AUBURN UNIVERSITY

BIOSYSTEMS ENGINEERING

BSEN 5560: Site Design

FEASIBILITY STUDY

Victoria Burnett & Jenny Walter

3 October 2014

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EXECUTIVE SUMMARY:

The condition of parcel 9 in Binford Heights subdivision, Auburn, Alabama is found to be feasible for further construction of a family home under major specified conditions.

By analyzing the peak runoff values and the soil data, it is determined that this parcel will have minimal concern pertaining to runoff and ponding or flooding. The anticipated peak runoff values from parcel 9 range from 1.64 to 2.07 cubic feet per second. The higher runoff values are respective to the post construction phases of the parcel.

Due to a lack of sewage lines, a septic tank system is suggested based on the allotted area for the proposed house and city regulations. The system consists of a septic tank and an effluent disposal field, located on the east side of the parcel.

The average slope of the site is approximately 12%, which could cause problems concerning a foundation for a house. Our proposal includes a two story log cabin that has a front and back entrance. The back entrance will exist through a partial basement, implementing the slope as a construction advantage. A grading revision will be needed. The front entrance will consist of a stairway approximately 3 feet tall, prohibiting water runoff from entering the house from the above watershed. The heated floorspace area is 2,666 square feet, having 1,333 square feet on each floor. This does not include the 240 square feet porch or sidewalk leading from the driveway to the house.

INTRODUCTION:

This report assesses the feasibility of a lot within the Binford Heights subdivision, located in Auburn. Various parameters are explored to determine the overall condition of the land, including, but not limited to, surrounding water bodies, soil classifications, jurisdictional boundaries, sewer systems, topography, storm-water facilities and paved surfaces. The general location is displayed in Figure 1. The orange area in the top left corner displays the corner of Auburn University campus. The green area between Auburn University campus and the boxed subdivision is Town Creek Park, with a river flowing through the park. There is also an unknown stream located in the southeast corner of the boxed subdivision.

An aerial photograph overlays the property subdivision, shown in Figure 2. It is noted that a preliminary road alignment, indicated in yellow, has been proposed, based on the existing road centerline. Further assessment on the road should be made before continuing with construction, such as soil type and grading evaluations.

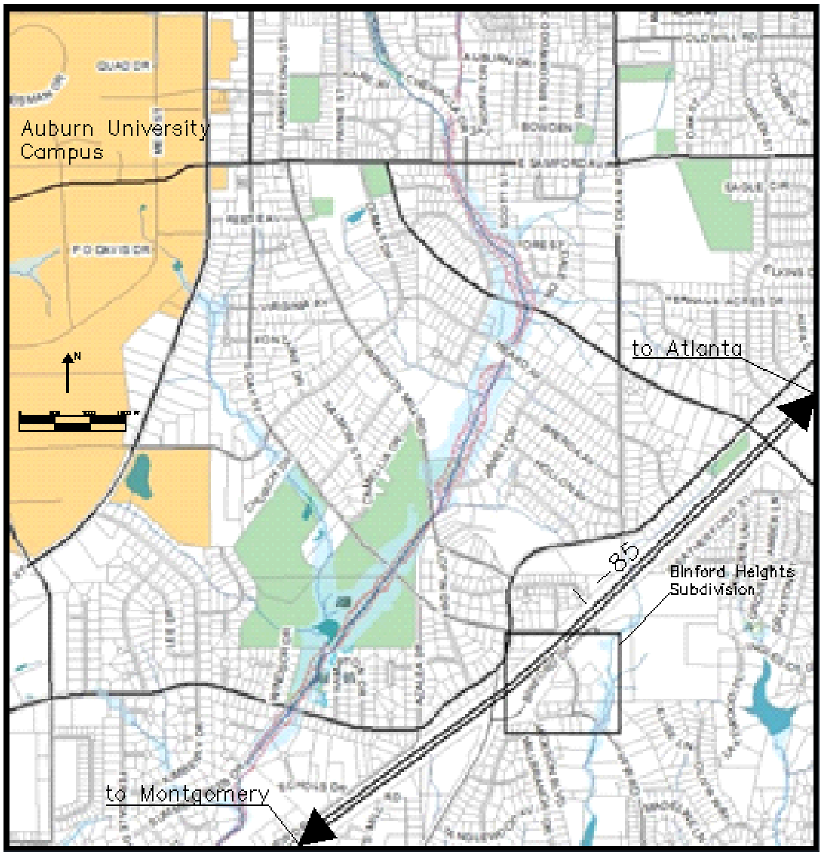

Figure 1. General location map for Binford Heights subdivision, Auburn, AL

Figure 2. Aerial photo of Binford Heights Subdivision, Auburn, AL, with preliminary road alignment.

As shown below, Figure 3 displays the entire subdivision with various allocated parcels. The specific parcel in question is parcel 9, indicated with a double green border. Also included in the figure is a separate student proposed road alignment for the remainder of the subdivision based on elevation contours, and indicated in purple.

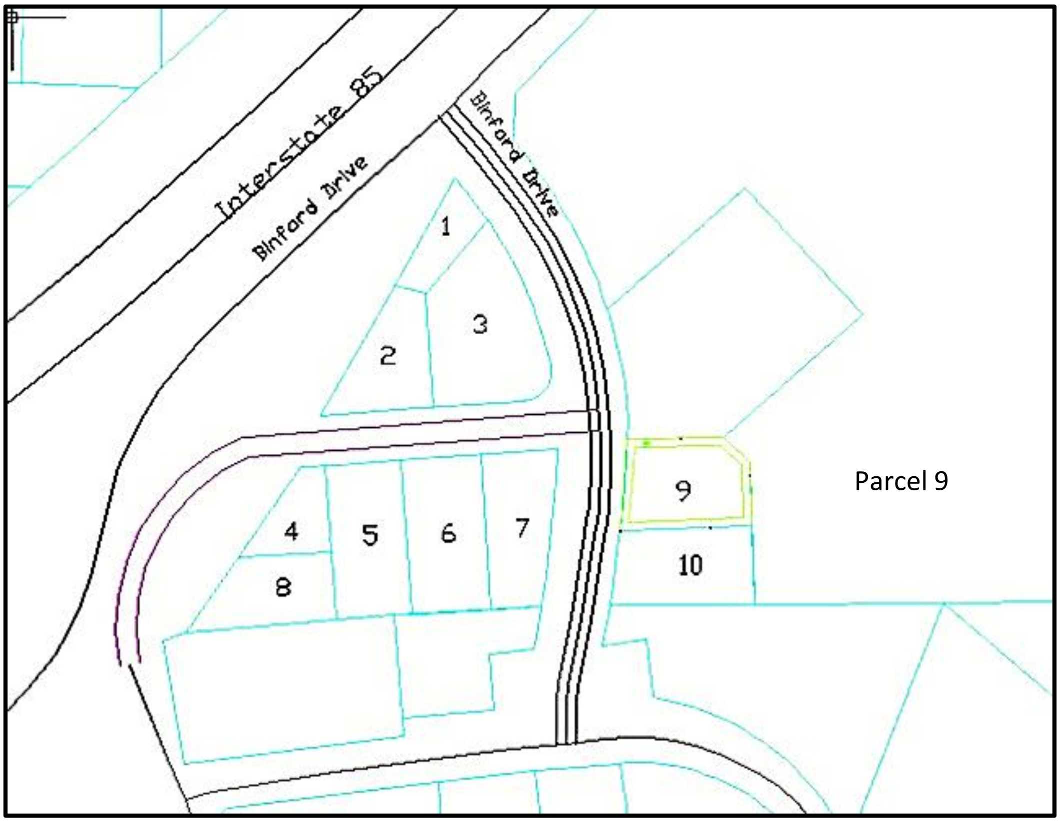

Figure 3. Binford Heights Subdivision, Auburn, AL – Parcel 9 highlighted

I. LOCATION AND ZONING

The parcel is being developed as part of Binford Heights subdivision. It is a residential subdivision. The current site is a pleasant wooded area located in proximity to Auburn University. There is also a stream located directly east of parcel 9 (Figure 4).

Figure 4. Water bodies close to parcel 9, located in Binford Heights subdivision, Auburn, AL.

The lot is located in Lee County within Auburn, Alabama. Lot 15, which includes Parcels 9 and 10, is appraised at $8,800.00. Our proposal is for Parcel 9. Property information is shown in Figure 5. The lot is along Binford Drive. Parcels 9 is 15,641 square feet, or 0.35908 acres. The current legal owner is Linda W. Hughes. The yearly property taxes for Lot 15 in 2013 were $95.04. The metes and bounds map is shown in Figure 6.

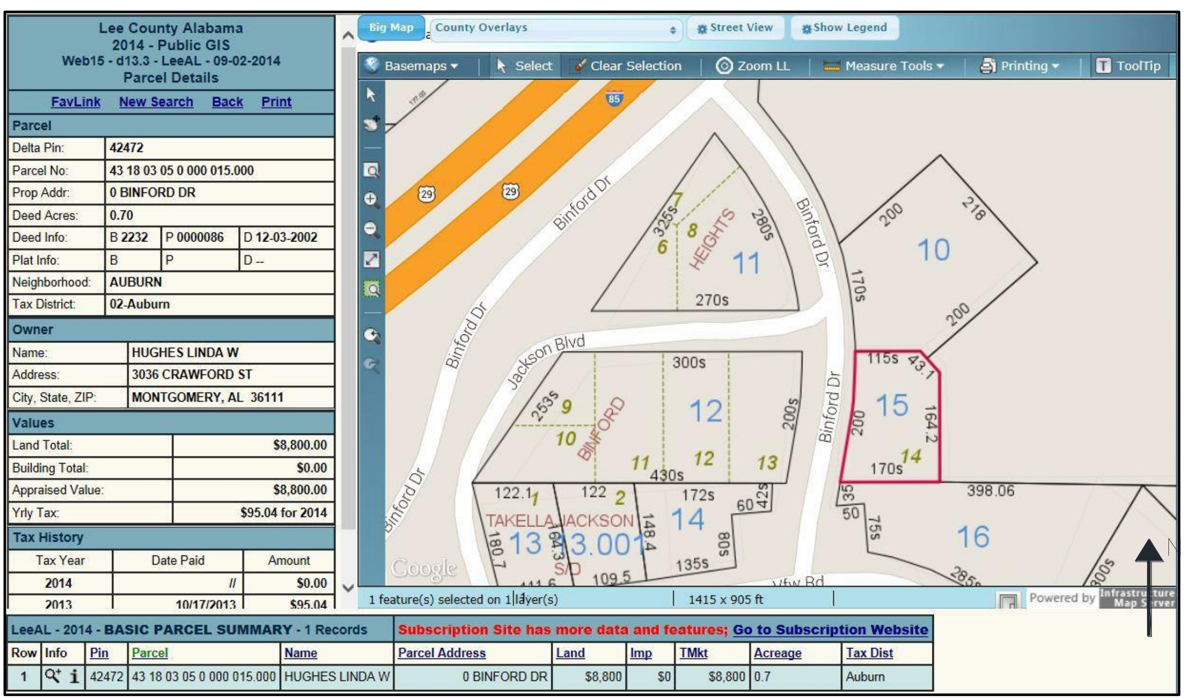

Figure 5. Property information for Lot 15, which includes parcels 9 and 10, Binford Heights subdivision, Auburn, AL.

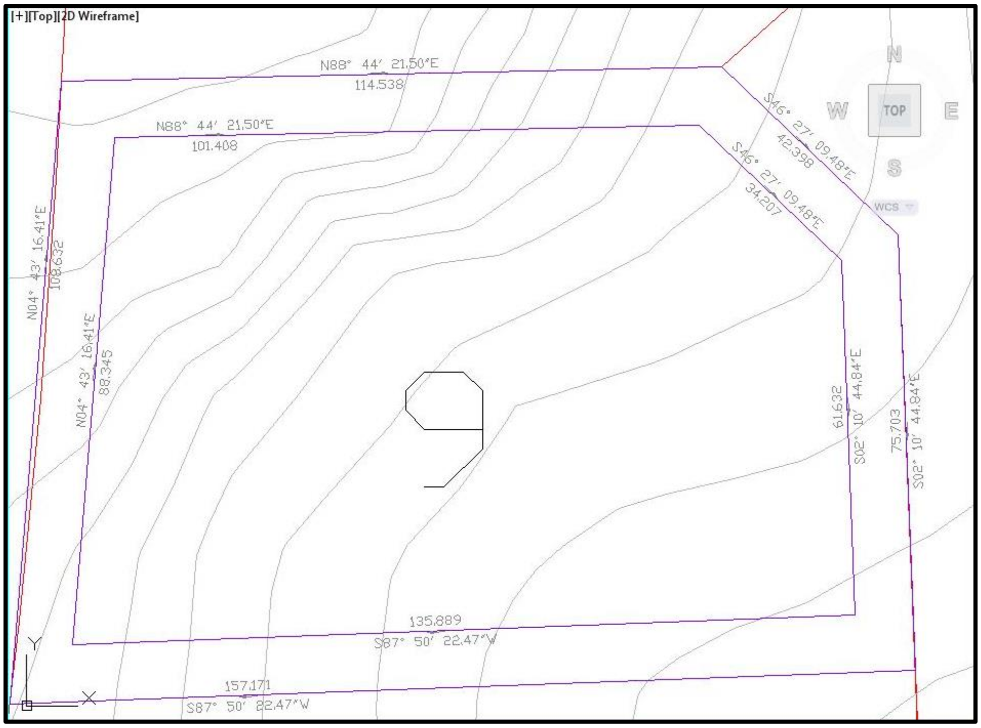

Figure 6. Metes and bounds for parcel 9, Binford Heights subdivision, Auburn, AL.

The parcel is located in close proximity to Interstate 85, southwest of downtown Auburn. It is a wooded lot with a slope of 12.32% (Appendix F). The parcel is located adjacent to an Auburn City Water plant. It is located 2.1 miles northeast of Chewacla State Park, and 0.7 miles southeast from Town Creek Park. It is 3.4 miles from Auburn University Campus.

Zoning

The lot is designated as NC-14. Parcel 9 satisfies the requirements set by NC-14, as the lot area is over 14,000 square feet. Being a NC-14 lot, the distance between the road and the house structure was confirmed to be over 25 feet. Allowable uses with this zoning includes residential use for "Family" (City of Auburn, 2014). The lot is not in a designated wetland (Figure 7).

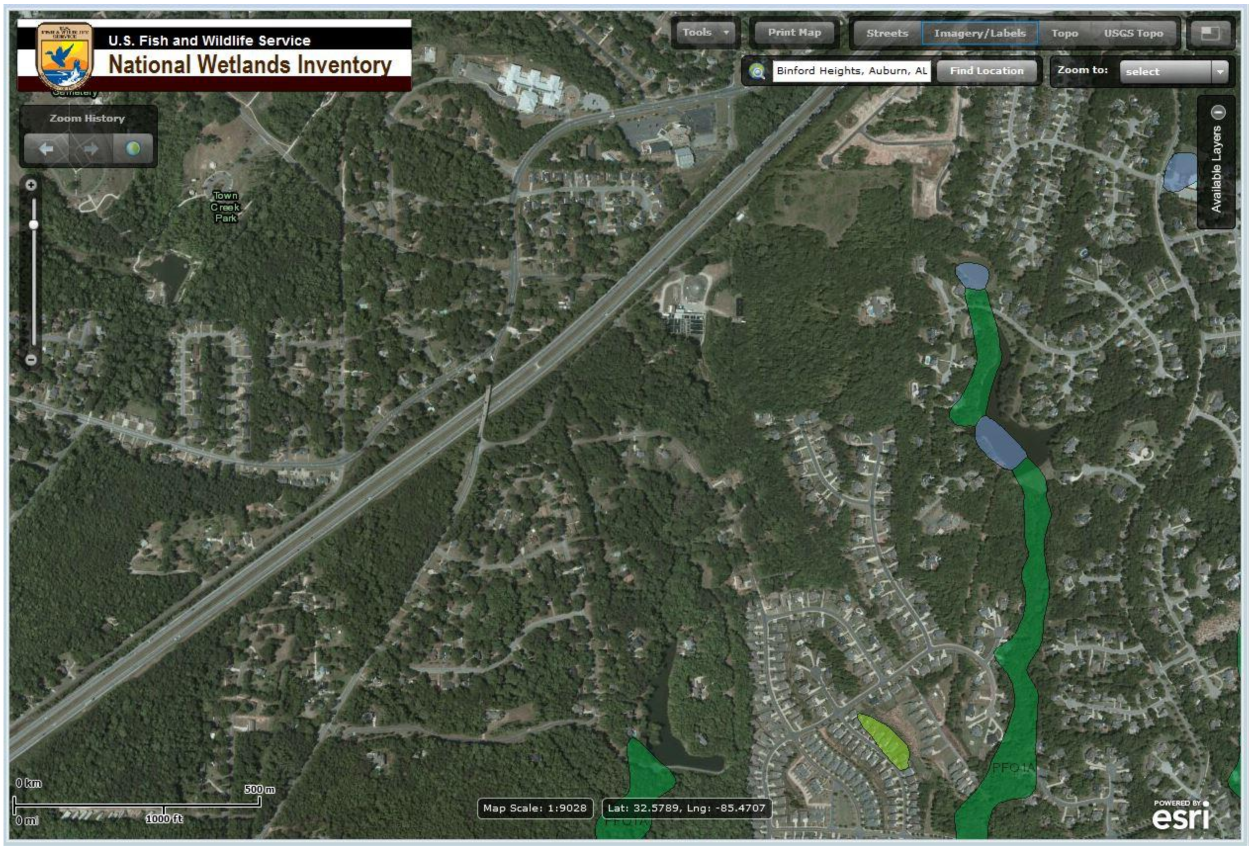

Figure 7. National Wetlands Inventory for Binford Heights, Auburn, AL.

The school zone for this lot is Dean Road and Wrights Mill Road. Note that parcel 9 borders the boundary line between "Dean Road and Wrights Mill Road" and "Auburn Early Education Center and Ogletree". There is already a proposed bike lane for Binford Heights, the road adjacent to our lot. The proposed bike lane connects shortly to Wright Mills Road, which already has bike lanes in place. The site is located within Police Beat 6 of the Auburn Police department.

II. GENERAL TOPOGRAPHY

Onsite elevations range from 624.5 feet MSL in the northeast corner to 602.2 feet MSL in the southwest corner (Appendix F). The high and low points on the border adjacent to the road Binford Drive are approximately 625 feet and 616 feet.

Parcel 9 has a slope of approximately 12% (Appendix F). The slope is fairly steep. There would have to be some grading technique implemented in the northwest corner of parcel 9 due to the placement of the home. Grading is not included in the feasibility report, however, will be developed if the project is approved.

III. UTILITY AVAILABILITY

Water will be supplied by James E. Estes Water Treatment facility. A septic tank and effluent disposal field should be installed to manage on-site sewage. Alabama Power will be used for electricity. Trash pickup will occur on Tuesday.

A. *Water*

The James E. Estes Water Treatment facility is the closest water facility to parcel 9. A water main from the facility would be the source of water. The treatment plant is owned and operated by the City of Auburn Water Works Board. The water for the facility is provided by Lake Ogletree, and is treated with chlorine treatment. It is about 600 feet above sea level. The plant has had issues with exposure of chlorine gas, although they have not had any “incidents” in the past five years (EPA, 2013). In the future, the site plans to remove chlorine gas and replace it with alternative disinfection (EPA, 2013).

B. *Sanitary Sewer*

It was found that a septic tank with an effluent disposal field is the best alternative for this parcel, as opposed to the sanitary sewer system available in the vicinity. It is undetermined whether the lot has access to sanitary sewer lines. As such, we will make the assumption that it does not. Under this assumption, it will be more cost effective to install a septic tank and effluent disposal field than to install the sanitary sewer lines. This also provides an advantage overtime for the resident as bills for sanitary sewer will not have to be paid to the city.

C. *Power*

The parcel is located within the Alabama Power service area. There are existing overhead power lines in the neighborhood.

IV. TRANSPORTATION/ACCESS REQUIREMENTS

The entry to the parcel is Binford Drive (Appendix G). Construction access will not be an issue. Additional Auburn University’s Tiger Transit stops within proximity to the lot should be suggested to Auburn University for transportation convenience.

V. SOIL CONDITION

The soil type of parcel 9, in area AL081, is cecil sandy loam with 6 to 10 percent slopes (Figure 8). Figure 9 outlines parcel 9. The elevation of the soil is between 200 and 1,400 feet. It also has a mean annual precipitation of 37 inches to 60 inches. The mean annual air temperature is 59 degrees Fahrenheit to 66 degrees Fahrenheit with a frost-free period of 175 to 240 days. The area is not prime area for farmland. The landform classification is ridges with a convex down-slope shape.

The sandy loam soil is derived from the parent material of clayey residuum weathered from granite and gneiss. The depth to restrictive feature is more than 80 inches, which indicates moderate infiltration. The natural drainage class is well drained, and in a low runoff class. The capacity to the most limiting layer to transmit water (ksat), the soil's capacity to hold water, is classified moderately high to high with rate of 0.57 to 1.98 inches per hour (USDS, 2007).

The depth to the water table is more than 80 inches. This means if construction digs more than 6.67 feet into the soil, the water table will be reached and cause ponding of water at the site and making it difficult to continue digging. If this happens, drains must be installed and an installed bank as high as the water table (B., Jay, 2011). This could be a problem if grading revisions are implemented. There is no frequency of flooding or of ponding, and the available water storage in the profile is moderate with approximately 8.3 inches (USDS, 2007).

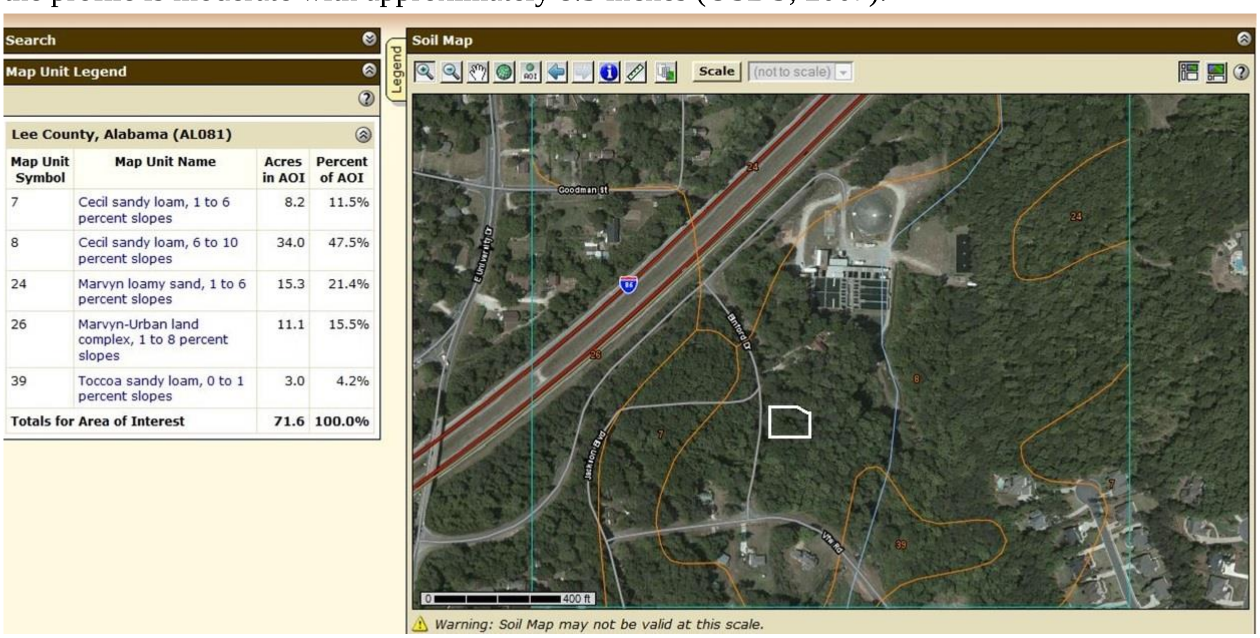

Figure 8. Web soil survey information for parcel 9, Binford Heights subdivision, Auburn, AL.

Figure 9. Soil data with Parcel 9 outlined, located in Binford Heights subdivision, Auburn, AL.

<u>Disclaimer:</u> Since the site was zoomed in significantly on the website, the elevation contours might not be exact. It is being assumed that parcel number 9 is outside of the few feet of error of the contours.

By assessing the hydrologic soil group, type B, the site will have moderately low runoff potential when thoroughly wet. B soils typically have between 10 to 20 percent clay and 50 to 90 percent sand and have a loamy sand texture (USDS, 2007).

The cecil sandly loam soil is categorized as too clayey and dusty and is unstable for excavation walls. Shallow excavations are trenches or holes dug to a maximum of 5 or 6 feet. The soil is somewhat limited concerning excavation, and very limited concerning small commercial buildings due to a small depth to saturated zone and flooding. This indicates that the soil has one or more features that are unfavorable for specified use and would need major soil reclamation, special design or expensive installation procedures (USDS, 2007).

The natural drainage of this site is well drained, with a depth of more than 80 inches below the surface to reach the water table, and the capacity to the most limiting layer to transmit water is going to be high, which can affect ponding. It is also seen that 37 to 60 inches of rain is expected to fall in this area per year. The runoff class for this site is low and the natural drainage area is considered well drained with no frequency for flooding or ponding (USDS, 2007).

The water runoff from rain influences erosion and weathering of the parcel. Since there is not susceptibility to ponding or flooding, the water runoff from parcel 9 will erode the northwest corner of the lot, because it is higher in elevation and in the middle of the watershed flow path. In order to minimize the erosion and sediment runoff, vegetated swales are suggested around the northwest corner and behind the house. This will reduce the soil runoff and also will allow more time for water infiltration in the soil surface.

VI. HYDROLOGY/STORMWATER MANAGEMENT

Figure 10 shows the water flow into Parcel 9. The top of the watershed is approximately 70 feet north of the northeast corner of the lot. The arrows in figure 10 show the direction of the water flow, indicating a southwest movement across Parcel 9. The bold pink outline is the water that will flow onto Parcel 9, and then flow off of Parcel 9.

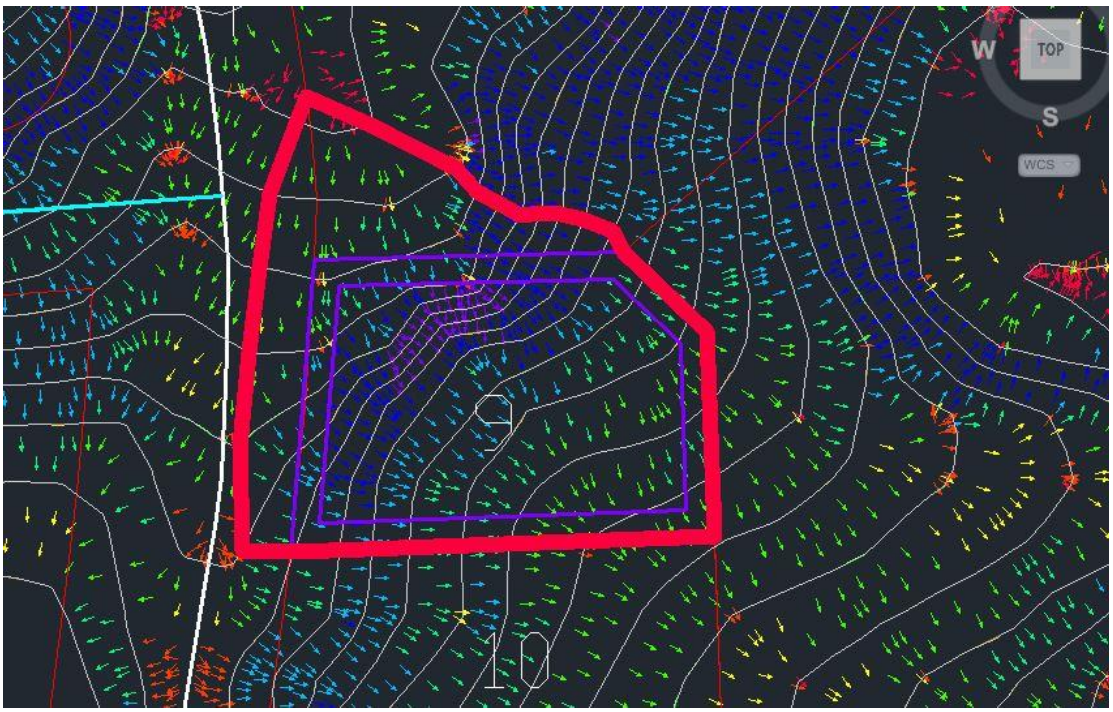

Figure 10. Water Inflow to Parcel 9, Binford Heights subdivision, Auburn, AL.

A water drop analysis was also performed with watershed delineation to illustrate peak runoff flows (Appendix H). The dark blue lines that flow from the top left corner to the bottom right corner show the flow of individual water drops and how they travel across the watershed. Parcel 9 is shown with a purple outline. As a house is constructed, there will need to be erosion and sedimentation practices on parcel 9 to ensure minimal runoff onto downstream lots.

The Rational Method was used to find the peak runoff rates of the watershed flowing onto parcel 9 because the calculated time of concentrations were below 15 minutes. These calculations and the peak runoff rate calculations are included in the Appendix I. Since the Rational Method was used, there were a few assumptions that were made to justify these results. These included runoff being linearly related to rainfall, rainfall occurring uniformly over a given site, peak runoff rate occurs when entire area is contributing flow, excess rainfall hyetograph is one of constant intensity for the duration to equal the time of concentration and that the frequency of peak runoff rate is the same as the frequency of the average rainfall intensity. The following summary information is reported.

Table 1 above is the determining factor to why the Rational Method was used to find the peak runoff rates. Since the highest time of concentration was almost 11 minutes, this is indeed less than 15 minutes, so calculations were continued using the Rational Method. This is determined by using the flow chart in Appendix J

Table 1. Times of Concentration

Time of Concentrations Using Rational Method		
Storm Type	Pre-Development	Post-Development
25 year, 24 hr	6.20 min	10.87 min
50 year, 24 hr	5.88 min	8.35 min

The peak runoff rates, shown in Table 2, shows that the highest peak rate of 2 cubic feet per second. This means that the highest amount of water that could run off of Parcel 9 will be two cubic feet per second after a 50 year precipitation event. Runoff volumes were found by using the runoff depths, shown in Appendix K, and multiplying them by the drainage area onto parcel 9. The drainage area used is shown in Appendix L. These calculations are located in Appendix I. The calculations confirm that our soil has considerably moderate peak runoff values, as stated previously in the soil conditions.

Table 2. Calculated Peak Runoff Rates

Anticipated Peak Runoff Rates Found Using Rational Method		
Storm Type	Pre-Development	Post-Development
25 year, 24 hr	1.64 cfs	1.67 cfs
50 year, 24 hr	1.93 cfs	2.07 cfs

This Rational Method data confirms our relatively moderate peak runoff values that were indicated in the soil analysis. The peak rainfall volumes were determined, shown in Table 3, for a 25 year, 24 hour storm and a 50 year, 24 hour storm. The city of Auburn requires that the peak volume runoff post-development be equivalent to pre-development. Due to these high volume runoff rates, storm water and sediment control practices are suggested to minimize construction runoff. A swale would divert water runoff around house structure and minimize erosion runoff onto downstream neighboring lots.

Table 3. Calculated Peak Volume

Anticipated Peak Volumes		
Storm Type	Pre-Development	Post-Development
25 year, 24 hr	13255 cubic feet	13255 cubic feet
50 year, 24 hr	14912 cubic feet	14912 cubic feet

VII. CONSTRUCTION PROPOSAL

A. *Building Site Development*

This site can support a 2,666 square foot home (Appendix G). It will be a two-story log cabin, with a partial basement. There will be a pervious concrete driveway and sidewalk, in addition to the septic tank and drain field.

B. *Sanitary facilities*

The lot is a small-flow onsite sewage treatment and disposal system (OSS) (less than 1,200 gpd). It meets the requirement of a minimum lot area of 15,000 square feet (APDH, 2010). A 1,000 gallon septic tank should be installed. An effluent disposal field (EDF) of 1,500 square feet should also be installed (Appendix N). It should be a minimum of 5 feet away from the property line and 5 feet away from any dwelling. The septic tank and drain field design is shown in Appendix O.

C. *Construction materials*

General construction materials should be used to build the house. This is up to the discrepancy of the owner, with minimal limitations. The proposed log materials are conducive for the site. Concrete is suggested for use in the driveway, sidewalk, and foundation.

D. *Water management*

Vegetated swales are recommended for placement in the northeast corner of the house. The water will be incoming from the watershed in that area and due to the house placement, erosion may occur on the north and west sides of the house. The swales are expected to minimize erosion.

VIII. COST ESTIMATE

Lot 15 was appraised to be $8,800 (Figure 5). Since parcel 9 is included in the lot (Figure 11), lot 15 would need to be bought. The average construction price of creating a 2,666 square foot home is estimated to be approximately $250,000 (Appendix P). This is approximately $95 per square foot. In total, the cost estimate is approximately $258,800.

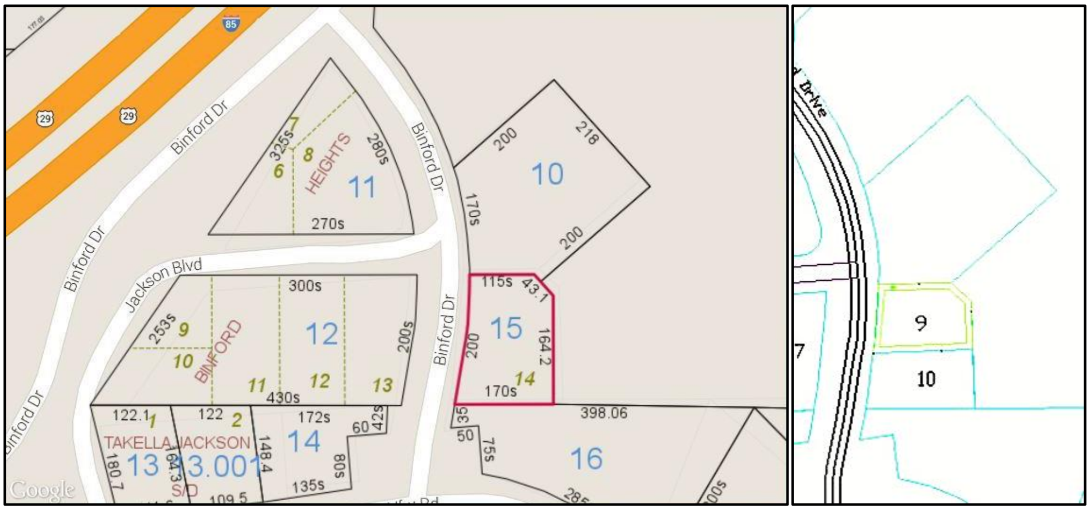

Figure 11. Lot 15, which is composed of parcels 9 and 10, Auburn, AL.

CONCLUSION

This site was determined to be a feasible site for a residential structure of 2,666 square feet. The site will include a two-floor 2,666 square foot home with a partial basement. Also included will be a porch, sidewalk, and driveway. It will include a septic tank and EDF. Water and power will be provided through outside facilities. Total cost is estimated to be approximately $258,800.

REFERENCES

Alabama Department of Public Health. "CHAPTER 420-3-1 Onsite Sewage Treatment And Disposal" *Division Of Community Environmental Protection* (2010): Web. 03 Oct. 2014. < http://www.adph.org/onsite/assets/OnsiteRules4-10.pdf>.

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United States Department of Agriculture, Natural Resources Conservation Service. "Hydrology National Engineering Handbook." *Hydrologic Soil Groups* 630th ser. (2007): n. pag. *United States Department of Agricutulre*. May 2007. Web. 28 Sept. 2014. <http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba>.

AUBURN UNIVERSITY

BIOSYSTEMS ENGINEERING

BSEN 5560: Site Design

FEASIBILITY STUDY: APPENDIX

Victoria Burnett & Jenny Walter

3 October 2014

BSEN 5560: Site Design
Team Design Project Assignment: Feasibility Study (200 points)
Due date: Sept. 30, 2014

Provide a typed Feasibility Report for your assigned building site in Auburn, AL. A formal cover letter should be submitted to the current landowner with your report. Your feasibility study will consist of narrative and graphics describing the feasibility of the site relative to items in Written Feasibility Study checklist (Figure 4-2 posted on class web page). Your feasibility report should include preliminary design alternatives followed by a recommendation whether proposed project alternatives are feasible.

Report should include the following:

- Cover letter, title page, table of contents, and executive summary.
- Introduction - describes the report scope and includes a concise easily identifiable problem statement that spells out your team's approach to design. Insert at least one general location map within the body of the introduction text.
- Design:
    - Engineer-scale drawing(s) to engineering scale of the property (at least one 11x17" map folded to 8-1/2x11") included within the body of the report text. Include property boundary, location of any water bodies, wetlands, jurisdictional boundaries, and size/layout/grade of all existing and proposed paved surfaces and water, sewer, and stormwater facilities, including diversions and swales. Use standard map format in AutoCAD. <u>No pencil or pen drawings</u>.
    - Provide a summary of major design components you will specify in your Final Report. Design components should meet City of Auburn specifications and provide:
        - Pre- and post-design runoff peak and volume for your specified storm.
        - Plan view of relevant roads, building, roof, driveways, parking areas, etc.
        - Plan and profile drawings of proposed facilities,
        - Grading revisions as needed, to include existing and proposed contours
        - Preliminary cost estimates of designs.
    - Stormwater volumes managed by design structures, based on stored volume of site runoff. Summarize calculation results in body of report.
    - Preliminary drawings of any road alignments and culvert structures, including existing and assumed elevations.
- Appendix – photocopies of all printouts and handwritten design procedures and calculations in neat, legible format are required
    - Design procedures - document your design steps with supporting calculations and reference all appendix within body of report (e.g., CN or peak runoff, stormwater detention, nomographs, standards, codes, manufacturer references, etc.)

Report format (typed and bound, all pages numbered consecutively):

- All tables numbered and labeled *above* table (eg., **Table 1. Typical velocities in a channel**).
- All figures numbered and labeled *below* figure (eg., **Figure 1. Location map**).
- All figures and tables must be referenced within the body of the report.
- All calculations should be done legibly on engineering paper, referenced, *photocopied*, and inserted into appendix. <u>No credit will be given for work submitted in pencil or pen</u>.
- Materials in landscape-mode inserted with top of page oriented towards binding edge.
- Include copy of original assignment *and writing rubric* at end of report for grading.
- Five (5) points off for each missing item from above.

To:	Ms. Linda W. Hughes
	1713 Graham Street
	Montgomery Al 36106
From:	Burnett &Walter Incorporated
Date:	30 September 2014
Re:	Binford Heights Parcel 9 Preliminary Feasibility Report

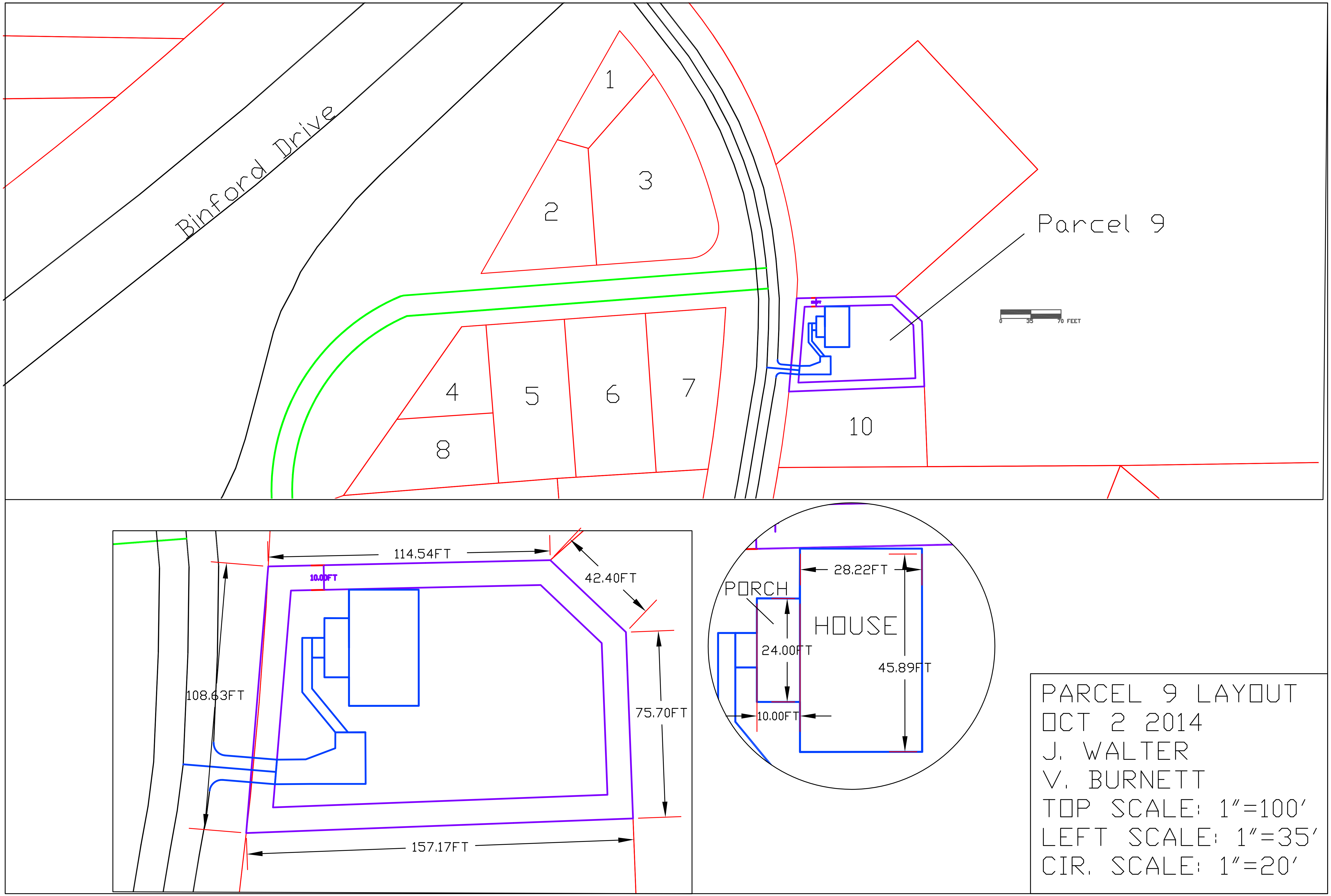
Burnett & Walter Incorporated received and completed the requested feasibility report for parcel 9 located in the Binford Heights subdivision. The following design report includes all major parameters that should be assessed before constructing on this property.

The site was found to have previous complications with the James E. Estes Water Treatment facility, located 0.2 miles northeast of the parcel. There was a release that allowed chlorine gas to migrate off the water treatment site in the south and southeast directions, along a natural drainage fall line towards parcel 9 and exposing approximately 1.1 miles of residential area to contamination. There have not been any incidences pertaining to chlorine gas since April 15, 2004 at this Water Treatment facility, therefore this should not prove to be a problem when furthering development of parcel 9.

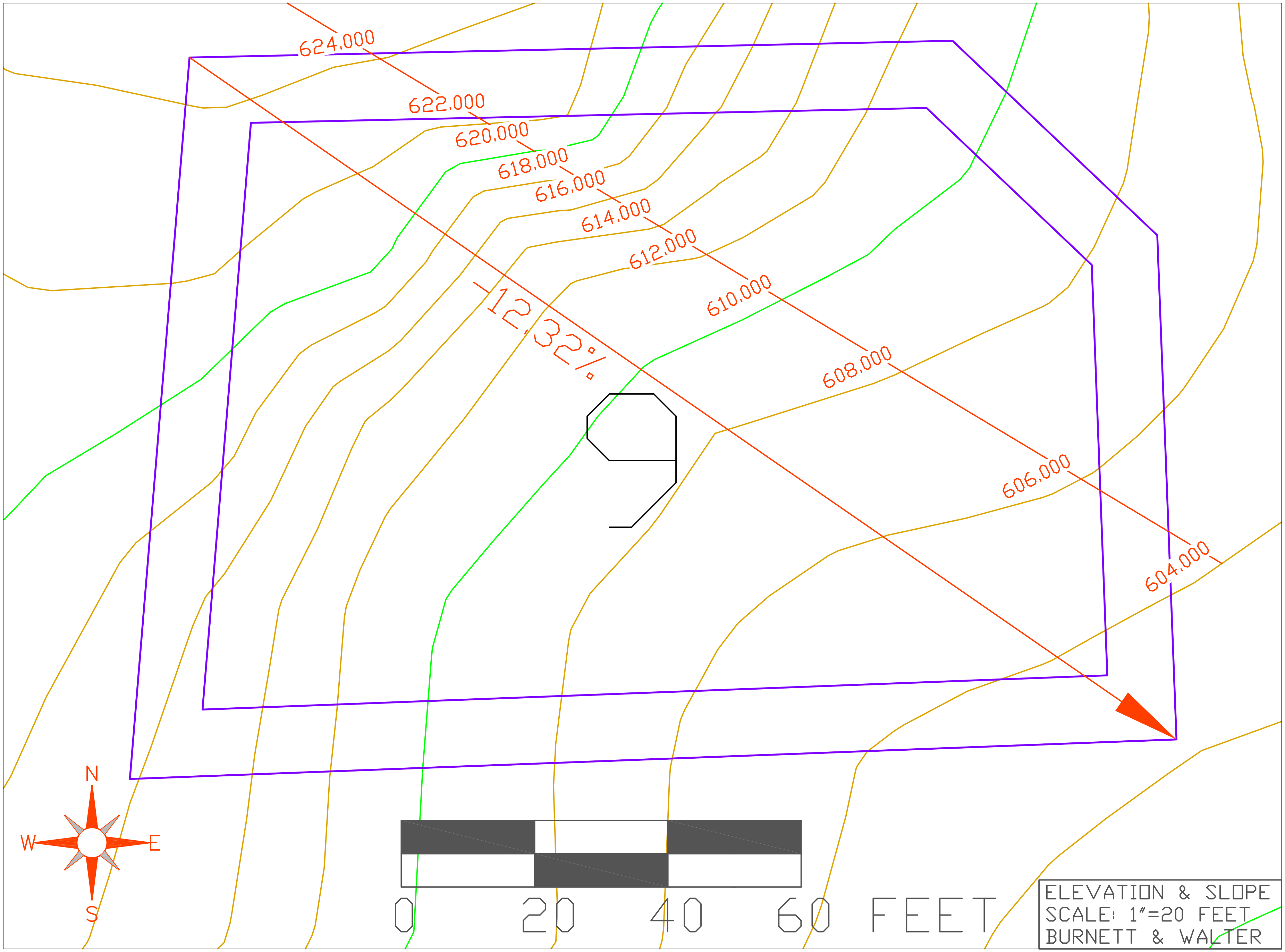
The proposal for the site is within the following feasibility report. All calculations are subject to revision and resubmission. Additional research will be provided for the site if it is further pursued.

Jenny Walter

Victoria Burnett



PARCEL 9 LAYOUT
OCT 2 2014
J. WALTER
V. BURNETT
TOP SCALE: 1″=100′
LEFT SCALE: 1″=35′
CIR. SCALE: 1″=20′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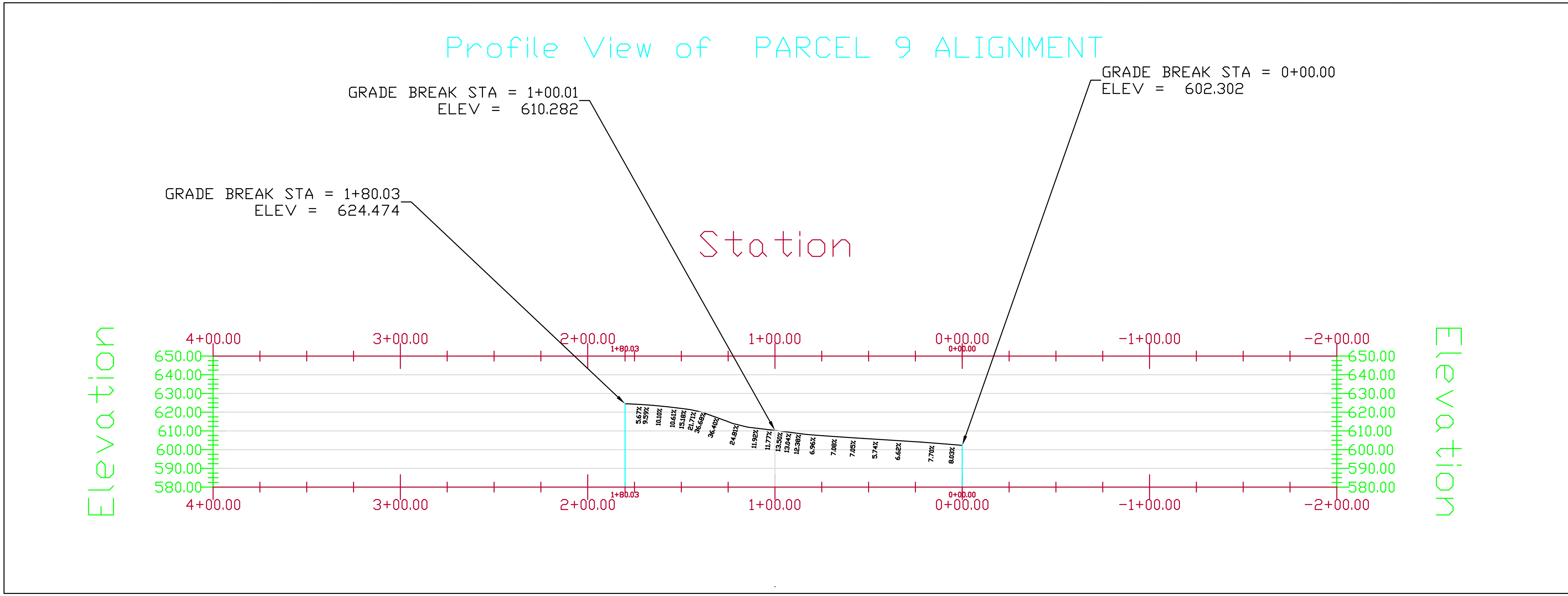
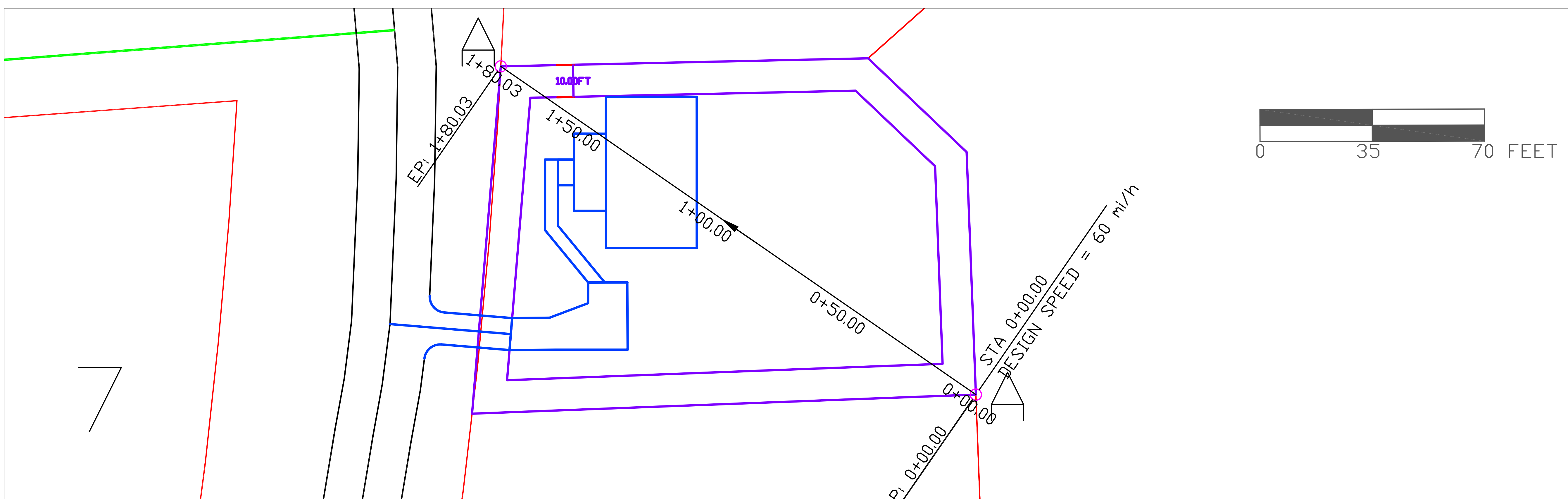
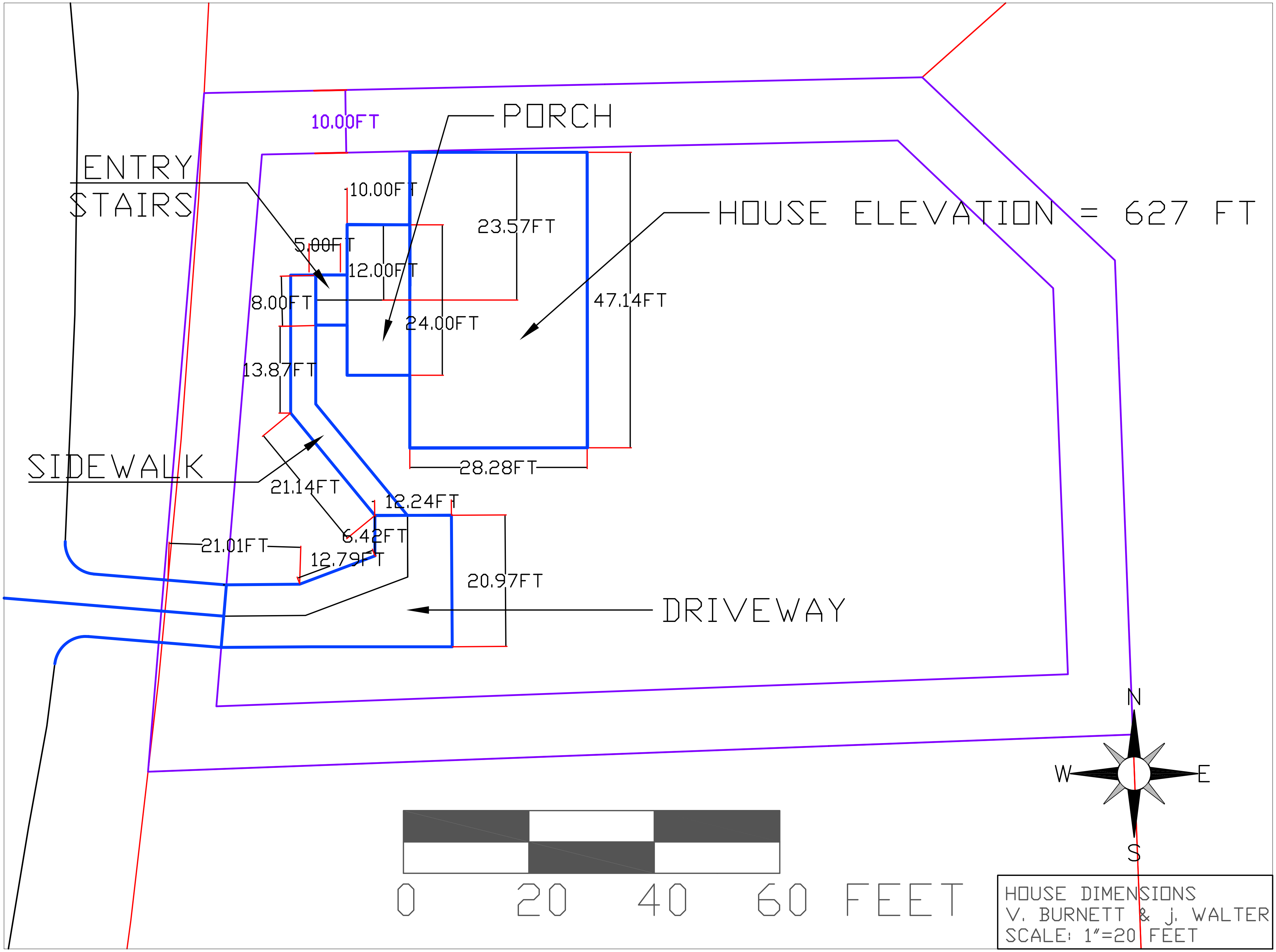
BURNETT & WALTER





PROFILE VIEW
J WALTER & V BURNETT
OCT 2, 2014
BOTTOM SCALE: 1'=35 FT


PORCH
10.00FT
ENTRY STAIRS
10.00FT
23.57FT
HOUSE ELEVATION = 627 FT
5.00FT
12.00FT
8.00FT
24.00FT
47.14FT
13.87FT
SIDEWALK
28.28FT
21.14FT
12.24FT
6.42FT
21.01FT
12.79FT
20.97FT
DRIVEWAY
N
W
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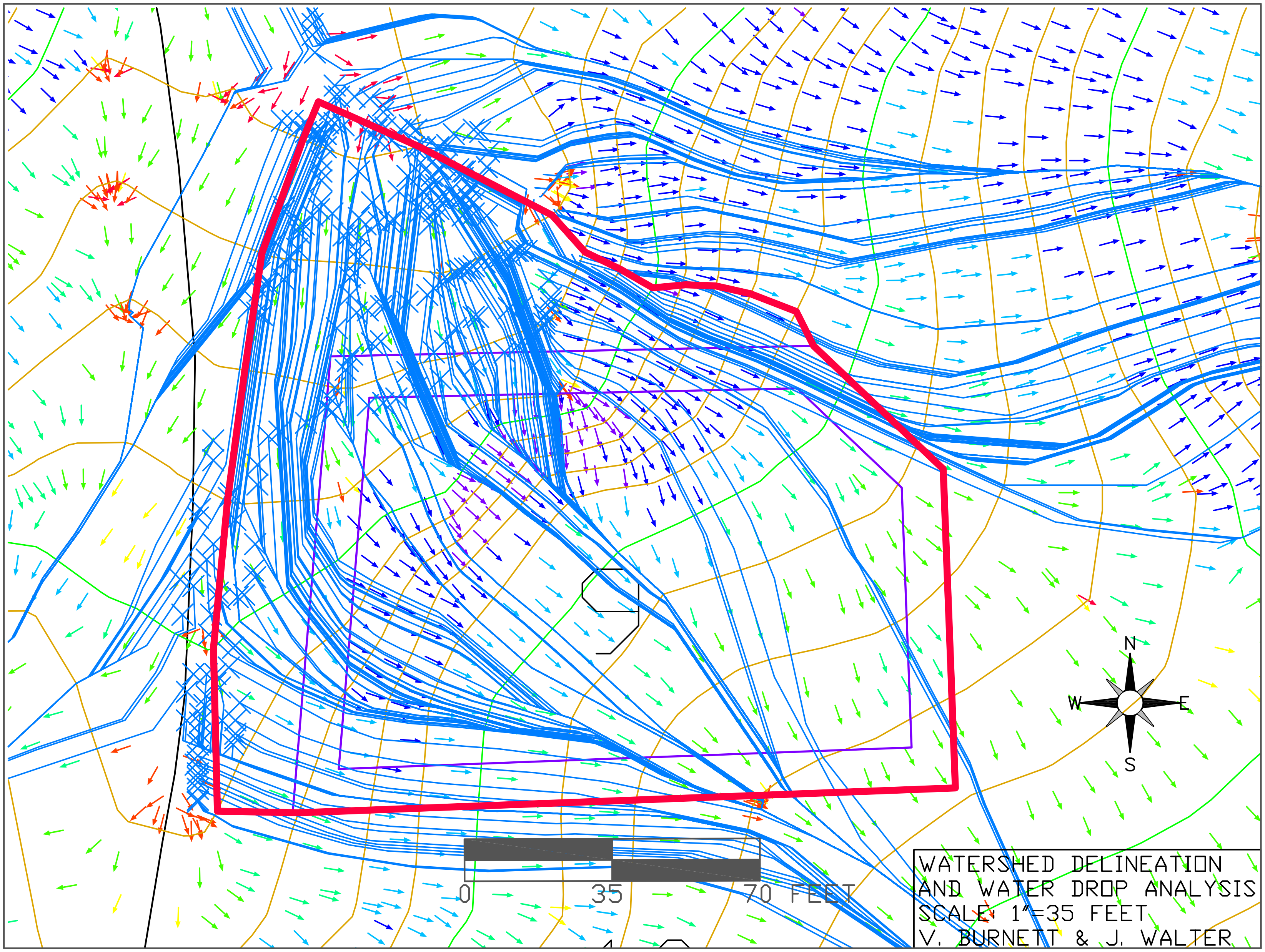
S
0
20
40
60
FEET
HOUSE DIMENSIONS
V. BURNETT & j. WALTER
SCALE: 1"=20 FEET


N
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0
35
70 FEET
WATERSHED DELINEATION
AND WATER DROP ANALYSIS
SCALE: 1"=35 FEET
V. BURNETT & J. WALTER

APPENDIX I:

Sep 28, 2014 | BSEN 5560 - F. R. Parcel #9 | V. Burnett | 1/7

DESIGN PROCEDURES - $\boxed{\text{PEAK RUNOFF}}$ PRE-DEVELOPEMENT

could either use the CN method or the Rational Method to determine the peak Runoff.

S = Slope of watercourse avg = 12.21%
L = longest course in watershed = 203.7849 ft
A = area drainage = 22092.0203 ft² → 0.507163 acres

Mannings coefficient = 0.15 for wooded land
→ Pre-developement land is mainly wooded

Storm Return Period → auburn Requires a 25 year, 24 hour storm & we would like to take into account a 50 year storm as well.

Return Period (yr)	24 hour Rainfall (in) (P)
25	7.2 in
50	8.1 in

$T_c = T_{sheet} + T_{flow}$

$$T_{c\ sheet} = \frac{0.007((n)(L))^{0.8}}{(P)^{0.5}\ S^{0.4}}$$

n = mannings coefficient
L = length water flow (ft)
P = rainfall
S = slope

$$T_{c\ sheet\ (25yr)} = \frac{0.007\ ((0.15)(203.7849))^{0.8}}{(7.2)^{0.5}\ (0.1221)^{0.4}}$$

(n used is 0.15 for trees since land is undeveloped).

$T_{c\ sheet\ (25yr)} = 0.093316$ hrs

$$T_{c\ shallow\ conc\ (25yr)} = T_c = \frac{L}{3600V}$$

L = length water flow (ft)
V = avg velocity ft/s

$V_{unpaved\ area} = 16.1345\ (S)^{0.5}$ ft/s

$V_{up} = 16.1345\ (0.1221)^{0.5}$
$V_{up} = 5.63785$ ft/s

$$T_{c\ shallow\ 25yr} = \frac{203.7849\text{ft}}{3600(5.63785\ \text{ft/s})} = 0.010041\ \text{hrs}$$

PEAK RUNOFF CONTINUED ...

$T_{c\ 25\ yr} = 0.093316\ hrs + 0.010041\ hrs$

$T_{c\ 25\ yr} = 0.103357\ hours \left(\frac{60 min}{1 hr}\right) = \underline{6.20\ min}$

For a 50 year storm:

$$T_{c\ sheet\ 50\ yr} = \frac{0.007\left((0.15)(203.7849\ ft)\right)^{0.8}}{(8.1)^{0.5}(0.1221)^{0.4}}$$

$T_{c\ sheet\ 50yr} = 0.087979\ hrs$

$T_{c\ conc\ 50yr} = \frac{L}{3600V}$ ⇒ still unpaved, so same Tc.

$T_{c\ conc\ 50\ yr} = 0.010041\ hrs$

$T_{c\ sheet} + T_{c\ conc\ 50yr} = 0.087979173 + 0.010041\ hrs$

$T_{c\ 50yr} = 0.0980202\ hrs \left(\frac{60 min}{1 hr}\right) = \underline{5.88\ min}$

Pre-developement

$T_{c\ 25\ yr} = 6.20\ min$

$T_{c\ 50yr} = 5.88\ min$

These allow us to look up the Rainfall intensities...

			INTENSITY
Tc = 6.20	25 yr	⇒	8.38 min

This is found by using interpolation between the Tc of 7 and Tc of 6.

Tc = 5.88	50 yr	⇒	9.14 min

25yr I = 8.38 in/hr
50 yr I = 9.14 in/hr

Now, take the Intensities and put into the Peak Runoff Rate Rational Method.

$$Q_T = C I_T A a$$

C = runoff coefficient (Table 2-4) = 0.35
I_T = intensity
A = area (acres) of drainage
a = 1.1 for 25 yrs 1.2 50 years

<u>25 yr</u>

$$Q_T = 0.35\ (8.380\ \text{min})(0.507163\ \text{acres})(1.1)$$
$$Q_T = 1.6363\ \text{cfs} = \frac{ft^3}{s}$$

<u>50 yr</u>

$$Q_T = 0.35\ (9.14\ \text{min})(0.507163\ \text{acres})(1.2)$$
$$Q_T = 1.94689\ \text{cfs} = \frac{ft^3}{s}$$

* The peak flow Rates for our parcel for <u>pre</u>-developement stages:
  Q_T 25 yr = 1.6363 cfs
  Q_T 50 yr = 1.947 cfs

For <u>Post</u> - developement land :

Manning's coefficient changes.
10.47 % of the land is now impervious $n = 0.012$ (concrete)
89.53 % of the land is earth $n = 0.035$

area total = 52092.0203 $ft^2 \rightarrow$ 89.53% unpaved
area pavement = 2314.2 $ft^2 \rightarrow$ 10.47% paved

also, the velocity to find T_c shallow concentrated flow changes. Since the land is not unpaved, and now paved use this equation:

$$V_p = 20.3282\,(S)^{0.5}$$

The slope for this will have to change, once we learn how to do a grading revision.

Assuming the slope is still the same, then

$$V_p = 20.3282\,(0.1221)^{0.5} = 2.48207 \text{ ft/s}$$

this will be the same for our 25 and 50 yr storms.

The Runoff coefficients will also change originally it was 0.35 from table 2-4.
Post - developement Runoff coefficient will be

$$C_T = \underbrace{(0.1047\%)(0.90)}_{\substack{10\%\ \text{concrete} \\ \text{completely impervious} \\ C = 0.90}} + \underbrace{(0.8953\%)(0.35)}_{\substack{90\%\ \text{woods} \\ \text{pervious} \\ C = 0.35}}$$

$$C_T = 0.09423 + 0.313355$$

$$\boxed{C_T = 0.407585}$$

Manning's coefficient will be:

$$n_T = \underbrace{0.012\,(0.10)}_{\substack{10\%\ \text{of} \\ \text{concrete} \\ n = 0.012}} + \underbrace{0.89\,(0.03)}_{\substack{90\%\ \text{of} \\ \text{earth/weed} \\ n = 0.03}}$$

earth/weed $\rightarrow$ weed will be grasser, & earth will be flatter and a little more developed than woods. so averaged the two (0.035 and 0.025) ~(0.03)

$$\boxed{n_T = 0.0279}$$

Post-developement flow distance (L) also changes because there is a house on the property, so original flow path is altered.

$L = 224.67$ ft

$$Tc_{sheet\,25yr} = \frac{0.007\left((0.0279)(224.67)\right)^{0.8}}{(7.2)^{0.5}(0.1221)^{0.4}}$$

$Tc_{sheet\,25yr} = 0.026365$ hrs

$$Tc_{shallow\,25yr} = \frac{(224.67)}{(3600)(2.48207)}$$

(V_p is calculated on the previous page)

$Tc_{shallow\,25yr} = 0.15490$ hrs

$Tc_{25yr} = 0.026365 + 0.15490$ hrs $= 0.181265$ hrs

$Tc_{25\,year} = 10.87$ min

$$Tc_{sheet\,50yr} = \frac{0.007\left((0.0279)(224.67)\right)^{0.8}}{(8.1)^{0.5}(0.1221)^{0.4}}$$

$Tc_{sheet\,50yr} = 0.005704$ hrs

$Tc_{shallow\,50yr} = 0.15490$ hrs (same as previous 25 yr storm)

$Tc_{50yr} = 0.005704 + 0.15490$ hrs $= 0.160604$ hrs

$Tc_{50yr} = 9.636$ min

$\boxed{Tc_{25\,year} = 10.87 \text{ min}, \quad Tc_{50\,year} = 9.64 \text{ min}}$

using the Rainfall Intensity from appendix table 2.1 & 2-2 can now find the Intensity of these storms.

$\boxed{I_{25yr} = 7.33 \text{ in/hr}, \quad I_{50yr} = 8.35 \text{ in/hr}}$

Now can plug into Rational Equation:

$\dot{Q}_T = C I_T A a$

$\dot{Q}_{T\,25yr} = 0.407585\,(7.33\text{ in/hr})(0.507163\text{ acr})(1.1)$

$\dot{Q}_{T25yr} = 1.6667\text{ cfs}$

$\dot{Q}_{T\,50yr} = 0.407585\,(8.35\text{ in/hr})(0.507163)(1.2)$

$\dot{Q}_{T\,50yr} = 2.07125\text{ cfs}$

$$\boxed{\begin{array}{l}\dot{Q}_{T\,25\,year} = 1.67\text{ cfs}\\ \dot{Q}_{T\,50year} = 2.07\text{ cfs}\end{array}}$$

Peak Runoff rates for post developement stages

Sep 28, 2014	BSEN 5560- Parcel #9 F.R.	V. Burnett	7/7

Pre-developement volumes

Detention Storage Volume:

$$V_r = QA$$

Q = Runoff depth (Ft) → Found in Table 2-2 in appendix
A = Watershed area (ft^2)

$$V_{25yr} = \left(7.2\ \cancel{in}\left(\frac{1ft}{12\ \cancel{in}}\right)\right)(22092\ ft^2) = \underline{13255.2 Ft^3}$$

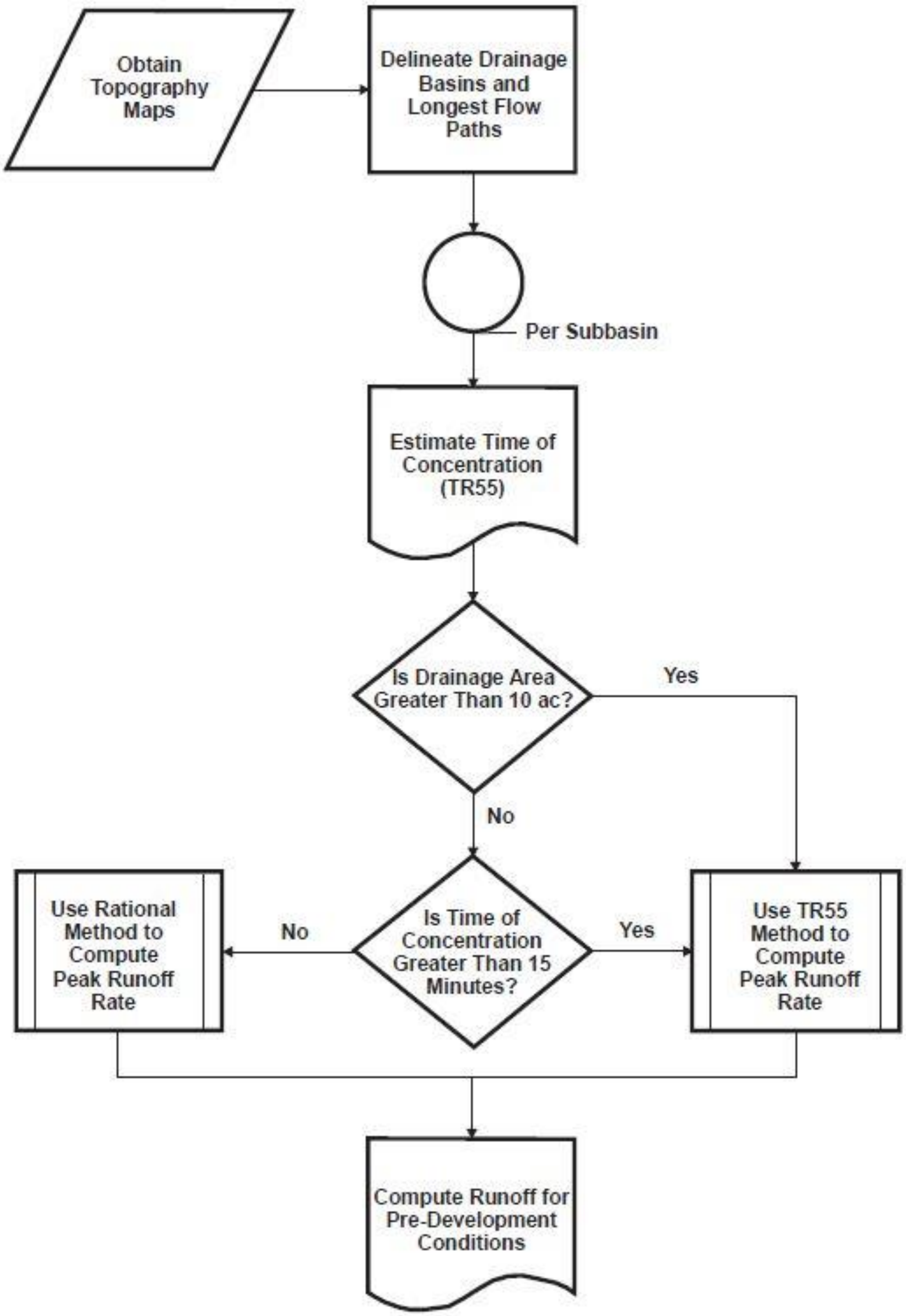
$$V_{50\ yr} = \left(8.1\ in\left(\frac{1Ft}{12in}\right)\right)(22092\ ft^2) = 14912.1\ ft^3$$

Volume for Pre developement volumes:

$$\boxed{\begin{aligned} V_{25\ yr} &= 13255.2\ ft^3 \\ V_{50\ yr} &= 14912.1\ Ft^3 \end{aligned}}$$

These will not change for post developement because the rain will still fall equivilantly in volume, just be displaced differently.

APPENDIX J:



Obtain Topography Maps
Delineate Drainage Basins and Longest Flow Paths
Per Subbasin
Estimate Time of Concentration (TR55)
Is Drainage Area Greater Than 10 ac?
Yes
No
Is Time of Concentration Greater Than 15 Minutes?
No
Yes
Use Rational Method to Compute Peak Runoff Rate
Use TR55 Method to Compute Peak Runoff Rate
Compute Runoff for Pre-Development Conditions

APPENDIX K:

Rainfall Intensity for Auburn, Alabama (in/hr)

	Time of Concentration (min)										
Return Period (yr)	5	6	7	8	9	10	11	12	13	14	15
2	6.2	5.9	5.8	5.6	5.4	5.2	5.1	4.9	4.7	4.5	4.5
5	7.1	6.8	6.6	6.5	6.3	6.0	5.9	5.7	5.5	5.3	5.1
10	7.7	7.5	7.3	7.1	6.9	6.5	6.4	6.3	6.1	5.8	5.6
25	8.7	8.5	8.2	8.0	7.8	7.4	7.3	7.1	6.8	6.6	6.3
50	9.4	9.1	8.9	8.6	8.4	8.1	7.9	7.7	7.4	7.2	6.9
100	10.2	9.8	9.6	9.3	9.0	8.8	8.5	8.2	8.0	7.7	7.6

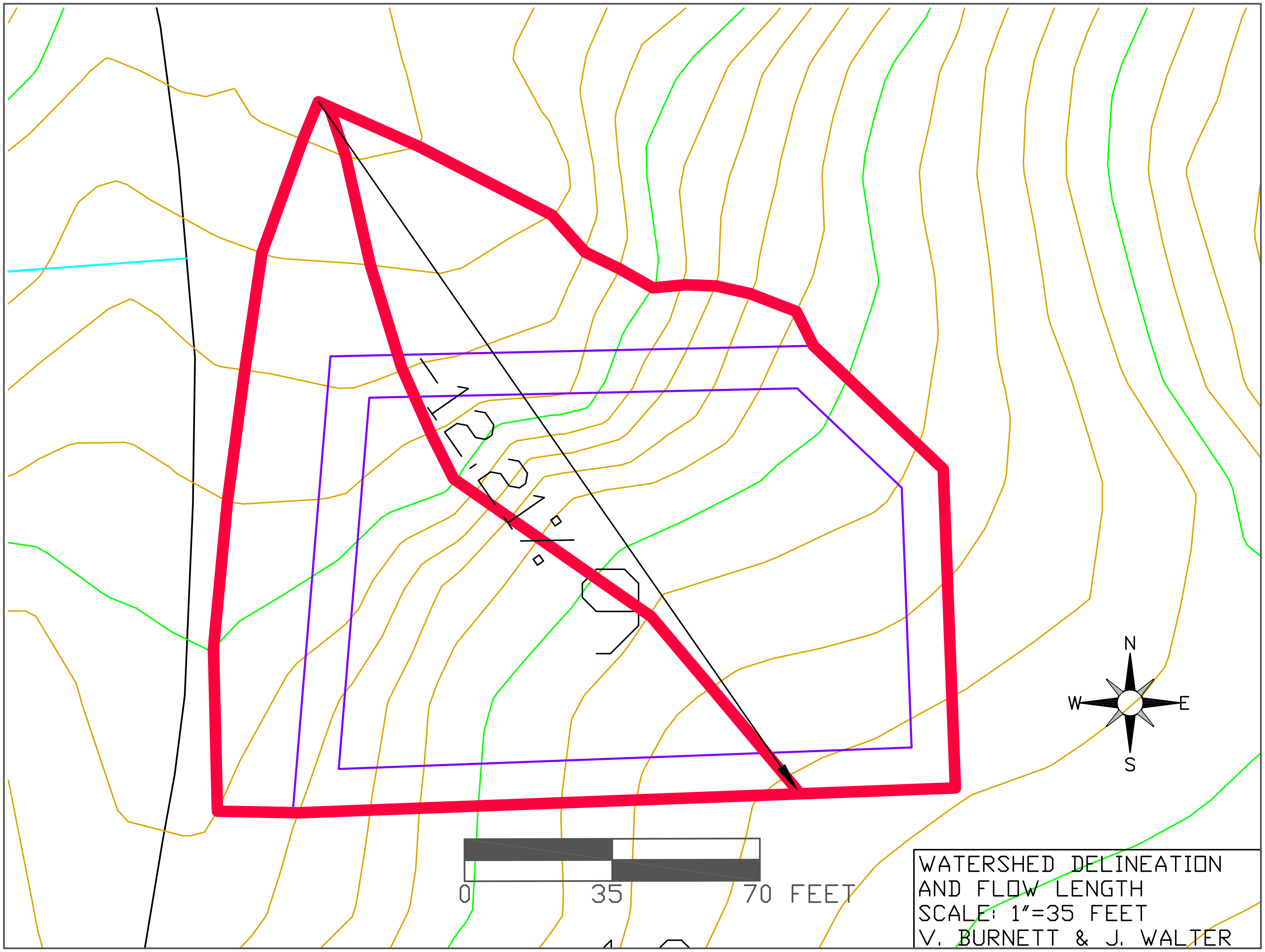
Each value is the corresponding intensity in/h.

Design Storm Volume for Auburn, Alabama

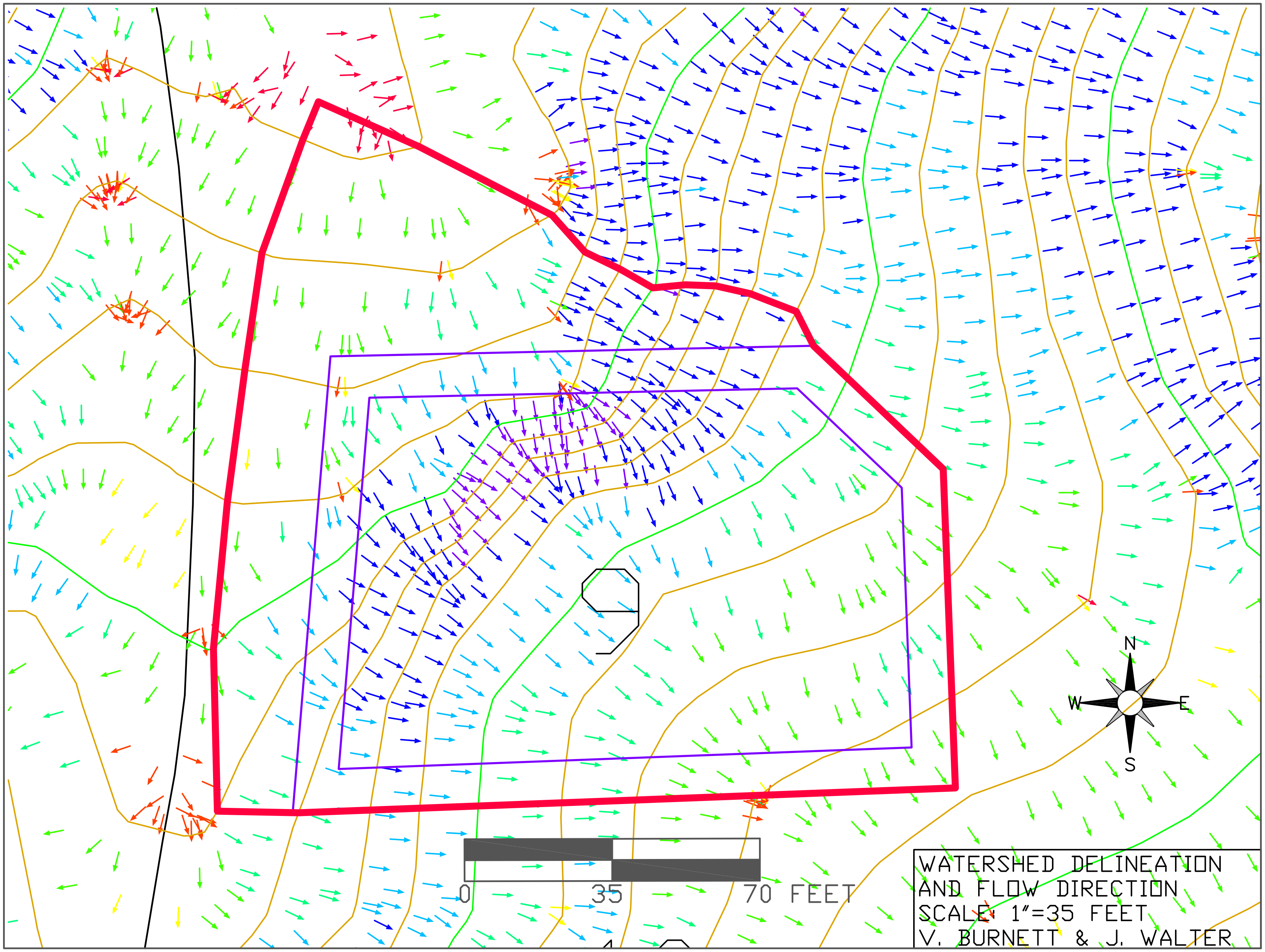
Return Period (yrs)	24-Hour Rainfall (in.) (P)
2	4.2
5	5.4
10	6.3
25	7.2
50	8.1
100	9.0

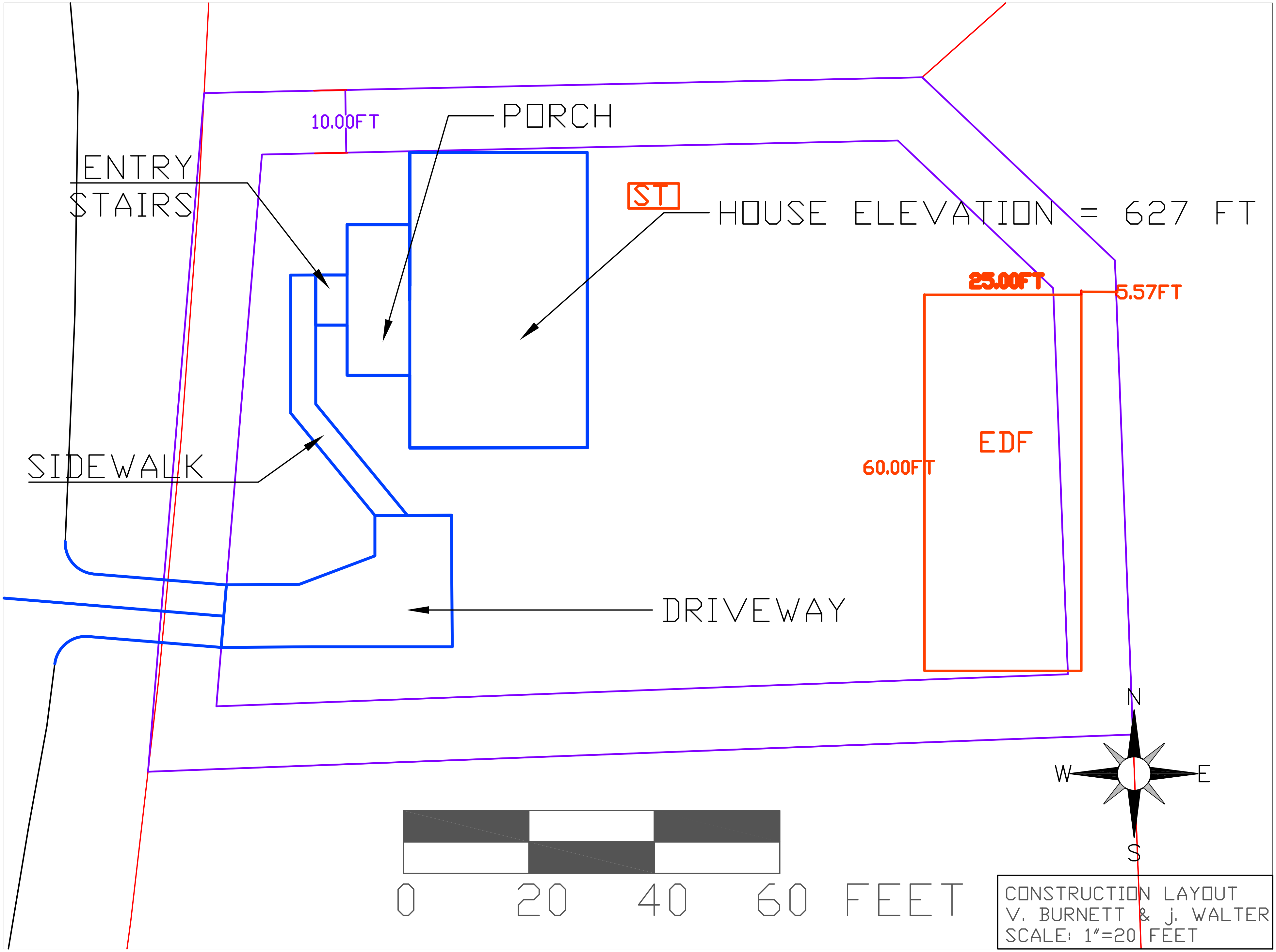
Table of Manning coefficients, n

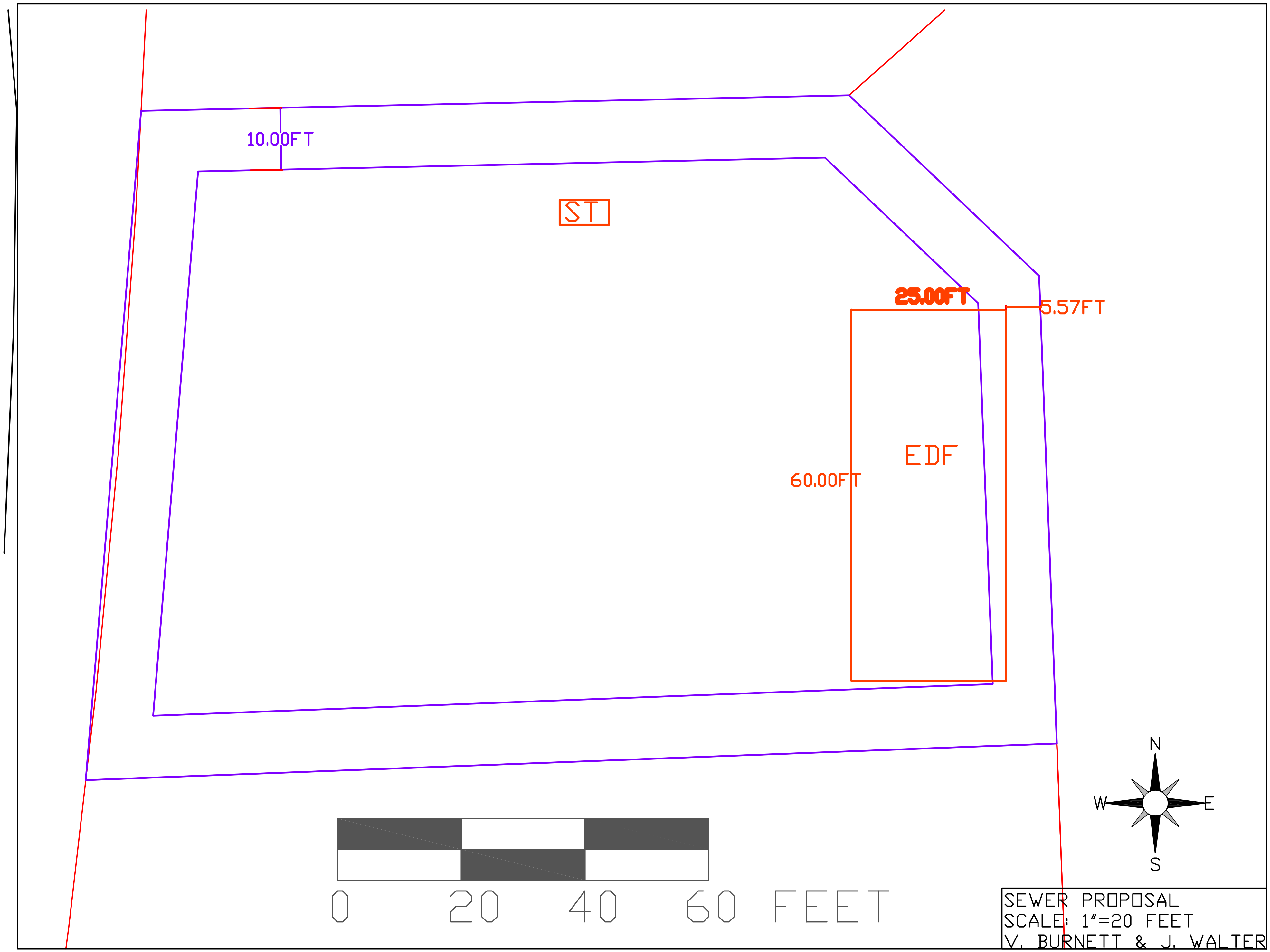
Material	Manning n	Material	Manning n
Natural Streams		*Excavated Earth Channels*	
Clean and Straight	0.030	Clean	0.022
Major Rivers	0.035	Gravelly	0.025
Sluggish with Deep Pools	0.040	Weedy	0.030
		Stony, Cobbles	0.035
Metals		*Floodplains*	
Brass	0.011	Pasture, Farmland	0.035
Cast Iron	0.013	Light Brush	0.050
Smooth Steel	0.012	Heavy Brush	0.075
Corrugated Metal	0.022	Trees	0.15
Non-Metals			
Glass	0.010	Finished Concrete	0.012
Clay Tile	0.014	Unfinished Concrete	0.014
Brickwork	0.015	Gravel	0.029
Asphalt	0.016	Earth	0.025
Masonry	0.025	Planed Wood	0.012
		Unplaned Wood	0.013
Corrugated Polyethylene (PE) with smooth inner walls [a,b]			0.009-0.015
Corrugated Polyethylene (PE) with corrugated inner walls [c]			0.018-0.025
Polyvinyl Chloride (PVC) with smooth inner walls [d,e]			0.009-0.011



12.2%
N
W
E
S
0
35
70 FEET
WATERSHED DELINEATION
AND FLOW LENGTH
SCALE: 1"=35 FEET
V. BURNETT & J. WALTER


N
W
E
S
0
35
70 FEET
WATERSHED DELINEATION
AND FLOW DIRECTION
SCALE: 1"=35 FEET
V. BURNETT & J. WALTER

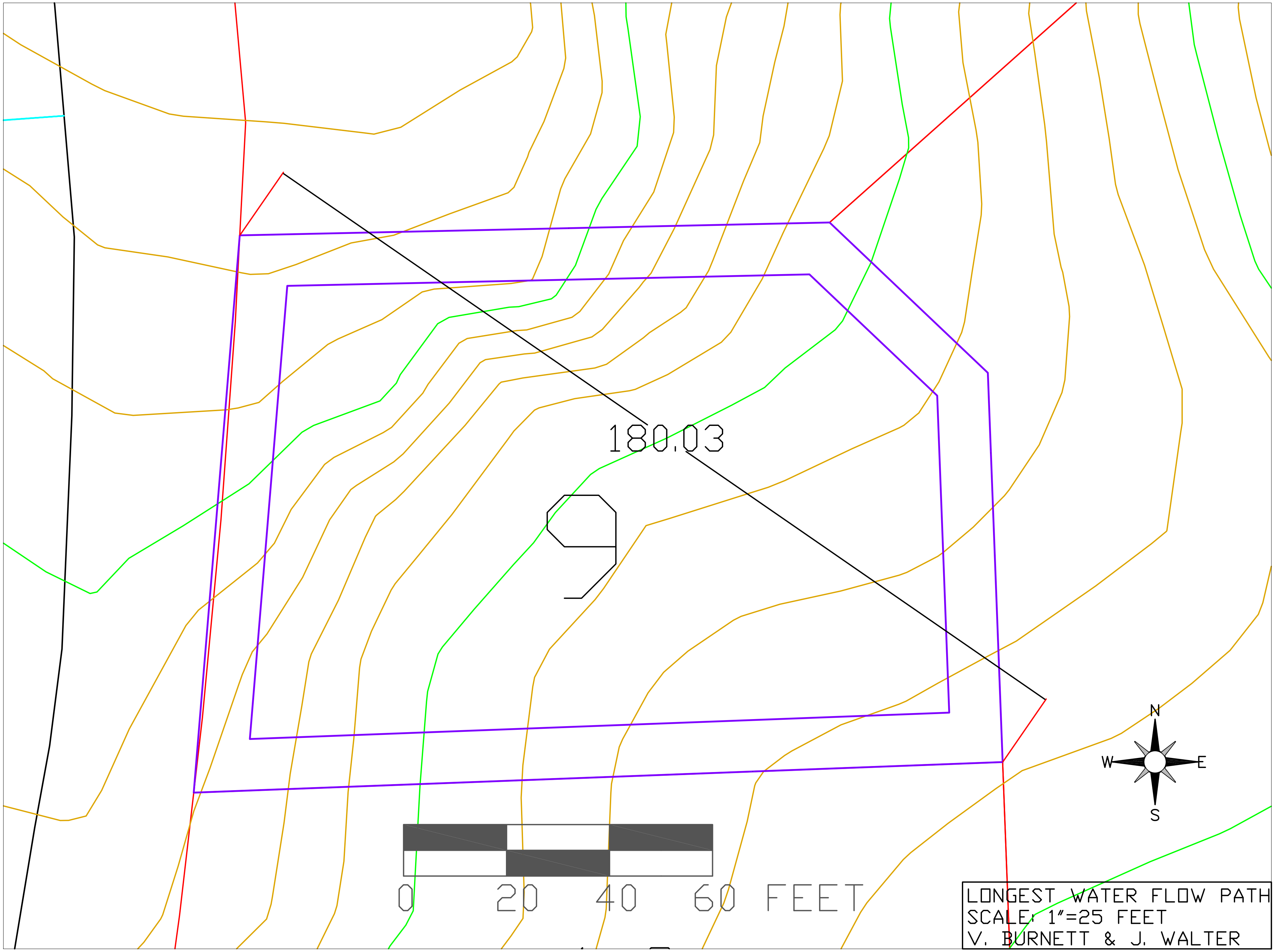

PORCH
10.00FT
ENTRY
STAIRS
ST
HOUSE ELEVATION = 627 FT
25.00FT
5.57FT
EDF
60.00FT
SIDEWALK
DRIVEWAY
N
W
E
S
0
20
40
60 FEET
CONSTRUCTION LAYOUT
V. BURNETT & j. WALTER
SCALE: 1"=20 FEET



SEWER PROPOSAL
SCALE: 1"=20 FEET
V. BURNETT & J. WALTER

APPENDIX P:

Table 1. Single Family Price and Cost Breakdowns 2013 Results		
Average Lot Size:	14,359 sq ft	
Average Finished Area:	2,607 sq ft	
I. Sale Price Breakdown	**Average**	**Share of Price**
A. Finished Lot Cost (including financing cost)	$74,509	18.60%
B. Total Construction Cost	$246,453	61.70%
C. Financing Cost	$5,479	1.40%
D. Overhead and General Expenses	$17,340	4.30%
E. Marketing Cost	$4,260	1.10%
F. Sales Commission	$14,235	3.60%
G. Profit	$37,255	9.30%
Total Sales Price	**$399,532**	**100%**
II. Construction Cost Breakdown	**Average**	**Share of**
I. Site Work (sum of A to E)	**$16,824**	**6.80%**
A. Building Permit Fees	$3,647	1.50%
B. Impact Fee	$3,312	1.30%
C. Water & Sewer Fees Inspections	$4,346	1.80%
D. Architecture, Engineering	$3,721	1.50%
E. Other	$1,799	0.70%
II. Foundations (sum of F to G)	**$23,401**	**9.50%**
F. Excavation, Foundation, Concrete, Retaining walls, and Backfill	$23,028	9.30%
G. Other	$373	0.20%
III. Framing (sum of H to L)	**$47,035**	**19.10%**
H. Framing (including roof)	$36,438	14.80%
I. Trusses (if not included above)	$5,461	2.20%
J. Sheathing (if not included above)	$2,332	0.90%
K. General Metal, Steel	$1,604	0.70%
L. Other	$1,201	0.50%
IV. Exterior Finishes (sum of M to P)	**$35,474**	**14.40%**
M. Exterior Wall Finish	$16,867	6.80%
N. Roofing	$7,932	3.20%
O. Windows and Doors (including garage door)	$10,117	4.10%
P. Other	$557	0.20%
V. Major Systems Rough-ins (sum of Q to T)	**$32,959**	**13.40%**
Q. Plumbing (except fixtures)	$11,823	4.80%
R. Electrical (except fixtures)	$9,967	4.00%
S. HVAC	$10,980	4.50%
T. Other	$189	0.10%
VI. Interior Finishes (sum of U to AE)	**$72,241**	**29.30%**
U. Insulation	$4,786	1.90%
V. Drywall	$9,376	3.80%
W. Interior Trims, Doors, and Mirrors	$10,536	4.30%
X. Painting	$8,355	3.40%
Y. Lighting	$3,008	1.20%
Z. Cabinets, Countertops	$12,785	5.20%
AA. Appliances	$4,189	1.70%
AB. Flooring	$12,378	5.00%
AC. Plumbing Fixtures	$4,265	1.70%
AD. Fireplace	$2,057	0.80%
AE. Other	$506	0.20%
VII. Final Steps (sum of AF to AJ)	**$16,254**	**6.60%**
AF. Landscaping	$5,744	2.30%
AG. Outdoor Structures (deck, patio, porches)	$2,891	1.20%
AH. Driveway	$3,741	1.50%
AI. Clean Up	$2,261	0.90%
AJ. Other	$1,617	0.70%
VIII. Other	**$2,265**	**0.90%**
Total	**$246,453**	**100%**


180.03
9
N
E
S
W
0 20 40 60 FEET
LONGEST WATER FLOW PATH
SCALE: 1"=25 FEET
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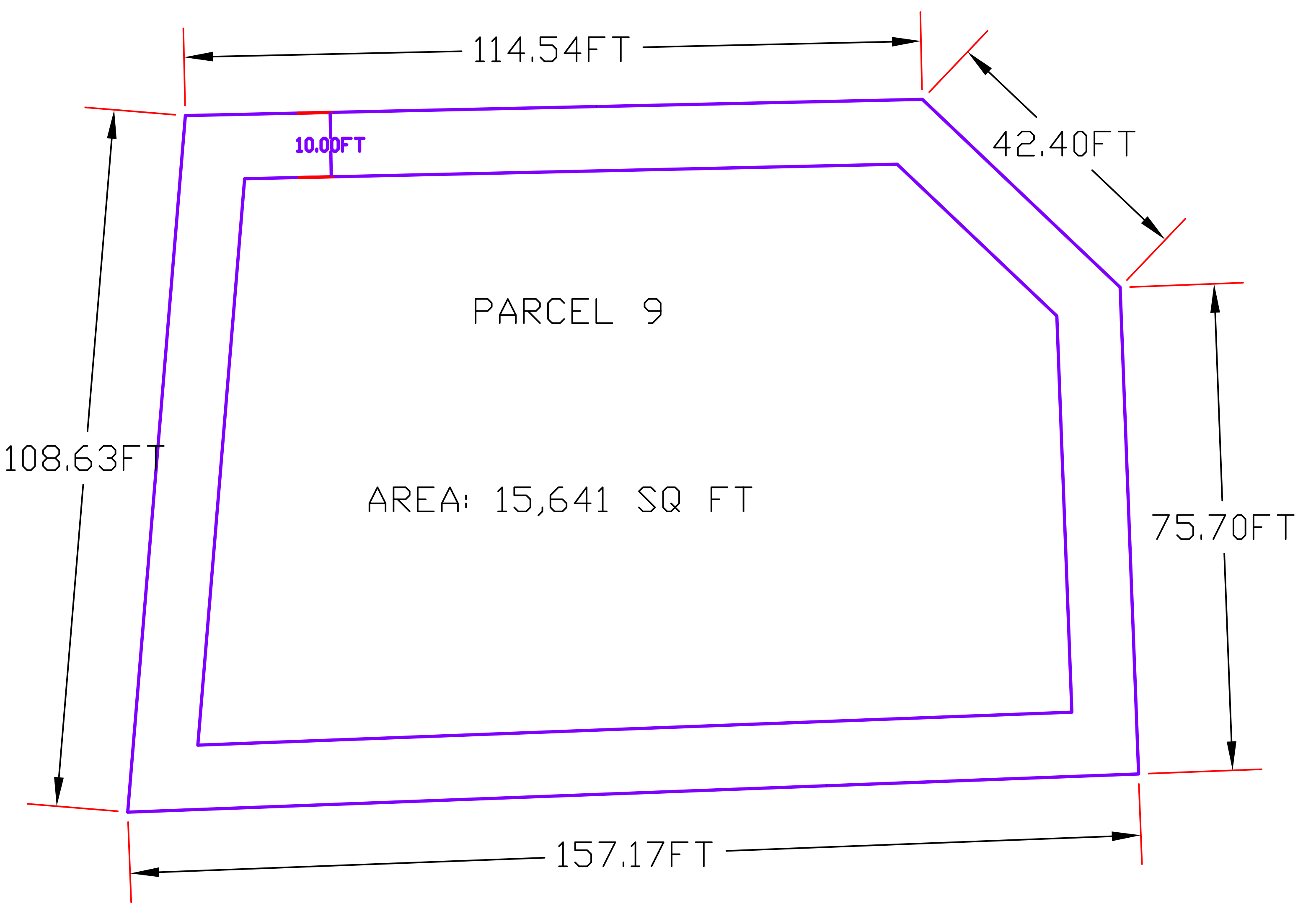
114.54FT
10.00FT
42.40FT
PARCEL 9
108.63FT
AREA: 15,641 SQ FT
75.70FT
157.17FT

Rubric for Assessing Writing in BSEN 4560

		(1) Unsatisfactory	(2) Partially meets expectations	(3) Meets expectations	(4) Exceeds expectations	Total out of 200
Performance Indicators	Engineering Design Solution	Engineering details of how solution was obtained lacking	Some engineering details, but may include extraneous or loosely related material	Provides adequate engineering details to support solution/argument	Provides ample engineering details to support a well-reasoned solution/argument	60
	Data/design analysis and evaluation	Fails to draw conclusions, overlooks differences in results	Paraphrases data, identifies some differences, identifies some conclusions	Evaluates data, notices differences, seeks out information, formulates conclusions	Views information critically, synthesizes data, uses reasonable judgment, conclusions in line with data/design	40
	Organization	Ad-hoc structure, little evidence of organization, little or no sense of wholeness and completeness	Attempt at organization, but little sense of wholeness and completeness	Organization pattern is logical and conveys completeness and wholeness with few lapses	Organization pattern is logical and conveys completeness and wholeness	20
	Style	Limited or inappropriate vocabulary for the intended audience and purpose	Limited and predictable vocabulary, perhaps not appropriate for intended audience and purpose	Uses effective language and appropriate word choices for intended audience and purpose	Uses effective language, makes engaging, appropriate word choices for audience and purpose	20
	Grammar	Does not follow rules of standard English	Generally does not follow the rules of standard English	Generally follows the rules for standard English	Consistently follows the rules for standard English	20
	Figures and Tables	Figures and tables do not support the text, or are poorly designed	Figures and tables sometimes support the text, and sometimes well designed	Figures and tables generally support the text, and are usually well designed	Figures and tables always support the text, and are well designed	20
	References and sources of information	References and other sources of information consistently not cited for material used in report	References and other sources of information not cited for some material used in the report, or inappropriate sources cited	References and other sources of information cited for material used in the report. Most of the sources are appropriate to support the discussion	References and other sources of information cited for material used in the report. All sources support the discussion.	20

Source: Adapted from Auburn Office of University Writing handout