



Figure 1. Google maps street view of Ponderosa Fire Department [1].

BELLEMONT FIRE STATION ADDITION



CENE 486-C
04/26/2019
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BACKGROUND

- Client: Chief Lee Antonides, City of Bellemont
- Location: Bellemont, Coconino County, Arizona
- Purpose: Increase living capacity, add office space, add community room, and vehicle storage



Figure 2. Close up location map of the Ponderosa Fire Department location [1].

SCOPE OF WORK

- Completed and processed field survey
- Created preliminary site layout, border block and cover page for the plan sets.
- Obtained geotechnical information.
- Determined theoretical reaction loads for anchor bolt and foundation designs.
- Completed structural design for anchor bolts and foundation including specifications of concrete and rebar.
- Completed plan sets which will include a plan view, profile view, details, and rebar layouts.
- Determined a construction cost estimate.

EXCLUSIONS

- Structural Frame Design of Addition
- Drainage Plan
- Electrical Plan
- Mechanical – Heating, Ventilation, Air Conditioning (HVAC)
- Building Permits
- Interior Design

TOPO/SURVEY



Figure 3. Land Surveyors [2].



Figure 4. Data collector with Survey Pro [3].

TOPO MAP

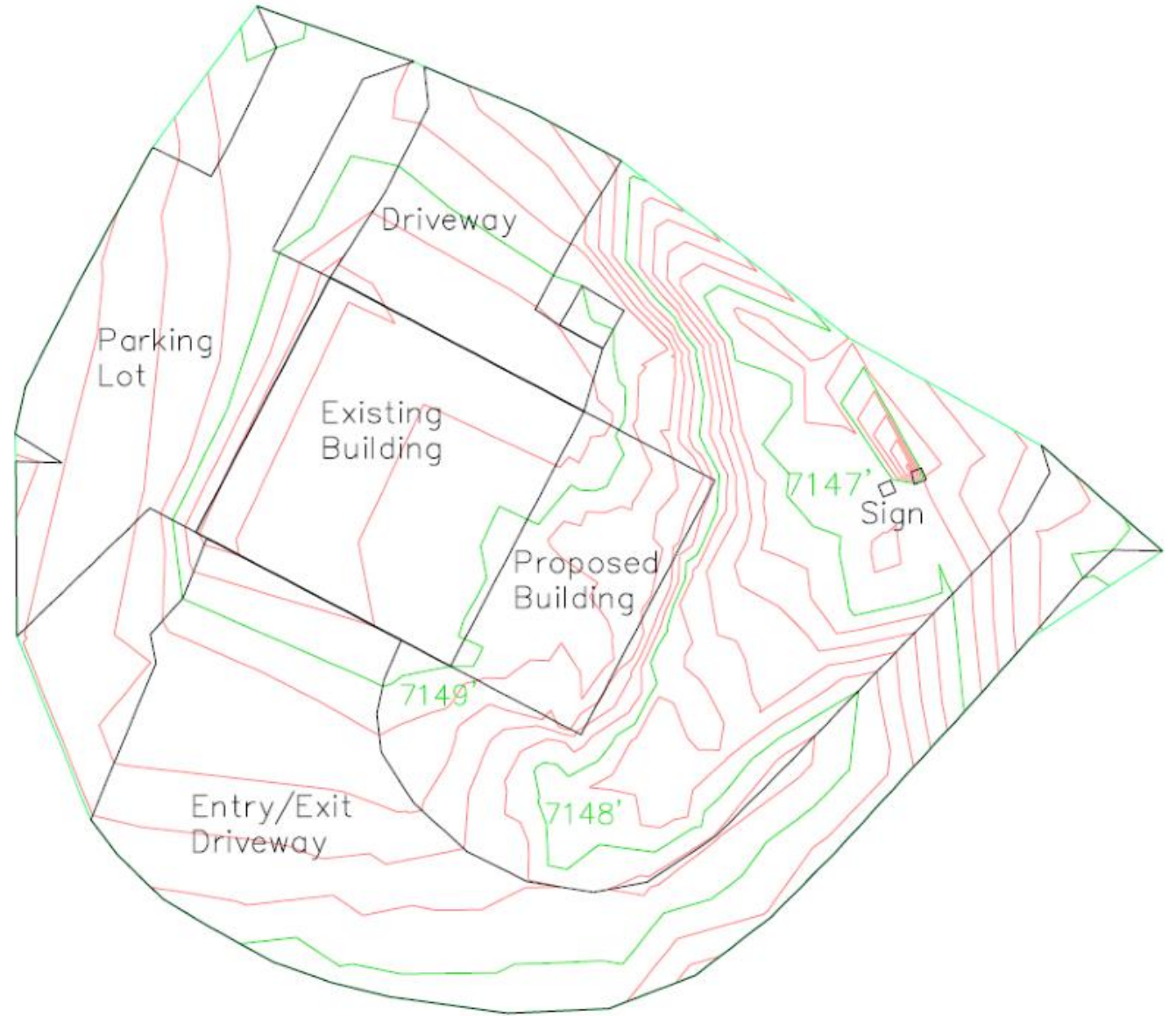


Figure 5. Topographic map with existing features.

SITE LAYOUT

TOTAL LOT SIZE:
1.437 ACRES

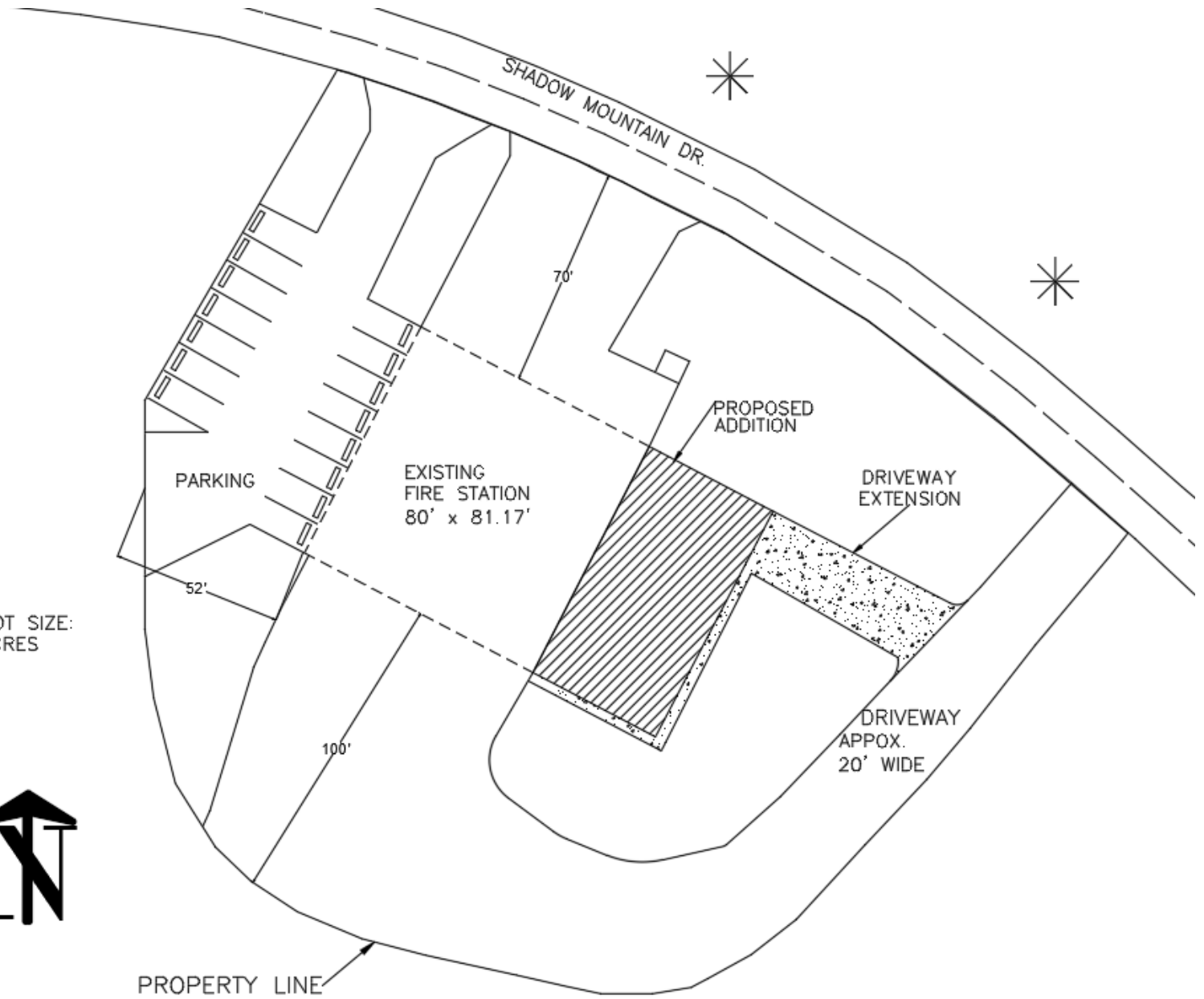


Figure 6. Created site layout proposed addition.

GEOTECHNICAL SOIL PROPERTIES

- Soil properties were needed for the foundation design
- Geotechnical Report provided by Capstone Homes for the Flagstaff Meadows project completed by Western Technologies Inc.
- 9 Boring Sample test results from the report were used to determine the soil properties for the fire station addition.

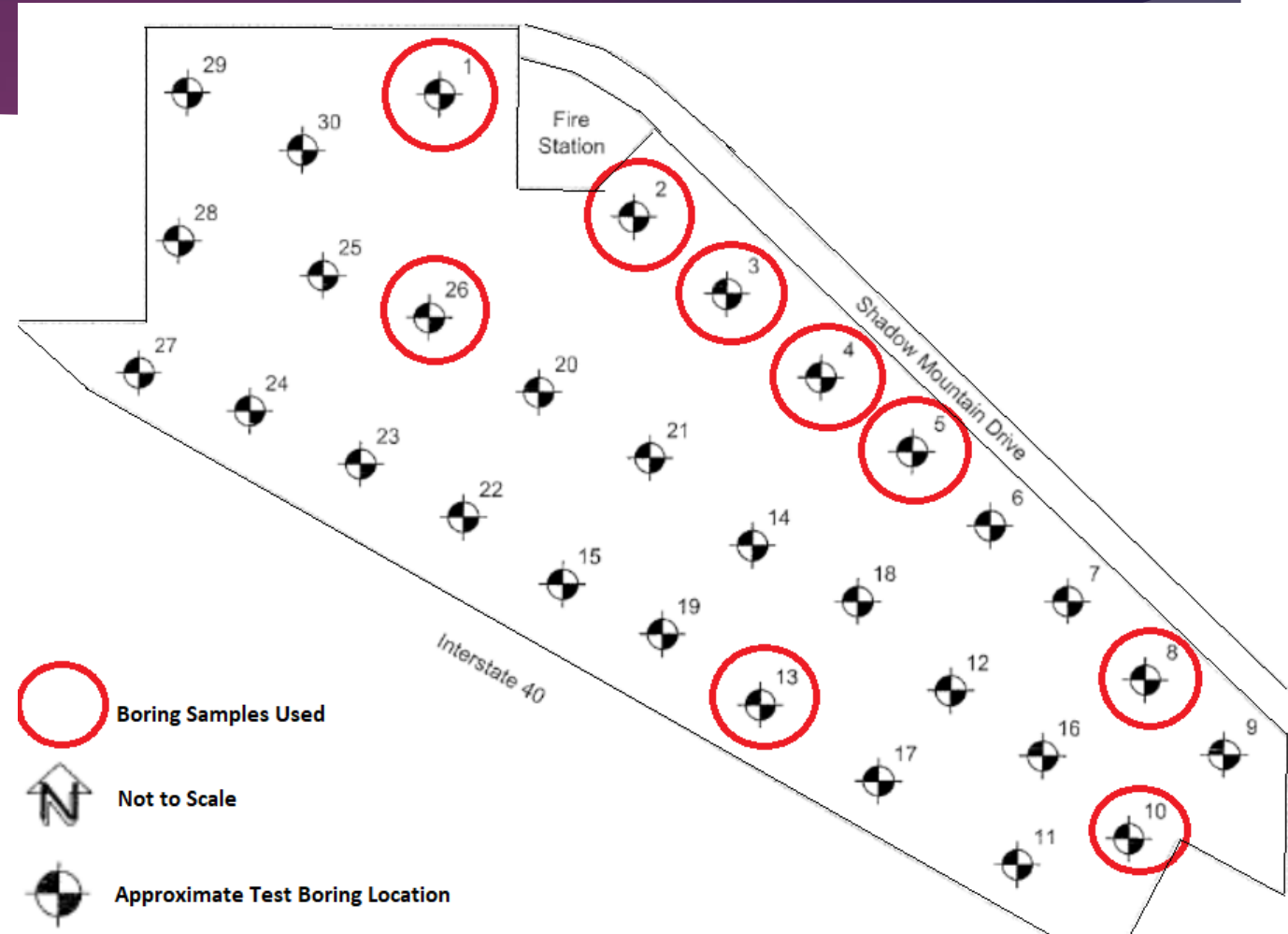


Figure 7. Western Technologies Boring hole locations for soil properties [4]. 8

GEOTECHNICAL SOIL PROPERTIES

Table 1. Geotechnical properties.

Geotechnical Soil Properties	
Soil Classification	Clayey Sand
	Fat Clay
Soil Bearing Capacity	1500 psf
Potential Expansion	Low
Plasticity Index	8 -25 (Medium)

STRUCTURAL DESIGN PARAMETERS

Table 2. Design Loads.

Design Loads	
Load	PSF
Dead (D)	15
Live (L)	40
Live Roof (Lr)	20
Snow (S)	40
Wind (W)	30

*U = Required Strength

ACI 318-14 Load Combinations: Section 5.3.1

Equation 1. $U = 1.4D = 24 \text{ psf}$

Equation 2. $U = 1.2D + 1.6L + 0.5S = 102 \text{ psf}$

Equation 3. $U = 1.2D + 1.6S + 0.5W$ (DETERMINING FACTOR) = 120 psf

Equation 4. $U = 1.2D + 1.0W + L + 0.5S = 108 \text{ psf}$

Equation 5. $U = 1.2D + 1.0E + L + 0.2S = 76 \text{ psf}$

Equation 6. $U = 0.9D + 1.0W = 43.5 \text{ psf}$

Equation 7. $U = 0.9D + 1.0E = 13.5 \text{ psf}$

TRIBUTARY AREAS

Table 3. Tributary area.

Trib Areas	
Area	S.F.
1	460
2	920
3	460
4	460
5	920
6	460

Footing Size:

Pressure Equation: $A = F/P$

P = Bearing Capacity (1500 psf)

F = Force (55.2 kips & 110.4 kips)

A = Area (sf)

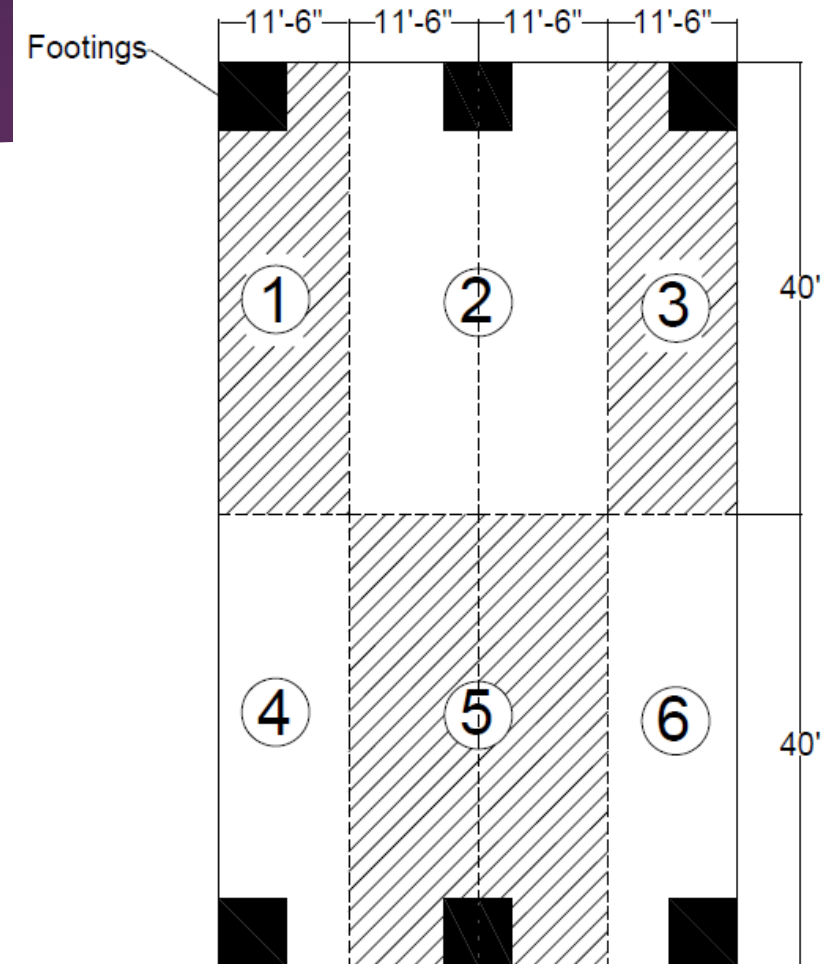


Figure 8. Tributary areas of proposed addition.

DESIGN SPECIFICATIONS

Concrete:

- Grade = A 40/50
- #4 Rebar Reinforcement

Anchor Bolt:

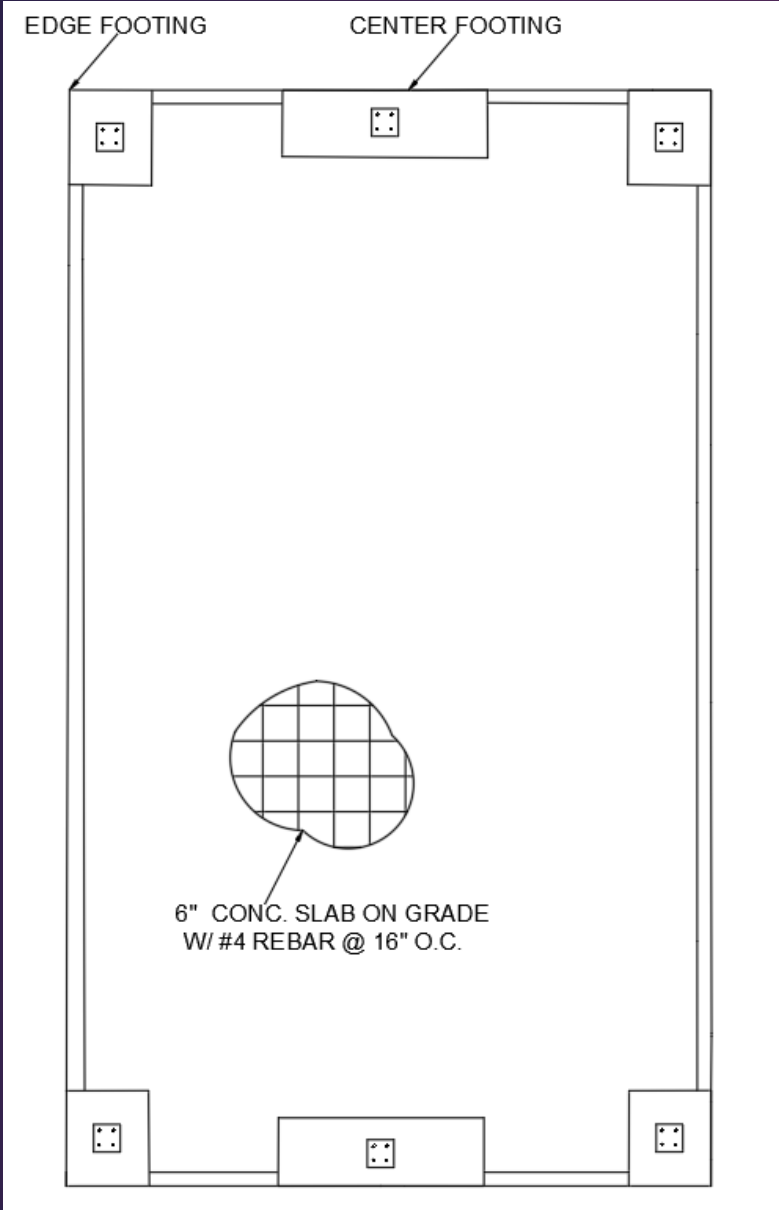
- 1-inch ASTM F1554- Grade 36
- L-Shaped
- 36 ksi yield strength



Figure 9. A 40/50 Concrete [5].



Figure 10. F1554-36 Anchor Bolt [6].



FOUNDATION DESIGN

- Slab on grade design
- Six Footings
 - Two footing designs
 - 6' x 7'
 - 15' x 5'
- Anchor Bolt Connection at each footing

Figure 11. Foundation design.

FOUNDATION DESIGN

- Slab Design

- Thickness = 6"
- Size 80' X 46'

- Concrete Specs
(IBC18 sec.1904.1)

- Compressive strength= 4500 psi
- Yield strength= 60000 psi

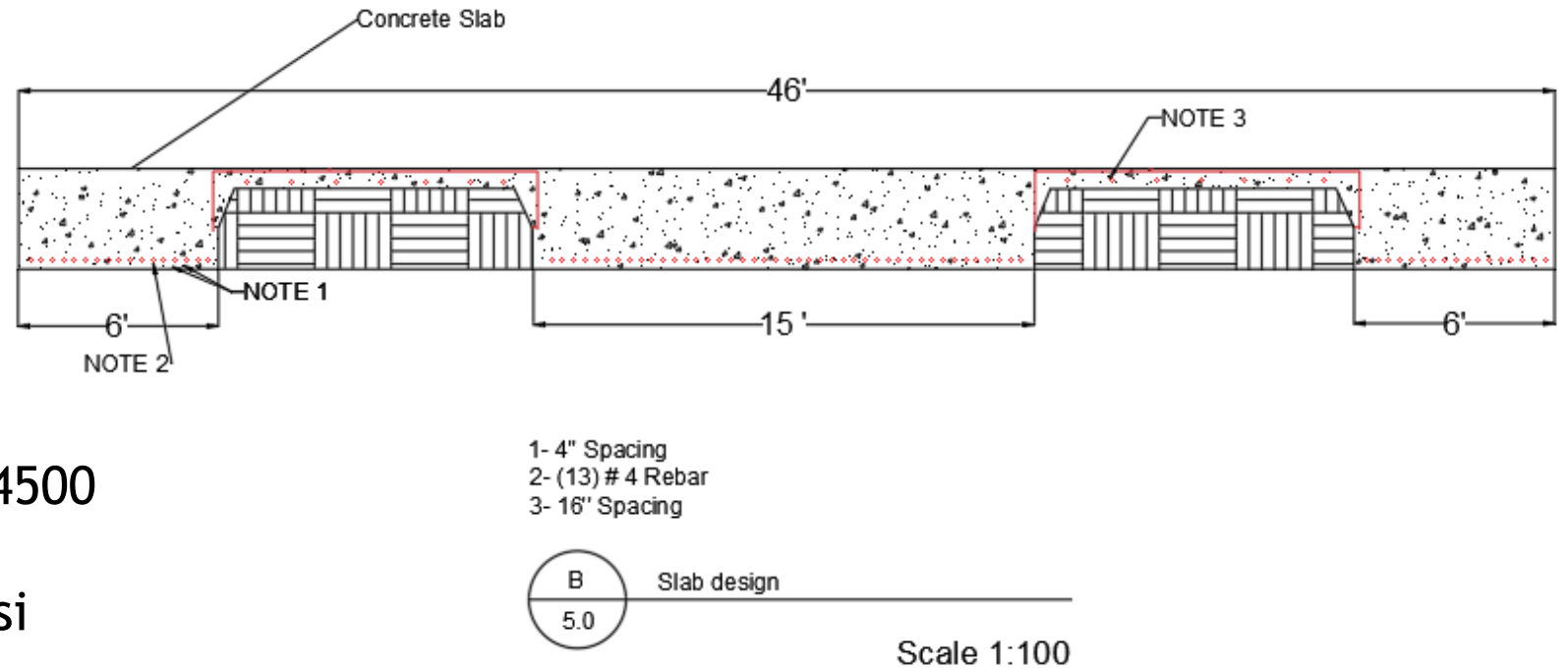
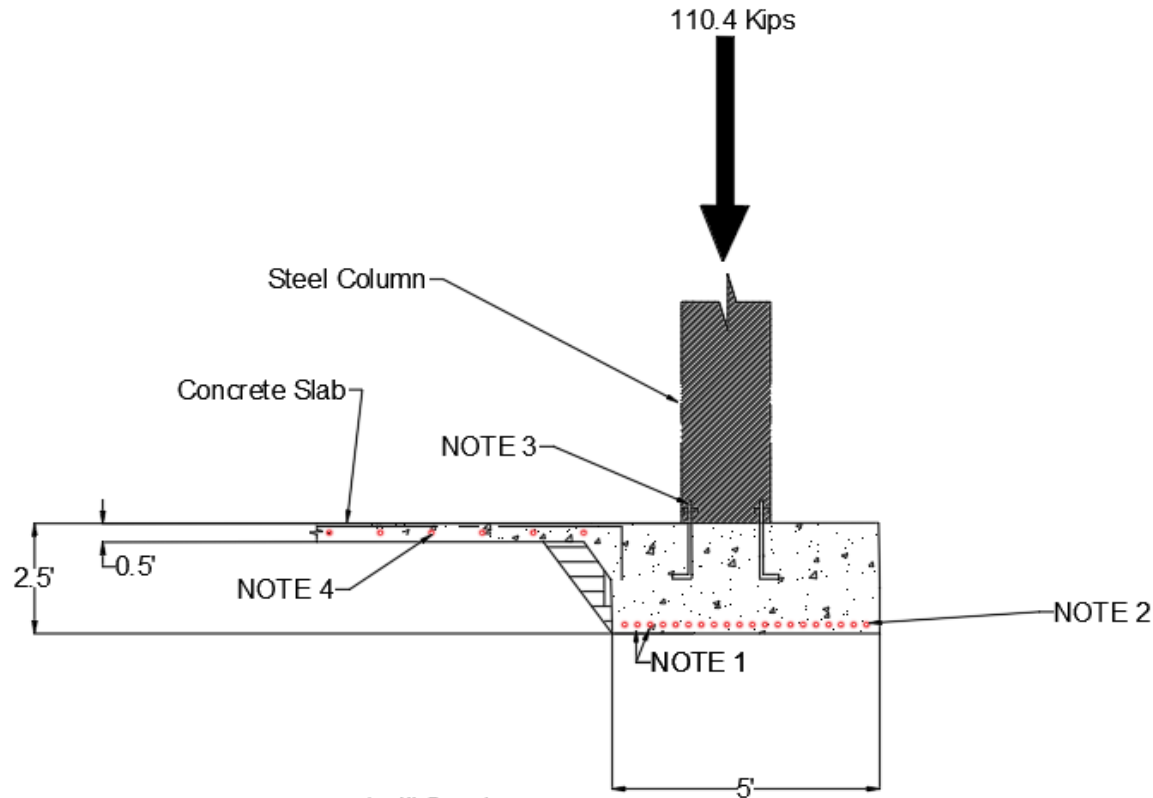


Figure 12. Foundation cross-sectional view.

FOOTING DESIGN



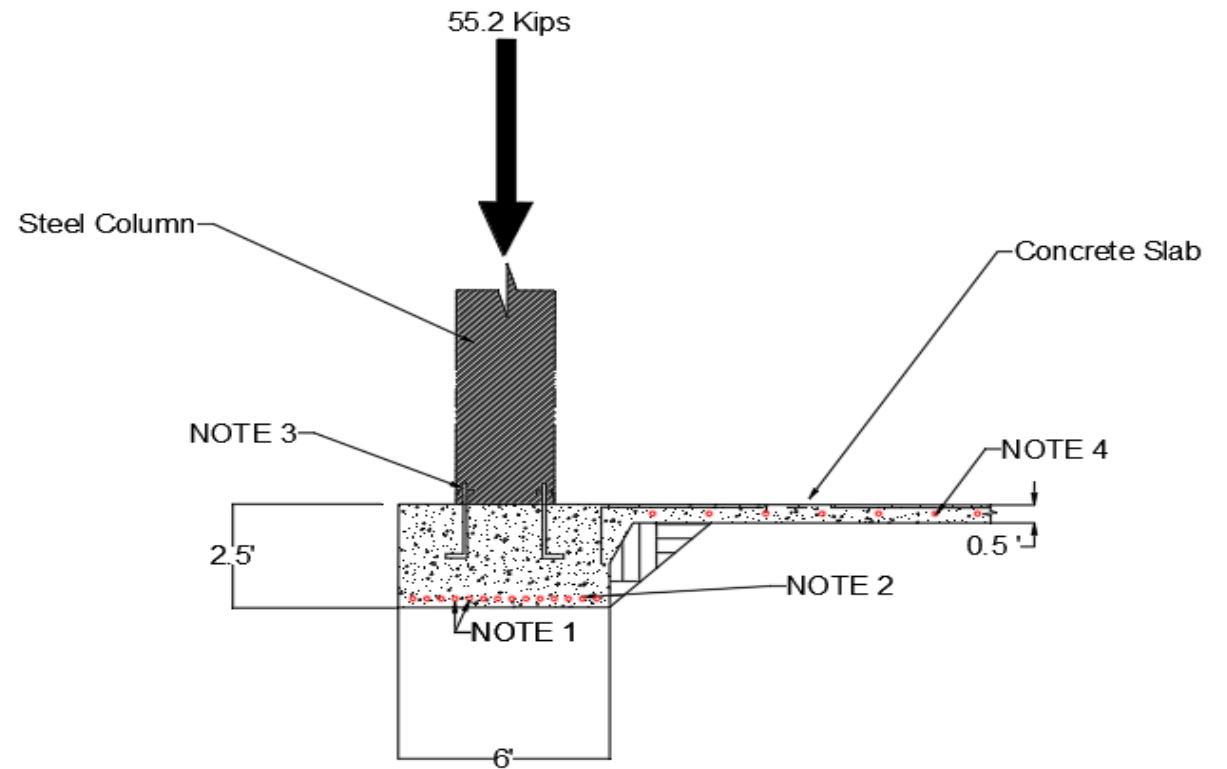
- 1- 4" Spacing
- 2- (19) # 4 Rebar
- 3- 1" Diameter Anchor Bolt
- 4- 16" Spacing

B
5.3

Footing design (Middle Footings)

Scale 1:50

Figure 13. Middle Footing Design.



- 1- 4" Spacing
- 2- (13) # 4 Rebar
- 3- 1" Diameter Anchor Bolt
- 4- 16" Spacing

B
5.2

Footing design (Edge Footings)

Scale 1:50

Figure 14. Edge Footing Design.

ANCHOR BOLT DESIGN

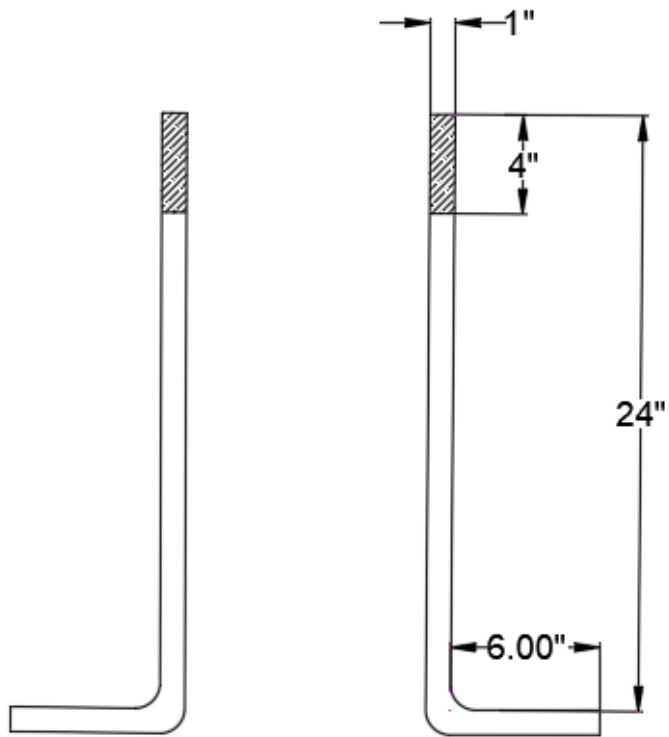


Figure 15. Anchor Bolt Dimensions.

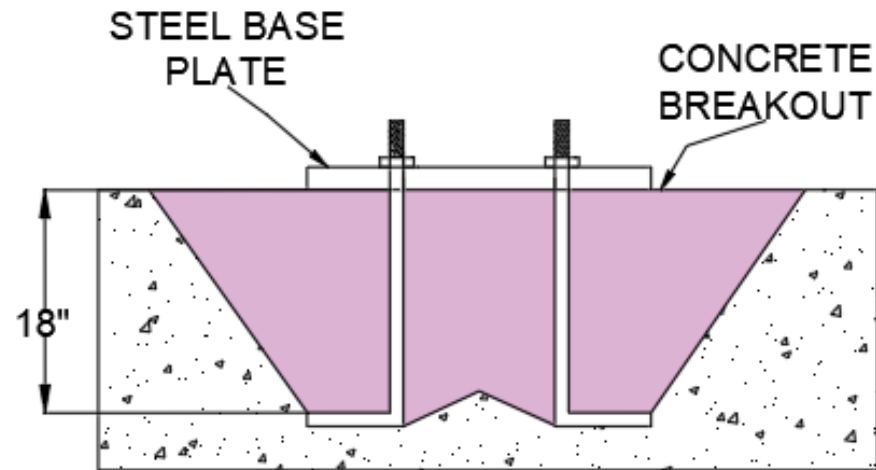




Figure 16. Anchor Bolt Cone of Failure.

ACI 318-14 ANCHOR BOLT CHECKS

Table 4: Anchor bolt calculation checks.

DESIGN CHECK	ACI 319-14 SECTION	MINIMUM	RESULTS
Nominal Strength in Shear	17.4.1.2	19.6 Kips	46 Kips
Nominal Strength in Tension	17.5.1.2a	22.7 Kips	47 Kips
Breakout Strength in Tension	17.5.2.1a	22.7 Kips	88 Kips
Breakout Strength in Shear	17.5.2.1b	19.6 Kips	44.2 Kips

*Results are higher due to high priority building

Passed	
Failed	



CONSTRUCTION DOCUMENTS

SHEET INDEX

ARCHITECTURAL DRAWINGS

- A1- SITE LAYOUT
- A2- FLOOR PLAN
- A3- ELEVATION VIEWS

STRUCTURAL DRAWING

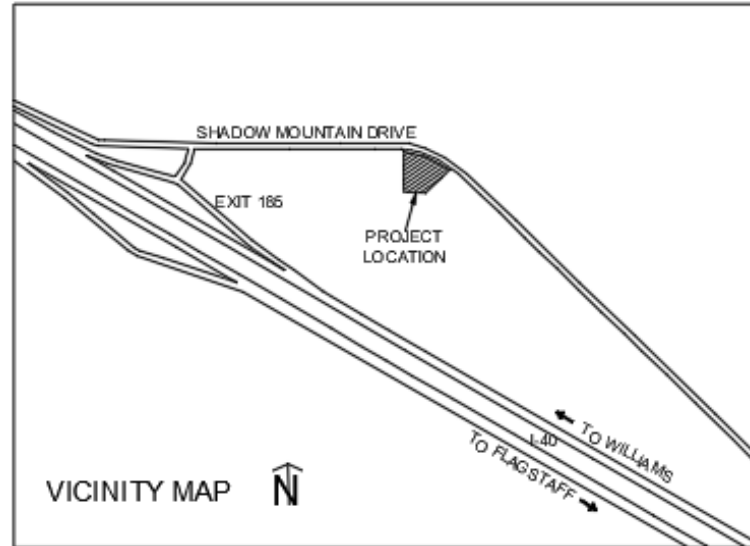
- S1- FOUNDATION PLAN
- S2- FOOTING DETAILS
- S2.1- ANCHOR BOLT DETAILS;
CROSS-SECTIONAL VIEW
- S2.2- ANCHOR BOLT DETAILS;
PLAN VIEW

LEGEND

- * - VEGETATION
- ⊖ - DETAIL CALLOUT

BELLEMONT FIRE STATION ADDITION

11951 W. Shadow Mountain Drive Belmont, AZ



BUILDING PARAMETERS

DESIGN LOADS:
 ROOF LIVE LOAD.....40 psf
 (snow)
 ROOF DEAD LOAD.....15 psf
 STEEL FRAME.....75 plf
WIND LOADS:
 BASIC WIND SPEED.....120 mph
 RISK CATEGORY.....IV
SEISMIC LOADS:
 SEISMIC ZONE.....C

FOUNDATIONS:
 GEOTECHNICAL CONSULTANT: WESTERN TECHNOLOGIES INC.
 JOB NUMBER: 2528JW127

SOIL BEARING CAPACITY.....1500 psf
 FOUNDATION TYPE.....Slab on Grade

CONCRETE:
 CLASS A CONCRETE 40/ 50
 COMPRESSIVE STRENGTH.....4500 psi
 YIELD STRENGTH.....60000 psi

REINFORCING:
 TYPICAL REINFORCING BARS
 #4 REBAR.....ASTM A815

TYPICAL CLEAR CONCRETE COVER
 CONCRETE CAST AGAINST EXPOSED EARTH.....3"
 ALL OTHERS PER ACI 318-14

STRUCTURAL STEEL:
 ANCHOR BOLTS.....1" ASTM F1554-38
 METAL FRAME.....From frame co.

PROJECT TEAM

ABDULLAH ALKHAYAT; SENIORENGINEER
 EMAIL: AMA783@NAU.EDU

LIONEL GOY; PROJECT ENGINEER
 EMAIL: LG839@NAU.EDU

JOCELYNE RIVAS; DRAFTER
 EMAIL: JSR249@NAU.EDU

MARC WASSERMAN; INTERN/ FIELD TECH
 EMAIL: MW258@NAU.EDU

SHEET
 1
 8

JAMT Engineering Firm
 Northern Arizona University Senior Capstone



NO.	DATE	DESCRIPTION

DESIGNED BY: ABDULLAH ALKHAYAT	DATE: 11/1/2014
CHECKED BY: LIONEL GOY	DATE: 11/1/2014
DRAWN BY: JOCELYNE RIVAS	DATE: 11/1/2014

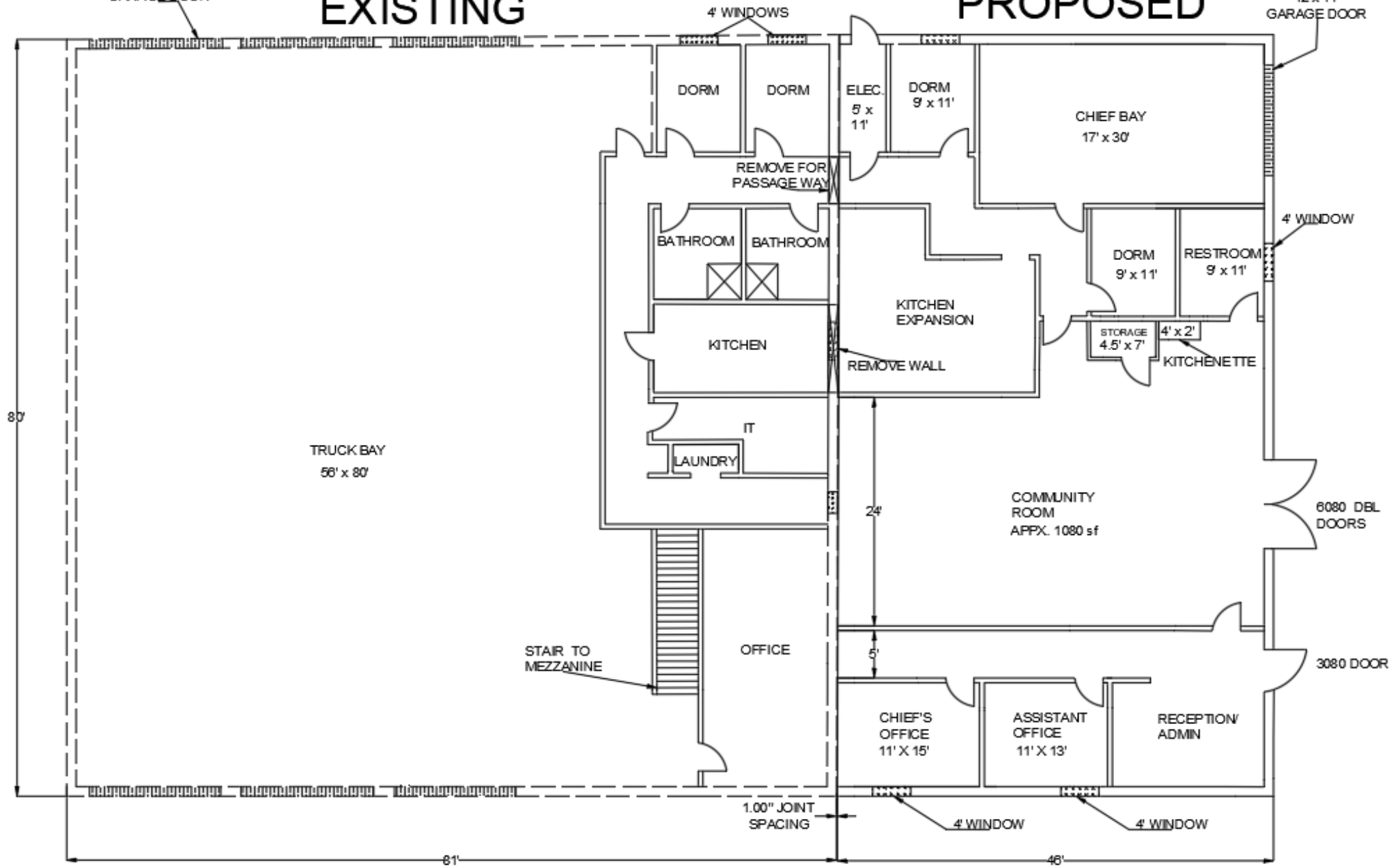
FIRE STATION ADDITION
 COVER

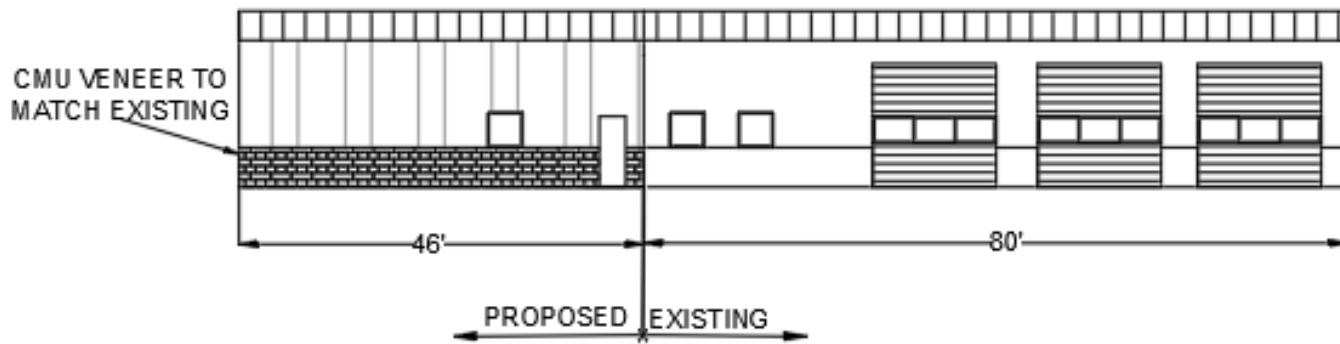
14' x 14' GARAGE DOOR

EXISTING

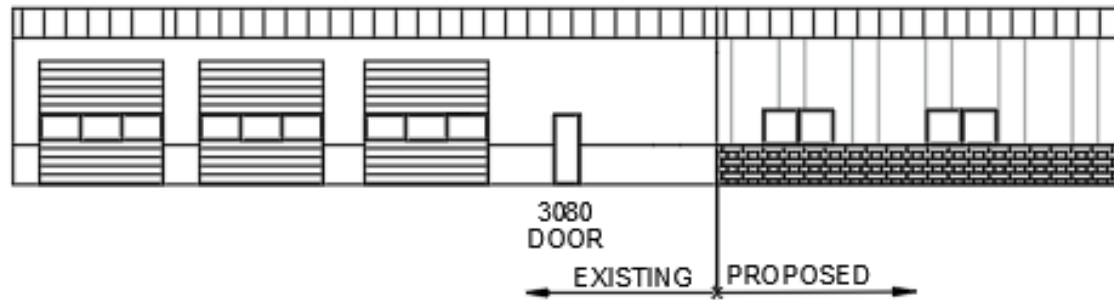
PROPOSED

12' x 14' GARAGE DOOR





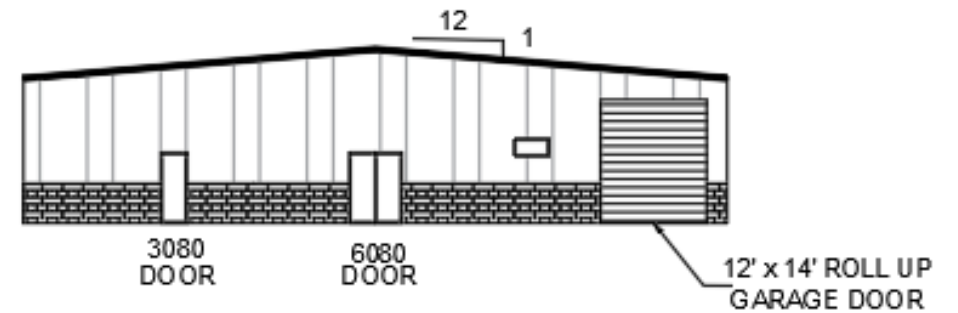
1 NORTH (FRONT) ELEVATION
A3



3 SOUTH ELEVATION
A3

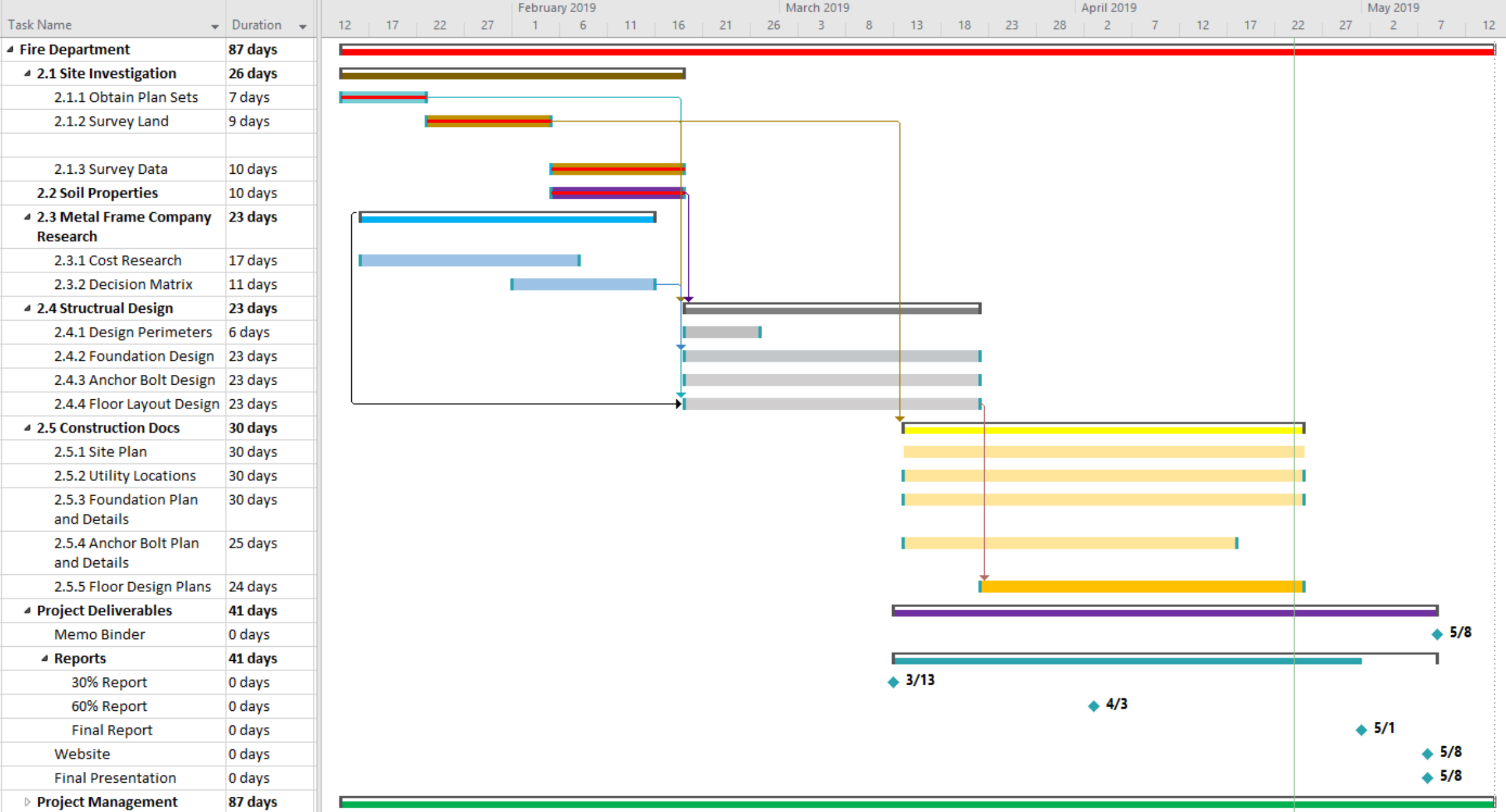


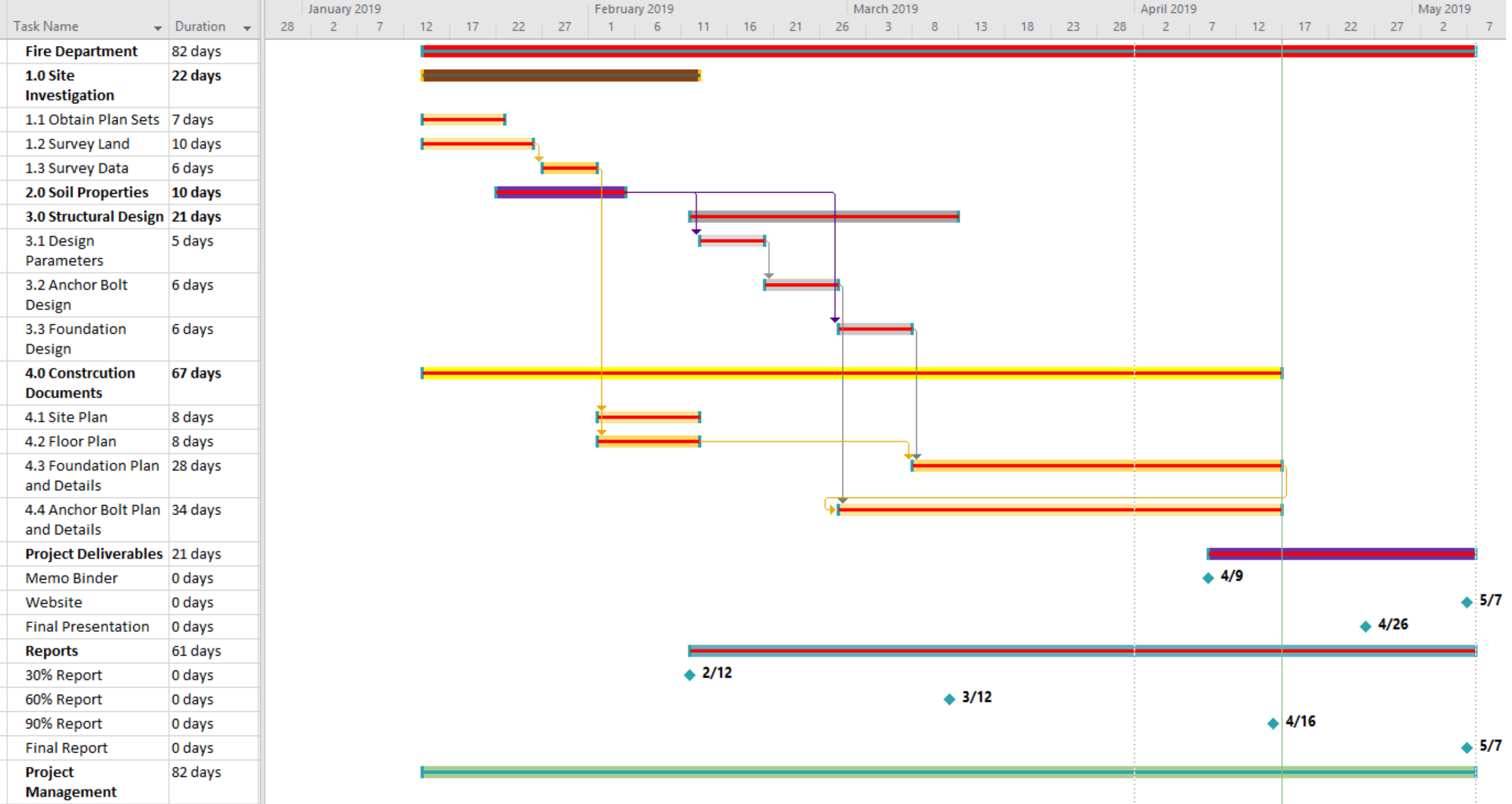
2 WEST ELEVATION
A3



4 EAST ELEVATION
A3

Figure 17. Elevation views of building.





CONSTRUCTION COSTS

Table 5: Construction costs.

Item Description	Quantity	Unit	(\$/unit)	Subtotal
Excavation	340	CY	\$9	\$3,060
Backfill	240	CY	\$7	\$1,680
Reinforced Concrete	100	CY	\$400	\$40,000
Anchor Bolts	24	EA	\$8	\$192
Metal Frame	1	EA	\$45,000	\$45,000
AC	23.5	TON	\$50	\$1,175
ABC	24	CY	\$60	\$1,440
			Total Cost:	\$92,547

COST OF ENGINEERING SERVICES

Table 6: Original vs new cost of services.

	Senior					Estimated Total Hours	Actual Total Hours	Estimated Cost Per Task	Actual Cost Per Task
	Engineer	Engineer	Field Tech	Drafter	Intern				
Billing Rate	\$255/hr	\$115/hr	\$51/hr	\$69/hr	\$21/hr				
1.0 Site Investigation	2	3	6	0	10	64	21	\$2,870	\$1,371
2.0 Lab Testing/Soil	4	0	0	0	0	25	4	\$759	\$1,020
3.0 Metal Frame Co Research	0	0	0	0	0	60	0	\$9,460	\$0
4.0 Structural Design	16	36	2	0	36	120	90	\$13,416	\$9,078
5.0 Construction Documents	18	18	0	81	61	213	178	\$12,421	\$13,530
6.0 Project Deliverables	30	35	5	7	19	70	96	\$11,138	\$12,812
7.0 Project Management	43	43	27	27	27	120	167	\$14,630	\$19,717
Hours per Position	113	135	40	115	153	672	556	\$64,694	\$57,528
							Survey	\$4,800	\$4,800
							Total Cost:	\$69,494	\$62,328

PROJECT IMPACTS

Social Impacts

- The fire department will be able to host more community events
- Will be able to meet the growing needs of Belmont
 - Quicker emergency response times

Economic Impact

- Will be able to house and employ more firefighters
- Insurance Service Offices (ISO) Rating could improve and lower insurance rates for the Belmont community



Figure 18. Firefighters in the community [7].

CONCLUSION

- The designed building addition addresses the existing building's current limitations by adding:
 - Two additional dorm rooms
 - Community room
 - Offices for the fire chief and staff
 - An additional vehicle bay
- The designed building addition followed all the relevant codes and regulations:
 - Coconino County Building Codes
 - IBC 2018
 - ACI 318-14
 - International Fire Code 2018

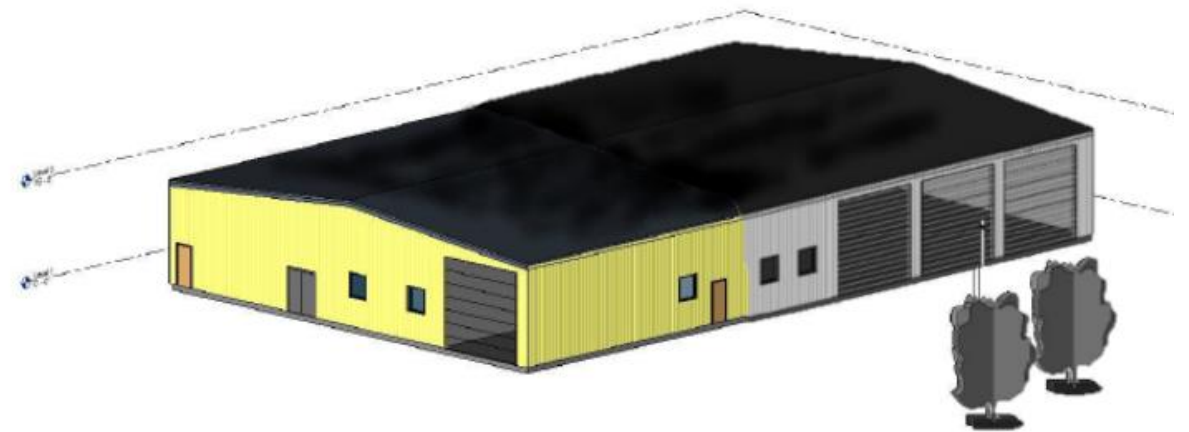


Figure 19. 3D Revit of fire department.



THANK YOU!

REFERENCES

[1] Google Maps, [Online]. Available: <https://www.google.com/search?client=firefox-b-1-ab&q=ponderosa+fire+station&npsic=0&rflfq=1&rlha=0&rlla>. [Accessed 8 November 2018].

[2] Harbor Compliance, "Arkansas Land Surveyor License," [Online]. Available: <https://www.harborcompliance.com/information/arkansas-land-surveyor-license-permit>. [Accessed 8 October 2018].

[3] "Spectra Precision Ranger 3's w/ Survey Pro Max and 2.4ghzra...", *RPLS Today*, 2019. [Online]. Available: <https://rplstoday.com/community/buy-sell-trade/spectra-precision-ranger-3s-w-survey-pro-max-and-2-4ghz-radios/>. [Accessed: 12- Feb- 2019].

[4] C. Wiedeman, "Flagstaff Meadows Unit III West Shadow Mountain Drive," Flagstaff, 2006.

[5] "Concrete" <https://theconstructor.org/concrete/>

[6] "Anchor bolts" https://www.alibaba.com/product-detail/Factory-Price-F1554-Grade-36-Grade_60804280071.html

[7] "Ponderosa FD" FB page. [2019]