Habit for Humanity House

PLTW | Engineering

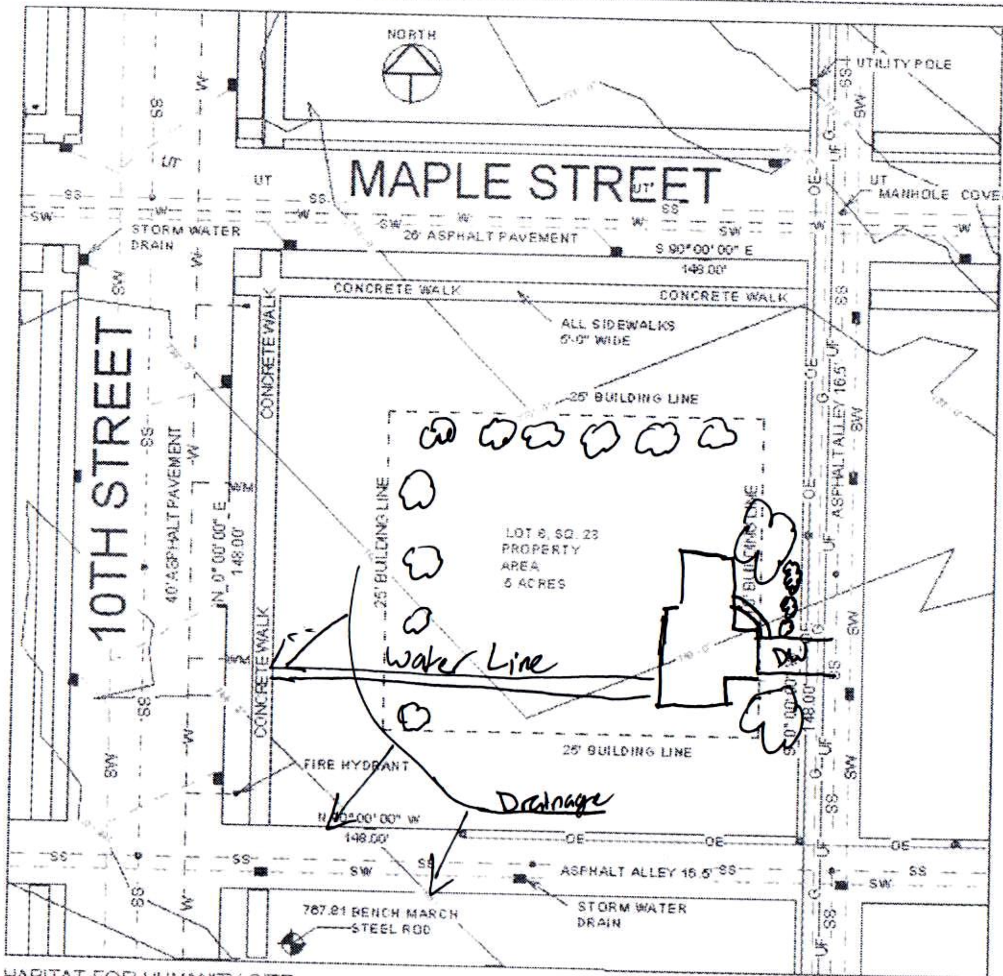
Table of Contents

Project Description

Upon the first meeting with my client, they requested a Bungalow style house, which has two normal bedrooms (in addition to the master bedroom) as well as lots of storage space. After proposing different sketches, it was determined that the client wanted an open floor plan, rather than compartmentalized rooms. As one walks through the main entrance, they enter the grand room, a spacious room that includes an open dining room with direct, open access to the kitchen, as well as an open living room with plenty of room to entertain the whole family. At the back of the grand room a hallway to the left provides access to two bedrooms for the kids as well as an office and a room dedicated to storage and utilities. At the back of the grand room, there is a double glass door that opens into the spacious backyard in the middle of grand Noblesville, Indiana. The master bedroom is accessible to the right of the grand room, just before the open living room. It has lots of space, enough for a bed, two nightstands, a full entertainment system and a private walk in closet and master bath. The master bath is fully equipped with a double sink vanity with cupboards both below and above for lots of storage. The master bath also has a large shower with built in seating for the comfort of the parents. The kitchen off of the open dining room is fully equipped with a range stove, a large refrigerator, a sink, a dishwasher, and plenty of cabinet space to house all of the client's kitchen utensils and ingredients. The garage is also suited for all the client's needs. It is a full, double-stall garage with extra space for storage-galore. The house has been strategically placed on the lot. The front door faces the east so that the dining room and kitchen receive bright, morning sunlight. The back door and open living room receive warm, evening sunlight for the client's perfect entertainment setting. Strategic placement of deciduous trees and conifer bushes allow for maximum heat efficiency as well as a sufficient barrier from both sound as well as prevailing wind.

City Hall

Offices



1 HABITAT FOR HUMANITY SITE
1" = 30'-0"

Restaurant/~~[illegible]~~ Offices ← Solar Orientation

ZONING

FRONT SETBACK	25'
SIDE SETBACK	25'
REAR SETBACK	10'
ADJACENT	20'
MAX HEIGHT	(4 STORIES)

BENCH MARKS

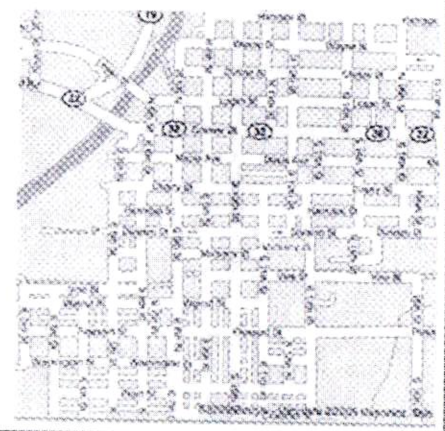
BM 1
STEEL ROD
ELEV. 787.81

LEGEND

SW	STORM WATER SEWER LINE
G	UNDERGROUND GAS LINE
W	UNDERGROUND WATER LINE
UT	UNDERGROUND TELEPHONE LINES
UF	UNDERGROUND FIBER OPTIC LINES
SS	SANITARY SEWER LINES
OE	OVERHEAD ELECTRIC LINES
	FIRE HYDRANT
	UTILITY POLE
	MANHOLE COVER
	STORM DRAIN
WM	WATER METER

MAP

NOBLESVILLE, IN



Autodesk Revit
www.autodesk.com/revit

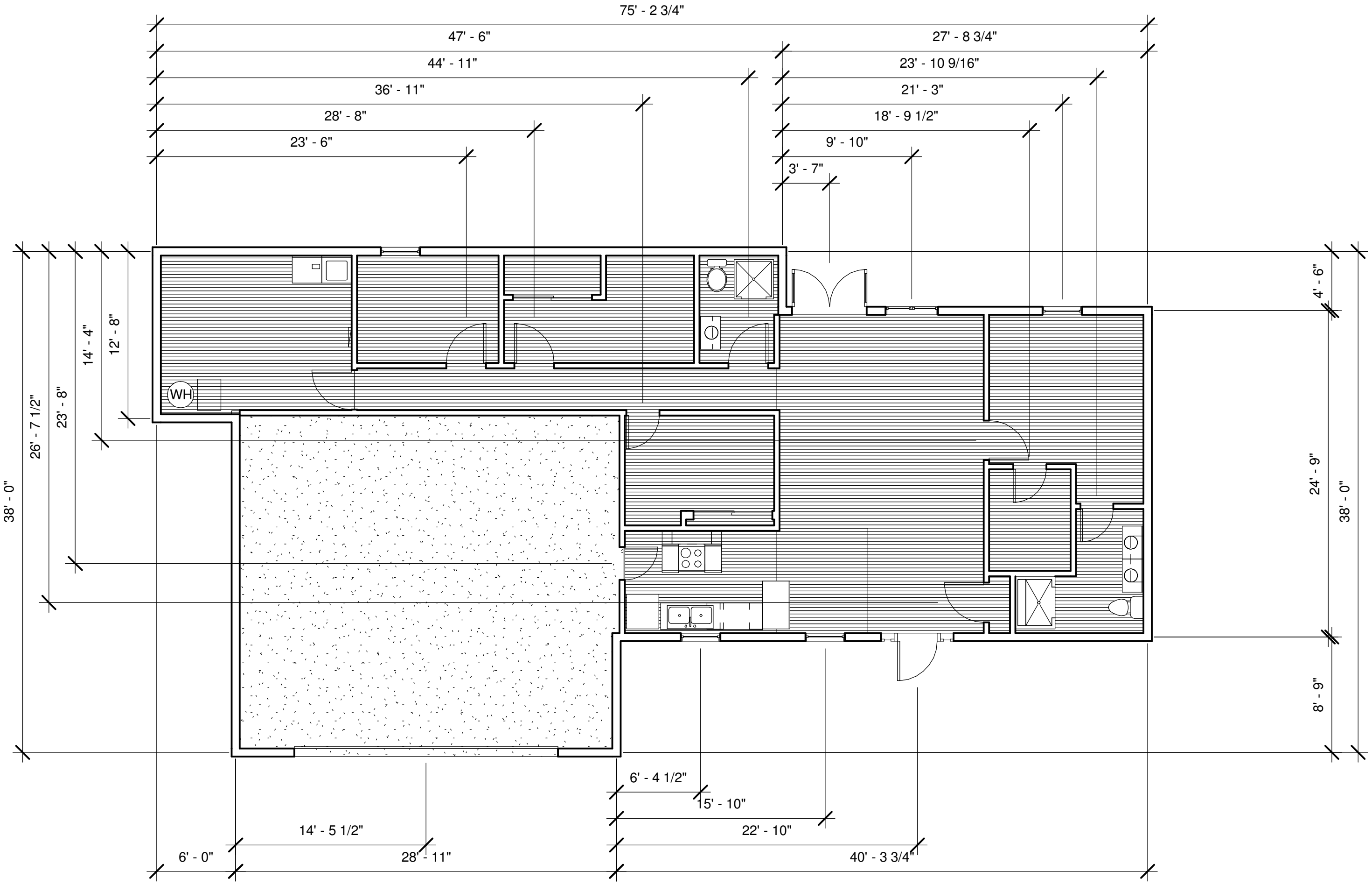
Project Lead the Way
Habitat for Humanity

No.	Description	Date

Student Handout

Project number	Project Number	A101
Date	Issue Date	
Drawn by	Author	
Checked by	Checker	Scale 1" = 30'-0"

3/8/2010 3:48:15 PM



1 Level 1 Dimensioned
1/8" = 1'-0"

Iowa PLTW PROJECT LEAD THE WAY

Project Name

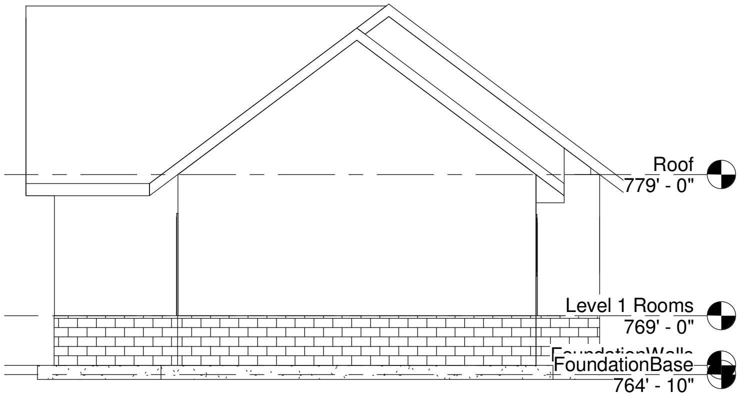
Civil Engineering & Architecture

No.	Description	Date

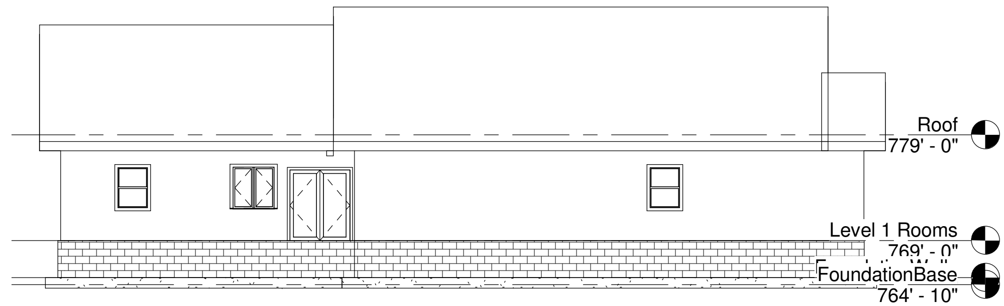
Floor Plan Dimensioned

Project number	Project Number	A103
Date	Issue Date	
Drawn by	Author	
Checked by	Checker	Scale 1/8" = 1'-0"

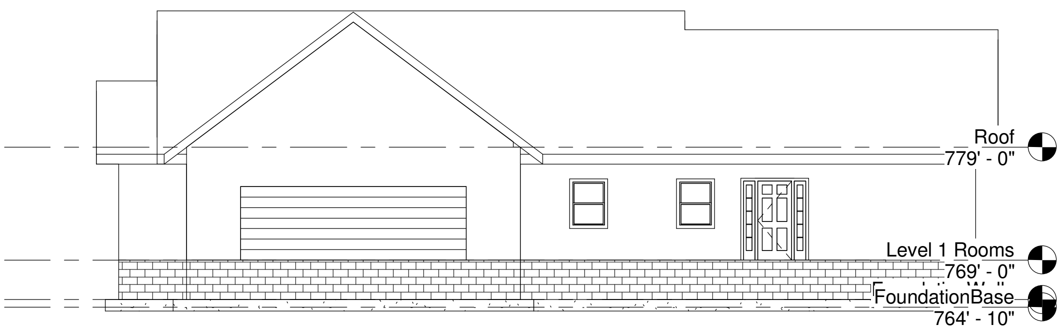
10/30/2014 10:18:40 AM



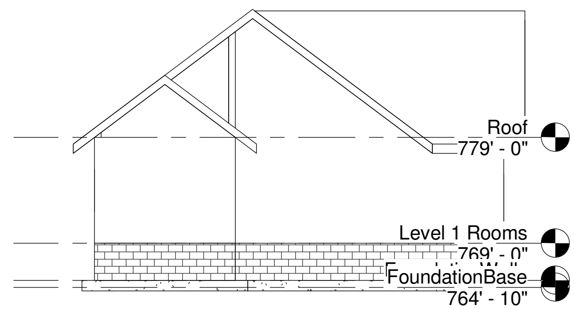
1 East
1/8" = 1'-0"



2 North
3/32" = 1'-0"



3 South
1" = 10'-0"



4 West
3/32" = 1'-0"

Iowa PLTW PROJECT LEAD THE WAY

Project Name

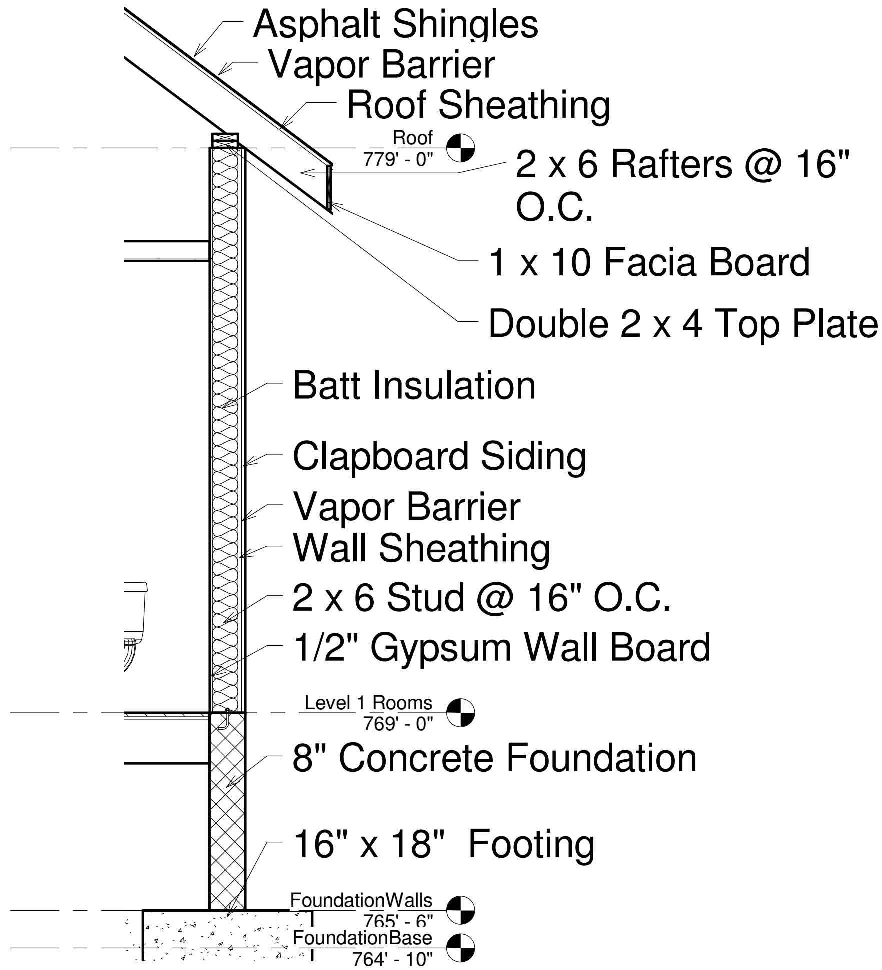
Civil Engineering & Architecture

No.	Description	Date

Elevations

Project number	Project Number	A109
Date	Issue Date	
Drawn by	Author	
Checked by	Checker	Scale As indicated

10/31/2014 10:42:42 AM



1 Section 1
1/2" = 1'-0"

Iowa PLTW PROJECT LEAD THE WAY

Project Name

Civil Engineering & Architecture

No.	Description	Date

Wall Section

Project number	Project Number	A106
Date	Issue Date	
Drawn by	Author	
Checked by	Checker	Scale 1/2" = 1'-0"

10/31/2014 2:17:21 PM

Door Schedule

Mark	Family and Type	Height	Sill Height	Width
1	Single-Flush: 36" x 84"	7' - 0"	0' - 0"	3' - 0"
2	Single-Flush: 36" x 84"	7' - 0"	0' - 0"	3' - 0"
3	Single-Flush: 36" x 84"	7' - 0"	0' - 0"	3' - 0"
4	Single-Flush: 36" x 84"	7' - 0"	0' - 0"	3' - 0"
5	Single-Flush: 30" x 80"	6' - 8"	0' - 0"	2' - 6"
8	Single-Flush: 36" x 84"	7' - 0"	0' - 0"	3' - 0"
9	Single-Flush: 36" x 84"	7' - 0"	0' - 0"	3' - 0"
15	Double-Glass 1: 68" x 80"	6' - 8"	0' - 0"	5' - 8"
16	Single-Raised Panel with Sidelights: 36" x 84"	7' - 0"	0' - 0"	3' - 0"
20	Sliding-Closet: 72" x 84"	7' - 0"	0' - 0"	6' - 0"
22	Sliding-Closet: 72" x 84"	7' - 0"	0' - 0"	6' - 0"
23	Single-Flush: 30" x 80"	6' - 8"	0' - 0"	2' - 6"
24	Single-Flush: 30" x 80"	6' - 8"	0' - 0"	2' - 6"
25	Single-Flush: 30" x 80"	6' - 8"	0' - 0"	2' - 6"
28	Overhead-Sectional: 8' x 6'-6"	6' - 6"	0' - 0"	20' - 0"

Room Schedule

Name	Area	Level
Grand Room	322 SF	Level 1 Rooms
Kitchen	89 SF	Level 1 Rooms
Bed	87 SF	Level 1 Rooms
Bath	48 SF	Level 1 Rooms
Bed	91 SF	Level 1 Rooms
Office	88 SF	Level 1 Rooms
Room	Not Placed	Not Placed
Garage	Not Placed	Not Placed
Master Bed	148 SF	Level 1 Rooms
Master Bath	68 SF	Level 1 Rooms
Room	Not Placed	Not Placed
Room	7 SF	Level 1 Rooms
Hall	101 SF	Level 1 Rooms
Dining Room	55 SF	Level 1 Rooms
Living Room	Not Placed	Not Placed
Room	Redundant Room	Level 1 Rooms
Garage	723 SF	Level 1 Rooms
Utilities	172 SF	Level 1 Rooms

Window Schedule

Mark	Family and Type	Height	Sill Height	Width
1	Casement Dbl with Trim: 48" x 48"	4' - 0"	3' - 0"	4' - 0"
4	Double Hung with Trim: 36" x 48"	4' - 0"	3' - 0"	3' - 0"
8	Double Hung with Trim: 36" x 48"	4' - 0"	3' - 0"	3' - 0"
9	Double Hung with Trim: 36" x 48"	4' - 0"	3' - 0"	3' - 0"
10	Double Hung with Trim: 36" x 48"	4' - 0"	3' - 0"	3' - 0"

Iowa PLTW
PROJECT LEAD THE WAY

Project Name

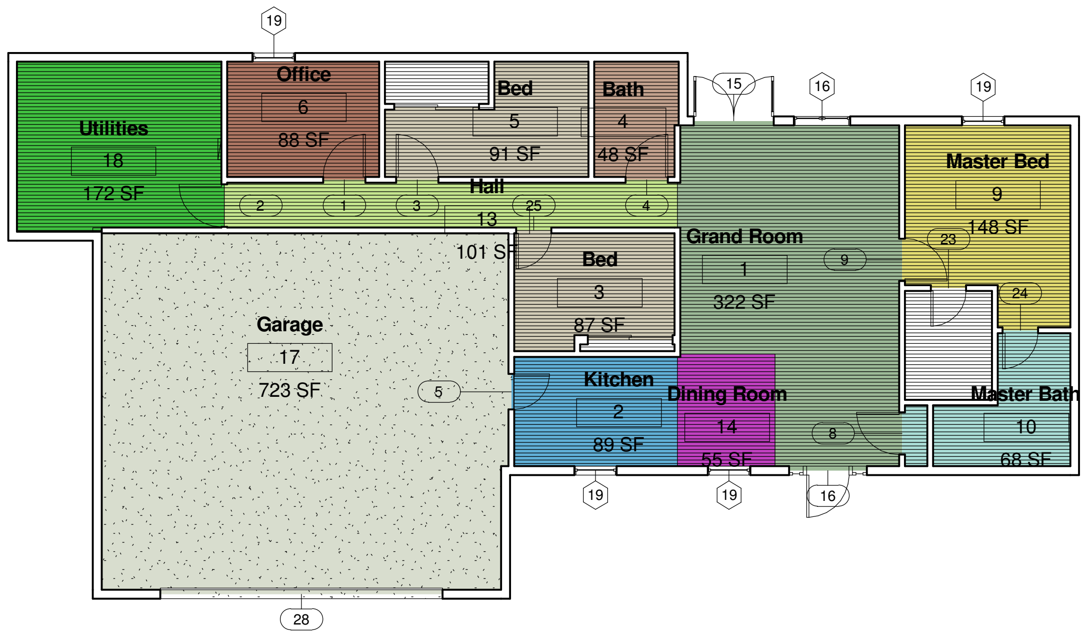
Civil Engineering & Architecture

No.	Description	Date

Schedules

Project number	Project Number	A108
Date	Issue Date	
Drawn by	Author	
Checked by	Checker	Scale

10/30/2014 10:18:41 AM



1 Level 1 Rooms
1/8" = 1'-0"

Room Legend

- Bath
- Bed
- Dining Room
- Garage
- Grand Room
- Hall
- Kitchen
- Master Bath
- Master Bed
- Office
- Room
- Utilities

Iowa PLTW PROJECT LEAD THE WAY

Project Name

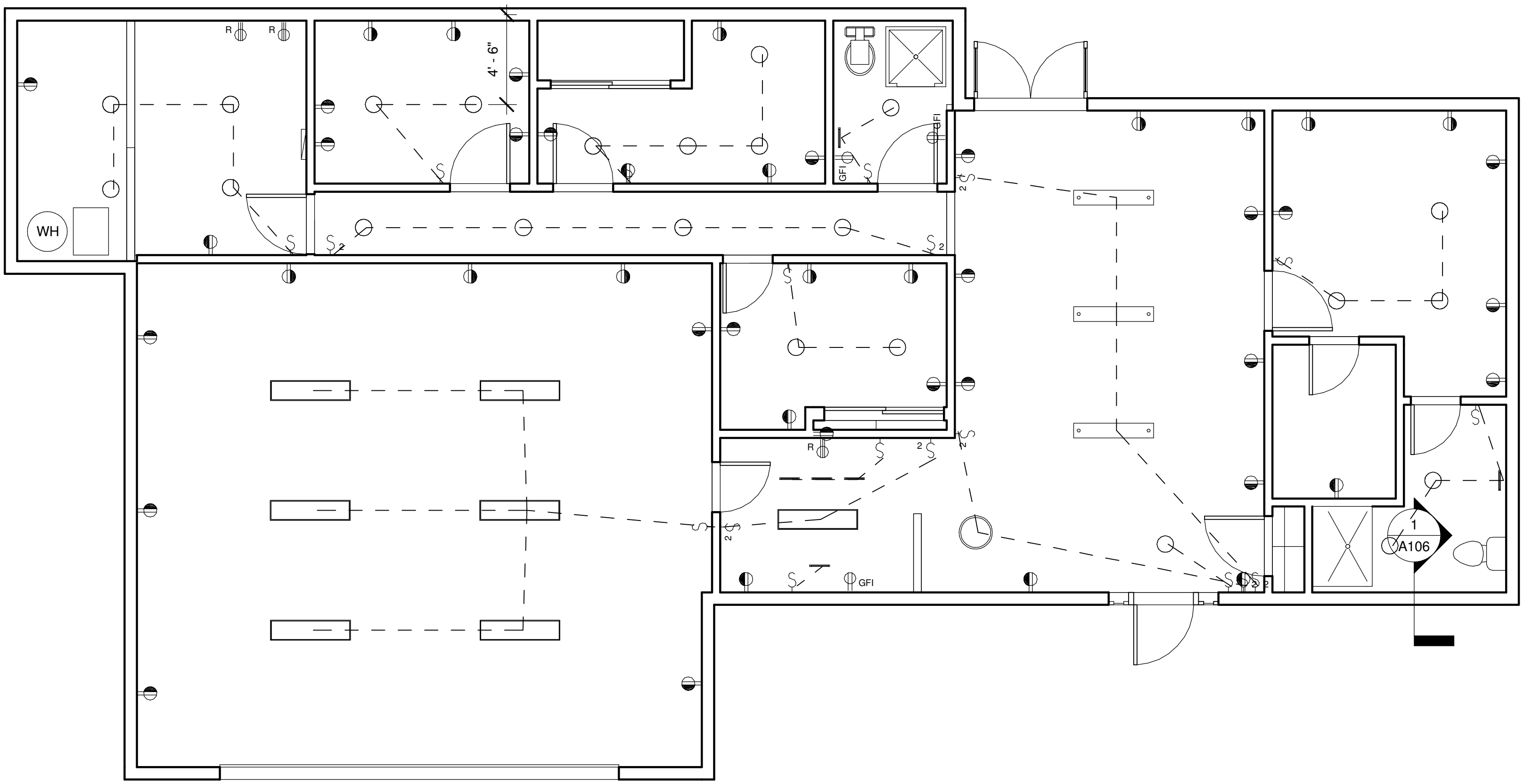
Civil Engineering & Architecture

No.	Description	Date

RoomLegend

Project number	Project Number	A104
Date	Issue Date	
Drawn by	Author	
Checked by	Checker	Scale 1/8" = 1'-0"

10/30/2014 10:18:40 AM



1 Electrical
3/16" = 1'-0"

Iowa PLTW PROJECT LEAD THE WAY

Project Name

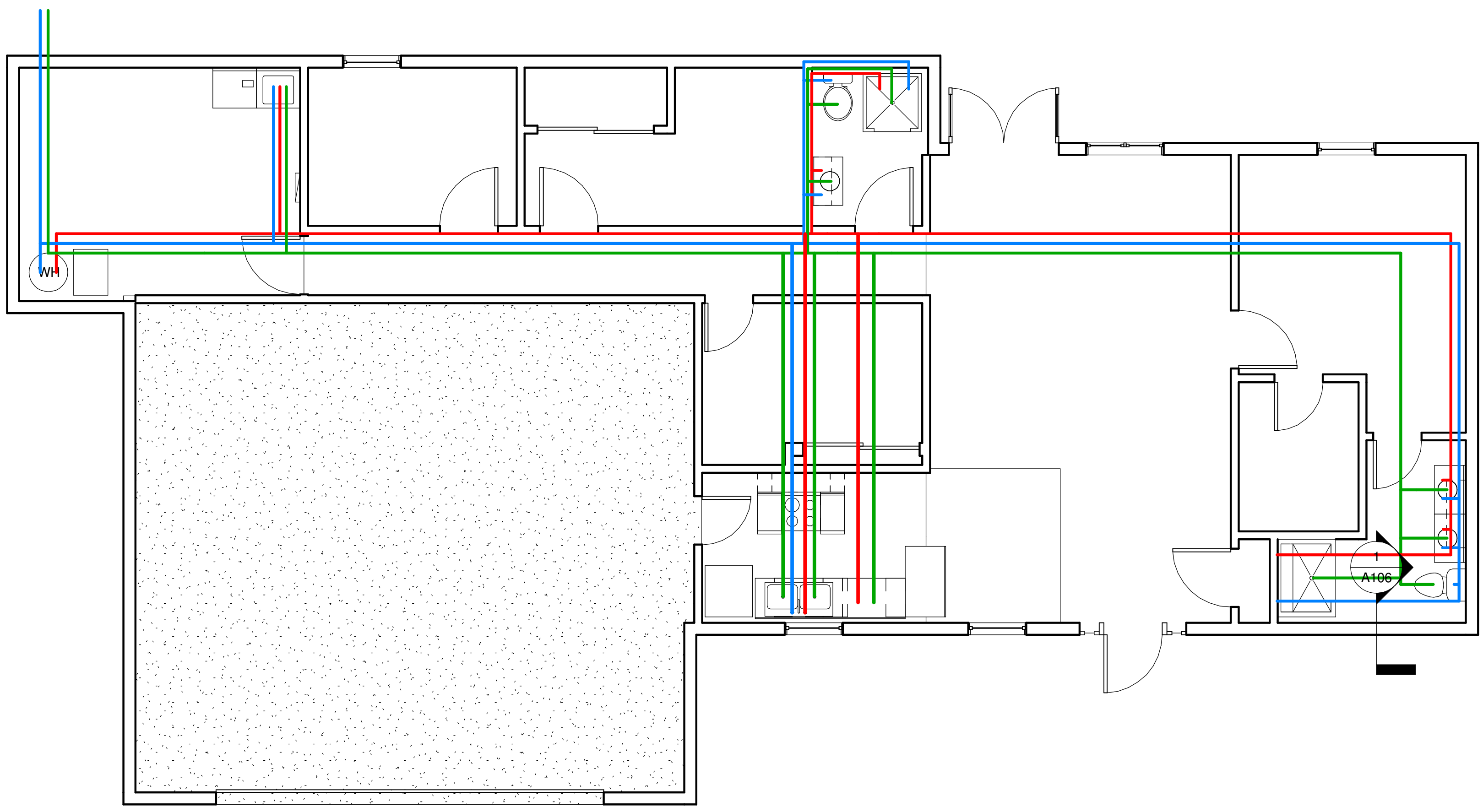
Civil Engineering & Architecture

No.	Description	Date

Electrical Plan

Project number	Project Number	A101
Date	Issue Date	
Drawn by	Author	
Checked by	Checker	Scale 3/16" = 1'-0"

10/30/2014 10:18:40 AM



1 Level 1 Plumbing
3/16" = 1'-0"

Iowa PLTW PROJECT LEAD THE WAY

Project Name

Civil Engineering & Architecture

No.	Description	Date

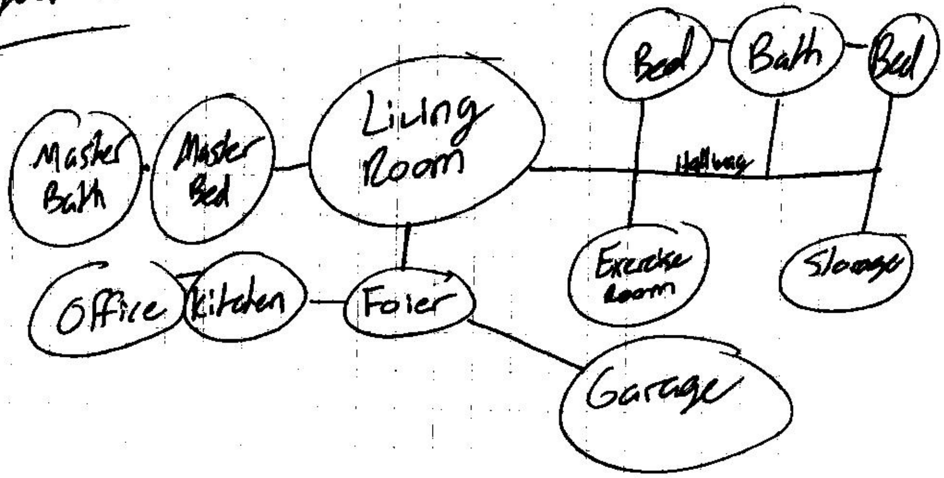
Plumbing

Project number	Project Number	A107
Date	Issue Date	
Drawn by	Author	
Checked by	Checker	Scale 3/16" = 1'-0"

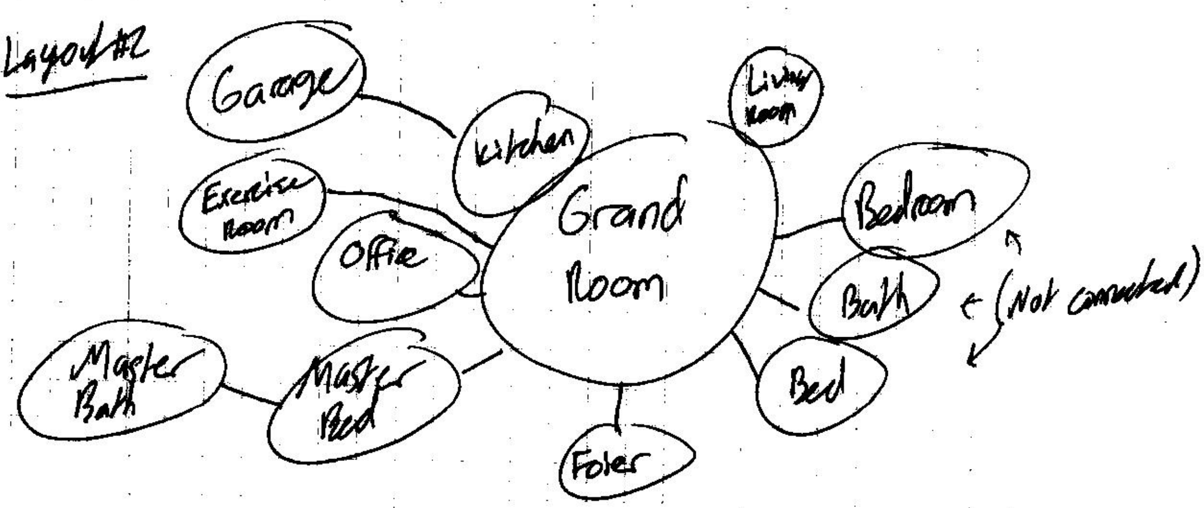
10/30/2014 10:18:41 AM

Erik's House

Layout #1

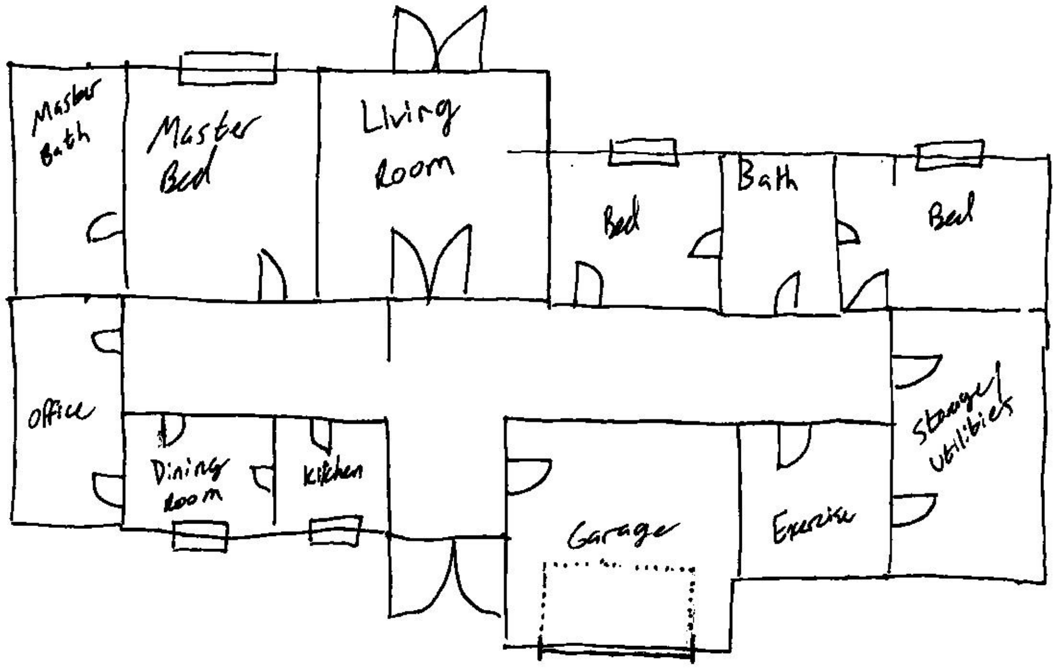


Layout #2

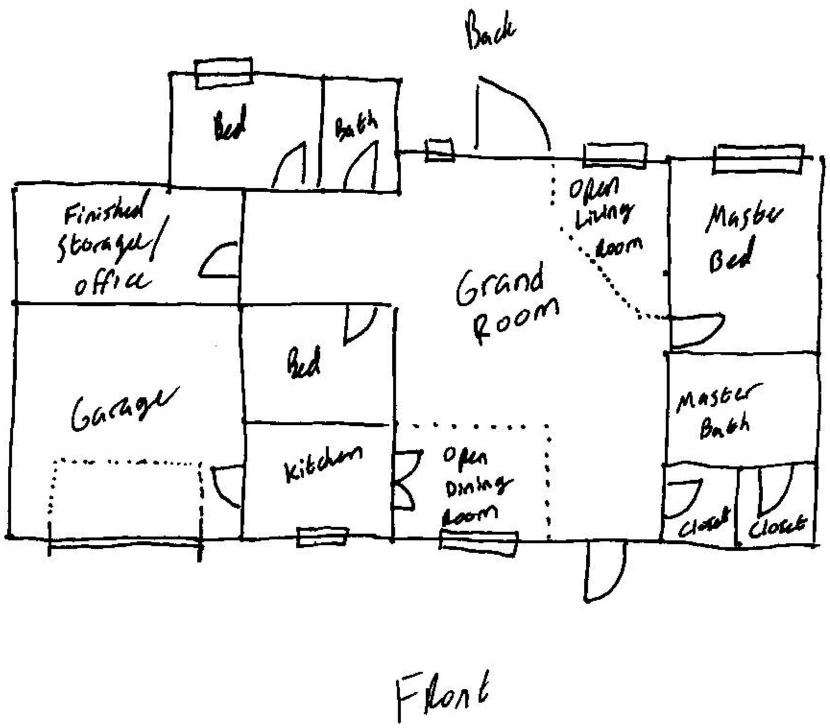


Erik & ummerbet

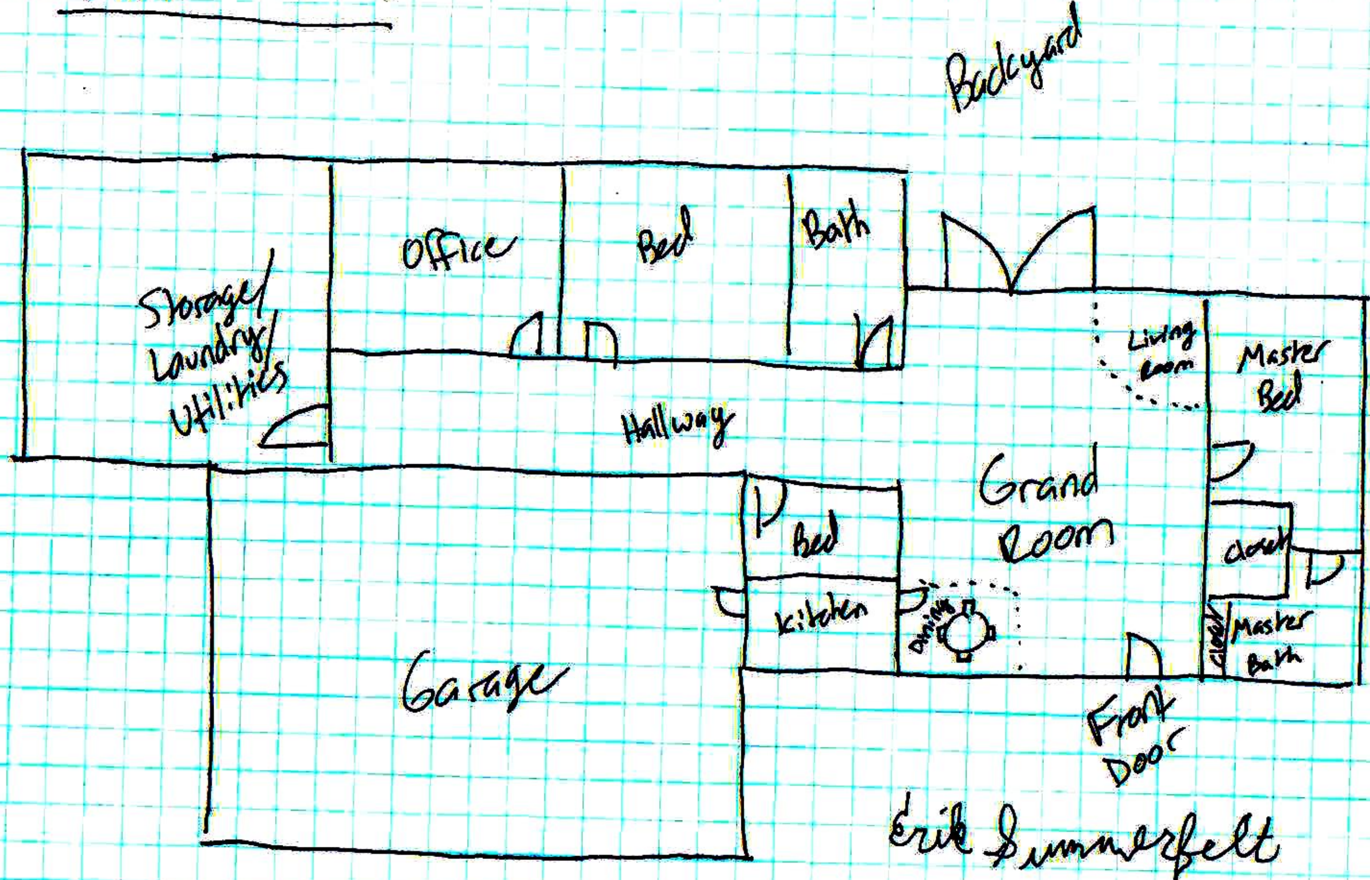
FLOOR PLAN #1



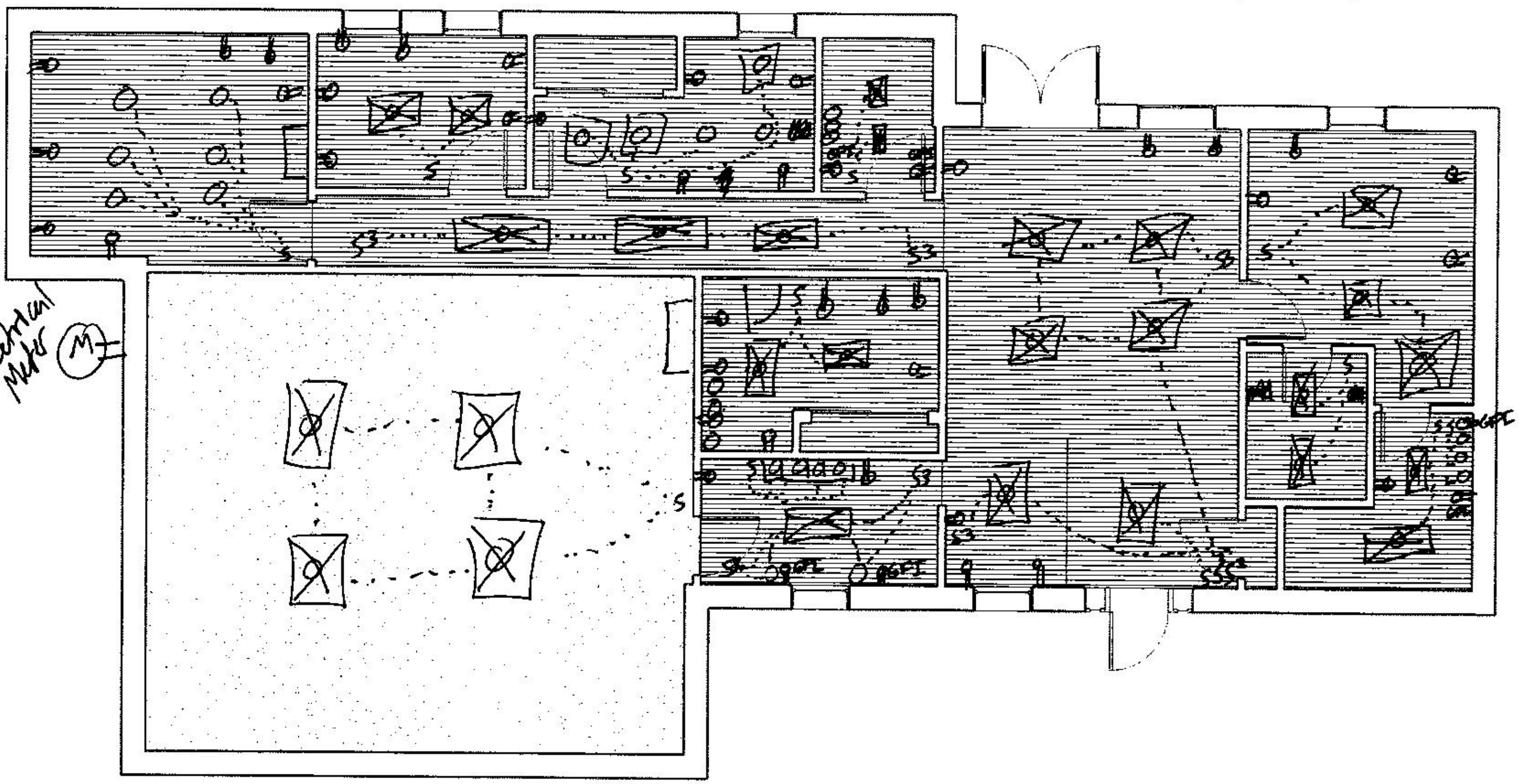
FLoor PLan #2



Final Sketches



Too many outlets



Electrical Meter

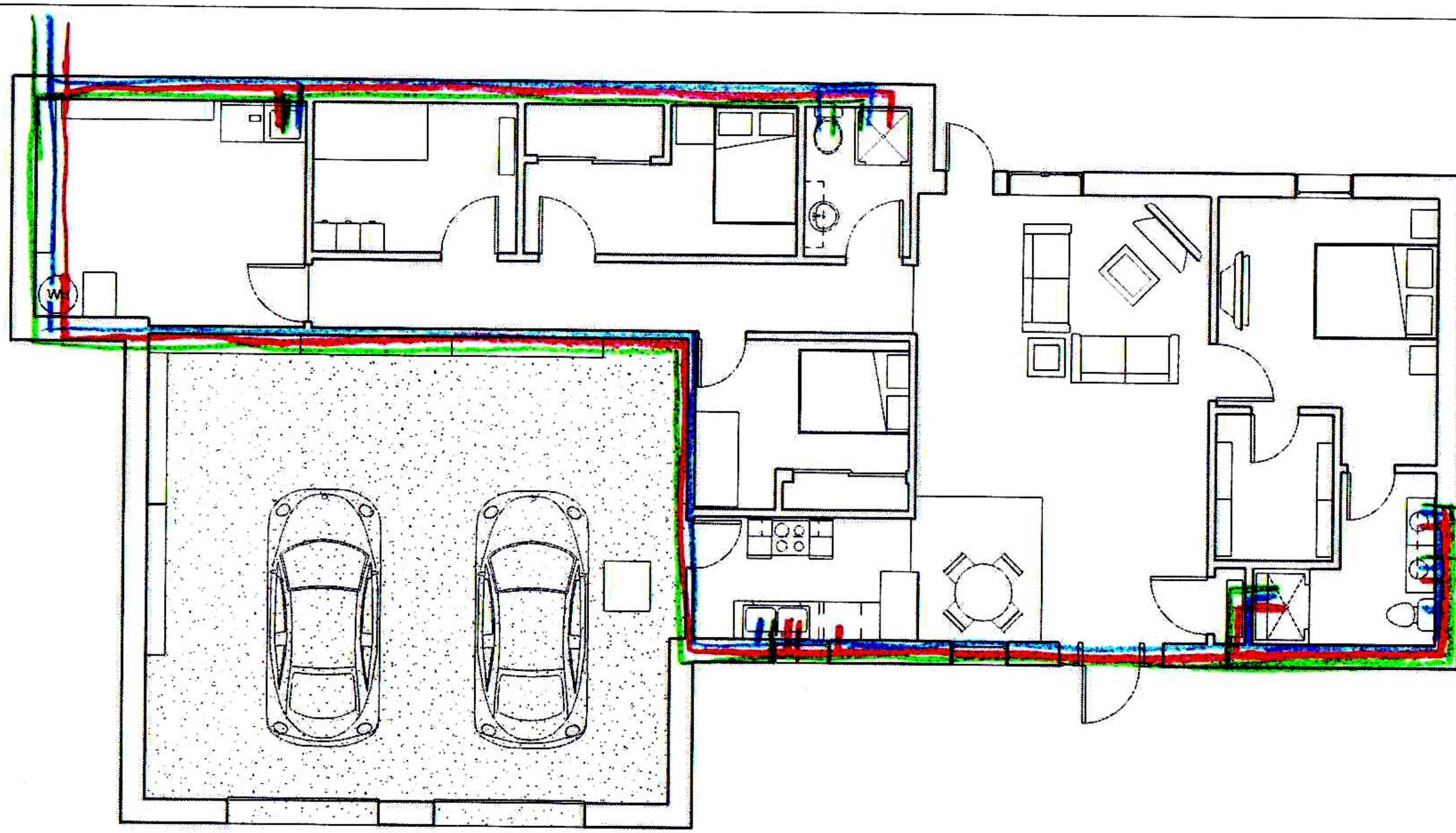
Project Name			
Civil Engineering & Architecture			

No.	Description	Date

Electrical Sketch		
Project number	Project Number	A101
Date	Issue Date	
Drawn by	Author	
Checked by	Checker	Scale 3/16" = 1'-0"

10/8/2014 2:54:58 PM

Erik Summerfield



1 Level 1
3/16" = 1'-0"

PLTW Iowa
PROJECT LEAD THE WAY

Project Name
Civil Engineering & Architecture

No.	Description	Date

Furnished Floor Plan

Project number	Project Number	A102
Date	Issue Date	
Drawn by	Author	
Checked by	Checker	Scale 3/16" = 1'-0"

10/15/2014 2:53:32 PM

Activity 2.3.8 Residential Water Supply

Introduction

Most people take it for granted that when they turn on a faucet, water is available. In fact a lot of planning has been completed to ensure that homes and business have adequate water. Engineers use codes and calculations to ensure that source and pressure are adequate. Historically civilizations in Rome and China were able to establish large urban areas and advance culture in large part because of their ability to transport large amounts of fresh water to citizens to meet their needs.

Equipment

- Calculator
- pencil
- Hazen Williams Constants & Equivalent Length of (Generic) Fittings handout

Procedure

Complete water supply calculations for each of the following.

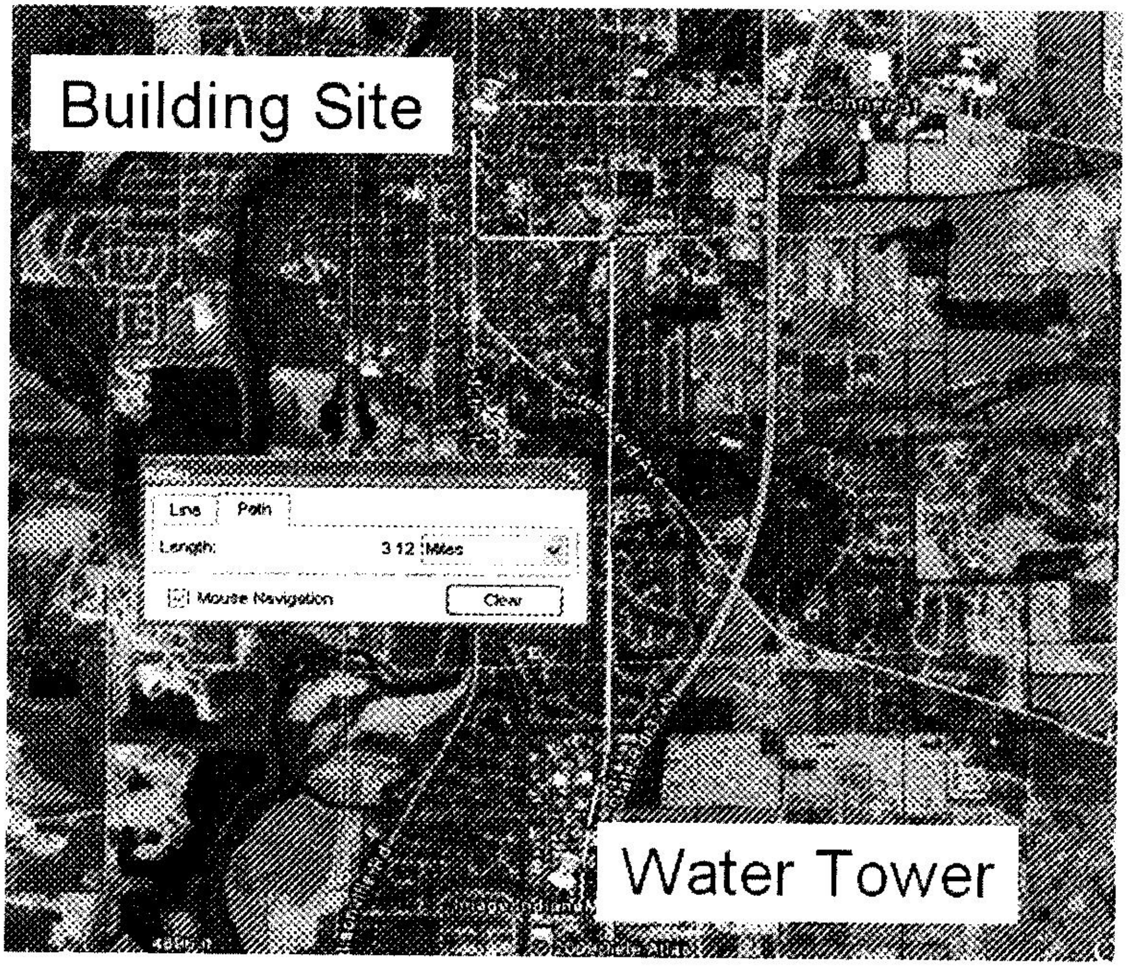
1. Complete the following calculations for your affordable home in your engineering notebook or journal.

Water Supply Line Facts

- The water line is 15 years old and is located 6 feet below 10th Street.
- The elevation at the lowest point of the tower's water cavity is 872.81 ft.
- The pipe's diameter is 8 in.
- The pipe's length is 3.12 miles.
- The pipe is cast iron.
- The pipe has seven 90 degree flanged elbows and one 45 degree flanged elbow.
- The pipe's flow rate is 100 gpm.

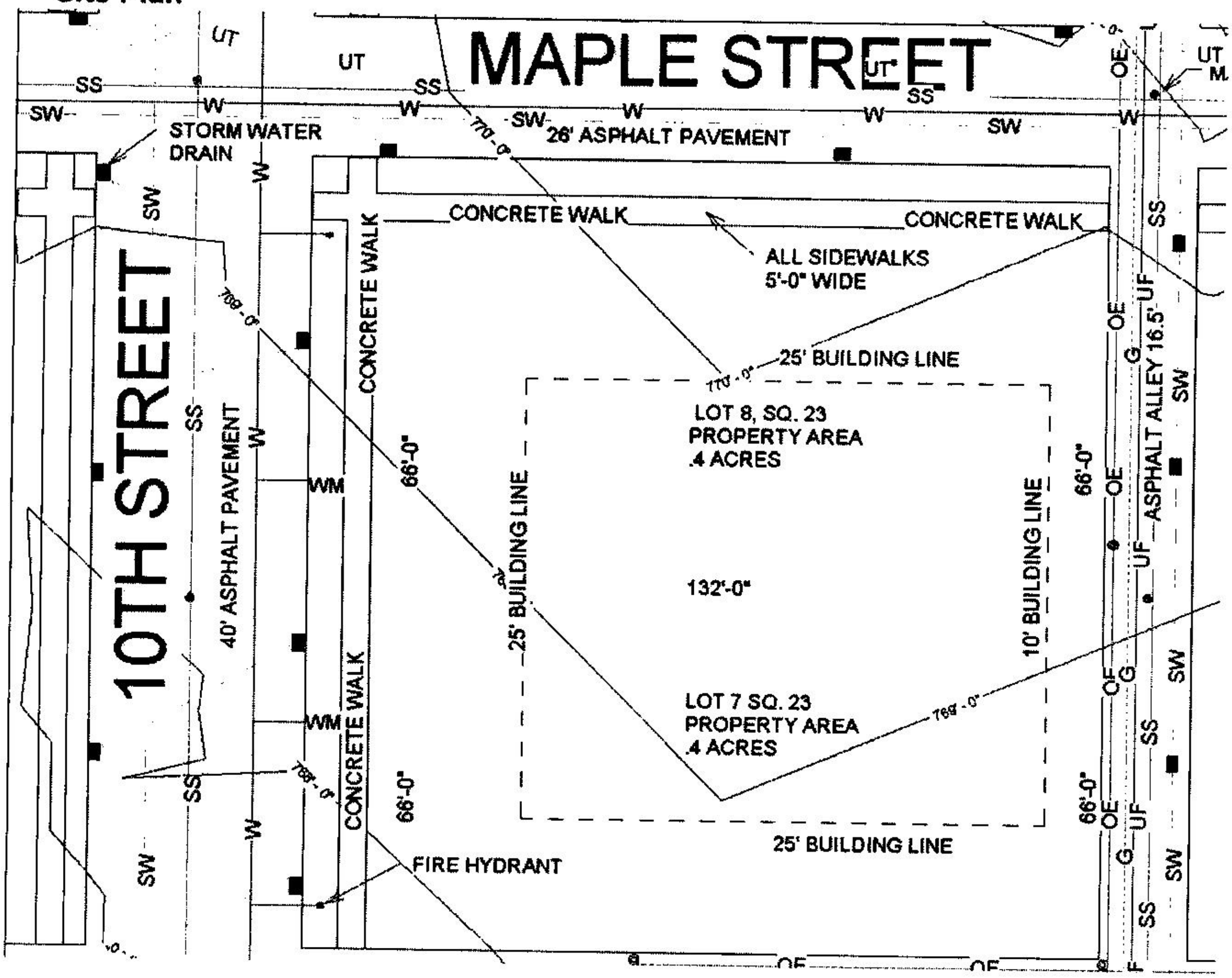
© 2010 Project Lead The Way, Inc.

Satellite Image



© 2010 Project Lead The Way, Inc.

Site Plan



a. Calculate the static head at the point of discharge under 10th street excluding head loss.

$h_s = 872.81\text{ ft} - 768\text{ ft} = 104.81\text{ ft}$

$3.12\text{ mi} \times \frac{5280\text{ ft}}{1\text{ mi}} = 16473\text{ ft}$

Minor $h_f = 7(7) + 1(7.7) = 63.6\text{ ft}$

b. Calculate the head loss, including the losses for pipe fittings.

$$h_f = \frac{(10.44)L \cdot Q^{1.85}}{C^{1.85} \cdot d^{4.8655}} = \frac{(10.44)(16537.2)(100\text{ gpm})^{1.85}}{(100)^{1.85}(8\text{ in})^{4.8655}} = 6.97\text{ ft head Loss}$$

c. Calculate the dynamic head at the point of discharge under 10th Street.

$h_d = h_s - h_f = 104.81\text{ ft} - 6.97\text{ ft} = 97.84\text{ ft}$

d. Calculate the actual pressure in front of the house.

$97.84\text{ ft} \times \frac{1\text{ psi}}{2.31\text{ ft}} = 42.4\text{ psi}$

e. Is the actual pressure sufficient for residential use? Should a pressure reducing valve be installed?

yes, pressure is sufficient $\because$ $40\text{ psi} < \underline{42.4\text{ psi}} < 80\text{ psi}$

No pressure reducing valve should be installed.

© 2010 Project Lead The Way, Inc.

2. A facility that receives water at an elevation of 350 ft at the water meter is 4.1 miles from the water tower. The water level in the tower is 527 ft. The water flow is rate is 110 gpm. Assume an 8 in. ductile or cast iron pipe with flanged fittings. The supply line includes the following fittings:

- 2-90 degree elbows ✓
- 2 gate valves ✓
- 17 line flow tees ✓
- 6 branch flow tees ✓
- 1 swing check valve ✓

a. Find the total dynamic head and actual water pressure at the water meter of this facility.

$h_s = 527 ft - 350 ft = 177 ft$

Major $h_f = \frac{10.44 \cdot L \cdot Q^{1.85}}{C^{1.85} \cdot d^{4.8655}}$

Gate valve, Line flow tees, Branch tees, Swing check valve

$L = 4.1 mi + \text{Minor } h_f = 4.1 \times \frac{5280 ft}{mi} + 2(3.2 ft) + 17(4.7) + 6(24) + 1(90)$
$+ 2(12)$

90° angle

$L = 21992.3 ft$

$h_f = \frac{(10.44)(21,992.3 ft)(110 gpm)^{1.85}}{(100)^{1.85} \cdot (8in)^{4.8655}} = 11.06 ft$

$h_d = h_s - h_f = 177 ft - 11.06 ft = 165.94 ft$

$165.94 ft \times \frac{1 psi}{2.31 ft} = \boxed{71.83 \text{ psi}}$

b. What is the static head at a sink on the second floor if the sink faucet elevation is 14 feet above the meter elevation? Hint: static head depends only on elevation.

~~$14 ft \times \frac{1 psi}{2.31 ft} = 6.06 psi$ ~~ ~~$71.83 psi - 6.06 = 65.78 psi$ @ sink~~

$177 - 14 ft = \boxed{163 ft}$

c. The water supply line from the meter to the house and up to the second floor sink is a 1" copper pipe with screwed fittings. If the pipe from the meter to the second floor is a total of 75 feet long and includes four line flow tees, ~~a~~ swing check valve and seven regular 90- degree elbow, calculate the actual pressure at the sink. Assume a flow rate of 10 gpm. Hint: the actual pressure at the sink is affected by the head loss from the water tower to the sink (which included head loss from the tower to the meter and from the meter to the sink).

$h_f = \frac{10.44(75 ft + 4(3.2) + 1(11.0) + 7(5.2))(10 gpm)^{1.85}}{130^{1.85} \cdot (1 in)^{4.8655}} = 12.27 ft$

$163 - 12.27 ft = 150.72 ft \times \frac{1 psi}{2.31} = \boxed{65.25 psi}$

© 2010 Project Lead The Way, Inc.

Activity 2.3.11 Calculating Property Drainage

Introduction

When a property is developed, it is important to understand that changes to watershed characteristics (i.e., land use, slope, soil type, vegetative cover) will change the amount of storm water runoff from the site. Development typically increases runoff and negatively affects water quality, which may impact downstream property owners and the environment as site storm water flows into drainage swales, ponds, creeks, or rivers.

Several different methods are used by civil engineers to assess the hydrology of a site. In this activity, you will calculate peak runoff using the rational method.

Equipment

- Calculator
- Journal

Procedure

For small drainage areas, the peak runoff can be easily computed using the rational formula. The formula is:

$$Q = C_f CiA$$

Q = Peak runoff rate in cubic feet per second
i = Rainfall intensity in inches per hour (see map)
A = Drainage area in acres
C = Runoff coefficient (see table)
C_f=Runoff coefficient adjustment factor (see table)

For Example

Suppose a developer purchased a three acre farm in Nashville, TN (in the middle of the state). As part of the project, a 30,000 sq ft asphalt parking lot area will be placed on one side of the three acre farm. The 10-year 1-hour rainfall chart (see map) indicates that the rainfall amount is 2.17 inches/hour. Solve the rational formula to determine the peak flow of the property prior to development (pre-development) and after the addition of the asphalt parking lot (post-development).

Part 1: Calculation of site runoff prior to addition of parking lot

Pre-development
i = 2.17 in. (see Precipitation Intensity Estimates chart)

© 2010 Project Lead The Way, Inc.

A = 3 acres

C = $\frac{0.3+0.05}{2} = 0.18$ (average Rational Runoff Coefficient for farmland, see chart)

C_f= 1.0

Q = C_fCiA =(1.0)(0.18) (2.17 in/hr) (3 ac) = 1.2 cfs

Part 2: Calculation of site runoff for parking lot. The additional runoff from the impermeable, asphalt parking lot must be accounted for.

Post-development

i = 2.17 in. (see Rainfall Intensity map or Precipitation Intensity Estimates table)

A_1 = 30,000 sq ft or 0.69 acres (parking lot)

A_2 = 3 acres – 0.69 acres = 2.31 acres (farmland minus parking lot)

C_1 = 0.95 (conservative coefficient for parking lot, see chart)

C_2 = $\frac{0.3+0.05}{2} = 0.18$ (average coefficient for farmland, see chart)

A composite runoff coefficient (C_c) must be calculated that reflects the post-development watershed characteristics before calculating the peak runoff when the parking lot is added to the farmland.

$$\boldsymbol{C_c} = \frac{\boldsymbol{C_1A_1} + \boldsymbol{C_2A_2} + \cdots}{\boldsymbol{A_1} + \boldsymbol{A_2} + \cdots}$$

$$\boldsymbol{C_c} = \frac{(0.18)(2.31\ \textbf{acres}) + (0.95)(0.69\ \textbf{acres})}{3\ \textbf{acres}}$$

$$\boldsymbol{C_c} = 0.36$$

Use the composite runoff coefficient in the rational formula to determine the runoff when the parking lot is added to the farmland.

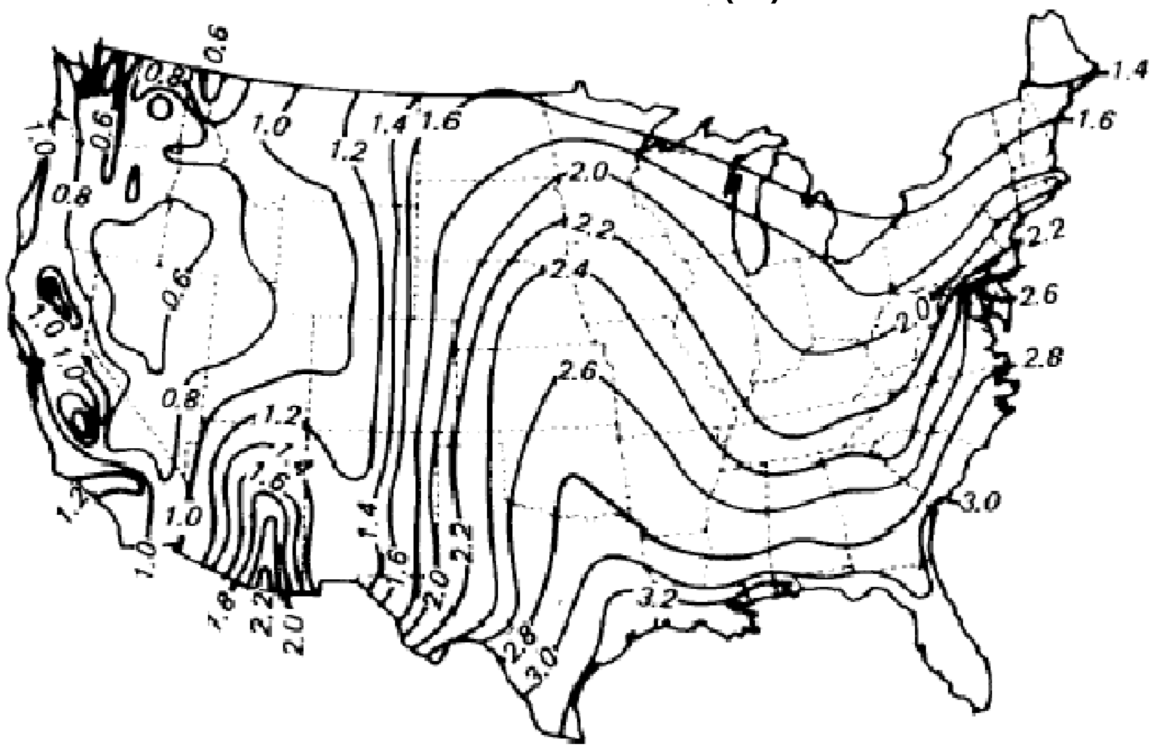
Q = C_fCiA = (1.0)(0.36) (2.17 in/hr) (3 ac) = 2.3 cfs

Part 3: Therefore, the peak runoff has increased from approximately 1.2 cfs to 2.3 cfs (nearly double) for a total change of 1.1 cfs as a result of paving over 30,000 sf (23% of property) of previously permeable farmland.

The engineer uses this information to create a storm water management plan for the site. The storm water management plan would include drainage swales (i.e., ditches) that direct site runoff to a detention basin. The basin will hold the site runoff and control the release of water to a maximum Q that is equal to the pre-development peak runoff.

© 2010 Project Lead The Way, Inc.

10-Year 1-Hour Rainfall (in.)



Precipitation Intensity Estimate Tables or IDF charts can be used as an alternative to rainfall intensity maps.

To obtain a Precipitation Intensity Table for locations within the United States, visit the Hydrometeorological Design Studies Center Precipitation Frequency Data Server at **http://hdsc.nws.noaa.gov/hdsc/pfds/index.html**. Choose the applicable state. Then choose *Precipitation Intensity* as the data type and *Partial duration* for the Time series type. Next select the location and depress the **Submit site** button. The Precipitation Intensity Estimates for Nashville follow. Note that the 10 yr – 1 hr intensity from the table differs slightly from the intensity map. In general the tabulated values should be more accurate.

Precipitation Intensity Estimates (in/hr)

ARI* (years)	5 min	10 min	15 min	30 min	60 min	120 min	3 hr	6 hr	12 hr	24 hr	48 hr	4 day	7 day	10 day	20 day	30 day	45 day	60 day
1	4.57	3.65	3.04	2.08	1.30	0.77	0.56	0.33	0.20	0.12	0.07	0.04	0.03	0.02	0.01	0.01	0.01	0.01
2	5.35	4.28	3.59	2.48	1.55	0.91	0.66	0.40	0.23	0.14	0.08	0.05	0.03	0.03	0.02	0.01	0.01	0.01
5	6.17	4.94	4.16	2.96	1.90	1.11	0.80	0.48	0.28	0.17	0.10	0.06	0.04	0.03	0.02	0.02	0.01	0.01
10	6.82	5.45	4.60	3.33	2.17	1.27	0.92	0.55	0.33	0.20	0.12	0.06	0.05	0.04	0.02	0.02	0.01	0.01
25	7.63	6.08	5.14	3.81	2.54	1.48	1.08	0.65	0.38	0.23	0.14	0.08	0.05	0.04	0.03	0.02	0.02	0.01
50	8.24	6.56	5.54	4.17	2.83	1.66	1.20	0.73	0.43	0.26	0.16	0.08	0.06	0.05	0.03	0.02	0.02	0.02
100	8.83	7.02	5.92	4.53	3.12	1.83	1.33	0.82	0.48	0.29	0.18	0.09	0.07	0.05	0.03	0.02	0.02	0.02
200	9.41	7.46	6.27	4.88	3.42	2.01	1.47	0.90	0.53	0.32	0.19	0.10	0.07	0.06	0.03	0.03	0.02	0.02
500	10.12	8.00	6.71	5.34	3.83	2.26	1.66	1.03	0.60	0.36	0.22	0.12	0.08	0.06	0.04	0.03	0.02	0.02
1000	10.66	8.39	7.02	5.69	4.15	2.45	1.80	1.12	0.66	0.39	0.24	0.13	0.09	0.07	0.04	0.03	0.02	0.02

* These precipitation frequency estimates are based on a partial duration series. ARI is the Average Recurrence Interval.
Please refer to NOAA Atlas 14 Document for more information. NOTE: Formatting forces estimates near zero to appear as zero.

© 2010 Project Lead The Way, Inc.

Rational Method Runoff Coefficients	
Categorized by Surface	
Forested	0.059—0.2
Asphalt	0.7—0.95
Brick	0.7—0.85
Concrete	0.8—0.95
Shingle roof	0.75—0.95
Lawns, well drained (sandy soil)	
Up to 2% slope	0.05—0.1
2% to 7% slope	0.10—0.15
Over 7% slope	0.15—0.2
Lawns, poor drainage (clay soil)	
Up to 2% slope	0.13—0.17
2% to 7% slope	0.18—0.22
Over 7% slope	0.25—0.35
Driveways, walkways	0.75—0.85
Categorized by Use	
Farmland	0.05—0.3
Pasture	0.05—0.3
Unimproved	0.1—0.3
Parks	0.1—0.25
Cemeteries	0.1—0.25
Railroad yard	0.2—0.40
Playgrounds (except asphalt or concrete)	0.2—0.35
Business Districts	
Neighborhood	0.5—0.7
City (downtown)	0.7—0.95
Residential	
Single-family	0.3—0.5
Multi-plexes, detached	0.4—0.6
Multi-plexes, attached	0.6—0.75
Suburban	0.25—0.4
Apartments, condominiums	0.5—0.7
Industrial	
Light	0.5—0.8
Heavy	0.6—0.9

Lindeburg, M. R. (1994). *Civil engineering reference manual* (9th ed.). Belmont, CA: Professional Publications, Inc.

Runoff Coefficient Adjustment Factor

Return Period	C_f
1, 2, 5, 10	1.0
25	1.1
50	1.2
100	1.25

© 2010 Project Lead The Way, Inc.

Procedure

Use the rational formula to calculate the answers to each of the following. Show all of your work. Use the rational formula to calculate the change in runoff for each of the following developed sites.

1. What is the change in storm water runoff for a 1.5 acre site near Chicago University in Chicago, IL that was forested before construction? A 50ft x 35ft coffee shop with a 100ft x 120ft parking lot was built on the site. The remainder of the site was planted with lawn in well drained, sandy soil that has a slope of over 7%. The design storm is a 25-yr 1-hr storm. Use average runoff coefficients for forested land and the post-development lawn, but use conservative values for the post-development roof and parking lot runoff coefficients. Remember to use the runoff coefficient adjustment factor for a recurrence interval greater than 10 years. Note: Use Hydrometeorological Design Studies Center Precipitation Frequency Data Server at **http://hdsc.nws.noaa.gov/hdsc/pfds/index.html** to estimate the precipitation intensity. Be sure to select precipitation intensity under Data Type – the default selection will produce the wrong chart. Conversion factor: 1 acre = 43,560 ft^2.

Pre-Construction:

$Q = C_fCiA$

A = 1.5 Acres

i = 2.54 in/min

$C_f = 1.0$

C = (0.2 + 0.059) / 2 = .13

Q = (1.0)(0.13)(2.54 in/min)(1.5 Acres) = 0.50 cfs

Post Construction:

Store

$Q = C_fCiA$

A = 1750 ft^2 /43,560 = 0.04 Acres

i = 2.54 in/min

$C_f = 1.0$

C = (0.95 + 0.75) / 2 = 0.85

Q = (1.0)(0.85)(2.54 in/min)(0.04 Acres) = 0.09 cfs

Parking Lot

$Q = C_fCiA$

A = 12000 ft^2 / 43560 ft^2 = 0.28 Acres

i = 2.54 in/min

$C_f = 1.0$

$C = (0.95 + 0.7) / 2 = .7705$

$Q = (1.0)(0.7705)(2.54\ in/min)(0.28\ Acres) = 0.55\ cfs$

Other Land

$Q = C_fCiA$

$A = 1.21\ Acres$

$i = 2.54\ in/min$

$C_f = 1.0$

$C = (0.15 + 0.10) / 2 = 0.025$

$Q = (1.0)(0.125)(2.54\ in/min)(1.21\ Acres) = 0.384\ cfs$

Total

$Q = Q1+Q2+Q3 = (0.09\ cfs) + (0.55\ cfs) + (0.384\ cfs) =$ ***1.02 cfs***

2. What is the change in storm water runoff for the Affordable Home site in Noblesville, IN? Assume the existing site is flat, well drained, and is covered by sandy soil with some vegetation and has an estimated runoff coefficient of 0.1. Assume a 100-yr, 1-hr design storm.

Pre-Construction:

$Q = C_fCiA$

$A = 0.5\ Acres$

$i = 3.12\ in/min$

$C_f = 1.0$

$C = (0.1 + 0.05) / 2 = 0.08$

$Q = (1.0)(0.08)(3.12\ in/min)(0.5\ Acres) = 0.13\ cfs$

Post Construction:

House

$Q = C_fCiA$

$A = 1070\ ft^2 / 43{,}560 = 0.03\ Acres$

$i = 3.12\ in/min$

$C_f = 1.0$

$C = (0.95 + 0.75) / 2 = 0.85$

$Q = (1.0)(0.85)(3.12\ in/min)(0.03\ Acres) = 0.08\ cfs$

© 2010 Project Lead The Way, Inc.

Other Land

$Q = C_f CiA$

A = 0.47 Acres

i = 3.12 in/min

$C_f = 1.0$

C = (0.1 + 0.05) / 2 = 0.08

Q = (1.0)(0.08)(3.12 in/min)(0.47 Acres) = 0.12 cfs

Total

Q = Q1+Q2 = (0.08 cfs) + (0.12 cfs) = ***0.20 cfs***

Conclusion

1. What impact does adding an asphalt parking lot have on the site runoff on a farm?

Greatly increases the amount of runoff because it decreases the area of land that can effectively absorb the rainwater

2. How can you limit the downstream negative effects of storm water runoff?

By making sure that the amount of runoff is the same or less after construction than before construction

© 2010 Project Lead The Way, Inc.

PLTW | Engineering

Activity 2.3.10 Wastewater Management

Introduction

As urban centers grew in size, it became apparent that dumping raw sewage into streets, creeks, rivers, and lakes ultimately threatened the drinking water supply. The concept of wastewater management was born.

Once water has entered a structure, it is inevitable that the water will be used and the quality changed – usually for the worse. The used water is called wastewater. The constituents (impurities) within wastewater are dependent upon how the water has been used.

Sanitary wastewater is generally accepted to consist of human waste, household cleaning solutions, oil and grease from cooking activities, small solid particles from garbage grinders, or soil from cleaning clothes and floors. Wastewater from commercial establishments may include metals, strong acids and bases, cleaning solvents, oil and grease, and grit (small plastic, glass, stone, or metal particles), in addition to sanitary wastewater. Sometimes water is used for cooling purposes; thermal pollution is created and must be managed correctly.

The selected method of wastewater management depends upon the quantity (i.e., flow rate) and quality of the wastewater, available treatment technologies, codes and regulations and economics.

A civil (environmental) engineer must decide how to manage the wastewater by considering three broad categorical options:

Reuse: Wastewater that can be used again without treatment of any kind
Recycling: Wastewater that is treated either on-site or off-site and used again
Discharge/treatment: Wastewater that is simply discharged from the structure for treatment either on-site or off-site

In this activity you will learn to select an appropriate wastewater management method and perform fundamental layout calculations.

Equipment

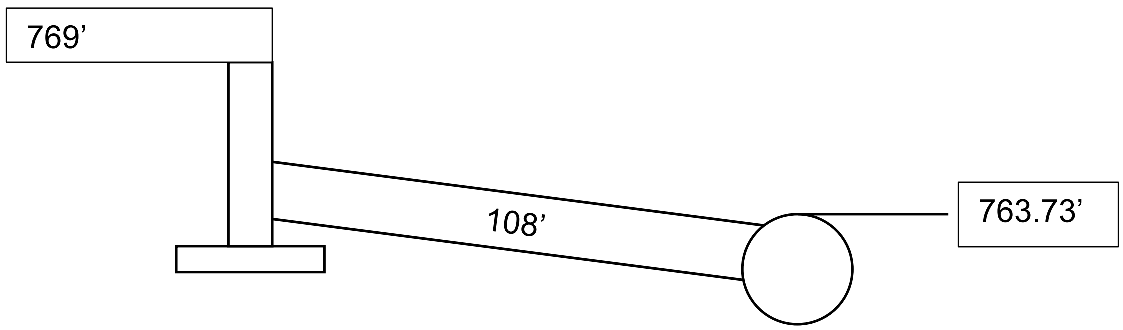
- Pencil
- Engineering notebook
- Calculator
- Computer with internet access
- Example Residential Plumbing Code Requirements

© 2010 Project Lead The Way, Inc.

Procedure

For the purposes of this activity, you will assume that the primary contaminant in the wastewater is organic matter and NOT toxic to microorganisms.

1. Apply what you have learned about wastewater management and the Example Residential Plumbing Codes Requirements to choose a wastewater treatment method for your Affordable Housing project.
2. Design the lateral connection from the house to the system. Show all work and document your design. Assume that the **invert** elevation of the 14 inch sewer main where the sewer lateral will connect is 763.15 feet.
    a. Create a sketch showing the sewer main, the sewer lateral, the house foundation, and the lowest floor elevation.



    b. Calculate approximate crown elevation of the existing 14 inch sanitary sewer main. Show this elevation on your sketch.

763.15’ + (14”/2) = 763.73’

    c. Assume that the sewer lateral must connect to the main on 10th Street. Determine horizontal distance from the structure to the existing sewer main. Indicate this dimension on your sketch.

108’

    d. Determine the minimum size allowed for the building sewer (sewer lateral).

3”

    e. Determine the maximum sewer lateral pipe invert elevation at the structure foundation and indicate this elevation on your sketch. Assume that the sewer invert must be at least 2 feet below the lowest floor requiring sanitary sewer drainage and that the sewer crown must be below frost depth. Frost depths are available at **http://www.soundfootings.com/pdf/US_Map_Frost_DepthAVG.pdf**

20”

© 2010 Project Lead The Way, Inc.

f. Calculate the slope of the proposed sewer lateral from the structure to the sewer main.

Slope = $\frac{(769-2)'-763.15'+\frac{1}{2}(7/12')}{108'}$ = *3.8% slope*

g. What is the minimum slope allowed for the wastewater pipe? Does your design meet the requirement?

2% minimum. Yes, this meets requirements

3. Revise the drawings of your affordable home to reflect the location and size of the sewer lateral.

Conclusion

1. When would the use of a septic system for wastewater management be appropriate?

When the public works system is not accessible

2. What course of action should an architect or civil engineer take if the proposed slope of the sewer lateral is less than 2% (¼ in. of drop per foot) of pipe?

Try accessing a different sewer main, or begin the sewer lateral at a different position

3. Why is it important that the wastewater from a structure(s) is not toxic to microorganisms?

Because the goal is to leave the existing ecosystem as untouched as possible to preserve the environment

4. Why is proper wastewater management critical for the health and welfare of society and the environment?

Because it is harmful to the environment as well as the occupant if the waste management system fails

© 2010 Project Lead The Way, Inc.

PLTW | Engineering

Client Survey

Family Information	
Adult Names/Ages	John Doe (35) Jane Doe (35)
Occupations	Engineer - Mechanical, teacher
Child Names/Ages	Jack Doe (14)
Child Names/Ages	Jill Doe (9)
Physical Disabilities	N/A
Other Special Needs	N/A
Pets	Hamster
Architectural Details	
House Style	Bungalow
Number of Bedrooms	3
Number of Bathrooms	2
Square Footage	1000 ft^2
Deck or Patio	N/A
Extra Storage	20 ft^2
Leisure Activities	
Hobbies	Jill writes, John astronimizes, Jack plays games, Jill plays soccer
Entertainment	Cable TV, Computer games, videogames
Equipment	Computer, Excersise station
Special Needs	
Disabilities/illness	Allergies, requires airfiltering
Energy Saving/ LEED Concepts and Ideas	
Site Development	
Water Savings	
Energy Efficiency	
Materials Selection	
Indoor Environmental Quality	
Other Ideas	1 car garage, office (?), compartmentalized Teacher

Erik Summer[illegible]

© 2010 Project Lead The Way, Inc.