Lightyear Residence

Project Information

Designer: Yusuf Morsi
Firm Name: Pixar Inc.
Address: 124 Conch Street
San Diego, CA 92000

Client: Buzz Lightyear
Address: 234 Elm Street
San Diego, CA 92120

Problem Statement

- **The task that I was assigned to do was to create an affordable ADA compliant two-bedroom house with a square footage of 900 square feet.**

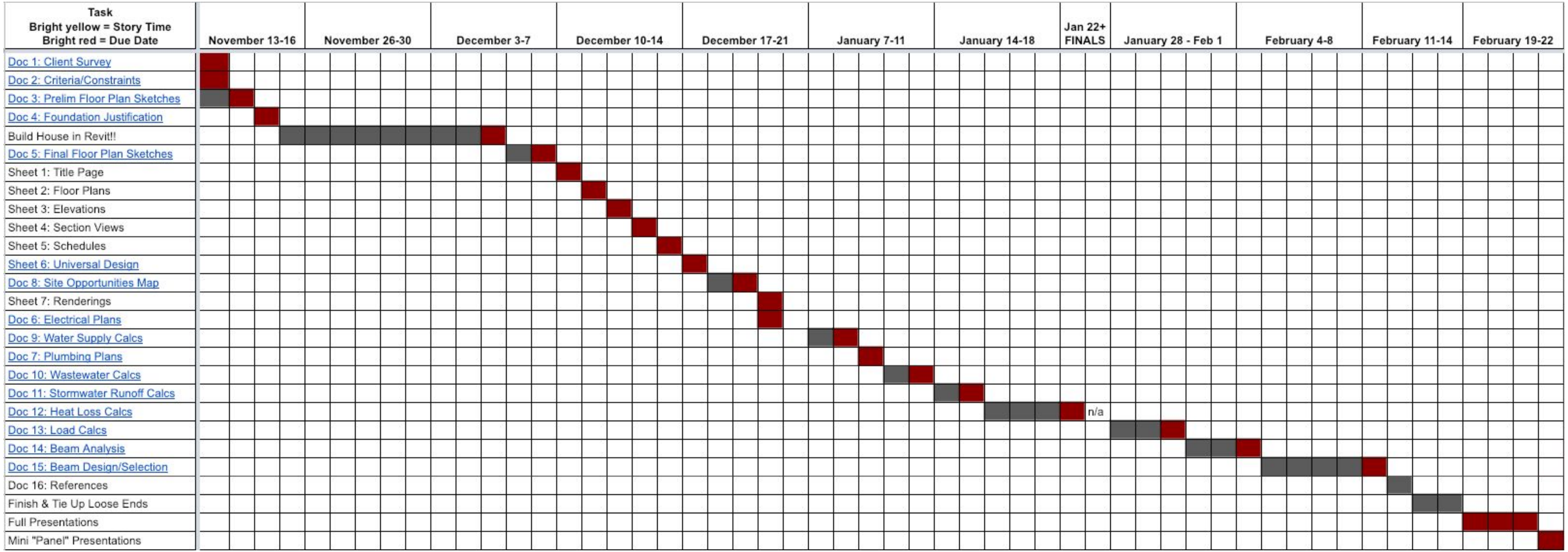
Constraints

- **House can cover up to 900 square feet**
- **House must conform to relevant codes and requirements of San Diego**
- **House must be ADA Compliant**
- **Must have at least one bathroom with adequate moving space, a toilet, and a shower**
- **Every bedroom must have at least one window**
- **Kitchen/dining room must have at least two windows**
- **There must be room for a 40 gallon water heater**

Constraints

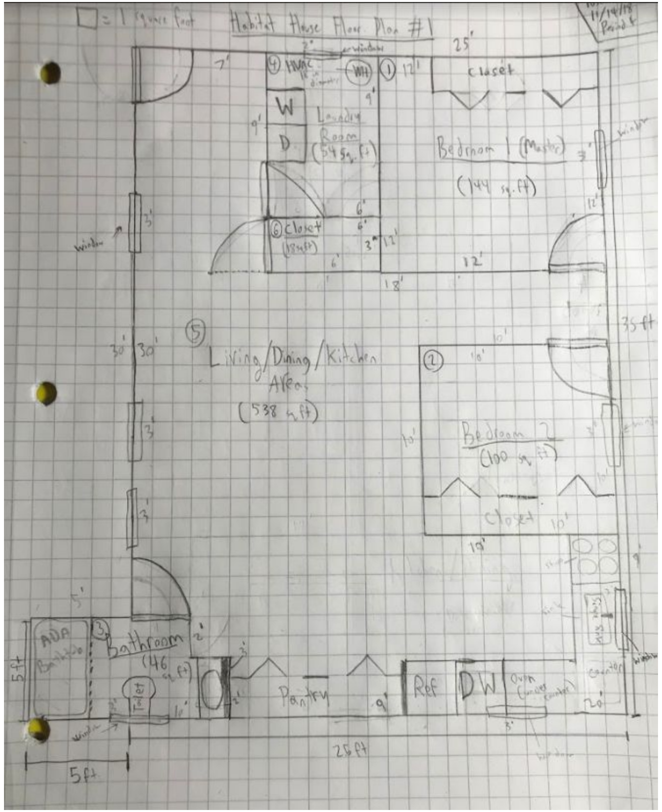
- Ceiling light fixtures for incandescent light shall be provided in all rooms
- All hallways must be 42 in. minimum frame to frame
- Exterior doors must be 3 feet wide and solid-core
- There must be an space for a clothes-washer and a dryer
- All passage doors, including the full bathroom, will be 36-in. wide

Gantt Chart


Task
Bright yellow = Story Time
Bright red = Due Date
November 13-16
November 26-30
December 3-7
December 10-14
December 17-21
January 7-11
January 14-18
Jan 22+
FINALS
January 28 - Feb 1
February 4-8
February 11-14
February 19-22
Doc 1: Client Survey
Doc 2: Criteria/Constraints
Doc 3: Prelim Floor Plan Sketches
Doc 4: Foundation Justification
Build House in Revit!!
Doc 5: Final Floor Plan Sketches
Sheet 1: Title Page
Sheet 2: Floor Plans
Sheet 3: Elevations
Sheet 4: Section Views
Sheet 5: Schedules
Sheet 6: Universal Design
Doc 8: Site Opportunities Map
Sheet 7: Renderings
Doc 6: Electrical Plans
Doc 9: Water Supply Calcs
Doc 7: Plumbing Plans
Doc 10: Wastewater Calcs
Doc 11: Stormwater Runoff Calcs
Doc 12: Heat Loss Calcs
n/a
Doc 13: Load Calcs
Doc 14: Beam Analysis
Doc 15: Beam Design/Selection
Doc 16: References
Finish & Tie Up Loose Ends
Full Presentations
Mini "Panel" Presentations

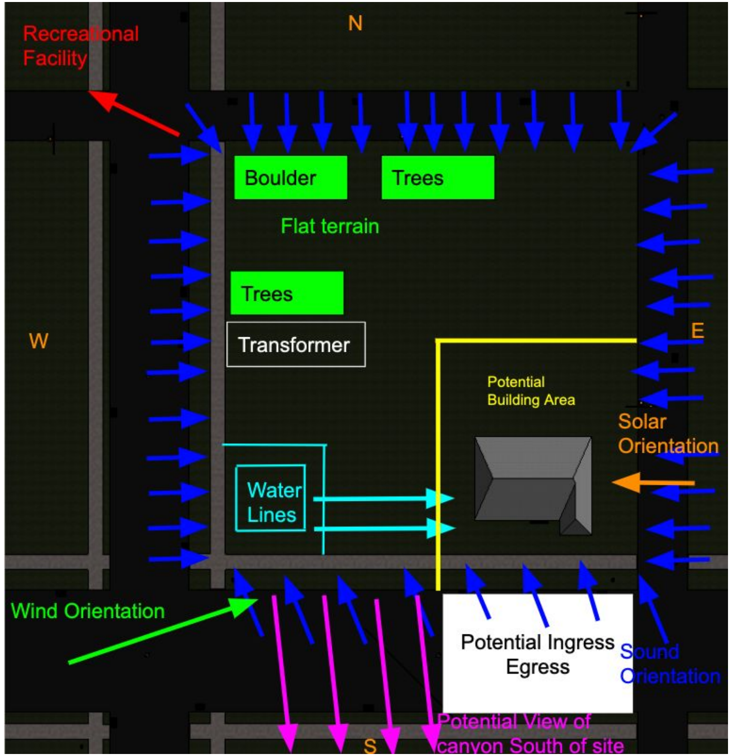
Preliminary Design

- **On the right is a picture of the preliminary design of the house. This was drawn in pencil, as it was subject to change.**



Site Details

- **This image depicts the facts about the given site that must be taken into consideration before the house is built**



Water Supply

- **The dynamic pressure must be calculated, so I can know if I should take measures such as replace pipe with something bigger, installing pipe, or replacing the pipe with one with a smaller diameter**

Step	Term	Definition (What is it and why is it important?)	Calculation for Your House (A picture of your work on paper or written out here will suffice)
1	Static Head	The total pressure the water has.	901 - 795= **106**
2	Static Pressure		106/2.31 = **45.89 psi**
3	Hazen-Williams Constant	The Hazen–Williams constant is a constant that relates the flow of water in a pipe with the physical properties of the pipe.	**100**
4	Miles-Feet Conversion	This converts the unit from miles to feet by multiplying by 5280 (as there are 5280 feet in one mile).	5.02 times 5280 = **26505.6 feet**
5	Equivalent Lengths	Equivalent lengths help calculate pressure drop.	4 times 12 = 48 6 times 7.7 = 46.2 46.2 + 48 = **94.2**
6	Head Loss	Head loss is the loss of pressure in pipe or duct flow due to the effect of the fluid's thickness near the surface of the pipe or duct.	$((10.44)(26505.6)(100^{1.85}))/((100^{1.85})(8^{4.8655}))$ = **11.170 feet**
7	Dynamic Head	Total Dynamic Head is the total equivalent height that a fluid is to be pumped. Calculating this accurately is important in order to determine the correct sizing and scale of pumping equipment for specific needs	106 - 11.170 = **94.83 feet**
8	Dynamic Pressure	The increase in a moving fluid's pressure over its static value. This is important because ft it is too low, the water pressure will be weak and if too high, the water will be shooting out of outputs quickly, which in some cases, could be dangerous.	94.83/2.31 = **41.05 psi**
After calculating dynamic pressure, what do you conclude about your pressure? What steps will you take, if any, to make sure pressure is appropriate?		My dynamic pressure is fine, but it is still a little bit low. If dynamic pressure is ever lower than 40 psi, then some measures should be taken, such as installing a pump or decreasing the pipe diameter.	

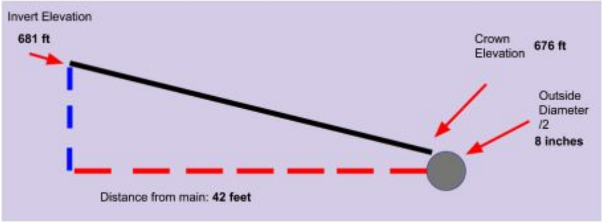
Storm Water Runoff

- **These calculations helped me determine if I will need to address the excess runoff storm water or not**

Step	Instructions	Answer, Drawing or Calculation (A picture of your work on paper or written out here will suffice)
1	What is the rainfall intensity? (assume a 50 year, 12 hour storm)	**I = 2.90** (inferred from table)
2	What is the Runoff Coefficient Adjustment Factor (C_f)?	The Runoff Coefficient Adjustment factor is **1.2** (inferred from table)
3	What is the runoff coefficient for the site? (Assume agricultural land, sandy soil, no crop)	The Runoff Coefficient is **0.3** (inferred from table)
4	Calculate pre-development runoff rate (Q)	Q = (0.52)(1.2)(0.3)(2.91) = **0.544752**
5	Calculate the area of your house (use Revit room schedule if you need help). Don't forget to convert to acres!	(968.3)/(43560) = **0.022229109 acres**
6	Calculate the area of your site MINUS the area of your house	0.52 - 0.022229109 = **0.497770891 acres**
7	Find the C value of the area you developed (your house)	Since it is a single family home: **0.4** (inferred from table)
8	Calculate post-development runoff rate (Q)	Qpost = (CfC1iA)undeveloped + (CfC2iA)developed Qpost = (1.2*0.3*2.9*.4977) + (1.2*.4*2.9*.0223) = **0.5506404 CFS**
9	What is the difference between your pre and post runoff rates?	0.5506404 - .544752 = **0.0058884 CFS**
10	Will you need to address the excess runoff? If so, what is your idea for enhancing drainage?	No, I will not, but if I had to, I would place a small pond so the excess water will have a place to go

Wastewater Slope

- **These calculations are important as they determine the slope for my house's wastewater**

Step	Instructions	Answer, Drawing or Calculation (A picture of your work on paper or written out here will suffice)
1	Convert inches to feet for pipe diameter	4 inches/12 inches = ⅓ **feet**
2	What is the minimum allowable slope for your wastewater?	682/42 = **16.2381 feet**
3	Draw a diagram of your wastewater "triangle" and label each section. Include the numbers for your particular residence.	
4	Use the equation to calculate sewer lateral slope for your house.	(((681-676) + (0.666667))/(42)) times 100 = **13.4621 %**
5	Does your slope exceed the minimum?	Yes, as the minimum is 12.5%
6	If not, what can you do to change it? Re-do your calculations and explain what number needs to change to make it work, and by how much.	N/A

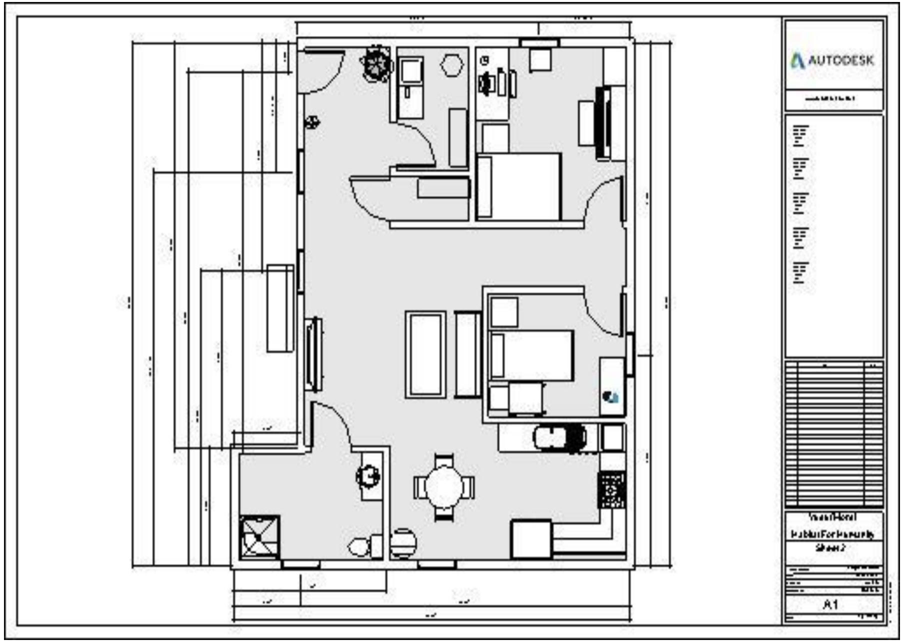
The Final Design

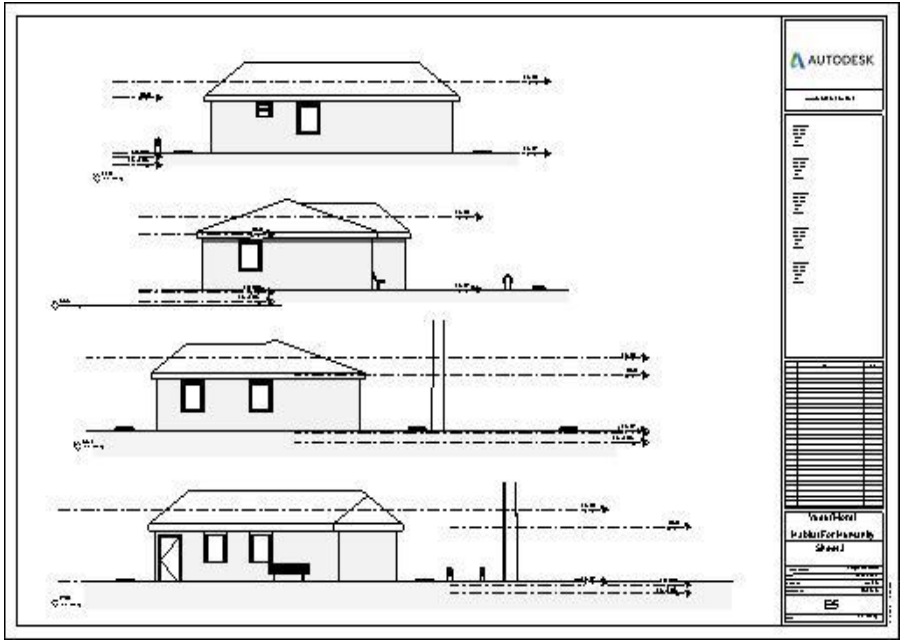
The Final Design

The Final Design

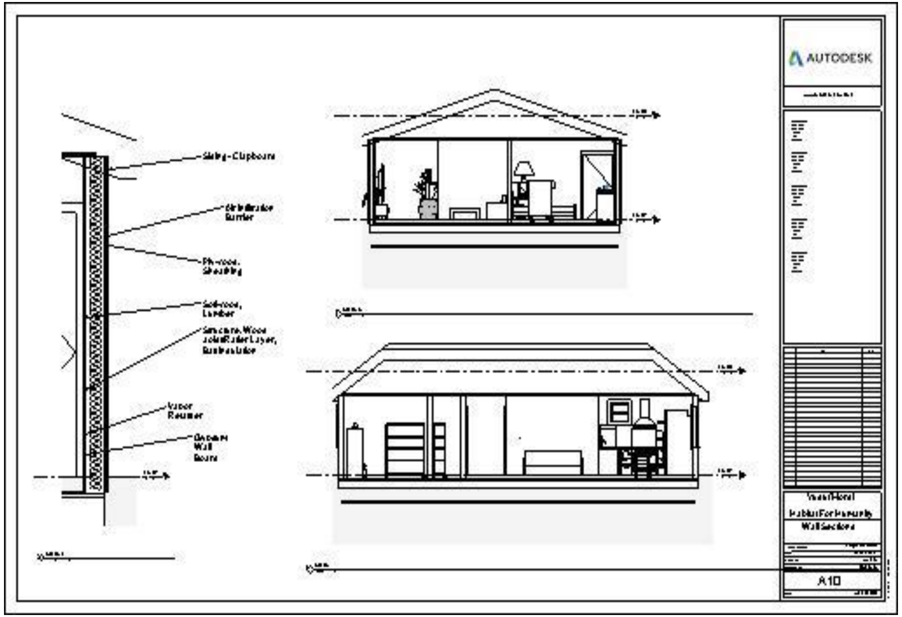
The Final Design

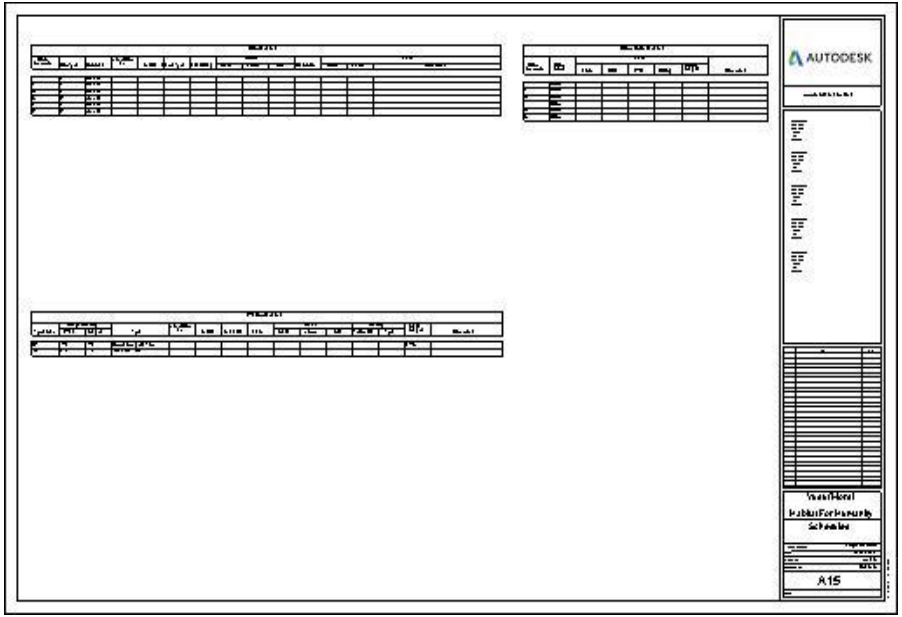
Plans



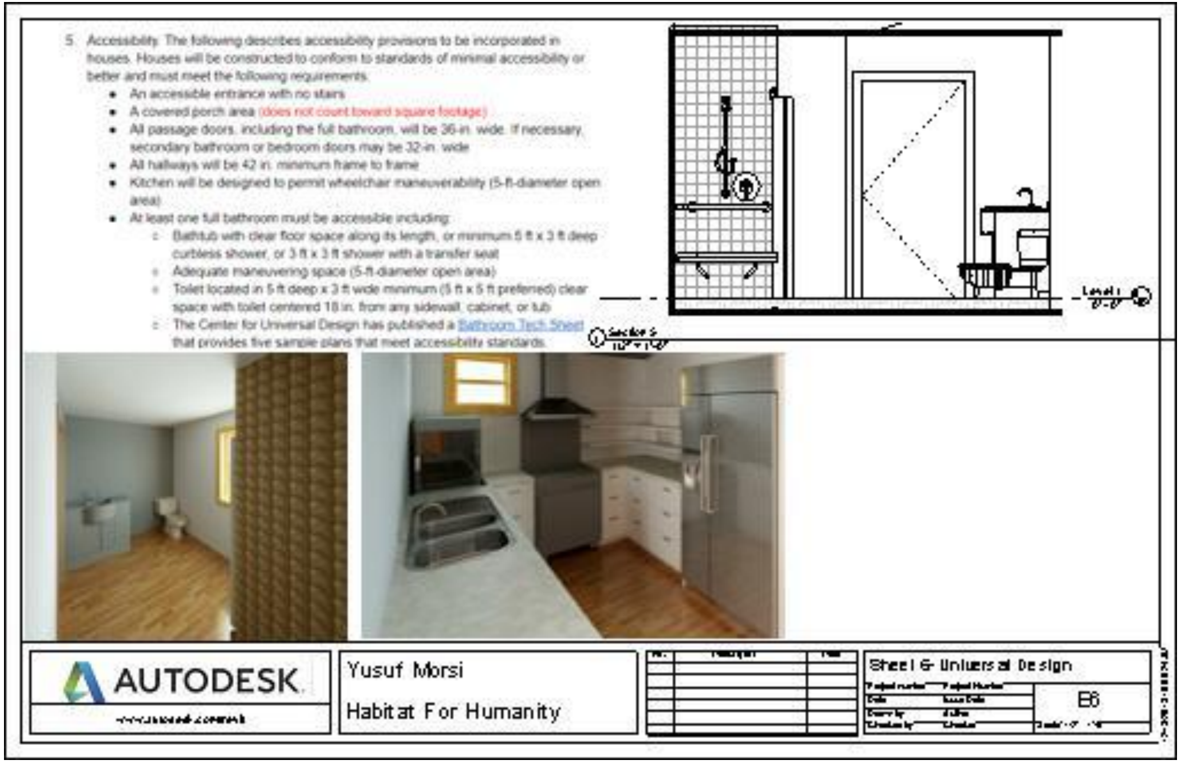


More Plans

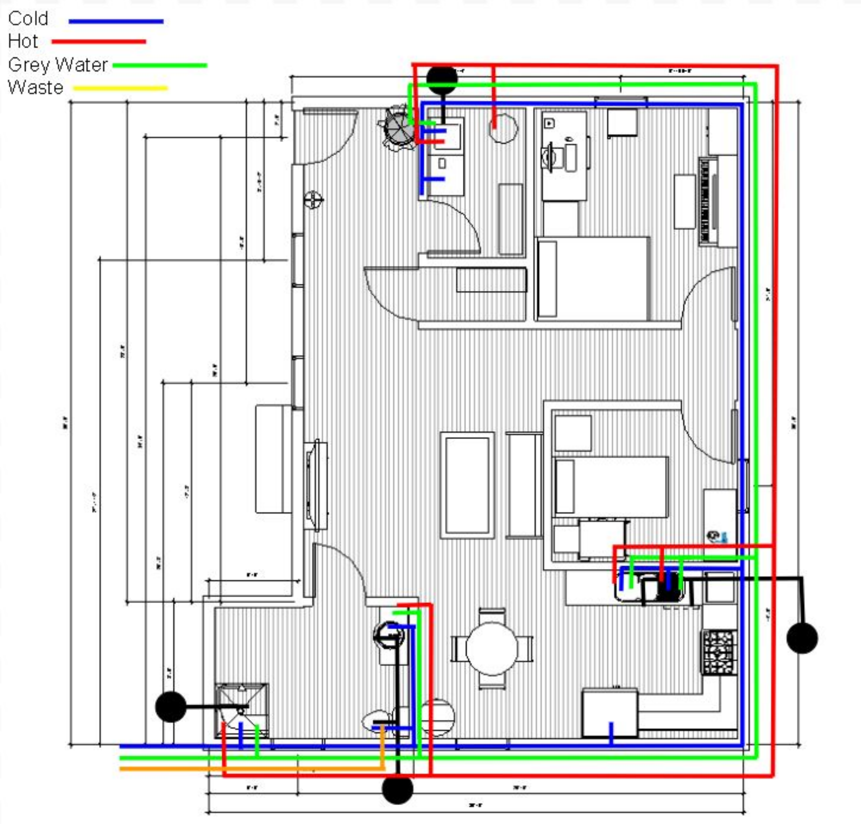


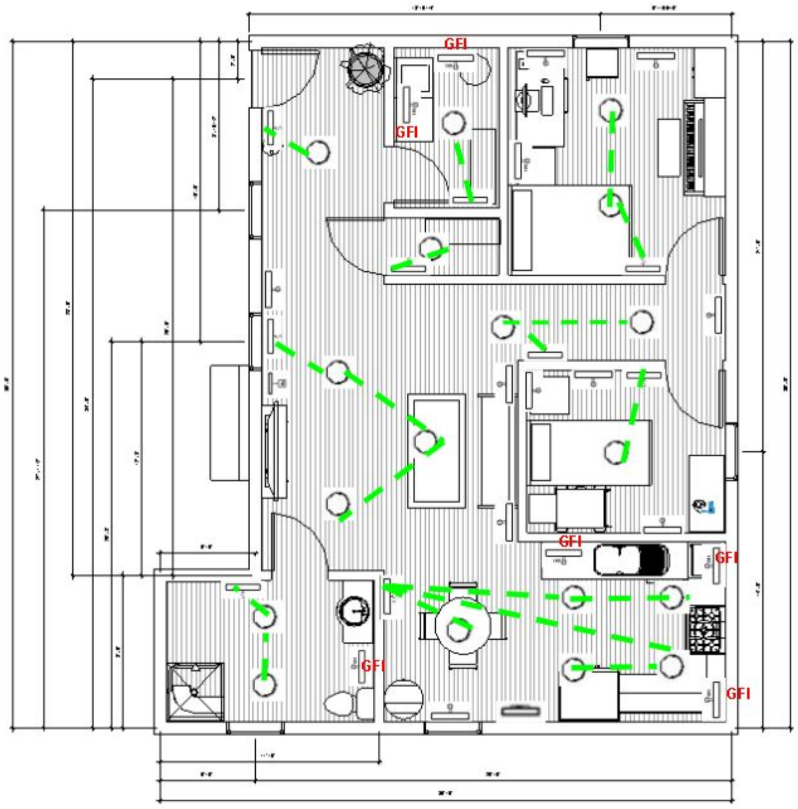


More Plans


5. Accessibility. The following describes accessibility provisions to be incorporated in houses. Houses will be constructed to conform to standards of minimal accessibility or better and must meet the following requirements:
An accessible entrance with no stairs
A covered porch area (does not count toward square footage)
All passage doors, including the full bathroom, will be 36-in. wide. If necessary, secondary bathroom or bedroom doors may be 32-in. wide
All hallways will be 42 in. minimum frame to frame
Kitchen will be designed to permit wheelchair maneuverability (5-ft-diameter open area)
At least one full bathroom must be accessible including:
Bathtub with clear floor space along its length, or minimum 5 ft x 3 ft deep curbless shower, or 3 ft x 3 ft shower with a transfer seat
Adequate maneuvering space (5-ft-diameter open area)
Toilet located in 5 ft deep x 3 ft wide minimum (5 ft x 5 ft preferred) clear space with toilet centered 18 in. from any sidewall, cabinet, or tub
The Center for Universal Design has published a Bathroom Tech Sheet that provides five sample plans that meet accessibility standards.
AUTODESK
Yusuf Morsi
Habitat For Humanity
Sheet & Universal Design
B6

More Plans

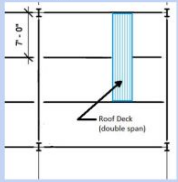
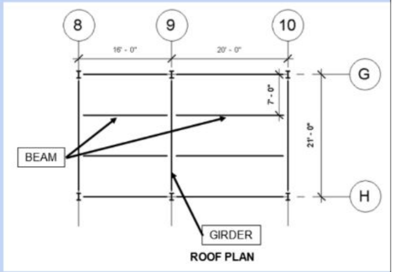




Transmission Load

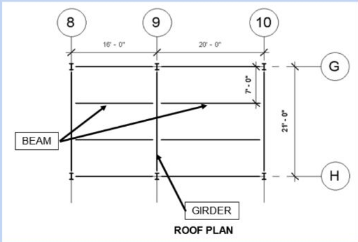
- **The calculations for transmission load are on the right**

1a	What is the Occupancy Category of your building? What is your Importance Factor? (Use the Occupancy Category Table)	Occupancy Category II
1b	Use the ATC Hazards site to find the ground snow load for Anchorage, Alaska.	50 lb/sq ft
1c	Calculate snow load.	.7(1)(1)(1)(1)(50) = 42 psf
1d	What is the minimum Snow Load for a flat, low slope, un-occupiable roof? Use the Up.Codes chart and look in section 26. Note: your roof is not occupiable because people don't go up there. Does the snow load you calculated exceed the minimum snow load you found in the chart?	20 Yes
	If it was bigger: $P_s = I_s \cdot$ Snow Load If it was smaller: $P_s = I_s \cdot$ Minimum Load What is the new value for P_s?	Ps = (1)(42) = 42 psf 42 psf
2	Calculate the Live Load of your building	
2a	What is the required roof live load for your building? (Hint: it's an ordinary residential roof) Use the Up.Codes chart and look in section 25 under residences.	20 psf
3	Calculate the Dead Load of your building by estimating the weight of all of the roof components. Note that typically the ceiling and mechanical, electrical, and plumbing (MEP) will be supported by the roof framing (and not the roof deck), but conservatively include these loads for all roof calculations. Use the Weight of Materials table.	
3a	Built-up Roof Weight:	6.5 psf
3b	5-in Rigid Insulation Weight:	3.75 psf
3c	⅝" Suspended Ceiling Weight:	1.4 psf
3e	MEP (mechanical, electrical, plumbing) weight:	10 psf (assumed)
3f	TOTAL Dead Load (DL) = sum of all of the above: (round up to the nearest whole number)	22 psf
4	Determine the total design load for the roof system. According to the IBC, the load combination D + L + (L_r or S or R) requires that either the roof live load (L_r) or the snow load (S) be included, not both. Therefore, to ensure you have enough structural support, use the larger of the two numbers.	
4a	Total Roof Design Load =	77 psf

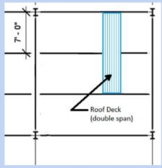
	EITHER Dead Load + Live Load OR Dead Load + Snow Load (whichever is bigger)	22 + 42 = 64 psf
5	Use the Load Span Table to select a **double span** steel roof deck to support the required loads.  	
5a	What steel roof deck type did you choose?	20 F steel deck
6	Assuming your beams look like the one in the diagram above, determine the Roof Beam Loading for both the interior and exterior beams.	
6a	Roof beam loading for Interior beams:	(7)(77) = 539
6b	Roof beam loading for Exterior beams:	(3.5)(77) = 269.5
7	Use the Standard ASD Load Table to choose open web steel joists to act as the roof beams. For now, use only the top load values in the table and ignore the live load deflection load values. Assume the roof deck will be installed with a triple span. *Note: the Load Table contains two numbers in each table cell. The top number is the total allowable load (not including the weight of the joists). The lower number (red in the original) is the allowable live load to maintain deflection limits. We will talk about deflection at a later time, but assume that deflection will not control in these cases.* Remember to use the roof plan:	
	 	
7a	Choose a steel joist for the interior beams between Girders 8 and 9.	7A > 16 ft and support (7)(77) = 539 Joist 12K1
7b	Choose a steel joist for the exterior beams between Girders 8 and 9.	7B > 16 ft and support (3.5)(77) = 269.5 Joist 12K1
7c	Choose a steel joist for the interior beams between Girders 9 and 10	7V > 20 ft and support (7)(77) = 539 Joist 12K5
7d	Choose a steel joist for the exterior beams between Girders 9 and 10	7D > 20 ft and support (3.5)(77) = 269.5 Joist 12K1

Loads & Load Path

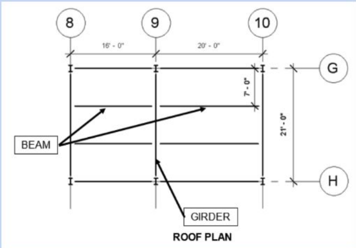
- **These calculation helped me determine what kind of loads my house can carry**



1a	What is the Occupancy Category of your building? What is your Importance Factor? (Use the Occupancy Category Table)	Occupancy Category II
1b	Use the ATC Hazards site to find the ground snow load for Anchorage, Alaska.	50 lb/sq ft
1c	Calculate snow load.	.7(1)(1)(1)(1)(50) = 42 psf
1d	What is the minimum Snow Load for a flat, low slope, un-occupiable roof? Use the Up.Codes chart and look in section 26. Note: your roof is not occupiable because people don't go up there. Does the snow load you calculated exceed the minimum snow load you found in the chart?	20 Yes
	If it was bigger: $P_s = I_s \cdot$ Snow Load If it was smaller: $P_s = I_s \cdot$ Minimum Load What is the new value for P_s?	Ps = (1)(42) = 42 psf 42 psf
2	Calculate the Live Load of your building	
2a	What is the required roof live load for your building? (Hint: it's an ordinary residential roof) Use the Up.Codes chart and look in section 25 under residences.	20 psf
3	Calculate the Dead Load of your building by estimating the weight of all of the roof components. Note that typically the ceiling and mechanical, electrical, and plumbing (MEP) will be supported by the roof framing (and not the roof deck), but conservatively include these loads for all roof calculations. Use the Weight of Materials table.	
3a	Built-up Roof Weight:	6.5 psf
3b	5-in Rigid Insulation Weight:	3.75 psf
3c	⅝" Suspended Ceiling Weight:	1.4 psf
3e	MEP (mechanical, electrical, plumbing) weight:	10 psf (assumed)
3f	TOTAL Dead Load (DL) = sum of all of the above: (round up to the nearest whole number)	22 psf
4	Determine the total design load for the roof system. According to the IBC, the load combination D + L + (L_r or S or R) requires that either the roof live load (L_r) or the snow load (S) be included, not both. Therefore, to ensure you have enough structural support, use the larger of the two numbers.	
4a	Total Roof Design Load =	77 psf
	EITHER Dead Load + Live Load OR Dead Load + Snow Load (whichever is bigger)	22 + 42 = 64 psf
5	Use the Load Span Table to select a **double span** steel roof deck to support the required loads.	



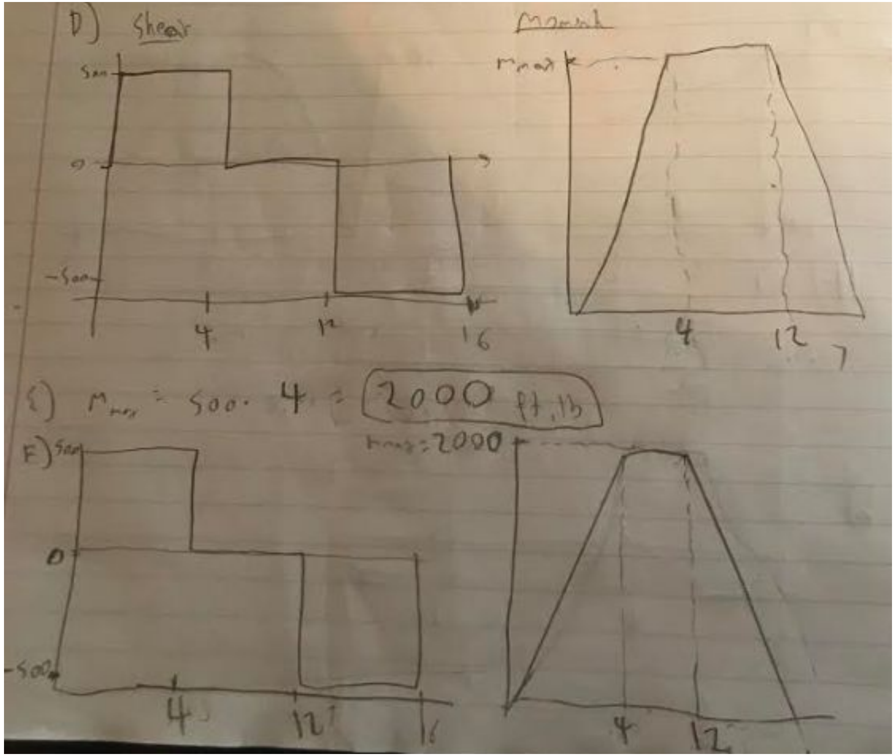
5a	What steel roof deck type did you choose?	20 F steel deck
6	Assuming your beams look like the one in the diagram above, determine the Roof Beam Loading for both the interior and exterior beams.	
6a	Roof beam loading for Interior beams:	(7)(77) = 539
6b	Roof beam loading for Exterior beams:	(3.5)(77) = 269.5
7	Use the Standard ASD Load Table to choose open web steel joists to act as the roof beams. For now, use only the top load values in the table and ignore the live load deflection load values. Assume the roof deck will be installed with a triple span. *Note: the Load Table contains two numbers in each table cell. The top number is the total allowable load (not including the weight of the joists). The lower number (red in the original) is the allowable live load to maintain deflection limits. We will talk about deflection at a later time, but assume that deflection will not control in these cases.* Remember to use the roof plan:	



7a	Choose a steel joist for the interior beams between Girders 8 and 9.	7A > 16 ft and support (7)(77) = 539 Joist 12K1
7b	Choose a steel joist for the exterior beams between Girders 8 and 9.	7B > 16 ft and support (3.5)(77) = 269.5 Joist 12K1
7c	Choose a steel joist for the interior beams between Girders 9 and 10	7V > 20 ft and support (7)(77) = 539 Joist 12K5
7d	Choose a steel joist for the exterior beams between Girders 9 and 10	7D > 20 ft and support (3.5)(77) = 269.5 Joist 12K1

Beam Analysis

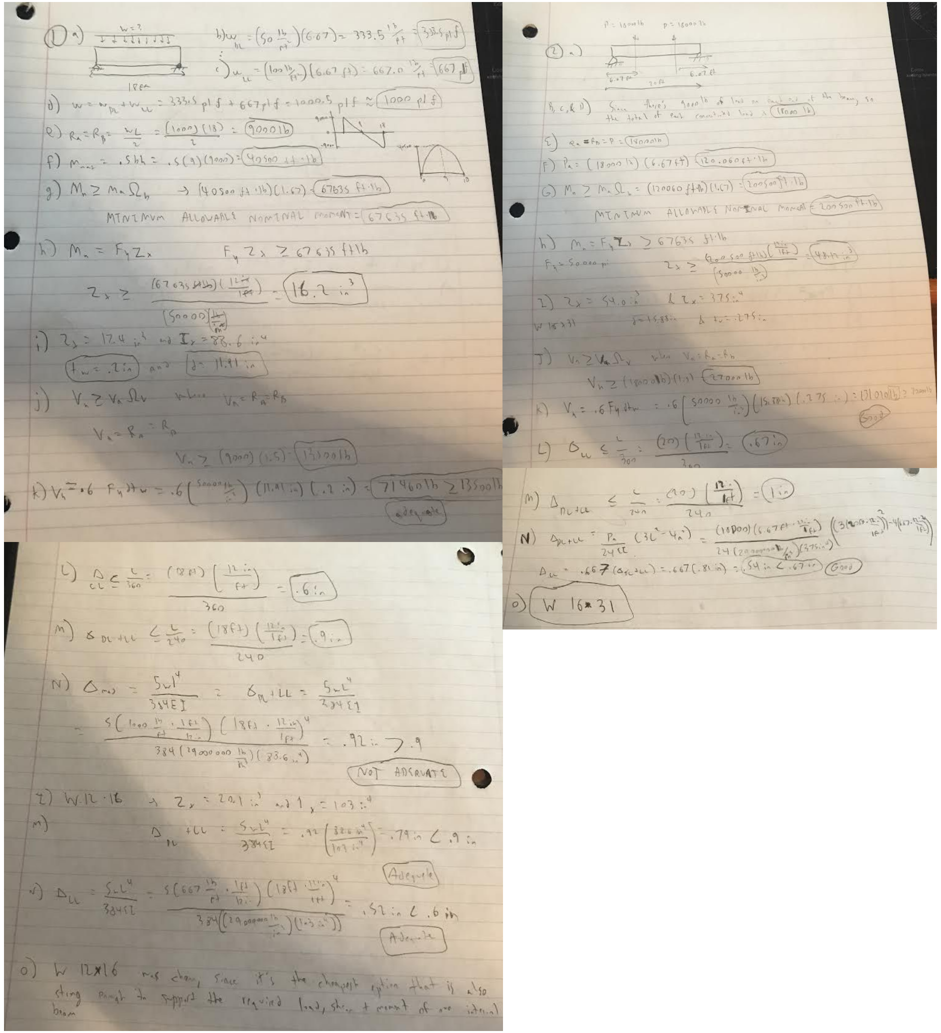
- **Beams are designed to carry the Shear and Bending Moment caused by the design loads**
- **They must be analyzed. The process is done arithmetic and graphical means**



Beam Design

•**Beams are designed for shear (force that acts perpendicular to beam) and moment (combination of tension & deflection that occurs when the beam is loaded) forces**

• **Beam deflection must be checked, and the process can be seen on the right**



Questions?