Other services provided by the ICC are uniform education and certification programs, plan reviews, monthly magazines and newsletters, training and informational videos, and publication of proposed code changes. This mission of the International Code Council is to provide the highest quality codes, standards, products, and services for all concerned with the safety and performance of the built environment.

When the ICC change occurred, the Department of Labor and Industry was no longer involved with the permitting processes for those municipalities and cites that adopted the new code. With the Department of Labor and Industry out of the process, many smaller municipalities either joined together to form a larger office, or started contracting the larger projects out to a third party agency such as Pennoni Associates, Inc. or the Bureau Veritas Group. Without enough personnel and resources within the municipality offices, the permitting packages are now sent to many different parties, each one requiring their own amount of time for review.

Permitting in Areas of Central Pennsylvania:

Name	Position	Municipality, Company
Michael Rupert	Senior Building Inspector	Centre Region Code Administration
Donald Fure	Code Enforcement Officer	Swatara Township
Ned Liggett	Commercial Plan Examiner	Centre Region Code Administration
Rod Smay	Manager	Bureau Veritas
Albert Wrightstone	Building Inspector	Susquehanna Township
Dan Slatt	Building Inspector	Lower Paxton Township

List of Surveyed Industry Members.

Currently in Pennsylvania, building permitting and approvals are handled by the municipality in which the project is located. There are two different approaches municipalities have taken on how their office handles building permitting and plans review.

First, the smaller municipalities, such as Swatara, Lower Paxton and Susquehanna Townships, tend to only review small projects (< 5,500 SF) in their office. For the larger projects being proposed in their areas, they contract out to a third party that has more resources and manpower to get the plans reviewed in the 30 day time limit. For these areas, there is one in-office plans reviewer per 9 square miles on average. When surveyed, all parties stated that the most time consuming part of the process is when larger commercial project plans are submitted. Additionally, the majority felt the best

way to improve the permitting process is for Architects and engineers to attend continuing education classes on the codes. When researching the permitting process online, it was very difficult to find the correct links to get any information on the necessary forms and the contact information of officials.

Secondly, municipalities have united to create a larger regional office to enforce building permitting and plans reviews such as the Centre Region Code Administration. The Centre Region Code Administration includes the State College Borough and the five townships that surround the borough. For this area, there is one in-office plans reviewer per 554 square miles on average. These areas are, however, not as urban as the previous discussed municipalities. Here, all plans are reviewed by two plan reviewers with no third party contracting. Centre Region Code Administration's online website is very easy to navigate and to find all documentation needed to prepare permitting packages. Those surveyed ranked the following as the best ways for contractors and design professionals to improve the permitting processes:

Best Ways For Contractors and Design Professionals to Improve the Permitting Process

- Schedule a Preliminary Meeting with Region Office
- Communication Between All Parties Involved with Plans and Plan Review
- Properly Prepare Permitting Packages Prior to Submittal

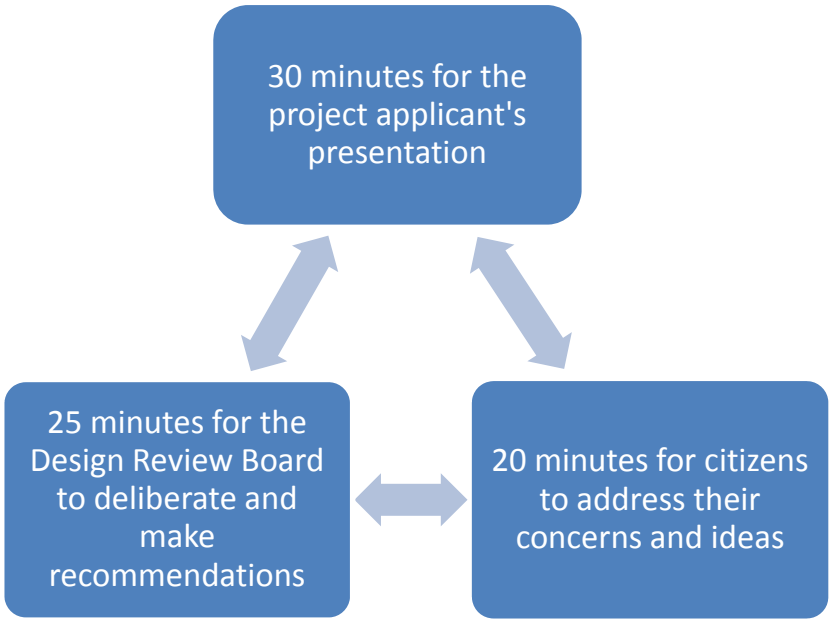
Other Current Permitting Processes:

Started in the 1960's, Seattle, Washington has included a new branch to their city government – the Department of Planning and Development, DPD. Within the city limits, DPD develops and enforces code standards for construction. DPD has developed their own set of codes and policies for the planning and developing processes which include the Seattle Building Code, the Seattle Mechanical Code and the Seattle Energy

Code to name a few. Approximately 80,000 on-site inspections are performed and over 23,000 land and construction related permits are approved each year in Seattle through the DPD.

The design review board consists of thirty-five members, five for each of the seven districts. Each individual board's five members represent key players in the development process. Each member severs a two-year term which can only be renewed once. Also, there is no financial compensation for the members. Typically, most boards only meet two times a month.

Another key development made by DPD is their Design Review Program. This program reviews private projects such as new commercial and multi-family developments in Seattle. The program has several objectives. First, to enhance the city and ensure the proposed project fits into its surroundings, the program encourages better design and site planning. Next, the program provides flexibility in the use of development standards. Lastly, the program strives to open the lines of communication and involvement of designers, citizens, and the City early in the design process. Built off the concept of a triangle, the citizens of Seattle, the project applicant and the City are all given a say in the review process. Below is a diagram of how the 90 minute review meetings are conducted to ensure everyone's voice is heard.



Design Review "Triangle"

Program Administrators manage the program, recruit and train citizens to serve on the Board, and schedule the Board's project review meetings. Design Review Planners lead design professional through the design review process and explain code and design guidelines.

Seattle's Department of Planning and Development's online website homepage is very straight forward. From this page you can directly find out such things as how to apply for a building permit, request a building inspection, and check the status of your building permit. Those visiting the site can easily get to the Applicant's Toolbox which gives detailed instructions on the design review process and the project application and submittal requirements.

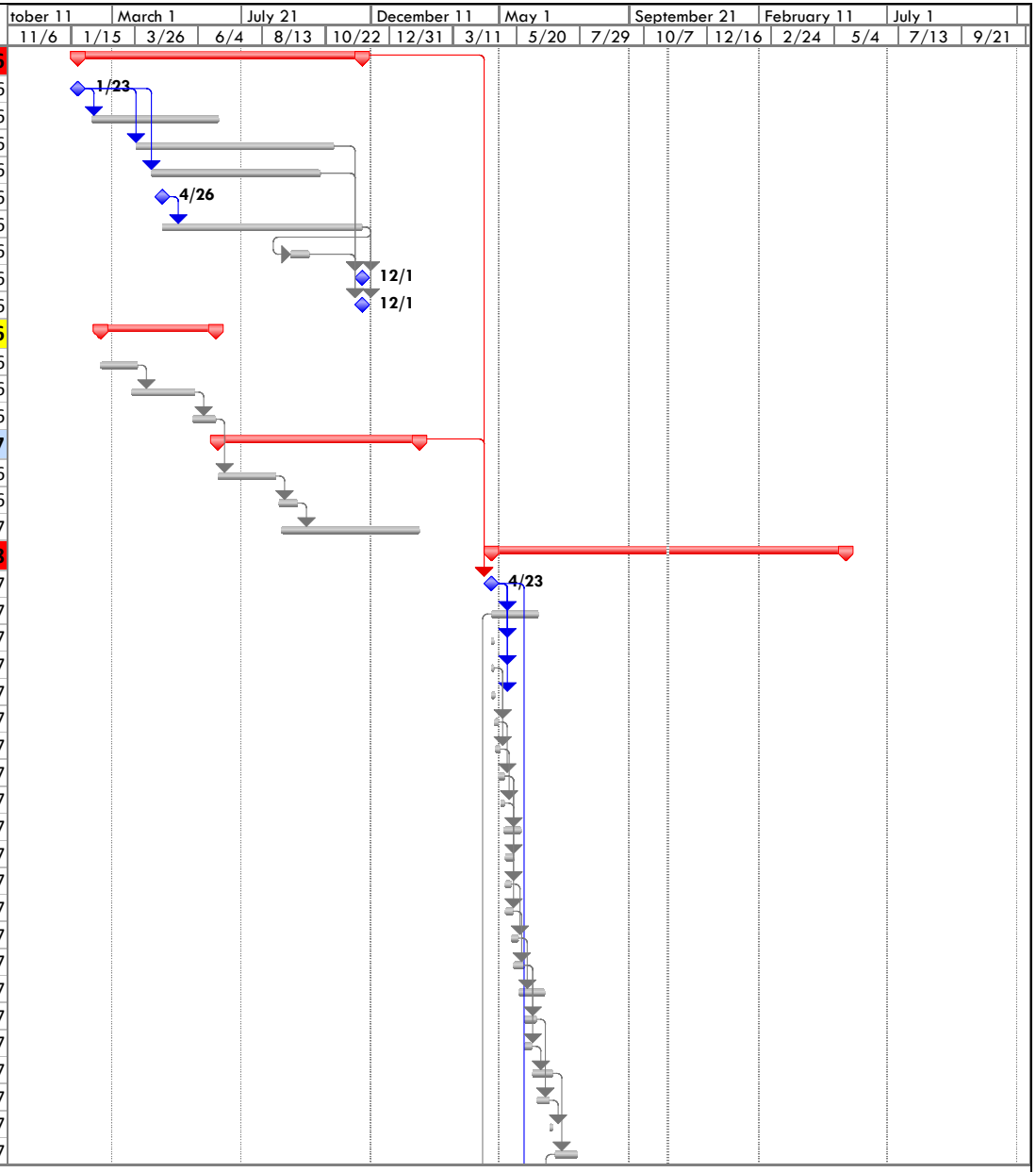
Conclusions and Recommendations:

Currently in Pennsylvania, building permitting and approvals are handled by the municipality in which the project is located. There are two different approaches municipalities have taken on how their office handles building permitting and plans review – in office reviews or contract out to third parties. With either process, it is vitally important that contractors know the codes and engage in early communication with the code officials during the design phase. For the Gray's Woods Project, better understanding the DEP processes would and preparing drawings that fulfill all requirements could have given some relief to both the Department of Environmental Protection and the project team. For this analysis, DEP was contacted several times with no complete response back. Rather, I was forwarded to another department or another person that "could" help me. The suggestion of having more plan reviewers in each municipality was discussed, but this would involve increasing taxes (for their pay) which could have deterrent effects on the community.

With seeing such success in Seattle, Washington, it should be only a matter of time until other municipalities around the nation research their process on their own and take from it what they can to improve their organization. Changing the code review process would require time and even more patience from all parties involved while the process is in limbo. And by creating a code review organization that is non-profit that could be funded by a private sector or donations, the community's taxes could possibly be reduced.

APPENDIX A:
DETAILED PROJECT SCHEDULE

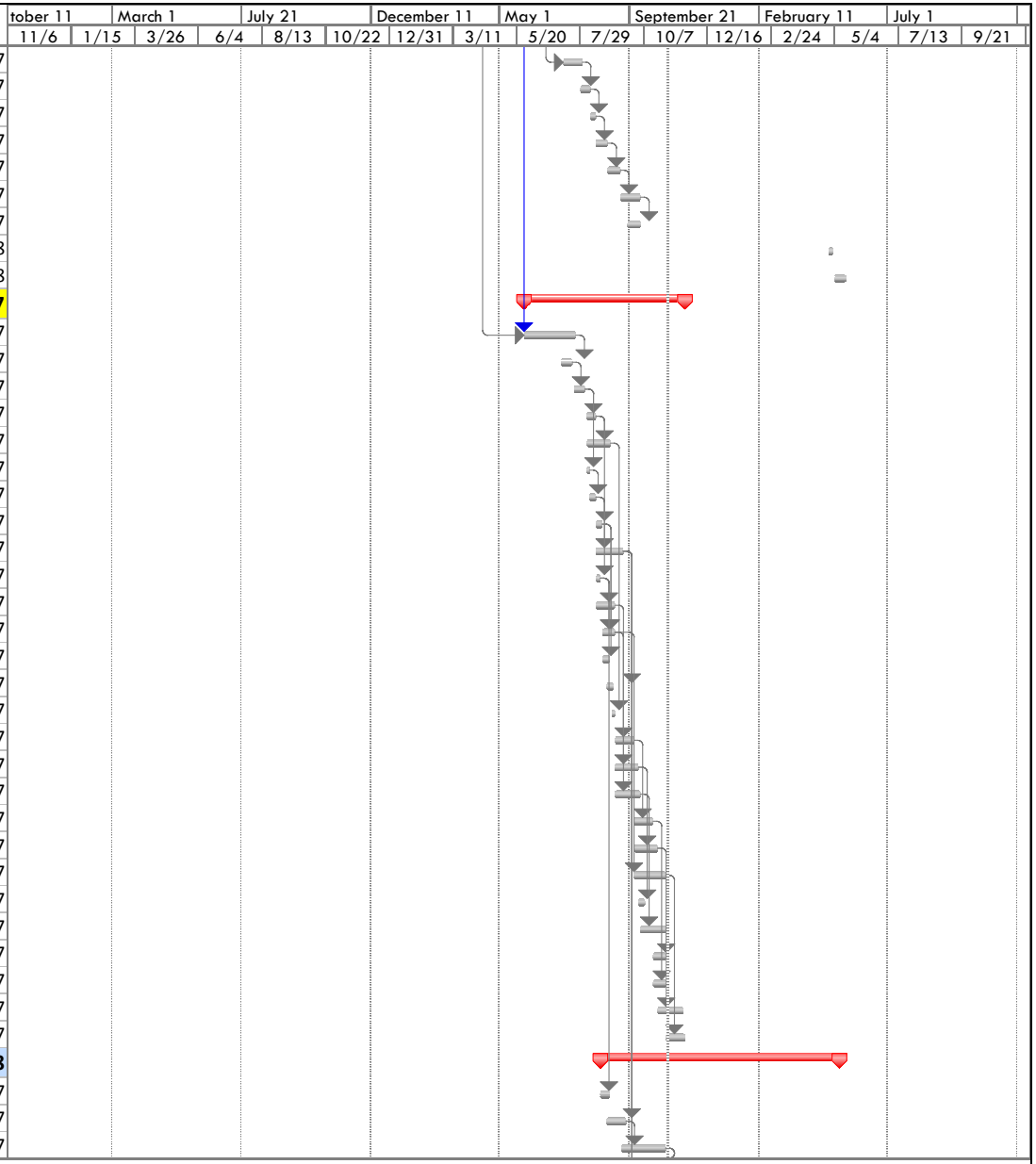
ID	Task Name	Duration	Start	Finish
1	**APPROVALS/PERMITS**	**225 days**	**Mon 1/23/06**	**Fri 12/1/06**
2	Site Master Plan Approved	0 days	Mon 1/23/06	Mon 1/23/06
3	Site Drawings & Easement Approvals	100 days	Tue 2/7/06	Mon 6/26/06
4	NPDES Plan Revision/Resubmission/Approval	156 days	Tue 3/28/06	Tue 10/31/06
5	Submit Plans to PennDOT/Approval	132 days	Fri 4/14/06	Mon 10/16/06
6	Centre Region Council of Gov't Meeting	0 days	Wed 4/26/06	Wed 4/26/06
7	537 DEP Planning/Approval	158 days	Wed 4/26/06	Fri 12/1/06
8	Sewer Authority Sewer Main Approval	15 days	Thu 9/14/06	Wed 10/4/06
9	Obtain Building Permit	0 days	Fri 12/1/06	Fri 12/1/06
10	Receive Final LDP Approval	0 days	Fri 12/1/06	Fri 12/1/06
11	**DESIGN DEVELOPMENT**	**91 days**	**Fri 2/17/06**	**Fri 6/23/06**
12	Select CM/Schematic Design Estimate	29 days	Fri 2/17/06	Wed 3/29/06
13	Design Development	50 days	Thu 3/23/06	Wed 5/31/06
14	D.D. Estimate	20 days	Mon 5/29/06	Fri 6/23/06
15	**CONSTRUCTION DOCUMENTS/GMP/PROCUREMEI**	**160 days**	**Mon 6/26/06**	**Fri 2/2/07**
16	Construction Documents	46 days	Mon 6/26/06	Mon 8/28/06
17	GMP	15 days	Fri 9/1/06	Thu 9/21/06
18	Fab. & Deliv. Structural Steel	110 days	Mon 9/4/06	Fri 2/2/07
19	**SITEWORK**	**280 days**	**Mon 4/23/07**	**Fri 5/16/08**
20	Mobilize on Site	0 days	Mon 4/23/07	Mon 4/23/07
21	Building Pad	38 days	Mon 4/23/07	Wed 6/13/07
22	Layout	3 days	Mon 4/23/07	Wed 4/25/07
23	E&S (Incl. Pipe)	3 days	Mon 4/23/07	Wed 4/25/07
24	Tree Protection Fence	4 days	Mon 4/23/07	Thu 4/26/07
25	Construction Entrance	3 days	Thu 4/26/07	Mon 4/30/07
26	Haul Road	4 days	Fri 4/27/07	Wed 5/2/07
27	Impact Basin	5 days	Tue 5/1/07	Mon 5/7/07
28	Waste Area E&S	3 days	Thu 5/3/07	Mon 5/7/07
29	Clear & Grubb	15 days	Mon 5/7/07	Fri 5/25/07
30	Impact Basin Walls	8 days	Tue 5/8/07	Thu 5/17/07
31	Waste Area Pond	5 days	Tue 5/8/07	Mon 5/14/07
32	Strip	7 days	Tue 5/8/07	Wed 5/16/07
33	Waste Area Prep	6 days	Tue 5/15/07	Tue 5/22/07
34	Cut to Fill	8 days	Thu 5/17/07	Mon 5/28/07
35	Retaining Wall	21 days	Wed 5/23/07	Wed 6/20/07
36	Cut to Waste	10 days	Tue 5/29/07	Mon 6/11/07
37	Sanitary	7 days	Tue 5/29/07	Wed 6/6/07
38	Waterline	17 days	Thu 6/7/07	Fri 6/29/07
39	Paving Subgrade - South Parking Lot	10 days	Tue 6/12/07	Mon 6/25/07
40	Base Paving - South Parking Lot	4 days	Tue 6/26/07	Fri 6/29/07
41	Storm	19 days	Mon 7/2/07	Thu 7/26/07



Project: Geisinger Gray's Woods Ambulatory Care Campus Phase 1
Summary Schedule

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
Project Summary
Group By Summary
Deadline

ID	Task Name	Duration	Start	Finish
42	Underground Detention Facility and Storm	15 days	Wed 7/11/07	Tue 7/31/07
43	Paving Subgrade - West Parking Lot	9 days	Mon 7/30/07	Thu 8/9/07
44	Base Paving - West Parking Lot	4 days	Fri 8/10/07	Wed 8/15/07
45	Concrete Slabs	9 days	Thu 8/16/07	Tue 8/28/07
46	Curb	10 days	Wed 8/29/07	Tue 9/11/07
47	Topsoil (Islands & Slopes	16 days	Wed 9/12/07	Wed 10/3/07
48	Landscaping & Seeding (Fall)	10 days	Thu 9/20/07	Wed 10/3/07
49	Wearing Paving	5 days	Mon 4/28/08	Fri 5/2/08
50	Landscaping & Seeding (Spring)	10 days	Mon 5/5/08	Fri 5/16/08
51	**SHELL & ENCLOSURE**	**127 days**	**Tue 5/29/07**	**Ved 11/21/07**
52	Foundation Concrete	41 days	Tue 5/29/07	Tue 7/24/07
53	Steel Erection Sequence 1	10 days	Mon 7/9/07	Fri 7/20/07
54	Steel Erection Sequence 2	10 days	Mon 7/23/07	Fri 8/3/07
55	Steel Erection Sequence 3	8 days	Mon 8/6/07	Wed 8/15/07
57	Underground Plumbing	20 days	Mon 8/6/07	Fri 8/31/07
58	Concrete 2nd Floor Seq. 1 & 2	3 days	Mon 8/6/07	Wed 8/8/07
59	Concrete Roof Seq. 1 & 2	5 days	Thu 8/9/07	Wed 8/15/07
56	Boiler Room Steel Erection	5 days	Thu 8/16/07	Wed 8/22/07
60	TPO Roof	22 days	Thu 8/16/07	Fri 9/14/07
61	Concrete 2nd Floor Seq. 3/SOG Seq. 1	3 days	Thu 8/16/07	Mon 8/20/07
66	Exterior Stud Framing/Sheathing North Elevation	15 days	Thu 8/16/07	Wed 9/5/07
63	Concrete Boiler Room Roof/SOG	10 days	Thu 8/23/07	Wed 9/5/07
64	East and West Stair Installation	6 days	Thu 8/23/07	Thu 8/30/07
65	Spray Fireproofing Shaft Bays	5 days	Tue 8/28/07	Mon 9/3/07
62	Concrete Roof Seq. 3/SOG Seq. 2 & 3	3 days	Mon 9/3/07	Wed 9/5/07
67	Exterior Stud Framing/Sheathing West Elevation	15 days	Thu 9/6/07	Wed 9/26/07
69	Brick Masonry North Elevation	18 days	Thu 9/6/07	Mon 10/1/07
72	Metal Roof	20 days	Thu 9/6/07	Wed 10/3/07
68	Exterior Stud Framing/Sheathing South Elevation	15 days	Thu 9/27/07	Wed 10/17/07
70	Brick Masonry West Elevation	18 days	Thu 9/27/07	Mon 10/22/07
73	Aluminum Curtain Wall East Elevation	25 days	Thu 9/27/07	Wed 10/31/07
76	Aluminum Windows North Elevation	5 days	Tue 10/2/07	Mon 10/8/07
75	Aluminum Composite Panels	20 days	Thu 10/4/07	Wed 10/31/07
71	EIFS	10 days	Thu 10/18/07	Wed 10/31/07
77	Monumnetal Stair Installation	10 days	Thu 10/18/07	Wed 10/31/07
78	Aluminum Windows West Elevation	20 days	Tue 10/23/07	Mon 11/19/07
74	Aluminum Curtain Wall South and West Elevation	15 days	Thu 11/1/07	Wed 11/21/07
79	**LEVEL 2 INTERIORS**	**189 days**	**Tue 8/21/07**	**Fri 5/9/08**
80	East & West Stairs	8 days	Tue 8/21/07	Thu 8/30/07
81	Hang Ductwork Mains	15 days	Tue 8/28/07	Mon 9/17/07
82	Interior Metal Studs	35 days	Thu 9/13/07	Wed 10/31/07



Project: Geisinger Gray's Woods Ambulatory Care Campus Phase 1
Summary Schedule

Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
Split
External Tasks
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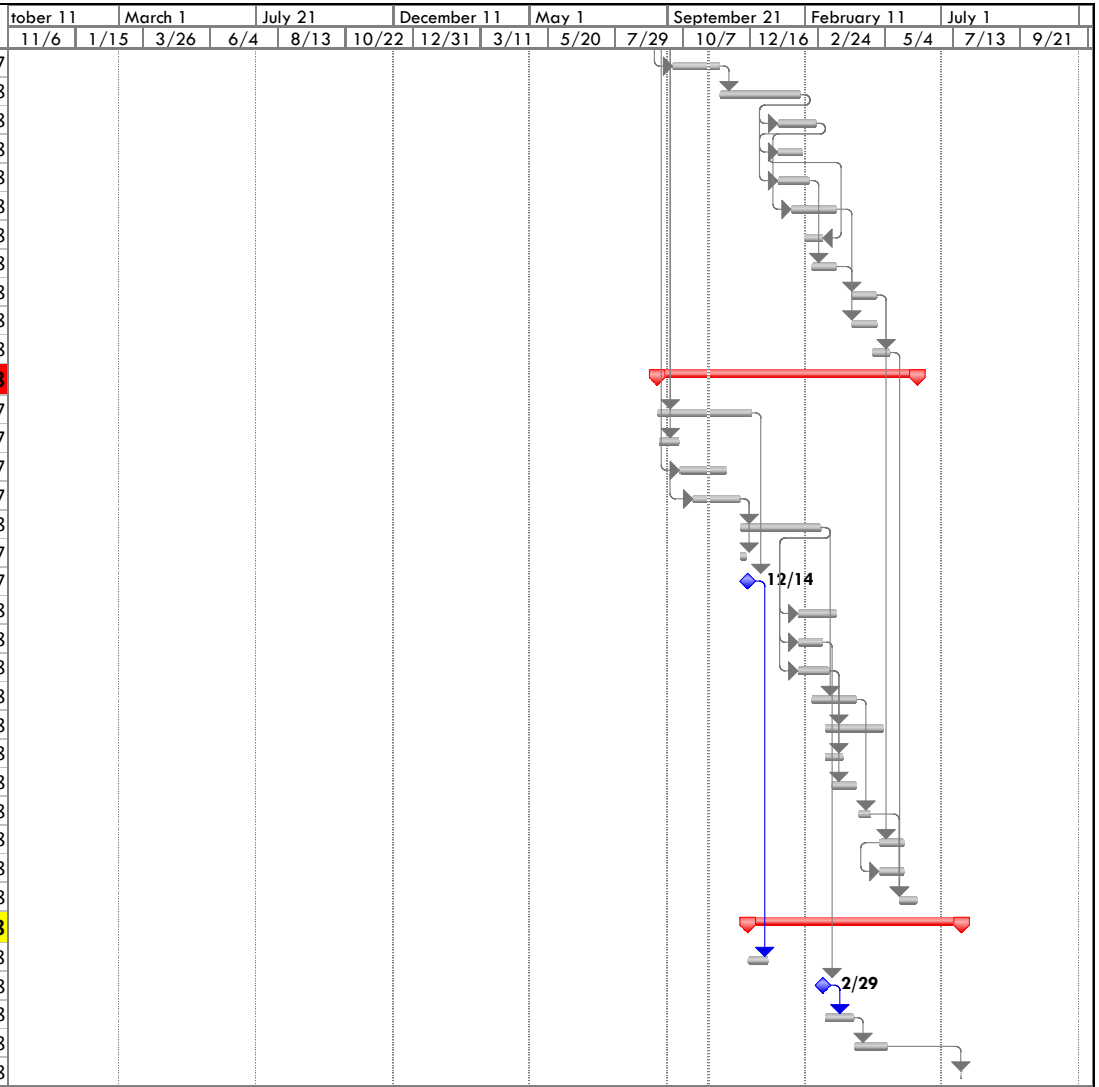
Deadline

ID	Task Name	Duration	Start	Finish
83	MEP in Wall	35 days	Thu 9/27/07	Wed 11/14/07
84	Drywall	60 days	Thu 11/15/07	Wed 2/6/08
85	Painting	30 days	Mon 1/14/08	Fri 2/22/08
86	Epoxy Terrazzo	20 days	Mon 1/14/08	Fri 2/8/08
88	Ceramic Tile	25 days	Mon 1/14/08	Fri 2/15/08
87	Ceiling Grid	35 days	Mon 1/28/08	Fri 3/14/08
89	Milcare Installation	15 days	Mon 2/11/08	Fri 2/29/08
90	Plumbing Fixtures	20 days	Mon 2/18/08	Fri 3/14/08
91	Light Fixtures/GRDs	20 days	Mon 3/31/08	Fri 4/25/08
92	Hang Doors	20 days	Mon 3/31/08	Fri 4/25/08
93	Floor Finishes	15 days	Mon 4/21/08	Fri 5/9/08
94	**LEVEL 1 INTERIORS**	**194 days**	**Tue 9/11/07**	**Fri 6/6/08**
95	Boiler Room Mechanical	70 days	Tue 9/11/07	Mon 12/17/07
96	Hang Ductwork Mains	15 days	Thu 9/13/07	Wed 10/3/07
97	Interior Metal Studs	35 days	Thu 10/4/07	Wed 11/21/07
98	MEP in Wall	35 days	Thu 10/18/07	Wed 12/5/07
99	Drywall	60 days	Thu 12/6/07	Wed 2/27/08
100	MRI RF Enclosure	5 days	Thu 12/6/07	Wed 12/12/07
102	Permanent System for Temporary Heat	0 days	Fri 12/14/07	Fri 12/14/07
101	Painting	30 days	Mon 2/4/08	Fri 3/14/08
103	Epoxy Terrazzo	20 days	Mon 2/4/08	Fri 2/29/08
104	Ceramic Tile	25 days	Mon 2/4/08	Fri 3/7/08
105	Ceiling Grid	35 days	Mon 2/18/08	Fri 4/4/08
106	Install Elevators	45 days	Mon 3/3/08	Fri 5/2/08
107	Milcare Installation	15 days	Mon 3/3/08	Fri 3/21/08
108	Plumbing Fixtures	20 days	Mon 3/10/08	Fri 4/4/08
109	Install Water Feature	10 days	Mon 4/7/08	Fri 4/18/08
110	Light Fixtures/GRDs	20 days	Mon 4/28/08	Fri 5/23/08
111	Hang Doors	20 days	Mon 4/28/08	Fri 5/23/08
112	Floor Finishes	15 days	Mon 5/19/08	Fri 6/6/08
113	**COMPLETION & CLOSEOUT**	**158 days**	**Fri 12/14/07**	**Tue 7/22/08**
114	Testing & Air Balancing	15 days	Fri 12/14/07	Thu 1/3/08
115	Substantial Completion	0 days	Fri 2/29/08	Fri 2/29/08
116	Punchlist	22 days	Mon 3/3/08	Tue 4/1/08
117	Functional Testing - Commissioning	25 days	Wed 4/2/08	Tue 5/6/08
118	Owner Move-In	1 day	Tue 7/22/08	Tue 7/22/08



Project: Geisinger Gray's Woods Ambulatory Care Campus Phase 1
Summary Schedule

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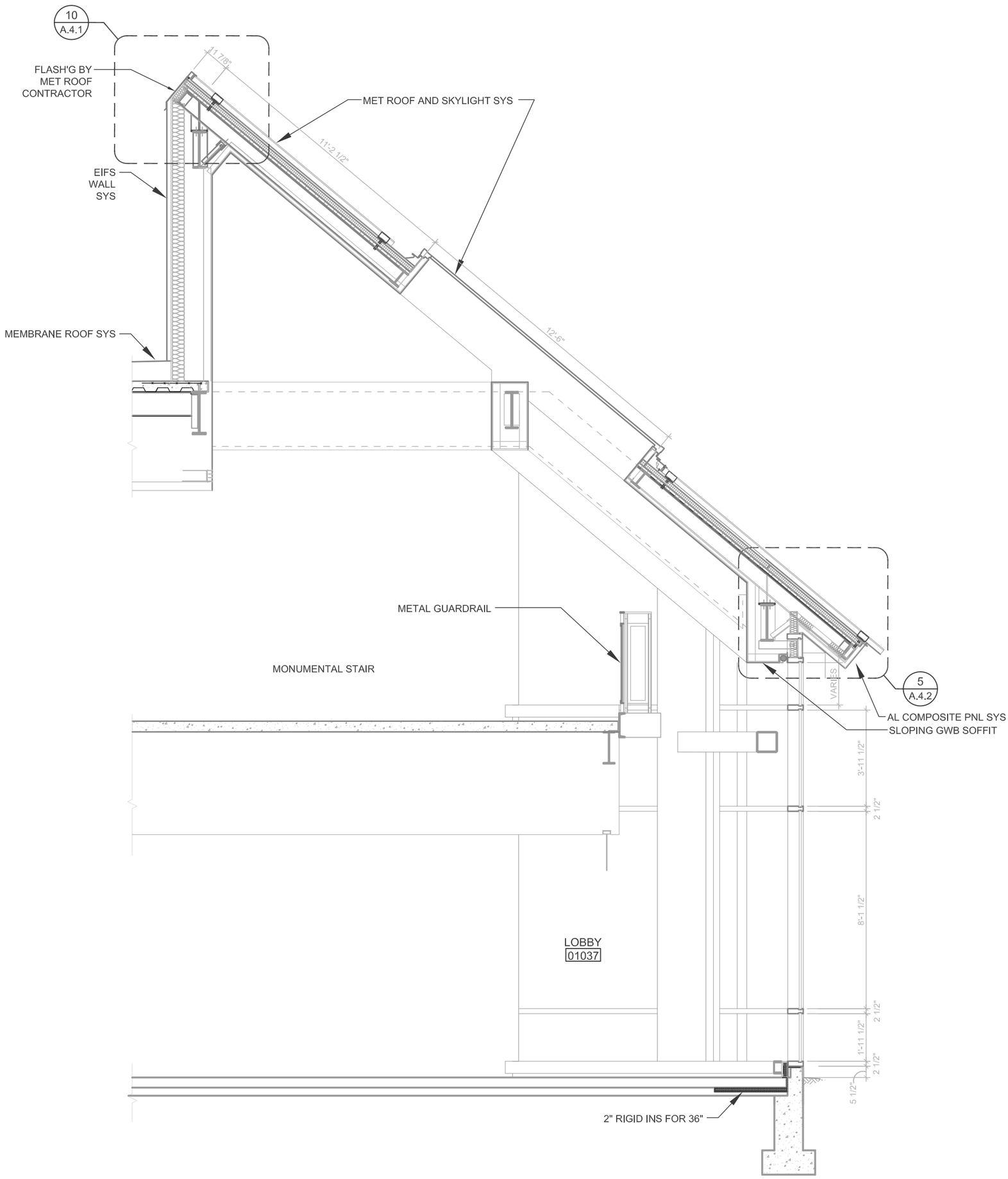
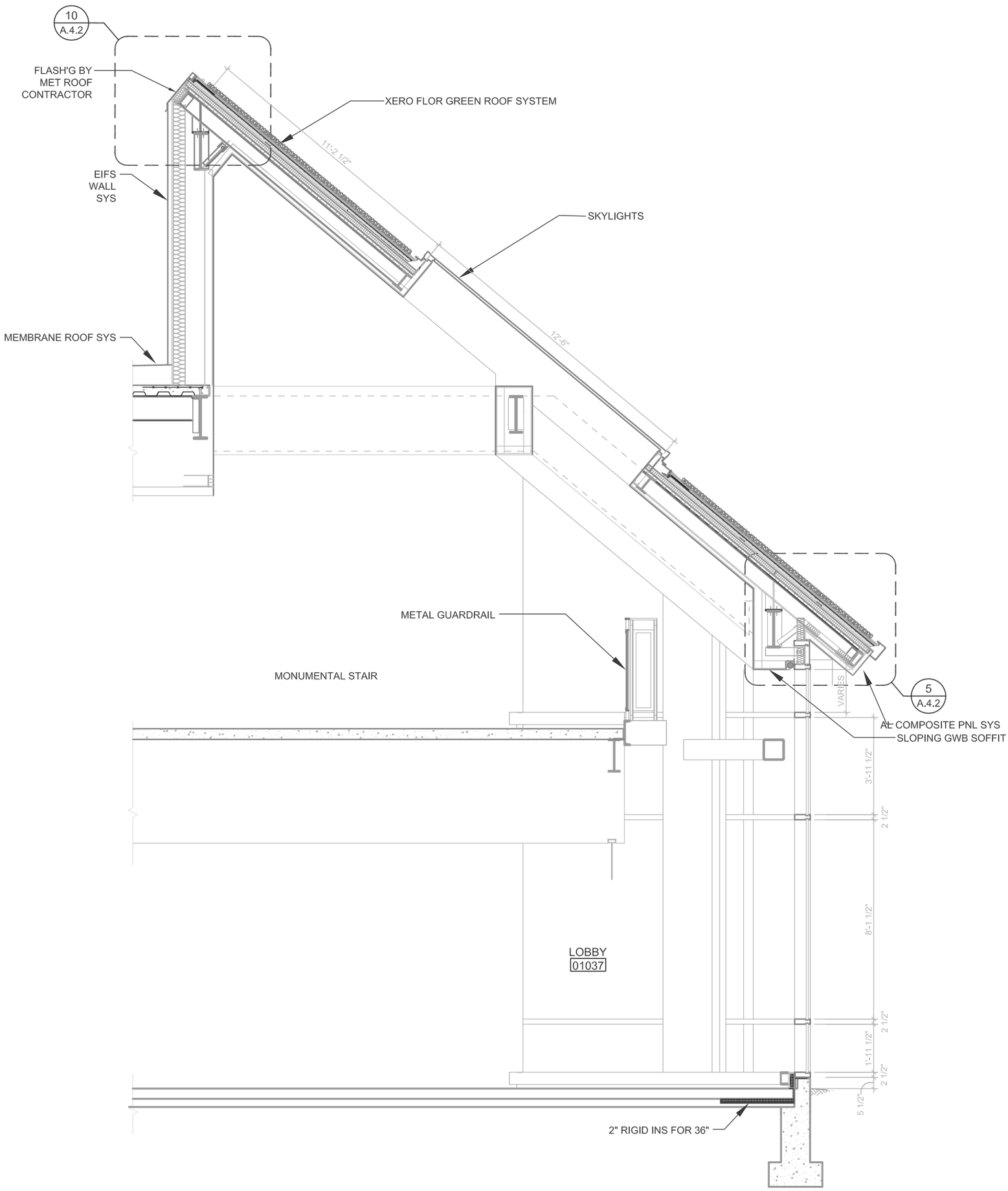
APPENDIX B:
ARCHITECTURAL DRAWINGS



WALL SECTION- EAST ELEVATION - METAL ROOF

3/8"=1'-0"

File No. 2007.9.29	Date 4/2/2008	WALL SECTION — EAST ELEVATION METAL ROOF GEISINGER GRAY'S WOODS AMBULATORY CARE CAMPUS PATTON TOWNSHIP, CENTRE COUNTY, PA	Drawn By ELC
Sheet No. A.3.1	Scale 1 1/2" = 1'	No. / DATE / REVISION / BY	Client Geisinger



WALL SECTION- EAST ELEVATION - XERO FLOR

3/8"=1'-0"

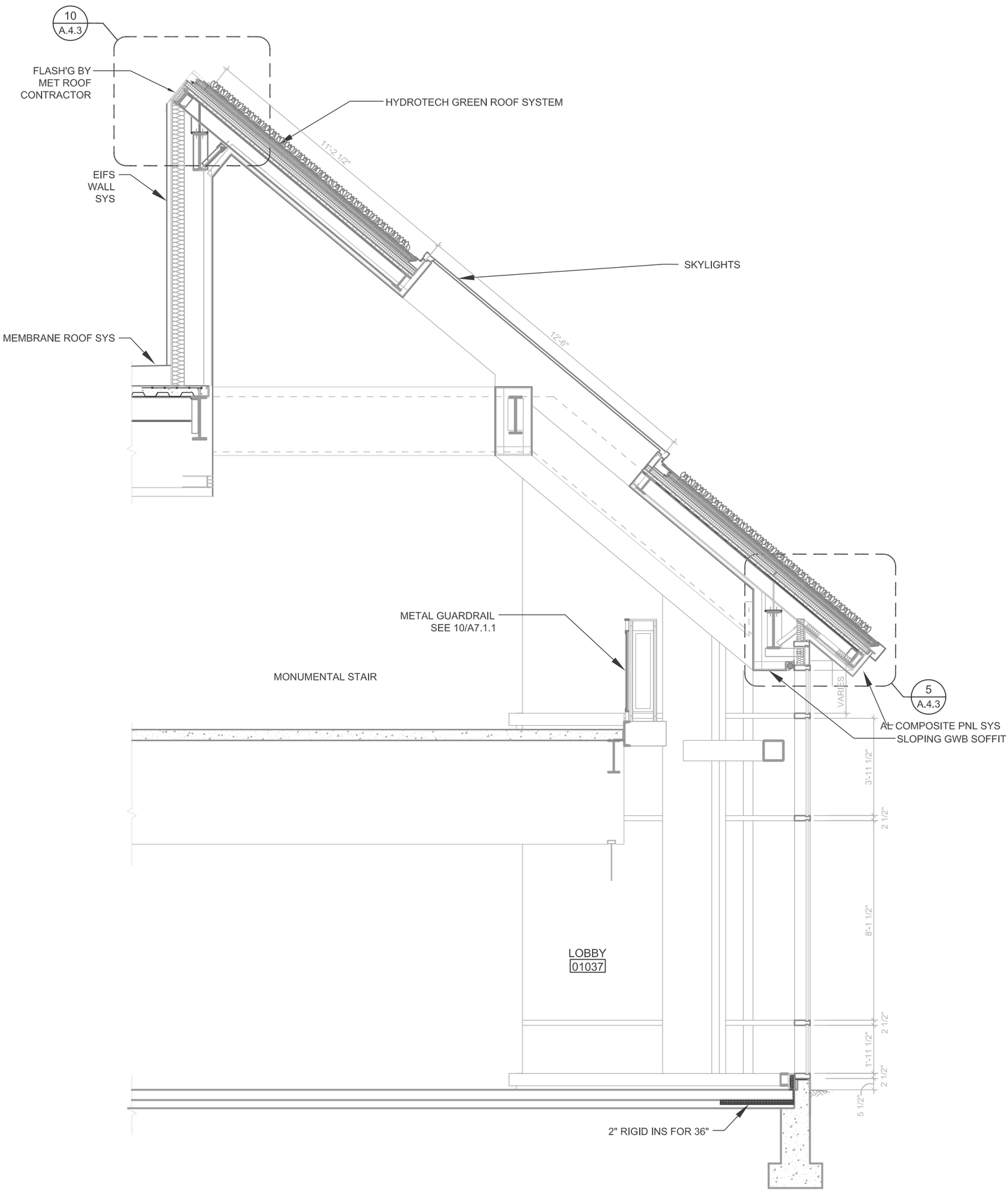
File No. 2007.9.29	Sheet No. A.3.2	Scale 1 1/2" = 1'	Date 4/2/2008

WALL SECTION — EAST ELEVATION
XERO FLOR GREEN ROOF
GEISINGER GRAY'S WOODS AMBULATORY CARE CAMPUS
PATTON TOWNSHIP, CENTRE COUNTY, PA

No.	DATE	REVISION	BY

Client: Geisinger

Drawn By: ELC

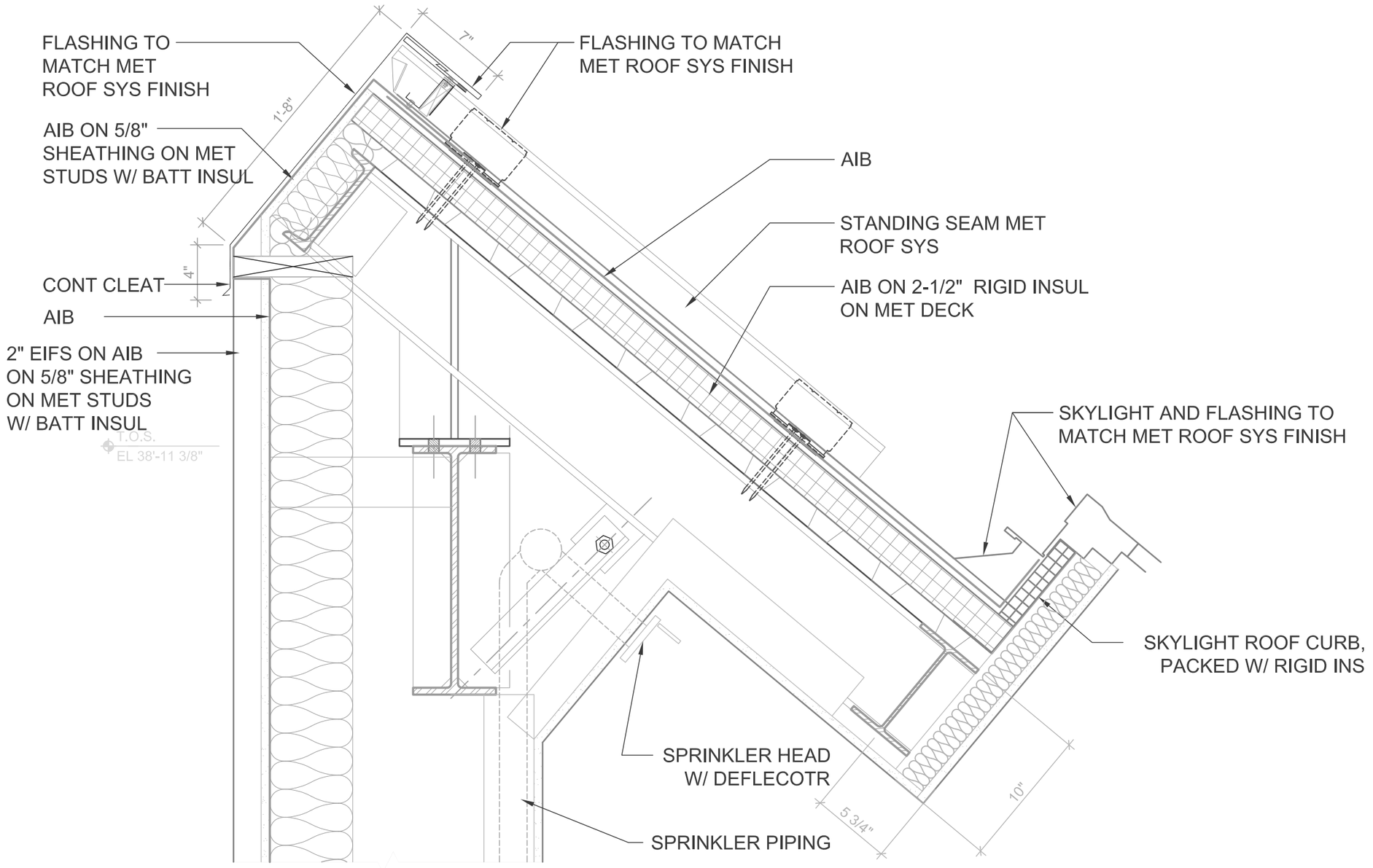


WALL SECTION- EAST ELEVATION - HYDROTECH

3/8"=1'-0"

File No. 2007.9.29	Date 4/2/2008	WALL SECTION — EAST ELEVATION HYDROTECH GREEN ROOF GEISINGER GRAY'S WOODS AMBULATORY CARE CAMPUS PATTON TOWNSHIP, CENTRE COUNTY, PA	Client Geisinger
Sheet No. A.3.3	Scale 1 1/2" = 1'		Drawn By ELC

No.	DATE	REVISION	BY



10 SECTION DETAIL @ ROOF SLOPE - METAL ROOF
1 1/2" = 1'-0"

Drawn By
ELC

Client
Geisinger

No.	DATE	REVISION	BY

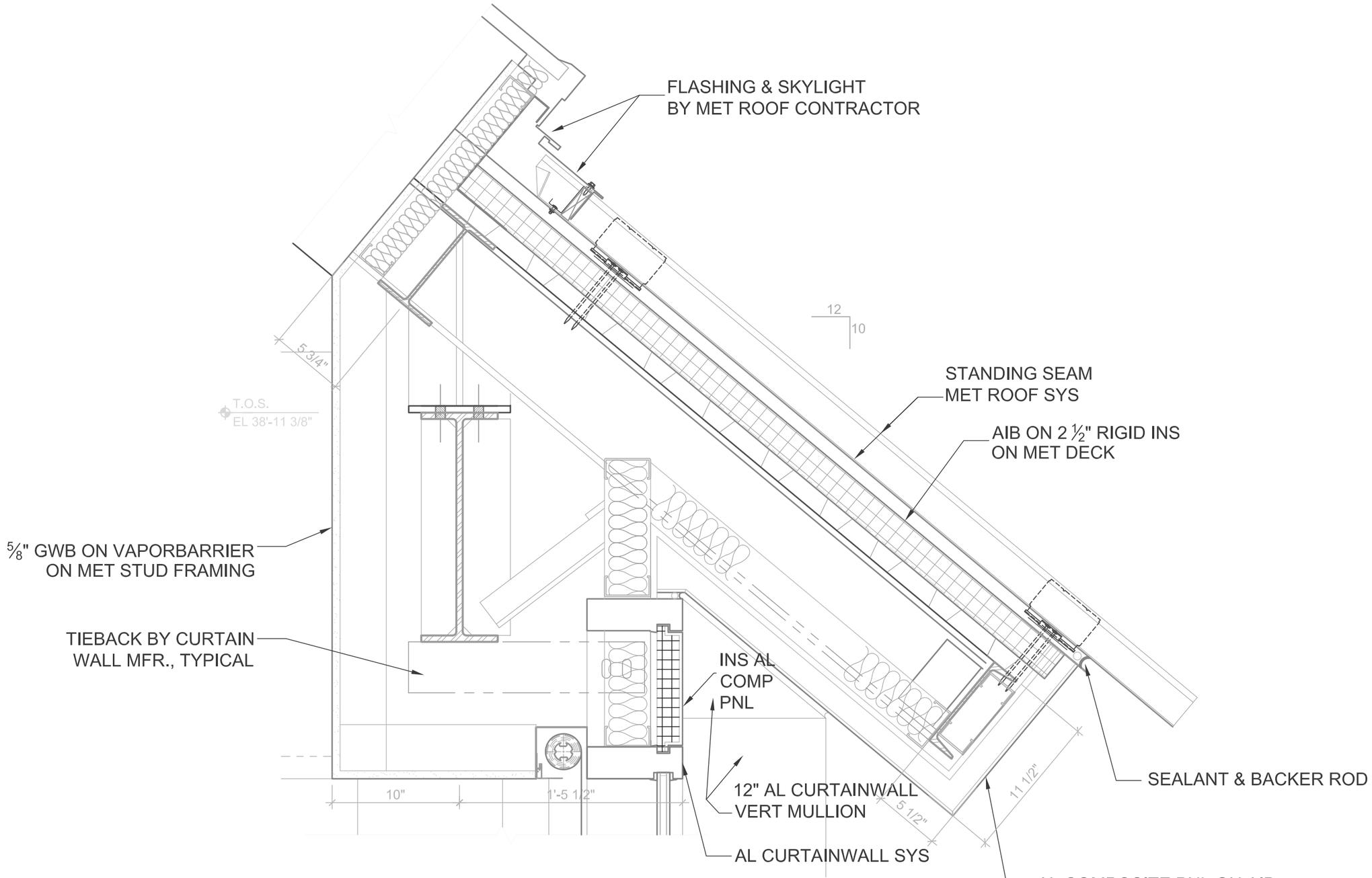
SECTION DETAIL AT ROOF SLOPE
METAL ROOF
GEISINGER GRAY'S WOODS AMBULATORY CARE CAMPUS
PATTON TOWNSHIP, CENTRE COUNTY, PA

Date
4/2/2008

Scale
1 1/2" = 1'

Sheet No.
A.4.1.1

File No.
2007.9.29



5 SECTION DETAIL @ ROOF EAVE - METAL ROOF
1 1/2" = 1'-0"

Drawn By
ELC

Client
Geisinger

No.	DATE	REVISION	BY

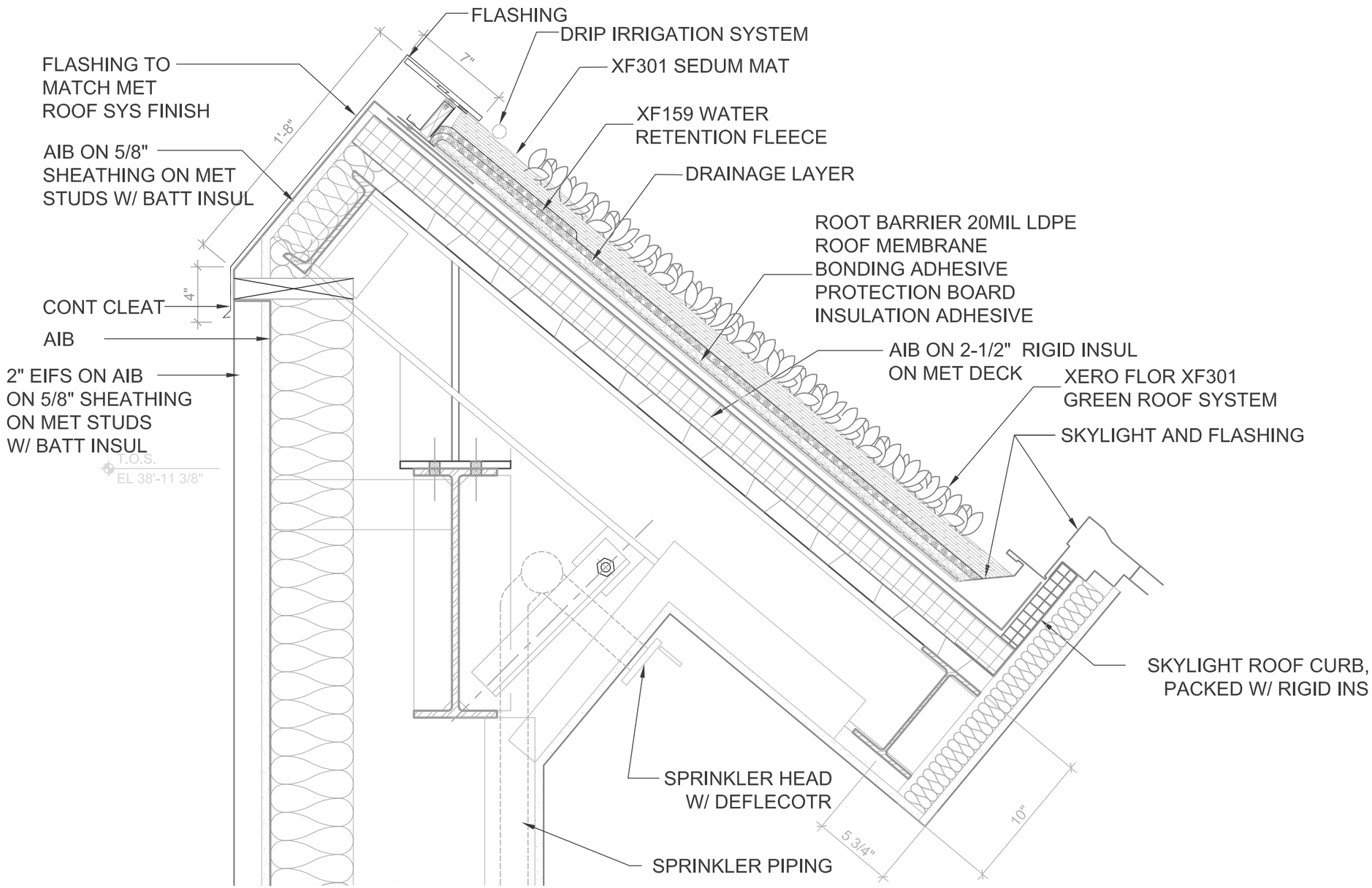
SECTION DETAIL AT ROOF EAVE
METAL ROOF
GEISINGER GRAY'S WOODS AMBULATORY CARE CAMPUS
PATTON TOWNSHIP, CENTRE COUNTY, PA

Date
4/2/2008

Scale
1 1/2" = 1'

Sheet No.
A.4.1.2

File No.
2007.9.29



10 SECTION DETAIL @ ROOF SLOPE - XERO FLOR

1 1/2" = 1'-0"

Drawn By
ELC

Client
Geisinger

No.	DATE	REVISION	BY

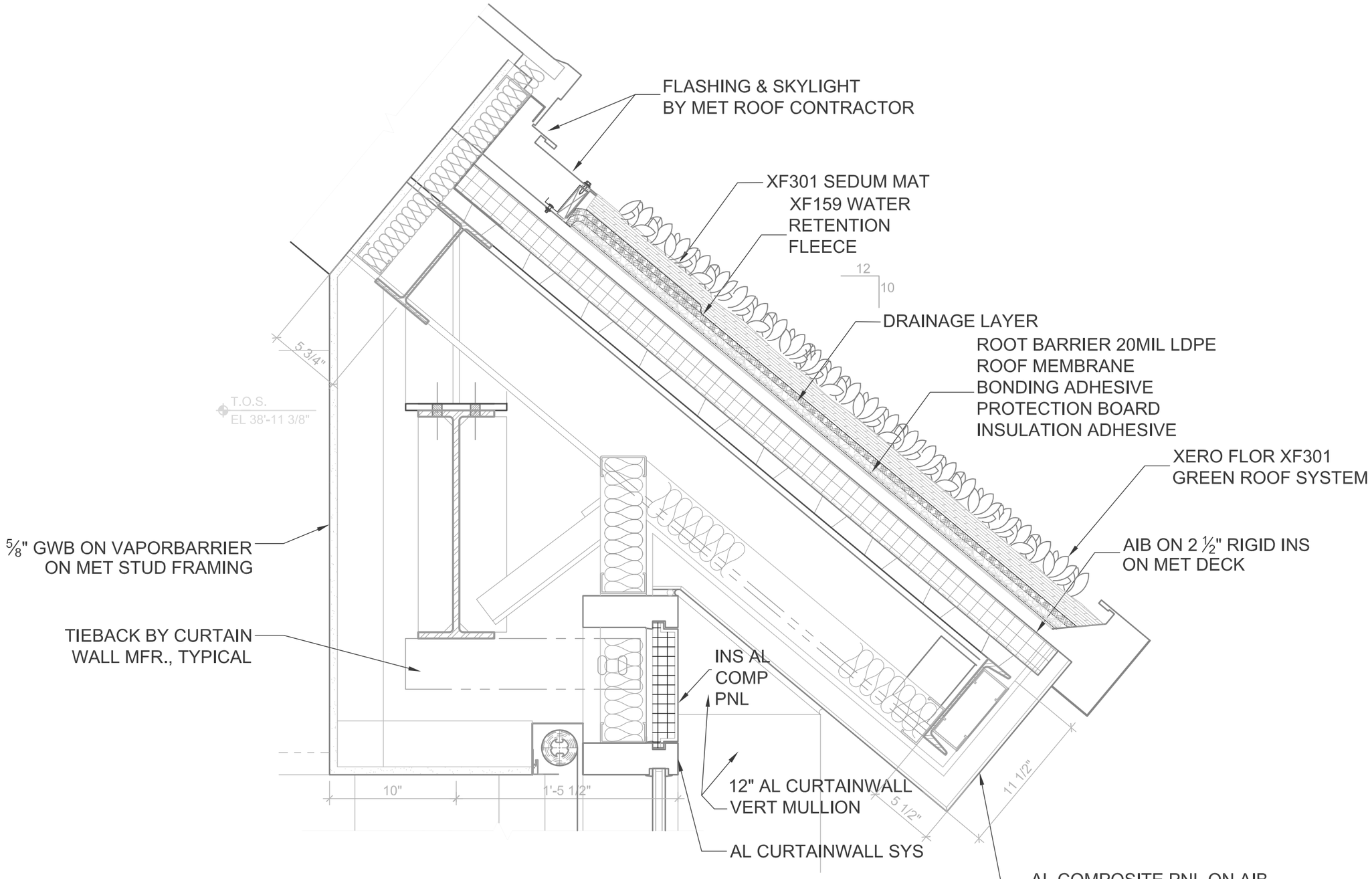
SECTION DETAIL AT ROOF SLOPE
XERO FLOR GREEN ROOF
GEISINGER GRAY'S WOODS AMBULATORY CARE CAMPUS
PATTON TOWNSHIP, CENTRE COUNTY, PA

Date
4/2/2008

Scale
1 1/2" = 1'

Sheet No.
A.4.2.1

File No.
2007.9.29



5 SECTION DETAIL @ ROOF EAVE - XERO FLOR
1 1/2" = 1'-0"

Drawn By
ELC

Client
Geisinger

No.	DATE	REVISION	BY

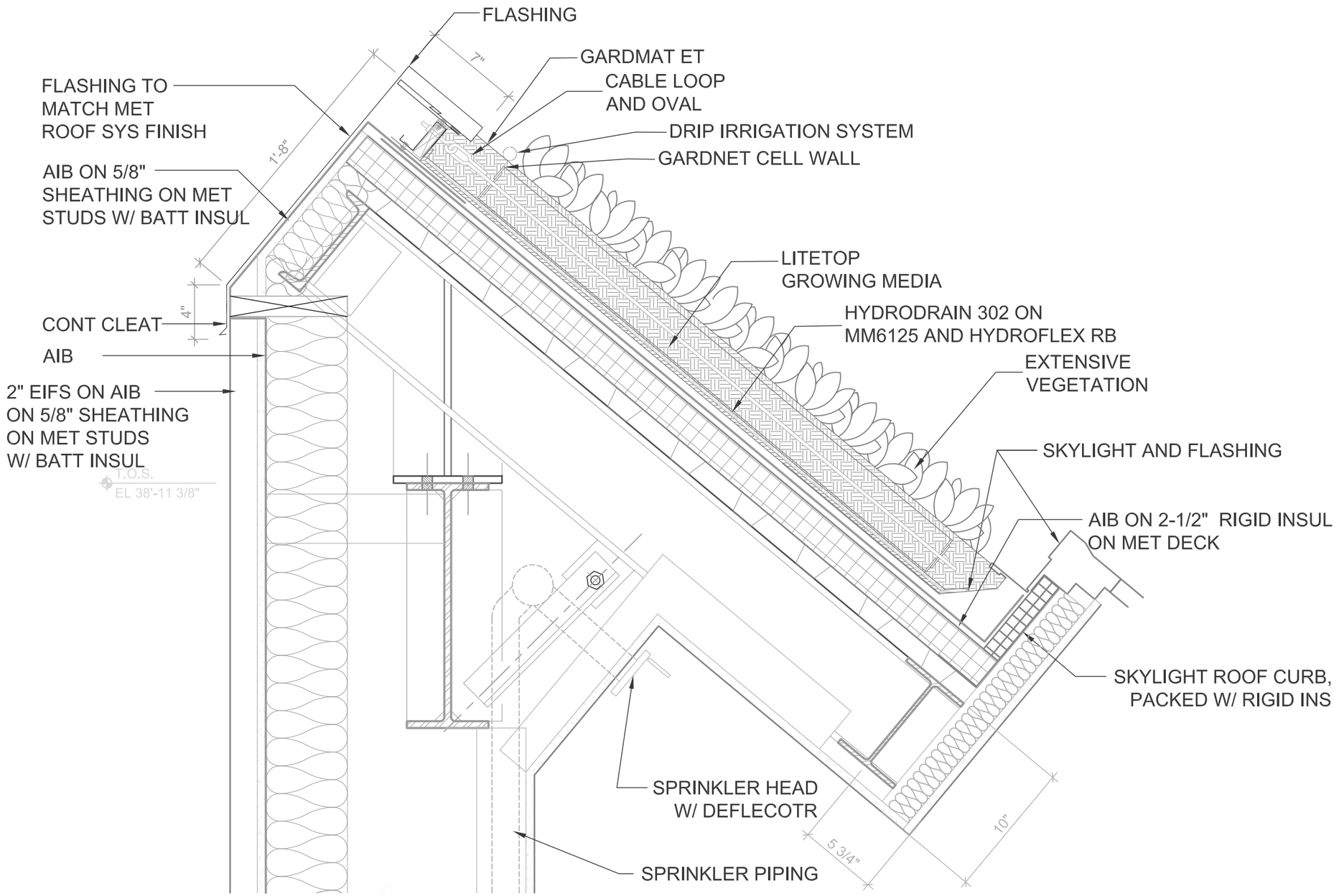
SECTION DETAIL AT ROOF EAVE
XERO FLOR GREEN ROOF
GEISINGER GRAY'S WOODS AMBULATORY CARE CAMPUS
PATTON TOWNSHIP, CENTRE COUNTY, PA

Date
4/2/2008

Scale
1 1/2" = 1'

Sheet No.
A.4.2.2

File No.
2007.9.29



10 SECTION DETAIL @ ROOF SLOPE - HYDROTECH

1 1/2" = 1'-0"

Drawn By
ELC

Client
Geisinger

No.	DATE	REVISION	BY

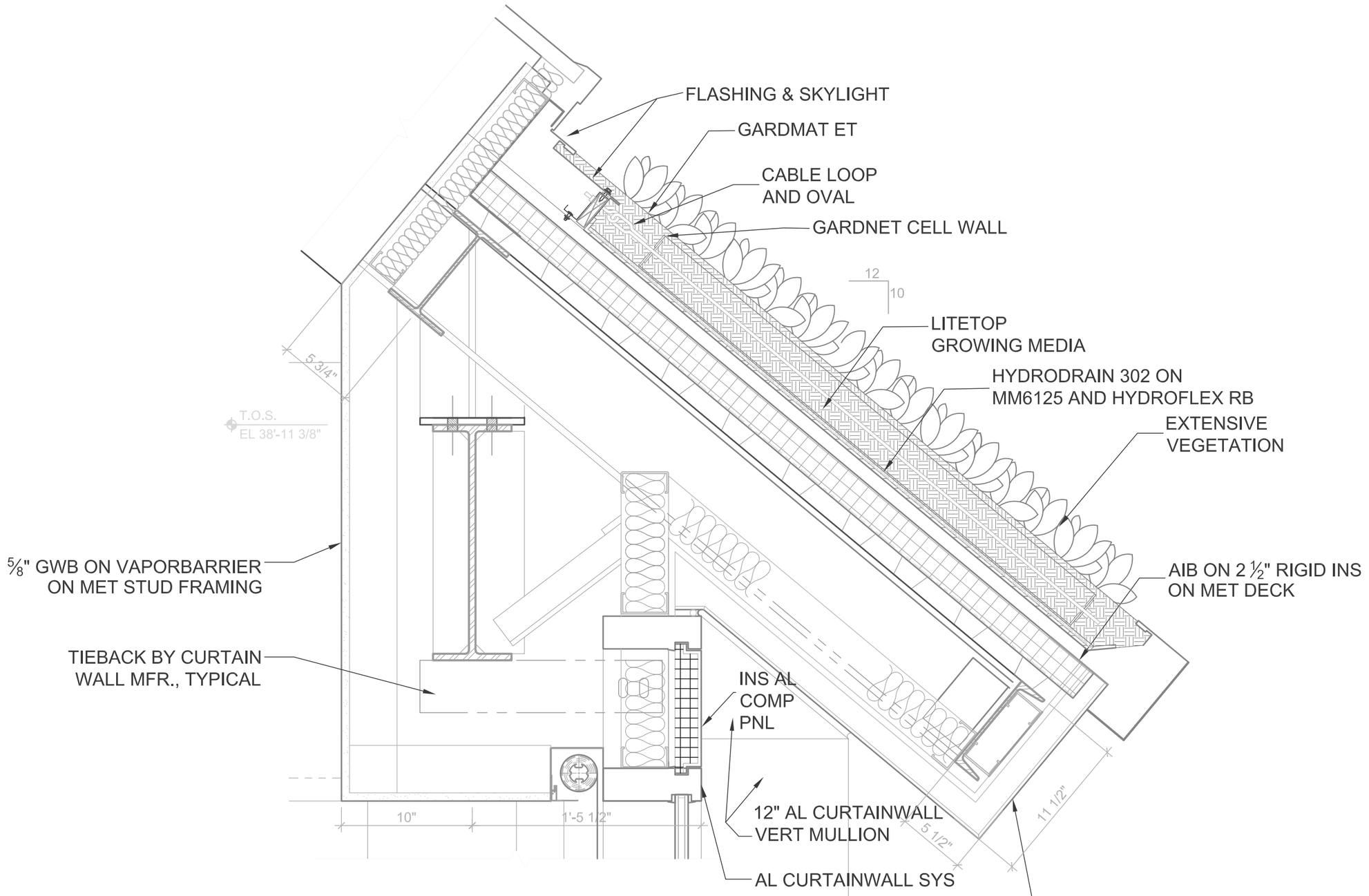
SECTION DETAIL AT ROOF SLOPE
HYDROTECH GREEN ROOF
GEISINGER GRAY'S WOODS AMBULATORY CARE CAMPUS
PATTON TOWNSHIP, CENTRE COUNTY, PA

Date
4/2/2008

Scale
1 1/2" = 1'

Sheet No.
A.4.3.1

File No.
2007.9.29



5 SECTION DETAIL @ ROOF EAVE - HYDROTECH
1 1/2" = 1'-0"

Drawn By
ELC

Client
Geisinger

No.	DATE	REVISION	BY

SECTION DETAIL AT ROOF EAVE
HYDROTECH GREEN ROOF
GEISINGER GRAY'S WOODS AMBULATORY CARE CAMPUS
PATTON TOWNSHIP, CENTRE COUNTY, PA

Date
4/2/2008

Scale
1 1/2" = 1'

Sheet No.
A.4.3.2

File No.
2007.9.29

APPENDIX C:
GREEN ROOF MATERIALS & MECHANICAL CALCULATIONS

Xero Flor® Green Roof Systems

Xero Flor green roof technologies provide a variety of roof vegetation solutions, from our lightweight XF301 extensive green roof system to our semi-intensive and intensive systems. Xero Flor systems are backed by 35 years of research and installation experience on green roof projects ranging in size from single-family residences to multiple acre commercial properties.

Xero Flor green roof mats contain a special blend of Sedums and other succulents, which are especially tolerant to the extreme conditions of the rooftop environment. These plants are naturally drought resistant and low profile, requiring very minimal maintenance. The Xero Flor green roof mat plant mix provides dramatic leaf and floral coloration in response to seasonal climate fluctuations. The Sedum and succulent plant community changes from light and dark greens in spring to greens, reds and yellows in autumn. The mats display a dynamic mosaic of yellow, white, and pink flower colors over the extended growing season.

Xero Flor systems are continually improved by field and greenhouse testing resulting in numerous patented and certified features for long lasting, proven products. Xero Flor components are made from recycled and fully recyclable materials earning additional LEED® credits for green building designs.

Xero Flor's patented, pre-cultivated vegetation blankets provide "instant green" coverage. The textile-based carrier design allows easier assembly with less waste than injected-plastic trays or dimple-sheet systems. Pre-vegetated blankets prevent substrate erosion and reduce labor costs and installation times relative to grown-on systems. The Xero Flor pre-vegetated mat design accommodates dynamic roof features, such as variable slope angles, curved edges, and roof penetrations.

Xero Flor America LLC 3821 East Geer Street Durham, NC 27704
919 - 683 -1073
www . xeroflora . com

Why Install A Green Roof ?

The primary appeal of green roofs is replacement of unattractive roof surfaces with a landscaped covering. Cityscapes typically contain an abundance of conventional roofing sightlines, which create an "urban desert" appearance.

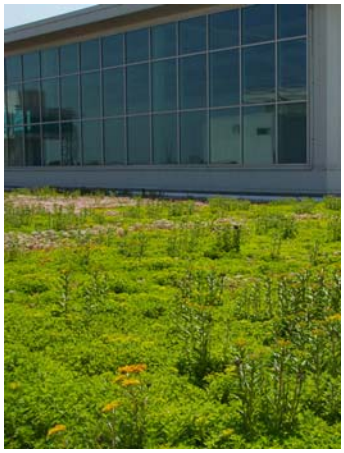
Green roofs provide both aesthetic quality and restore a portion of the natural habitat displaced by the building footprint. This ecosystem attracts birds and beneficial insects, including pollinators and predators of insect pests.

Green roofs reduce and purify storm water runoff. Incoming rainfall is retained and slowly released and evaporated, with as much as 80% decrease in annual stormwater runoff.

Green roofs filter numerous hazardous substances from rainfall runoff, including heavy metals, acid rain, and airborne pathogens. Green roofs also clean the air of green house gases and particulate debris, which cause urban smog and respiratory distress.

Green roofs protect roof membranes from harmful UV rays and extreme temperature fluctuations. The result is a 2- to 3-fold lifetime extension of roofing materials, saving building owners from roof replacement costs.

Local environments also benefit from overall cooler building temperatures by reducing the Urban Heat Island Effect, which have been shown to increase ambient air temperatures in city centers as much as 10ºC (~20ºF).



As well as saving money through roof lifetime extension, green roofs reduce cooling costs and energy consumption. Less heat is conducted through vegetated layers compared to typical roofing materials. In addition to diminished thermal loading, cooler air temperatures are drawn into intake vents resulting in further reduction in air conditioning energy costs. Due to the multiple environmental and economic benefits, green roofs are becoming an essential design tool for urban planning, sustainable architecture and construction, and land use policymaking.

BENEFITS

- INCREASED AESTHETIC VALUE
- REDUCTION OF AIR POLLUTION
- OXYGEN PRODUCTION
- STORMWATER MANAGEMENT
- REDUCED COOLING COSTS
- INCREASED LIFESPAN OF ROOF MEMBRANES
- SOUND INSULATION





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Durham, NC 27704

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greenroof@xeroflora.com

Xero Flor XF301 green roof system:

- saturated weight (as shown) 12 lbs/sqft
- XF301-2FL (extra fleece) 15 lbs/sqft
- XF301+ (extra medium) 15 – 18 lbs/sqft
- may be ballasted to 24 lbs/sqft

} XF301 Sedum Mat (1 1/2”)

} XF159 Water Retention Fleece (1/2”)

} XF108H Drainage Layer (1/2”)

(not shown: XF112 Root Barrier 20mil LDPE)

HYDROTECH

GARDEN ROOF

GREEN

ROOFS

FOR THE

LIFE OF THE

STRUCTURE

"We shape our dwellings and afterwards our dwellings shape our lives."

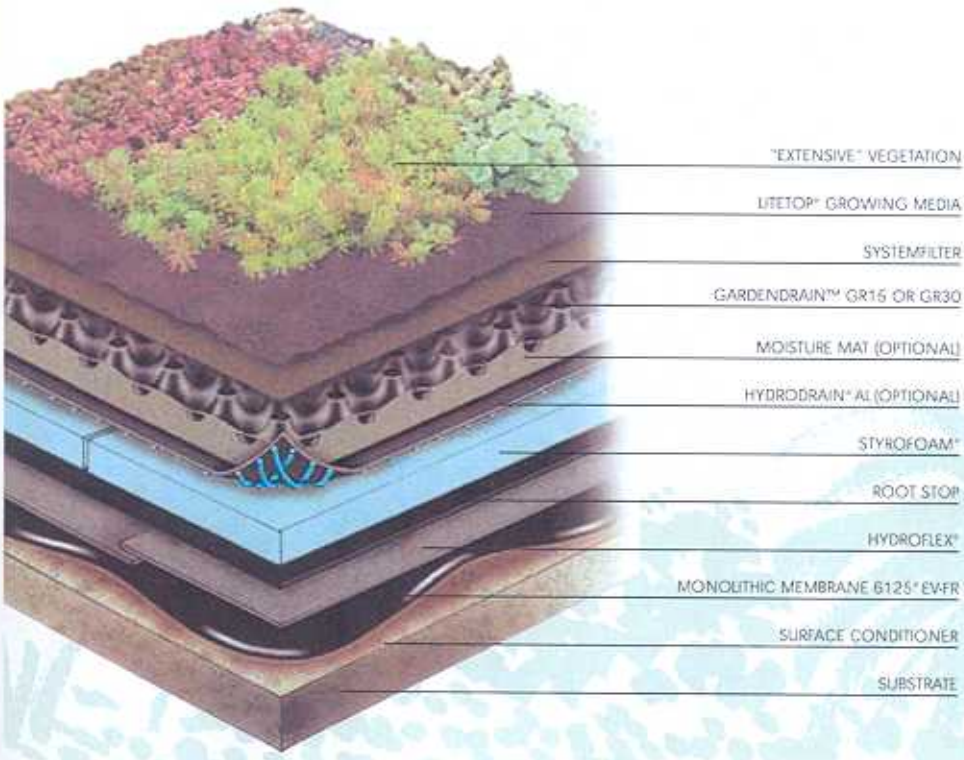
WINSTON CHURCHILL, 1960

Hydrotech, a global leader in the development of waterproofing and roofing technology, is once again reshaping the future of roofing with the Garden Roof® Assembly. Our roofing/waterproofing membrane, MM6125, has been in the field for over 40 years and is rated by the British Board of Agrément as ". . . an effective barrier to the transmission of water . . . for the design life of the roof of which it is incorporated." This is a critical element when considering "life cycle" costs. Now, Hydrotech has combined state-of-the-art European technology with our decades of field experience to bring the building owner the most advanced "green" roof system in the marketplace today.

Hydrotech's Garden Roof® adds beauty to the once forgotten area of a building, reclaiming this neglected "fifth elevation" to nature by integrating the building and surrounding landscape. The naked roof level can now be revitalized with a wide variety of plantings from sedums, herbs, grasses, wild flowers, sod lawns, shrubs and small ornamental trees. Hardscape elements, such as pavers, and water features can also be integrated into your design.

Existing flat and sloping roofs offer an ideal opportunity for creating new "green" areas for either ecological, economic or recreational benefits to the Building Owner, such as:

- storm water management
- improving energy efficiency of building
- increasing useable space for tenants
- increasing property value
- creating therapeutic and peaceful environments for hospitals
- absorbing external noise pollution
- improving quality of life
- increasing aesthetic appeal
- recycling of nutrients
- processing of airborne toxins
- reoxygenating the air
- provision of wildlife corridors



The Garden Roof® Assembly combines Hydrotech's superior waterproofing technology with an engineered system of drainage/water retention components. Hydrotech can offer detailed solutions to the architect and owner to bring the structure back to "life".

A brief description of some of the **Garden Roof®** components:

Roofing Membrane—Monolithic Membrane 6125-EV, a high endurance waterproofing membrane, no VOC's, 25% post-consumer recycled content.

Protection Course/Root Barrier—Hydroflex 30 and Root Stop or Hydroflex RB. Light weight or heavy-duty root barrier sheets.

Insulation—Dow STYROFOAM® moisture resistant, thermally stable, reusable, CFC free. (optional component)

Drainage/Water Retention Elements—GR15, GR30 or GR50; 100% recycled polyethylene three-dimensional panels provide water storage, drainage, and aeration for substrate soil. Moisture Mat, a specially designed polypropylene mat can be added for extra water retention.

In addition to providing the **Garden Roof®** components, Hydrotech can work in tandem with the landscape architect to provide technical guidance on the selection of an appropriate blend of our LiteTop® lightweight soils with the selected vegetation.

The **Garden Roof®** Assembly by Hydrotech is a sustainable system design; backed by over 40 years of combined experience in premium waterproofing and green roof components. For more detailed information regarding the planning of your next "Garden Roof", contact a Hydrotech representative to request a Planning Guide.

WEIGHT SAVINGS COMPARISON

System	Approximate Wet Weight/SF
Traditional Green Roof	125 - 180 lbs.
Hydrotech Garden Roof - Intensive	45 lbs.+
Hydrotech Garden Roof - Extensive	18 - 31 lbs.

UNITED STATES

American Hydrotech Inc. 303 East Ohio Street, Chicago, Illinois 60611-3387

Chicago 800.877.6125 312.337.4998 FAX 312.661.0731

CANADA

Hydrotech Membrane Corporation 10,951 Parkway, Ville D'Anjou, Quebec H1J 1S1

Montreal 800.361.8924 514.353.6000 FAX 514.354.6649

WORLDWIDE

World Wide Web: www.hydrotechusa.com

CCMC CANADIAN CONSTRUCTION MATERIALS CENTRE

National Defence

Table 7-3 Solar Intensity and Solar Heat Gain Factors for 40°N Latitude[a]

(Table 8, Chapter 27, 1989 ASHRAE *Handbook — Fundamentals*)

Date	Solar Time	Direct Normal Btu/h·ft²	Solar Heat Gain Factors, Btu/h·ft²																	Solar Time
			N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	HOR	
Jan 21	0800	142	5	5	17	71	111	132	133	114	75	22	6	5	5	5	5	5	14	1600
	0900	239	12	12	13	74	154	205	224	209	160	82	13	12	12	12	12	12	55	1500
	1000	274	16	16	16	31	124	199	241	246	213	146	51	17	16	16	16	16	96	1400
	1100	289	19	19	19	20	61	156	222	252	244	198	118	28	19	19	19	19	124	1300
	1200	294	20	20	20	20	21	90	179	234	254	234	179	90	21	20	20	20	133	1200
	HALF DAY TOTALS		61	61	73	199	452	734	904	932	813	561	273	101	62	61	61	61	354	
Feb 21	0700	55	2	3	23	40	51	53	47	34	14	2	2	2	2	2	2	2	4	1700
	0800	219	10	11	50	129	183	206	199	160	94	18	10	10	10	10	10	10	43	1600
	0900	271	16	16	22	107	186	234	245	218	157	66	17	16	16	16	16	16	98	1500
	1000	294	21	21	21	49	143	211	246	243	203	129	38	21	21	21	21	21	143	1400
	1100	304	23	23	23	24	71	160	219	244	231	184	103	27	23	23	23	23	171	1300
	1200	307	24	24	24	24	25	86	170	222	241	222	170	86	25	24	24	24	180	1200
	HALF DAY TOTALS		84	86	152	361	648	916	1049	1015	821	508	250	114	85	84	84	84	548	
Mar 21	0700	171	9	29	93	140	163	161	135	86	22	8	8	8	8	8	8	8	26	1700
	0800	250	16	18	91	169	218	232	211	157	74	17	16	16	16	16	16	16	85	1600
	0900	282	21	22	47	136	203	238	236	198	128	40	22	21	21	21	21	21	143	1500
	1000	297	25	25	27	72	153	207	229	216	171	95	29	25	25	25	25	25	186	1400
	1100	305	28	28	28	30	78	151	198	213	197	150	77	30	28	28	28	28	213	1300
	1200	307	29	29	29	29	31	75	145	191	206	191	145	75	31	29	29	29	223	1200
	HALF DAY TOTALS		114	139	302	563	832	1035	1087	968	694	403	220	132	114	113	113	113	764	
Apr 21	0600	89	11	46	72	87	88	76	52	18	5	5	5	5	5	5	5	5	11	1800
	0700	206	16	71	140	185	201	186	143	75	16	14	14	14	14	14	14	14	61	1700
	0800	252	22	44	128	190	224	223	188	124	41	22	21	21	21	21	21	21	123	1600
	0900	274	27	29	80	155	202	219	203	156	83	29	27	27	27	27	27	27	177	1500
	1000	286	31	31	37	92	152	187	193	170	121	56	32	31	31	31	31	41	217	1400
	1100	292	33	33	34	39	81	130	160	166	146	102	52	35	33	33	33	33	243	1300
	1200	293	34	34	34	34	36	62	108	142	154	142	108	62	36	34	34	34	252	1200
	HALF DAY TOTALS		154	265	501	758	957	1051	994	782	488	296	199	157	148	147	147	147	957	
May 21	0500	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1900
	0600	144	36	90	128	145	141	115	71	18	10	10	10	10	10	10	10	11	31	1800
	0700	216	28	102	165	202	209	184	131	54	20	19	19	19	19	19	19	19	87	1700
	0800	250	27	73	149	199	220	208	164	93	29	25	25	25	25	25	25	25	146	1600
	0900	267	31	42	105	164	197	200	175	121	53	32	30	30	30	30	30	30	195	1500
	1000	277	34	36	54	105	148	168	163	133	83	40	35	34	34	34	34	34	234	1400
	1100	283	36	36	38	48	81	113	130	127	105	70	42	38	36	36	36	36	257	1300
	1200	284	37	37	37	38	40	54	82	104	113	104	82	54	40	38	37	37	265	1200
	HALF DAY TOTALS		215	404	666	893	1024	1025	881	601	358	247	200	180	176	175	174	175	1083	
Jun 21	0500	22	10	17	21	22	20	14	6	2	1	1	1	1	1	1	1	2	3	1900
	0600	155	48	104	143	159	151	121	70	17	13	13	13	13	13	13	13	14	40	1800
	0700	216	37	113	172	205	207	178	122	46	22	21	21	21	21	21	21	21	97	1700
	0800	246	30	85	156	201	216	199	152	80	29	27	27	27	27	27	27	27	153	1600
	0900	263	33	51	114	166	192	190	161	105	45	33	32	32	32	32	32	32	201	1500
	1000	272	35	38	63	109	145	158	148	116	69	39	36	35	35	35	35	35	238	1400
	1100	277	38	39	40	52	81	105	116	110	88	60	41	39	38	38	38	38	260	1300
	1200	279	38	38	38	40	41	52	72	89	95	89	72	52	41	40	38	38	267	1200
	HALF DAY TOTALS		253	470	734	941	1038	999	818	523	315	236	204	191	188	187	186	188	1126	
Jul 21	0500	2	1	2	2	2	2	1	1	0	0	0	0	0	0	0	0	0	0	1900
	0600	138	37	89	125	142	137	112	68	18	11	11	11	11	11	11	11	12	32	1800
	0700	208	30	102	163	198	204	179	127	53	21	20	20	20	20	20	20	20	88	1700
	0800	241	28	75	148	196	216	203	160	90	30	26	26	26	26	26	26	26	145	1600
	0900	259	32	44	106	163	193	196	170	118	52	33	31	31	31	31	31	31	194	1500
	1000	269	35	37	56	106	146	165	159	129	81	41	36	35	35	35	35	35	231	1400
	1100	275	37	38	40	50	81	111	127	123	102	69	43	39	37	37	37	37	254	1300
	1200	276	38	38	38	40	41	55	80	101	109	101	80	55	41	40	38	38	262	1200
	HALF DAY TOTALS		223	411	666	885	1008	1003	858	584	352	248	204	186	181	180	180	181	1076	
Aug 21	0600	81	12	44	68	81	82	71	48	17	6	5	5	5	5	5	5	5	12	1800
	0700	191	17	71	135	177	191	177	135	70	17	16	16	16	16	16	16	16	62	1700
	0800	237	24	47	126	185	216	214	180	118	41	23	23	23	23	23	23	23	122	1600
	0900	260	28	31	82	153	197	212	196	151	80	31	28	28	28	28	28	28	174	1500
	1000	272	32	33	40	93	150	182	187	165	116	56	34	32	32	32	32	32	214	1400
	1100	278	35	35	36	41	81	128	156	160	141	99	52	37	35	35	35	35	239	1300
	1200	280	35	35	35	36	38	63	106	138	149	138	106	63	38	36	35	35	247	1200
	HALF DAY TOTALS		164	273	498	741	928	1013	956	751	474	296	205	166	157	156	156	156	946	
Sep 21	0700	149	9	27	84	125	146	144	121	77	21	9	9	9	9	9	9	9	25	1700
	0800	230	17	19	87	160	205	218	199	148	71	18	17	17	17	17	17	17	82	1600
	0900	263	22	23	47	131	194	227	226	190	124	41	23	22	22	22	22	22	138	1500
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	1100	287	29	29	29	31	78	147	192	207	191	146	77	31	29	29	29	29	206	1300
	1200	290	30	30	30	30	32	75	142	185	200	185	142	75	32	30	30	30	215	1200
	HALF DAY TOTALS		119	142	291	534	787	980	1033	925	672	396	222	137	119	118	118	118	738	
Oct 21	0700	48	2	3	20	36	45	47	42	30	12	2	2	2	2	2	2	2	4	1700
	0800	204	11	12	49	123	173	195	188	151	89	18	11	11	11	11	11	11	43	1600
	0900	257	17	17	23	104	180	225	235	209	151	64	18	17	17	17	17	17	97	1500
	1000	280	21	21	22	50	139	205	238	235	196	125	38	22	21	21	21	21	140	1400
	1100	291	24	24	24	25	71	156	212	236	224	178	101	28	24	24	24	24	168	1300
	1200	294	25	25	25	25	27	85	165	216	234	216	165	85	27	25	25	25	177	1200
	HALF DAY TOTALS		88	89	152	351	623	878	1006	974	791	493	247	117	89	88	88	88	540	
Nov 21	0800	136	5	5	18	69	108	128	129	110	72	21	6	5	5	5	5	5	14	1600
	0900	232	12	12	13	73	151	201	219	204	156	80	13	12	12	12	12	12	55	1500
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	1100	283	19	19	19	20	61	154	218	248	240	194	116	28	19	19	19	19	123	1300
	1200	288	20	20	20	20	21	89	176	231	250	231	176	89	21	20	20	20	132	1200
	HALF DAY TOTALS		63	63	75	198	445	721	887	914	798	551	269	101	63	63	63	63	354	
Dec 21	0800	89	3	3	8	41	67	82	84	73	50	17	3	3	3	3	3	3	6	1600
	0900	217	10	10	11	60	135	185	205	194	151	83	13	10	10	10	10	10	39	1500
	1000	261	14	14	14	25	113	188	232	239	210	146	55	15	14	14	14	14	77	1400
	1100	280	17	17	17	17	56	151	217	249	242	198	120	28	17	17	17	17	104	1300
	1200	285	18	18	18	18	19	89	178	233	253	233	178	89	19	18	18	18	113	1200
	HALF DAY TOTALS		52	52	56	146	374	649	822	867	775	557	276	94	53	52	52	52	282	

	N	NNW	NW	WNW	W	WSW	SW	SSW	S	SSE	SE	ESE	E	ENE	NE	NNE	HOR	PM

Roof No.	Description of construction	Weight, lb/ft^2	U value, Btu/hr·ft^2·°F	Solar time 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Hr of max. CLTD	Min. CLTD	Max. CLTD	Diff. CLTD
1	Steel sheet with 1" (or 2") insulation	9 (10)	0.134 (0.092)	2	0	-2	-3	-4	-4	-1	9	23	37	50	62	71	77	78	74	67	56	42	28	18	12	8	5	15	-4	78	82
2	1" wood with 1" insulation	10	0.115	20	15	11	8	5	3	2	3	7	13	21	30	40	48	55	60	62	61	58	51	44	37	30	25	17	2	62	60
3	4" lightweight concrete	20	0.134	19	14	10	7	4	2	0	0	4	10	19	29	39	48	56	62	65	64	61	54	46	38	30	24	17	0	65	65
4	2" heavyweight concrete with 1" (or 2") insulation	30	0.131	28	25	23	20	17	15	13	13	14	16	20	25	30	35	39	43	46	47	46	44	41	38	35	32	18	13	47	34
5	1" wood with 2 " insulation	10	0.083	25	20	16	13	10	7	5	5	7	12	18	25	33	41	48	53	57	57	56	52	46	40	34	29	18	5	57	52
6	6" lightweight concrete	26	0.109	32	28	23	19	16	13	10	8	7	8	11	16	22	29	36	42	48	52	54	54	51	47	42	37	20	7	54	47
7	2.5" wood with 1" insulation	15	0.096	34	31	29	26	23	21	18	16	15	15	16	18	21	25	30	34	38	41	43	44	44	42	40	37	21	15	44	29
8	8" lightweight concrete	33	0.093	39	36	33	29	26	23	20	18	15	14	14	15	17	20	25	29	34	38	42	45	46	45	44	42	21	14	46	32
9	4" heavyweight concrete with 1" (or 2") insulation	53 (54)	0.128 (0.090)	30	29	27	26	24	22	21	20	20	21	22	24	27	29	32	34	36	38	38	38	37	36	34	33	19	20	38	18
10	2.5" wood with 2" insulation	15	0.072	35	33	30	28	26	24	22	20	18	18	18	20	22	25	28	32	35	38	40	41	41	40	39	37	21	18	41	23
11	Roof terrace system	77	0.082	30	29	28	27	26	25	24	23	22	22	22	23	23	25	26	28	29	31	32	33	33	33	33	32	22	22	33	11
12	6" heavyweight concrete with 1" (or 2") insulation	77 (77)	0.125 (0.088)	29	28	27	26	25	24	23	22	21	21	22	23	25	26	28	30	32	33	34	34	34	33	32	31	20	21	34	13
13	4" wood with 1" (or 2") insulation	19 (20)	0.082 (0.064)	35	34	33	32	31	29	27	26	24	23	22	21	22	22	24	25	27	30	32	34	35	36	37	36	23	21	37	16

Erica L. Craig
Construction Management
April 9th, 2008
Final Report
Dr. Riley

Current Roofing Systems					
	Amount		Cost		Total
Green Roof - Boiler Room	3290	SF	25	$/SF	82,250
+ Plants for Green Roof	3290	SF	5	$/SF	16,450
Cool Roof - Flat Main Roof	24200	SF	10	$/SF	242,000
Metal System	5105	SF	16	$/SF	81,680
				PRICE	***$422,380***

Relocation of Green Roof - Hydrotech					
	Amount		Cost		Total
Cool Roof - Boiler Room	3290	SF	10	$/SF	32,900
Cool Roof - Flat Main Roof	24200	SF	10	$/SF	242,000
Green Roof - Sloped	5105	SF	32	$/SF	163,360
+ Irrigation					2,500
+ Plants for Green Roof	5105	SF	5	$/SF	25,525
				PRICE	***$466,285***

Relocation of Green Roof - XeroFlor					
	Amount		Cost		Total
Cool Roof - Boiler Room	3290	SF	10	$/SF	32,900
Cool Roof - Flat Main Roof	24200	SF	10	$/SF	242,000
Green Roof - Sloped	5105	SF	13	$/SF	66,365
+ Shipping Costs	5105	SF	0.25	$/SF	1,500
+ Roofing Membrane & Insulation	5105	SF	8	$/SF	40,840
+ Tacking and Accessories	5105	SF	2	$/SF	10,210
+ Irrigation					2,500
				PRICE	***$396,315***

	Current Roofing System	Relocation with Hydrotech	Relocation with XeroFlor
Initial Cost	$422,400	$466,300	$396,300
Difference		$43,900	-$26,100

Erica L. Craig
Construction Management
April 9th, 2008
Final Report
Dr. RIley

Metal Roof Thermal Calculations

Design Temp Change 20 °
Area of Roof 5015 SF

Material	Thickness Inches	Thermal Conductance But/hr*ft²°F	Thermal Resistance hr*ft²°F/Btu	Temperature Change Δ
Inside Air Film	-	1.64	0.61	0.56
Gypsum Wallboard	0.50	2.22	0.45	0.41
Air Space	6.00	-	1.00	0.92
Metal Decking	1.00	-	0.00	0.00
Rigid Insulation	2.50	0.07	15.30	14.02
AIB	1.00	0.23	4.30	3.94
Metal Roof	0.04	-	0.00	0.00
Outside Air Film	-	5.88	0.17	0.16
Total		0.05	21.83	20.00

Heat Flow Rate 4,594.59 Btu/hr
Degree Days 4926
543,191,351.35 Btu/year
162,957.41 kWh/year
$0.09 /kWh
Cost for Entire Year $14,666.17 /Year

Hydrotech Green Roof

Design Temp Change 20 °
Area of Roof 5015 SF

Material	Thickness Inches	Thermal Conductance But/hr*ft2°F	Thermal Resistance hr*ft2°F/Btu	Temperature Change Δ
Inside Air Film	-	1.64	0.61	0.52
Gypsum Wallboard	0.50	2.22	0.45	0.39
Air Space	6.00	-	1.00	0.86
Metal Decking	1.00	-	0.00	0.00
Rigid Insulation	2.50	0.07	15.30	13.11
Acoustical Board	1.00	0.23	4.30	3.68
HydroFlex 30	0.09	16.67	0.06	0.05
HydroDrain 300	0.22	2.22	0.45	0.39
LiteTop Soil	3.00	1.00	1.00	0.86
Outside Air Film	-	5.88	0.17	0.15
Total		0.04	23.34	20.00

Heat Flow Rate 4297.343616 Btu/hr
Degree Days 4926
508049151.7 Btu/year
152,414.75 kWh/year
$0.09 /kWh
Cost for Entire Year $13,717.33 /Year

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Construction Management
April 9th, 2008
Final Report
Dr. Riley

Xero Flor Green Roof

Design Temp Change	20	°
Area of Roof	5015	SF

Material	Thickness	Thermal Conductance	Thermal Resistance	Temperature Change
	Inches	But/hr*ft^2°F	hr*ft^2°F/Btu	Δ
Inside Air Film	-	1.64	0.61	0.52
Gypsum Wallboard	0.50	2.22	0.45	0.38
Air Space	6.00	1.00	1.00	0.85
Metal Decking	1.00	-	0.00	0.00
Rigid Insulation	2.50	0.07	15.30	13.03
Acoustical Board	1.00	0.23	4.30	3.66
Drainage Layer	0.50	2.22	0.45	0.38
Water Retention Fleece	0.50	5.00	0.20	0.17
Sedum Mat	1.50	1.00	1.00	0.85
Outside Air Film	-	5.88	0.17	0.14
Total		0.04	23.48	20.00

Heat Flow Rate	4,271.72	Btu/hr
Degree Days	4926	
	505,019,897.79	Btu/year
	151,505.97	kWh/year
	$0.09	/kWh
Cost for Entire Year	$13,635.54	/Year

Comparisons

	Metal Roof Current Design	Xero Flor Roof	Hydrotech Roof
Btu/Year	581,300,101	535,549,898	538,579,152
Difference from Current Design		45,750,204	42,720,950

	Metal Roof Current Design	Xero Flor Roof	Hydrotech Roof
R-Value	21.83	23.48	23.34
Difference from Current Design		-1.65	-1.51

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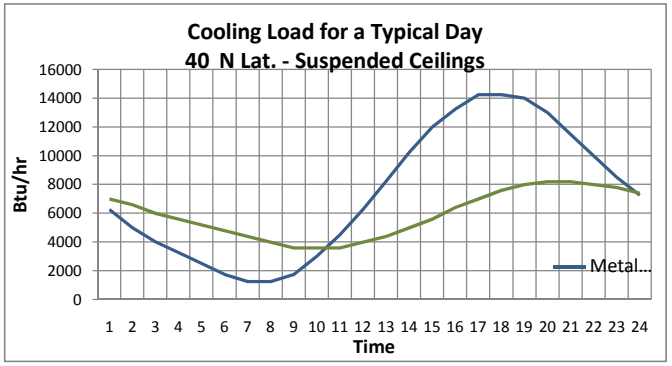
Construction Management
April 9th, 2008
Final Report
Dr. Riley

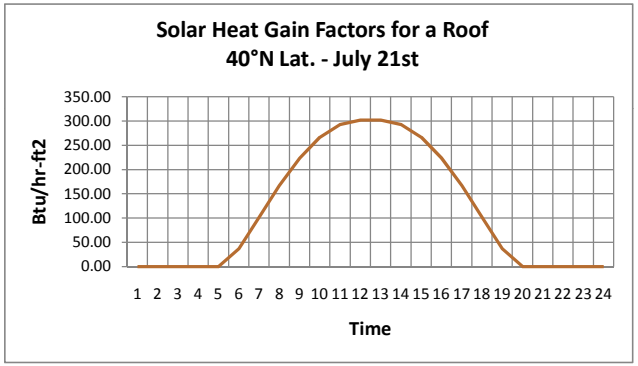
Solar Radiation Calculations for Geisinger Gray's Woods - 40°N Latitude - July 21st - Roofs with Suspended Ceilings

Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
HOR	0	0	0	0	0	32	88	145	194	231	254	262	262	254	231	194	145	88	32	0	0	0	0	0
x 1.15	0.00	0.00	0.00	0.00	0.00	36.80	101.20	166.75	223.10	265.65	292.10	301.30	301.30	292.10	265.65	223.10	166.75	101.20	36.80	0.00	0.00	0.00	0.00	0.00
Hour	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00
Metal Roof	-0.35	-0.35	-0.35	-0.35	-0.35	0.23	1.24	2.26	3.15	3.81	4.23	4.37	4.37	4.23	3.81	3.15	2.26	1.24	0.23	-0.35	-0.35	-0.35	-0.35	-0.35
Green Roof	-0.28	-0.28	-0.28	-0.28	-0.28	0.09	0.73	1.39	1.95	2.38	2.64	2.73	2.73	2.64	2.38	1.95	1.39	0.73	0.09	-0.28	-0.28	-0.28	-0.28	-0.28
CLTD																								
Metal Roof	25	20	16	13	10	7	5	5	7	12	18	25	33	41	48	53	57	57	56	52	46	40	34	29
Green Roof	35	33	30	28	26	24	22	20	18	18	18	20	22	25	28	32	35	38	40	41	41	40	39	37
Cooling Load													Btu/hr											

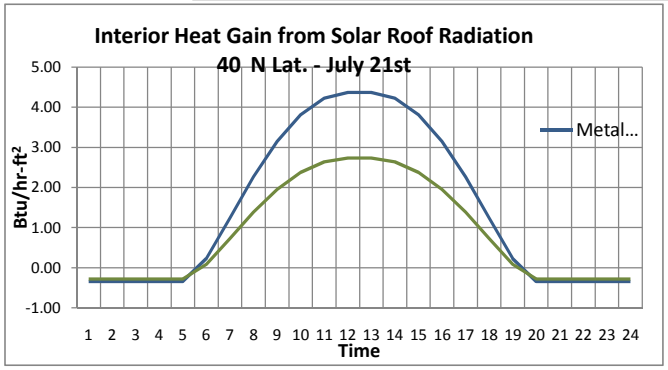
Hour	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Total Btu/Day	Number of Sunny Days Per Year	Total Btu/Year
Metal Roof	6250	5000	4000	3250	2500	1750	1250	1250	1750	3000	4500	6250	8250	10250	12000	13250	14250	14250	14000	13000	11500	10000	8500	7250	177,250	215	38,108,750
Green Roof	7000	6600	6000	5600	5200	4800	4400	4000	3600	3600	3600	4000	4400	5000	5600	6400	7000	7600	8000	8200	8200	8000	7800	7400	142,000	215	30,530,000

	Total kWh/Year	Cost /Year
Metal	11,432.63	$1,028.94
Green	9,159.00	$824.31





	Total Btu/Day	# of Sunny Days Per Year	Total Btu/Year
Metal Roof	177,250	215	38,108,750
Green Roof	142,000	215	30,530,000



Erica L. Craig
Construction Management
April 9th, 2008
Final Report
Dr. Riley

OPERATING COST SUMMARIES

	Current Roofing System	Relocation with Hydrotech	Relocation with XeroFlor
Initial Cost	$422,400	$466,300	$396,300
Difference		$43,900	-$26,100

CONDUCTION

	Current Roofing System	Relocation with Xero Flor	Relocation with Hydrotech
Yearly Operating Costs	$14,650.00	$13,700	$13,650
Difference		-$950	-$1,000

RADIATION

	Current Roofing System	Relocation with Hydrotech	Relocation with XeroFlor
Yearly Operating Costs	$1,030.00	$830	$830
Difference		-$200	-$200

XERO FLOR

Item	Savings
Initial Building Cost	26,100
Yearly Energy Costs	1,150
Total:	$27,250

HYDROTECH

Item	Savings
Initial Building Cost	-43,900
Yearly Energy Costs	1,200
Total:	-$34,600

APPENDIX D:
STRUCTURAL TABLES

Erica L. Craig
Construction Management
April 9th, 2008
Final Report
Dr. Riley

2" Decking with LW Concrete						
	Size	Amount		Cost		Total
LW Concrete	3.5"	12.5	CY	142	/CY	1,775
Concrete Placing	< 6" thick	12.5	CY	29	/CY	363
Steel Decking	2" LOK	0.09	100 Sq	16,000	/100 Sq	1,440
Steel Beams	W 16x26 3	30	Ft	40.5	/Ft	3,645
Steel Girders	W24x55 1	30	Ft	88	/Ft	2,640
Steel Columns	W10x68 2	15	Ft	103.23	/Ft	3,097
Fireproofing		900	SF	0.47	/SF	423
					PRICE	***$13,382***

Conclusions: **$685,000 cost, 51 days on schedule.**

2" Decking with Normal Weight Concrete						
	Size	Amount		Cost		Total
NW Concrete	4.5"	15.3	CY	97	/CY	1,484
Concrete Placing	< 6" thick	15.3	CY	29	/CY	444
Steel Decking	2" LOK	0.09	100 Sq	16,000	/100 Sq	1,440
Steel Beams	W14x22 4	30	Ft	35	/Ft	4,200
Steel Girders	W24x68 1	30	Ft	97	/Ft	2,910
Steel Columns	W10x88 2	15	Ft	127	/Ft	3,810
Fireproofing		900	SF	0.47	/SF	423
					PRICE	***$14,711***

Conclusions: **$75,000 over original design, approx. two days longer on schedule.**

CURRENT DESIGN	Size
LW Concrete	3.5"
Concrete Placing	< 6" thick
Steel Decking	2" LOK
Steel Beams	W 16x26 3
Steel Girders	W24x55 1
Steel Columns	W10x68 2
Fireproofing	

NW CONCRETE	Size
NW Concrete	4.5"
Concrete Placing	< 6" thick
Steel Decking	2" LOK
Steel Beams	W14x22 4
Steel Girders	W24x68 1
Steel Columns	W10x88 2
Fireproofing	

9/16" Formdecking w/ NW Concrete						
	Size	Amount		Cost		Total
NW Concrete	3"	8.3	CY	97	/CY	805
Concrete Placing	< 6" thick	8.3	CY	29	/CY	241
Steel Decking	9/6" FD	0.090	100 Sq	9500	/100 Sq	855
Steel Joists	18K9 10	30	Ft	229	/Ea	2,290
Steel Girders	W24x76 1	30	Ft	108	/Ft	3,240
Steel Columns	W10x88 2	15	Ft	127	/Ft	3,810
Steel Dunnage		900	SF	1.2	/SF	1,080
Fireproofing		900	SF	0.47	/SF	423
					PRICE	***$12,744***

Conclusions: **$40,000 under original design, same schedule.**

CURRENT DESIGN	Size
LW Concrete	3.5"
Concrete Placing	< 6" thick
Steel Decking	2" LOK
Steel Beams	W 16x26 3
Steel Girders	W24x55 1
Steel Columns	W10x68 2
Fireproofing	

FORMDECK	Size
NW Concrete	3"
Concrete Placing	< 6" thick
Steel Decking	9/6" FD
Steel Joists	18K9 10
Steel Girders	W24x76 1
Steel Columns	W10x88 2
Steel Dunnage	
Fireproofing	

System	Cost	Difference
2"Decking with LW Concrete - *Current Design*	$347,942	-
2" Decking with NW Concrete	$382,481	$34,538
9/16" Form Decking with NW Concrete	$331,339	-$16,604

APPENDIX E:
SURVEY MATERIAL

Industry Survey

Permitting and Approvals for New Commercial Construction

Name:
Position:

Are you responsible for approving any or all building permits for new commercial construction projects, and which ones?

If so, what is the most time and money consuming component of the process for your department?

Are there some permits that are easier (faster, cheaper) to approve than others?

What, do you feel, is the best way for developers, construction managers to improve permitting packages so not to cause resubmissions or delays?

Has your department ever considered changing the permitting process? If it has been changed recently, why did the change occur?

Industry Survey

Permitting and Approvals for New Commercial Construction

Name: Ned Liggett
Position: Commercial Plan Examiner

Are you responsible for approving any or all building permits for new commercial construction projects, and which ones?
I am responsible for reviewing and approving approximately 200 plan reviews annually; they range from minor interior alterations to multi-story buildings of various occupancy type.

If so, what is the most time and money consuming component of the process for your department?
Review of poorly prepared plans where design professionals are either unaware of, or are uninterested in minimum code requirements and how they apply to their project.

Are there some permits that are easier (faster, cheaper) to approve than others?
Yes, usually minor alterations (if you want me to elaborate you need to ask a specific follow-up question).

What, do you feel, is the best way for developers, construction managers to improve permitting packages so not to cause resubmissions or delays?
Where developers or construction managers are directing the "permit package" they should make sure that they have a clear understanding of what the permit package is to include; this can vary in jurisdictions due to a number of variables. Communication is critical; whoever is handling procurement of a permit should know what each department in the jurisdiction needs: number of copies of plans, geotechnical reports, energy compliance path info, site plans, copies of other approvals (zoning, water, sewer, etc.).

Has your department ever considered changing the permitting process? If it has been changed recently, why did the change occur?
Yes; we are in the process of changing the fee structure to reflect and recapture costs associated with poorly prepared plans that cause time delays for other more responsible design professionals. Additionally, we have increased the time allotment for turn-around time on plan review due to new requirements/details based on the energy and accessibility code. We also provide site meetings with owners, design professionals and contractors to discuss proposed alterations to existing buildings so as to facilitate a smoother review and permitting process.

Erica Craig February 5, 2008

PSU AE Senior Thesis
Industry Survey
Permitting and Approvals for New Commercial Construction

Name: **Michael R. Rupert**
Position: **Senior Building Inspector**
Centre Region Code Administration

Q: Are you responsible for approving any or all building permits for new commercial construction projects and which ones?

A: **Yes, I am one of two Plans Examiners who review commercial project drawings and correspond with architects and contractors in order to maintain code compliance.**

Q: If so, what is the most time and money consuming component of the process for your department?

A: **Our policy is to review the drawings and produce comments within 15 business days of the date of receipt. The actual plan review takes anywhere from 2 to 12 hours depending on the size and complexity of the project. My day is filled with email and telephone questions which can be time consuming and essentially offered as a free service.**

Q: Are there some permits that are easier (faster, cheaper) to approve than others?

A: **The smaller the project, the easier they are to review because the code has built-in exceptions for low occupancy spaces and buildings. If a building is being renovated but the use group does not change (Business Office to Business Office) then a lot of the existing components may remain. For instance, restaurants have more requirements and require more review time than an insurance office.**

Q: What, do you feel, is the best way for developers, construction managers to improve permitting packages so not to cause resubmissions or delays?

A: **A practice that I used while in the architectural field and recommend to anyone who asks is to schedule a preliminary meeting with the code office to briefly review the project and identify any obvious issues that may be associated with the project.**

Q: Has your department ever considered changing the permitting process? If there have been changes recently, why did the changes occur?

A: **We often visit the issue of making the permitting process easier and more profitable for everyone. Our agency offers next day inspections and site meetings which greatly decreases the "down time" some contractors experience waiting for an inspection. Most of the code officers here come from the design/construction industry and recognize the problems that can be caused by a failed permit process. Recently, our attention has been on addressing the issue of reviews being performed that are never permitted and therefore not paid for. Our salaries are paid by permit fees alone and offering free site meetings, etc. can have a detrimental affect on our budget.**

Erica Craig February 5, 2008

PSU AE Senior Thesis
Industry Survey
Permitting and Approvals for New Commercial Construction

Name: **Dan Slatt**
Position: **Lower Paxton Building Inspector**

Q: Are you responsible for approving any or all building permits for new commercial construction projects and which ones?

A: **Certified for approving commercial construction plans**

Q: If so, what is the most time and money consuming component of the process for your department?

A: **Bigger jobs – hotel, – ship out to a third party approval, we pay, to have them review. Smaller jobs they review. Time consuming the mechanical aspects cause the most time to the code. Pennoni Engineers, and others.**

Q: Are there some permits that are easier (faster, cheaper) to approve than others?

A: **same rate regardless, for all developers. Depends on size of projects. Tenant fitout – faster. By law 30 business days to get reviewed, and if comments, delievered to applicate, so 30 days start over again.**

Q: What, do you feel, is the best way for developers, construction managers to improve permitting packages so not to cause resubmissions or delays?

A: **When looking at plans, looking architects and engineers to make sure they do their job to the best of their ability and be updated on all aspects of the codes. Continueing education for everyone.**

Q: Has your department ever considered changing the permitting process? If there have been changes recently, why did the changes occur?

A: **Uniform Construction Code – 1999 – 2004 enacted by PA. Labor and Industry out of the process now, after that, started to contract out to third parties for larger buildings.**

Lower Paxton – 2 examiners.

Industry Survey

Permitting and Approvals for New Commercial Construction

Name: Rod Smay
Position: manager

Are you responsible for approving any or all building permits for new commercial construction projects, and which ones?

I don't do all the commercial plan review right now. But I issue all The permits when they are ready.

If so, what is the most time and money consuming component of the process for your department?

The time spent between the architect and the plan reviewer when things don't meet code.

Are there some permits that are easier (faster, cheaper) to approve than others?

Yes, Residential permits. (one book)

What, do you feel, is the best way for developers, construction managers to improve permitting packages so not to cause resubmissions or delays

Guardian give out permit kits and if they follow the kits then there isn't to many problems

Has your department ever considered changing the permitting process? If it has been changed recently, why did the change occur?

We did change our kits this year, but we just up dated and made things easier

Industry Survey

Permitting and Approvals for New Commercial Construction

Name: Albert Wrightstone
Position: Building Inspections

Are you responsible for approving any or all building permits for new commercial construction projects, and which ones?

This office subcontracted out the review and inspection of commercial permits to a third party agency. I still review some minor ones. But it is my signature that goes on the permit when it is issued. This was done in May of 2006 because of the backlog of permits. With the third party being hired, all reviews including accessibility came under the purview of the third party. Prior to this, accessibility reviews were handled by the PA. Department of Labor and Industry since I am not certified for accessibility reviews and inspections. The Third party agency also provides reviews and inspections for residential permits when I am out of the office for vacations.

If so, what is the most time and money consuming component of the process for your department?

The most time consuming component is the review process because of the time involved in looking over plans, researching code issues, getting review comments to the applicant then performing second review after revisions are provided.

Are there some permits that are easier (faster, cheaper) to approve than others?

I would say there are some simple tenant space fitouts that are among the easier permits to review. Most likely where the size is smaller and the plan itself is simple.

New residential permits (single family detached, townhouses) where the builder has been working in the municipality for some time and knows what the inspector wants and has the complete information makes the review process much easier as well.

What, do you feel, is the best way for developers, construction managers to improve permitting packages so not to cause resubmissions or delays?

I would say have plans code compliant at the very beginning. A second point to make is that the package as submitted should be complete. When just parts of a package are submitted, that draws out the review process tremendously.

Has your department ever considered changing the permitting process? If it has been changed recently, why did the change occur?

See above for the change that SusquehannaTownship made in the commercial permit process.

Contact Information

Seattle Design Commission

700 5th Ave., Suite 2000
P.O. Box 34019
Seattle, WA 98124-4019
(206) 615-1349
www.seattle.gov/designcommission

Design Review Boards

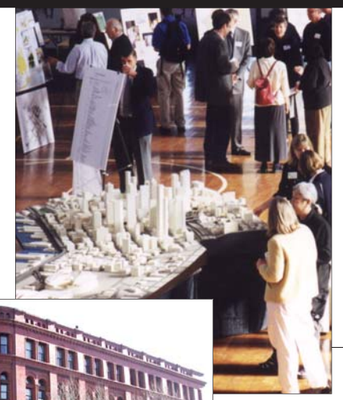
700 5th Ave., Suite 2000
P.O. Box 34019
Seattle, WA 98124-4019
(206) 684-4686
www.seattle.gov/designreview

Seattle Planning Commission

700 5th Ave., Suite 2000
P.O. Box 34019
Seattle, WA 98124-4019
(206) 684-3486
www.seattle.gov/planningcommission

Historic Landmarks Boards/ Landmarks Preservation Board

Department of Neighborhoods
700 5th Ave., Suite 1700
P.O. Box 94649
Seattle, WA 98124-4649
(206) 684-0228
www.seattle.gov/neighborhoods



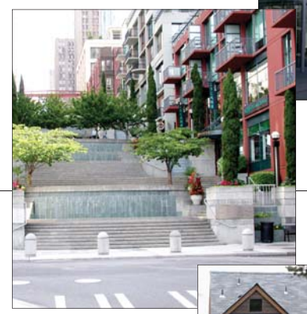


Photo credit: Johnston Architects

City of Seattle
Department of Planning and Development

Project Design Review

in Seattle

encouraging & incorporating...

communication & participation

better design

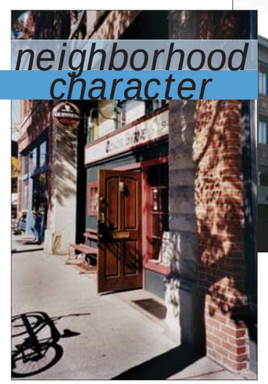
creating & enhancing...

sensitive development

consistency in neighborhoods

Photo credit: Weinstein AU

preserving & protecting...



neighborhood character

historical value

architectural significance

Navigating Seattle's Process

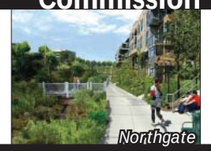
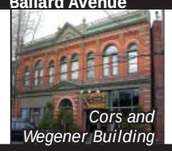
Just how Seattle handles design review is rather confusing to many. To demystify the process, we have composed this document to explain who does what in carrying out the important function of project design review.

Seattle is unique in having an intricate network of review bodies—staffed by citizen volunteers—that work in close coordination to ensure thorough review of major projects, whether public or private, under development within the city.

This network includes the Seattle Design Commission and the Seattle Planning Commission, both of which are advisory to the City at large; seven neighborhood-based design review boards that advise DPD in carrying out regulatory review of private multifamily and commercial projects; and a centralized Landmarks Board, along with several additional area-specific boards, charged with regulatory review of Seattle's historic districts.

April 2007

Project Design Review Throughout Seattle...

	Design Commission	Design Review Boards	Planning Commission	Historic District Boards: Pioneer Square	Historic District Boards: Pike Place Market	Historic District Boards: International District	Historic District Boards: Ballard Avenue	Landmarks Preservation Board
	 Olympic Sculpture Park	 The Greenlake	 Northgate	 Interurban Building	 Public Market	 Chong Wa Benevolent Assn.	 Cors and Wegener Building	 Admiral Theater (Individual landmarks plus Columbia City, Ft. Lawton, Harvard-Belmont Historic Districts)
established								
when	1968	1994	1911	1970	1971	1973	1976	1973
why	City officials wanted oversight of the City's capital projects, starting with those created by the voter-approved Forward Thrust Bond.	Citizens, designers and developers decried the incompatible design of many buildings built in the 1980s, the result of the City's prescriptive land use code.	Voters, after two decades of fast growth, passed an amendment to create a commission to draw up plans for the city's future expansion.	Visionaries and activists were concerned that a ring road proposed by the City's urban renewal plans would raze most of the area's historic buildings.	Voters, worried that Pike Place Market would be demolished under an urban renewal plan, passed an initiative to preserve the Market's character.	Community members were concerned that their neighborhood—and its Asian character—would be damaged by the development of the Kingdome.	Property owners wanted to preserve the qualities of its "small town main street" that reflected early 20th century America.	To provide protection for historic properties throughout the city, a citywide landmarks ordinance was enacted.
goal(s)								
	To ensure that public facilities and projects within the City's right-of-way incorporate "design excellence." To ensure wise allocation of the City's resources. To ensure City projects fit the City's design goals.	To encourage better design and responsiveness to a site's context. To provide flexibility in the application of the City's development standards. To engage citizens and developers early in the design process to resolve issues.	To advise the Mayor, City Council and City departments on broad planning goals, policies and plans for the physical development of Seattle. To engage citizens in the work of planning for the city's future.	To preserve the district's unique historic and architectural character. To assure the sensitive rehabilitation of buildings. To promote development of residential uses for all income levels. To enhance the district's economic climate.	To preserve the character of Pike Place Market. To perpetuate the district's architectural, cultural, economic and historical qualities.	To protect the district's character and architectural significance, emphasizing the neighborhood's Asian character.	To protect the district's significance and its historical and architectural values. To create and maintain continuity of architectural characteristics, arrangement, and design of the district's buildings.	To identify, preserve, protect, and ensure appropriate alterations to landmarks. To preserve, protect and ensure compatible alterations to the significant characteristics of the Harvard-Belmont, Columbia City and Ft. Lawton Districts.
projects								
project type	City facilities (parks, libraries, etc.) and projects on City land or in right-of-way, including large transportation projects, street vacations, skybridges and special street uses	Private development (commercial and large-scale residential) above a certain threshold	Comp Plan, neighborhood plans, subarea plans, citywide or region-wide public infrastructure projects, major public projects and plans (e.g., Civic Center, major institution master plans)	Businesses, buildings, parks, open space, rights-of-way	Businesses, buildings, parks, open space, rights-of-way	Businesses, buildings, parks, open space, rights-of-way	Businesses, buildings, parks, open space, rights-of-way	Public or private building, site or object over 25 years old that meets designation criteria
what is reviewed	Exterior, public interiors, urban design, projects that affect the public right-of-way and streets	As detailed in the City's design guidelines—site plan; building's height, bulk and scale; architectural elements and materials; pedestrian environment; and landscaping	Policies, goals and plans that affect the City's future physical development	All alterations to public and private building exteriors, rights-of-way, open spaces, demolition, new construction, changes of use	Use in building/business; interior and exterior of all businesses/buildings; street use and design; use and design of park	All alterations to building exteriors, rights-of-way, public and private exterior, open spaces, demolition, new construction, changes of use	Changes to the exteriors of buildings visible from public right-of-way, park, street design	Exterior, interior and site may be designated for individual landmarks
project proponents	City agencies, private developers	Private developers	City agencies	Private developers, property owners, business owners, residents, public agencies	Private developers, property owners, business owners, residents, public agencies	Private developers, property owners, business owners, residents, public agencies	Private developers, property owners, business owners, residents, public agencies	Private developers, property owners, business owners, residents, public agencies
reviews per project	2-4	2-4	as needed on case by case basis	2	2	1	1	2
avg. reviews per year	100+	200+	as needed on case by case basis	120	250	75	20	100+
board								
# of boards	1	7	1	1	1	1	1	1
purview	Citywide	Neighborhood-based	City-wide	Pioneer Square Preservation Dist.	Pike Place Market Historical Dist.	International Special Review Dist.	Ballard Avenue Landmark Dist.	City-wide
# of board members	10	5 per board (35 total)	16	10	12	7	7	11
member terms	2 years + reappointment	2 years + reappointment	3-year terms, renewable	3 years + reappointment	3 years + reappointment	2 years + re-election/reappt.	2 years + re-election/reappt.	3 years + reappointment
appointed	by Mayor	by Mayor/Council	by Mayor/Council	by Mayor	by Mayor	2 by Mayor; 5 elected within Dist.	2 by Mayor; 5 elected within Dist.	by Mayor
roles represented	architect (2), landscape architect (2), fine artist, engineer, urban planner, urban designer, member at large, Get Engaged	design professional, community representative, developer, business representative, resident, Get Engaged	an engineer or architect, an urban planner, ethnic minority members, and citizens active in neighborhood or community affairs, Get Engaged	architect (2), resident, retail business owner, property owner (2), historian/arch. historian, attorney, human services rep., Get Engaged	2 each: Allied Arts, Friends of the Market, AIA Seattle, district merchants, residents and property owners	Appointed: 2 members. Elected: business/property owners (2); resident, tenant or person interested in community (2); at-large member	Appointed: architect, community historian. Elected: property owners (2); property-business owners (2); tenant or resident	architects (2), historians (2), structural engineer, planning commissioner, real estate manager, finance, at-large (3), Get Engaged
meetings	Twice a month (1st & 3rd Thurs.)	Each board meets twice a month (days vary per board)	Twice a month (2nd & 4th Thurs.)	Twice a month (1st & 3rd Wed.)	Twice a month (2nd & 4th Wed.)	Twice a month (2nd & 4th Tues.)	Once a month (1st Thurs.)	Twice a month (1st & 3rd Wed.)
authority								
advises who?	Mayor, City Council, City departments	Department of Planning and Development Director	Mayor, City Council, City departments	Mayor, City Council, Department of Neighborhoods Director	Mayor, City Council	Mayor, City Council, Department of Neighborhoods Director	Mayor, City Council, Department of Neighborhoods Director	Mayor, City Council
decisions	advisory	advisory/regulatory	advisory	regulatory	regulatory	regulatory	regulatory	regulatory