PLUMBING DESIGN OF A BUILDING

BY:

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DEPARTMENT OF CIVIL ENGINEERING

DAFFODIL INTERNATIONAL UNIVERSITY

PLUMBING DESIGN OF A BUILDING

Submitted by

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A Project submitted to the Department of Civil Engineering, Daffodil International University in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Science in Civil Engineering

Department of Civil Engineering

Daffodil International University

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APPROVAL

This is to certify that this project "Plumbing design of a building" is done by the following students under my direct supervision and this work has been carried out by them in the Department of Civil Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering.

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The project titled "**Plumbing design of a building**" submitted by Md. Momin Hossain, Student ID: 182-47-758, and Md. Tauhidur Akhter, Student ID: 182-47-727, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Civil Engineering on 28-Mar-2022.

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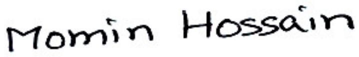
DECLARATION

It is hereby declared that except for the contents where specific reference have been made to the work of others, the design contained in this project report is the result of an detailed design exercise carried out by the author under the supervision of **Dr. Miah M. Hussainuzzaman**, Associate Professor, Department of Civil Engineering, Daffodil International University.

No part of this project has been submitted to any other university or other educational establishments for a degree, diploma, or other qualification (except for publication).

Signature of the candidates



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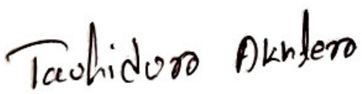

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Finally, we would like to express a very special indebtedness to our Father and Mother, whose encouragement and support was a continuous source of inspiration for this work.

DEDICATION

Dedicated

To

Our Families

ABSTRACT

Plumbing and sanitary system is very important for a building. Proper planning and designing of plumbing system is crucial as it takes care of the hygiene requirements of the occupants. A plumbing system will help make sure that there are air gaps, physical separations, and adherence to building codes that separate connections of waste and clean water plumbing elements. Plumbing maintenance can prevent cross-contamination, hence keeping the water in your home clean and safe at all times. In this report the plumbing system design for a four storey residential building has been presented. This includes the necessary CAD files as well as all the calculations and considerations in detail.

সারমর্ম

আবাসিক এবং বাণিজ্যিক ভবনের জন্য প্লাম্বিং এবং স্যানিটারি সিস্টেম অত্যন্ত প্রয়োজনীয় একটি পরিসেবা। বাসিন্দাদের স্বাস্থ্য ঝুঁকি কমাতে একটি সঠিক প্লাম্বিং সিস্টেমের সঠিক পরিকল্পনা অত্যন্ত গুরুত্বপূর্ণ । প্লাম্বিং সিস্টেম সঠিকভাবে পরিকল্পনা এবং বাস্তবায়নের ফলে ভবন ব্যবহারকারীগণের স্বাস্থ্য ঝুঁকি হ্রাস পাবে এবং নির্মানে অপ্রয়োজনীয় ব্যয় কিংবা অপচয় রোধ করবে। একটি বিল্ডিং প্লাম্বিং রক্ষণাবেক্ষণ ক্রস-দূষণ প্রতিরোধ করতে পারে, যেটা আমাদের ভবন সর্বদা পরিষ্কার এবং নিরাপদ রাখে। একটি ভাল প্লাম্বিং সিস্টেম প্রত্যেকটি ভবনের জন্য জন্য অত্যন্ত উপকারী হতে পারে। এই রিপোর্টে একটি চার তলা আবাসিক ভবনের সম্পুর্ন প্লাম্বিং সিস্টেমের নকশা উপস্থাপন করা হয়েছে। নকশাতে এর ক্যাড ফাইলগুলো ছাড়াও প্রয়োজনীয় হিসাব নিকাশ, বিবেচনাসমূহ বিস্তারিতভাবে উল্লেখ করা হয়েছে।

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CHAPTER 1
INTRODUCTION

1.1 General

All the places where people live needs basic services like water supply and sanitation. In a residential or commercial building where people need to stay for longer period of time requires those services integrated into the building. Proper design and construction of those services ensures economy and safety of the users. Therefore, plumbing design is an integrated part of the detailed design of the building along with architectural, structural electrical designs. Building in large cities may require to have an approved design from the water supply authority to get a water and sewage connection. This project report presents such a design for a residential building.

1.2 Objectives

Objective of this report is to present the design of the plumbing system which includes -

- Provide all calculations to determine the right size of different components of this system.
- Provide all the design drawings (CAD) for this system.

1.3 Limitations

Some of the features of a complete design is not presented in this report which are:

- Some of the sizing options are fixed by architectural design and this report only verifies those size provided.
- Detailed design of structural elements to hold the plumbing in place is not included.
- Cost and volume estimation is not included.

1.4 Organization Of The Report

This report has five chapters, a bibliographic section and appendices. The first chapter describes the general background information, rational, objectives, limitations and structure of this report. The second chapter provides general information of the specific project. The third, fourth and fifth chapter includes all the calculations and required for water supply, wastewater plumbing and storm water drainage system. Bibliographic section includes the listing of all the references used for these calculations. The the drawings (CAD: Computer Aided Drawing) are provided in the appendices and are referred from the corresponding chapters.

1.5 Summary

This chapter of the report introduces the project and the report. The description summarizes all the design that are presented throughout the report along with the objectives and limitations. The following chapter provides the specific project data.

CHAPTER 2

GENERAL INFORMATION OF THE PROJECT

2.1 GENERAL DATA

Occupancy type	: Residential
Number of floors	: 4 Storied
Number of basements	: N/A
Building height	: 14.63 meters
Number of residents	: 60
Land Area	: 7853 sft
Plinth Area	: 2310 sft
Floor Area	: 9240 sft
Type of structure	: RCC frame

2.2 Location Of The Project

Address of the project	: Aladatpur Narail Sadar, Narail -7500
GPS location	: 23°10'35.5"N 89°30'05.2"E

2.3 Plumbing Design Considerations

- BNBC 2020 has been followed for the design.
- Every Flat has balconies.
- Water supply:
    - WASA is supplying water to the underground reservoir tank.
    - Water distribution system is gravity driven system (not a pressure system)
    - Own pumping system will be used to pump the water to the over head tank above the roof.
    - Only cold water (no hot water supply) distribution system is considered; anyone can install geyser if they want.
    - Water will be pumped to the over head tank (OHT) twice a day.

- All pipe material will be HDPE.

- Sewerage system:
  - No sewers are available in the area. Buildings must have their own treatment facility – Septic tank
  - Two pipe system is used and hence Soil and Waste water are drained separately.
  - Only black water (from soil stack) will be diverted into the septic tank.
    - Effluent from septic tank will flow to the open drain along with the wastewater.
- Storm / Rain Water
  - There is no rain water harvesting system.
  - Rain water from roof and balcony will be collected by separate stack system.
  - Rain water will flow to the building drains for wastewater and ultimately will be released to the open drain.

CHAPTER 3
DESIGN OF WATER SUPPLY SYSTEM

3.1 General

A water supply system design requires the following components to be considered:

- Calculation of demand and estimate the water volume.
- Determine / Check adequacy of the underground water reservoir.
- Calculate / select the capacity of the pump to deliver water to the over head tank within a certain time limit (say, about 30 minutes pumping). This will include the pump riser size.
- Determine / Check adequacy of the underground water reservoir.
- Design the distribution pipe line over the roof and the risers.
- Design the distribution pipes over each of the facilities. Generally these pipes run over the false slab of the toilets and through the walls.
- Check the pressure of the most vulnerable water fixture (predicted to have the lowest pressure). This fixture is generally located on the top floor and having the longest supply pipe network.

3.2 Supply System

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3.2.1 Demand Calculation

Use total people number and per capita demand for specific occupancy type.

Total demand = Population * per capita demand

=> Q = p*q

Here, P = Number of flats/Apartment* 6 persons/flat

q = 180 Ipcd (for apartment BNBC 2020)

Determined demand for a 4-storey apartment building with 10 flats with 6 persons in each flat:

Q = P * q

= (10 * 6) *180

Figure 3.1: Project location on the map

= 10800 Liters/ Day

= 10.8 m^3/day

3.2.2 Under Ground (UG) Reservoir

Generally the Architect provides the design and location for such reservoirs. In such case it is necessary to check the adequacy of the volume provided. A ratio of Volume/Demand provides the security or extra water that can be stored in case of a water supply disruption. The actual volume of the reservoir should include dead volumes at bottom (never be pumped out) and free board (at top, which will never be filled).

Water demand V = 10.8 m^3/day

Require Volume of UG water tank,

V = (10.8 + 10.8) [From BNBC 2020 Table 5.9.1.2.c]

= 21.6 m^3

Depth of UG water tank,

H = $V^{1\backslash 3}$ = $(21.6)^{1/3}$ = 2.784 m

Free board, FB = 0.15 m

Total depth, H = H + FB

= 2.784 + 0.15

= 2.934 m

Tank Area, A = L * B = V / H

=> A = 21.6 / 2.784

$= 7.75\ m^2$

Assume, length to width ratio of 2

$\Rightarrow L = 2B$

Now, Area, $A = L * B$

$\Rightarrow 2B * B = 7.75\ m^2$

$\Rightarrow B^2 = 7.75 / 2 = 3.87$

$\Rightarrow B = \sqrt{3.87} = 1.96\ m$

Therefore, $L = 2B$

$= 2 * 1.96 = 3.93\ m$

UG Water Tank Size

L = 3.93 m B = 1.96 m H = 2.934 m

3.2.3 Over Head Tank (OHT)

In this part of the report the available size provided or set by the Architect is being checked. If architectural design is not available than the size is designed. Larger OHT size leads to higher live load. As it has been decided to pump twice everyday, therefore the size of OHT should include 50% daily demand, dead volume and volume for free board. This results in the size is about 60~70% of daily demand.

Daily water demand, $V = 10.8\ m^3/day$

It is decided that the users will pump 50% of the daily demand twice a day.

So, the required volume of OHT water tank

$V = 0.5*10.8 = 5.4\ m^3$

Depth of OHT, $H = V^{1\backslash 3} = (5.4)^{1/3} = 1.75\ m$

Free board, $FB = 0.15\ m$

Total depth, $H = H + FB = 1.75+0.15 = 1.90\ m$

Tank Area, $A = 5.4 / 1.90 = 2.84\ m^2$

Assume, $L = 2B$

$A = 2B * B = 2.84\ m^2$

$\Rightarrow B^2 = 2.84 / 2 = 1.42$

$\Rightarrow B = \sqrt{1.42} = 1.19\ m$

Therefore, $L = 2B = 2 * 1.19 = 2.38\ m$

OHT water tank Size

L = 2.38 m B = 1.19 m H = 1.90 m

Figure for the tank with pump and risers is shown in **CAD #13**.

3.2.4 Pump Selection

Pump capacity should be such that, it matches the electricity type (volt) and should be able to pump the desired volume within 30 minutes or so.

Estimation of power required for the pump

$$KW = \frac{Q\ (l/s) \times Head\ (m)}{75 \times Efficiency} \times 0.746$$

Here, Q = 5.4 m^3 / hr. = $\frac{5400\,lts}{1*60*60}$ = 1.5 lps

Efficiency = 50%

and, Head = (14.63+1.5) = 16.13 m

$$KW = \frac{1.5 \times 16.13}{75 \times 0.5} \times 0.746 = 0.48$$

3.2.5 Riser Size

Riser size is related to pump delivery pipe diameter. With the pumping rate, head and diameter of the pipe, head loss can be calculated. The water velocity should not exceed 1.5 m/s (to minimize water hammer). Typical figure for risers along with the OHT and UG reservoir and pump is shown in **CAD #13**.

3.3 Distribution Piping Design

CAD figures are provided showing riser, and distribution piping over the false ceiling with all the branches. BNBC provides the typical standard diameter for these pipes. For example all risers to the fixtures to be 13 mm dia (0.5 inch) pipes, while pipes running over the false ceiling are 19 mm in diameter (0.75 inch). But, those standards should be checked for pressure drop study.

3.3.1 Pressure Check For Distribution Network.

The distribution pipeline diameters are checked for pressure. The objective of this calculation is to ensure minimum water pressure in the most difficult fixture. Most difficult fixture is generally located on the top floor with the highest pipe length from the source. The calculation table also helps to identify any inadequacy in the preliminary design and take corrective measures, i.e. adjust the diameter of the pipes which produce excessive head loss.

An isometric sketch showing the pipe layout on the roof and the risers were created to better understand this design and head-loss calculation. **CAD #3**, **CAD #07** and **CAD**

#09 are used to get a total picture of that part of network which are used to deliver water to the most difficult fixture.

The Hazen Williams equation is used for head-loss calculations. The equation can be written in the following form:

$$Q = 3.7\times10^{-6} C\ D^{2.63}\left(\frac{H}{L}\right)^{0.54}$$

Where, Q = Flows, lps
C = Roughness coefficient (100 – 140 for rough to smooth pipes)
D = Diameter, mm
H = Head loss, m
L = Length of pipe, m

For a definite value of C, the equation can be written as:

$$\frac{H}{L} = 1.39\times10^{6}\frac{Q^{1.85}}{D^{4.87}} \quad \text{---- ---- --- [for C = 130]}$$

This above formula is used to calculate the head-loss or pressure check. WSFU were obtained from BNBC Table 1 in Appendix: BNBC Tables. Besides BNBC Table 2 is used to get the equivalent lengths for different valves and fittings. BNBC figure P1 is used to convert WSFU values to lpm values. For lower range of values a simple conversion factor is used as it is very difficult to obtain lpm values in that range.

Table 3.1: Analysis and design of distribution pipes based on head loss calculation

Pipe	Length L (m)	Diameter D (mm)	WSFU	(lpm)	(lps)	Unit loss H_f/L (m/m)	Loss H_f (m)
1	2	3	4	5	6	7	8
A-Elbow	2.13	50	140	252	4.2	0.10521	0.22409
AB	2.56	50	140	252	4.2	0.10521	0.26933
B-Elbow	2.13	50	140	252	4.2	0.10521	0.22409
BC	2.85	50	140	252	4.2	0.10521	0.29984
C-Tee, St	0.61	50	96	172.8	2.88	0.05235	0.03193
CD	3.3	50	96	172.8	2.88	0.05235	0.17275
D-Tee	0.61	50	52	93.6	1.56	0.01684	0.01027
DE	2.79	38	52	93.6	1.56	0.06408	0.17879
E-Elbow	1.52	38	52	93.6	1.56	0.06408	0.09741
EF	4.34	38	52	93.6	1.56	0.06408	0.27812
F-Elbow	1.52	38	52	93.6	1.56	0.06408	0.09741
FG	0.53	38	52	93.6	1.56	0.06408	0.03396
G-Elbow	1.52	38	52	93.6	1.56	0.06408	0.09741
GH	1.54	38	52	93.6	1.56	0.06408	0.09869
H-Tee	0.27	25	13	23.4	0.39	0.03789	0.01023

Pipe	Length L (m)	Diameter D (mm)	WSFU	(lpm)	(lps)	Unit loss H_f/L (m/m)	Loss H_f (m)
HI	0.63	25	13	23.4	0.39	0.03789	0.02387
I-Tee	0.24	19	11	19.8	0.33	0.10586	0.02541
IJ	0.55	19	11	19.8	0.33	0.10586	0.05822
J tee,st	0.24	19	4	7.2	0.12	0.01629	0.00391
JK	1.03	19	4	7.2	0.12	0.01629	0.01678
K-Elbow	0.76	19	4	7.2	0.12	0.01629	0.01238
KL	0.81	19	4	7.2	0.12	0.01629	0.0132
L-Tee	0.24	19	1	1.8	0.03	0.00125	0.0003
LM	1.12	19	1	1.8	0.03	0.00125	0.0014
M-Elbow	0.76	19	1	1.8	0.03	0.00125	0.00095
MN	0.33	19	1	1.8	0.03	0.00125	0.00041
N	0.76	19	1	1.8	0.03	0.00125	0.00095
							2.28212

Total Head = 5.330 m

Head loss = 2.282 m

Available Head = 3.048 m = 4.3 psi

3.3.2 Typical Figure For Connections

Typical standard for valves, joints, clumps etc. are also provided in the CAD.

CHAPTER 4
DESIGN OF SEWERAGE SYSTEM

4.1 General

The detailed calculations for the design of different components are presented in this chapter. The sewerage plumbing pipes for each floors are generally located below the floor slab and the vertical stacks run through the designated voids to the building drains.

A waste water drainage system design requires the following components to be considered:

- Determine the wastewater load in terms of fixture unit from each bathroom or other units which produces wastewater.
- Selection / Check adequacy of the size (diameter) of the branch pipes according to BNBC.
- Selection / Check adequacy of the size (diameter) of the vertical stack pipes according to BNBC.
- Determining the grade and diameter of the building drain.
- Design the septic tank.

4.2 Wastewater **LOADS**

There are six toilet unit locations and three kitchen location in the upper two floors while the bottom 2 floors have some less number of toilets due to different space arrangements. All these kitchens and toilets are using a total of six (6) voids to run down the vertical stacks. Waste water loads are calculated based on the Fixture Unit (FU) system. In this system a load value is assigned for each type of wastewater fixture. The relevant table from BNBC [Table 8.7.14] is provided in Appendix: BNBC Tables. FU values are picked up from that table to determine the total FU load coming from each toilet to each type of vertical stacks. The fixture unit loads to different stacks from these toilets are listed in the following table:

Table 4.1: Listing of fixutue unit loads from each toilet and kitchen (2nd & 3rd floor)

Sl. #	Description	Fixture Unit (FU) for Waste Stack (WS)	Fixture Unit (FU) for Soil Stack (SS)	Void Area
1	Toilet 1	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	1
2	Toilet 2	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	2
3	Toilet 3	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	3
4	Toilet 4	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	4
5	Toilet 5	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	5
6	Toilet 6	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	6
7	Kitchen 1	Sink (2)	-	2
8	Kitchen 2	Sink (2)	-	3
9	Kitchen 3	Sink (2)	-	7

These pipe generally runs below the floor and above the false ceiling of the floor below. The floor plan is different in 1st floor, the fixture loads from this floor is listed below:

Table 4.2: Listing of fixutue unit loads from each toilet and kitchen (1st floor)

Sl. #	Description	Fixture Unit (FU) for Waste Stack (WS)	Fixture Unit (FU) for Soil Stack (SS)	Void Area
1	Toilet 1	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	1
2	Toilet 2	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	2
3	Toilet 3	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	3
4	Toilet 4	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	4
5	Toilet 5	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	5
6	Toilet 6	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	6
7	Kitchen 2	Sink (2)	-	3

Sl. #	Description	Fixture Unit (FU) for Waste Stack (WS)	Fixture Unit (FU) for Soil Stack (SS)	Void Area
8	Kitchen 3	Sink (2)	-	7

The ground floor has a different orientation as well. This floor has to accommodate the garage or the limited parking area. Besides the underground water reservoir and the septic tank is located in this floor. The listing is as follows:

Table 4.3: Listing of fixture unit loads from each toilet and kitchen (Ground floor)

Sl. #	Description	Fixture Unit (FU) for Waste Stack (WS)	Fixture Unit (FU) for Soil Stack (SS)	Void Area
1	Toilet 1	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	1
2	Toilet 2	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	2
3	Toilet 3	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Low Pan (6)	3
4	Toilet 5	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	5
5	Toilet 6	Floor Trap (1) + Shower (2) + Wash Basin (1) + Laundry (3)	Water Closet (6)	6
6	Kitchen 1	Sink (2)	-	2
7	Kitchen 2	Sink (2)	-	3
8	Kitchen 3	Sink (2)	-	7

Total fixture load on each stack is listed below:

Table 4.4: List of Wastewater fixture loads on different stacks (Ground floor ~ 3rd floor)

Void area designation	Fixture unit load on Waste Stack **(WS)**					Fixture unit load on Soil Stack **(SS)**				
	GF	1F	2F	3F	**Total**	GF	1F	2F	3F	**Total**
1	7	7	7	7	28	6	6	6	6	24
2	9	7	9	9	34	6	6	6	6	24
3	9	9	9	9	36	6	6	6	6	24
4	0	7	7	7	21	0	6	6	6	18
5	7	7	7	7	28	6	6	6	6	24
6	7	7	7	7	28	6	6	6	6	24
7	2	2	2	2	8	-	-	-	-	-

CAD #11 includes the section detail of fixtures.

4.3 Selection Of Branch And Stack Pipe Size

All branch pipes are selected to be 100 mm in diameter. This uniform size selection will eliminate the need of reducers and will reduce the hassle of maintaining different sized pipe stocks for any repair work. According to Table 8.7.16 from BNBC (Appendix: BNBC Tables) this 100 mm branch pipe can take up to 160 FU load and hence this selection is more than enough. That table also indicate that the vertical stacks of this size can take upto 500 FU load and hence this design or selection is enough. **CAD#17** includes a sketch of stack with velocity reducer arrangement. **CAD #10** includes typical wastewater and rain pipe joint details.

4.4 Design Of Building Drain

Total load on building drains for SS and WS are 138 and 183 FU accordingly. Therefore, according to BNBC Table 8.7.17 (Appendix: BNBC Tables), Ø150 mm pipe is selected with a slope of 1/100. This setup has a capacity of 700 FU load.

Layout of the building drain with, Septic tank, building sewer etc are shown in **CAD #06**. A layout of the UG reservoir for water supply is shown in **CAD #5**. These two elements are separated by sufficient distance to prevent any chance of cross contamination. CAD#14 and CAD#15 shows the detailed of stack connections and detailed sections of typical inspection pits for building drains.

4.5 Design Of Septic Tank.

Septic tank has been designed according to the process described in the text book. All the CAD for septic tank and soak well arrangements are provided in **CAD #16** and **CAD #17**.

CHAPTER 5
DESIGN OF STORM WATER DRAINAGE

5.1 General

There is no special arrangements to store and manage storm water for this building. Arrangements were made to discharge rain water easily from roof through several rain stacks to the building drain.

5.2 Storm Water Management System

There are seven zones of vertical pipe groups in this building. Five (5) of these zones include a rain drainage pipe / stack. **CAD #08** shows the drainage plan for the storm/ rain water from roof with the slope directions and rain pipe locations.
CAD #12: AC wastewater system

REFERENCES

Bibliography

1: McGraw hill book company, Water quality and treatment, 1990

2: Ahmed, F.and smith,P.G., Design and performmance of a comunity type iron removal plant for hand pump tubewell., 1987

APPENDICES

Appendix: BNBC Tables

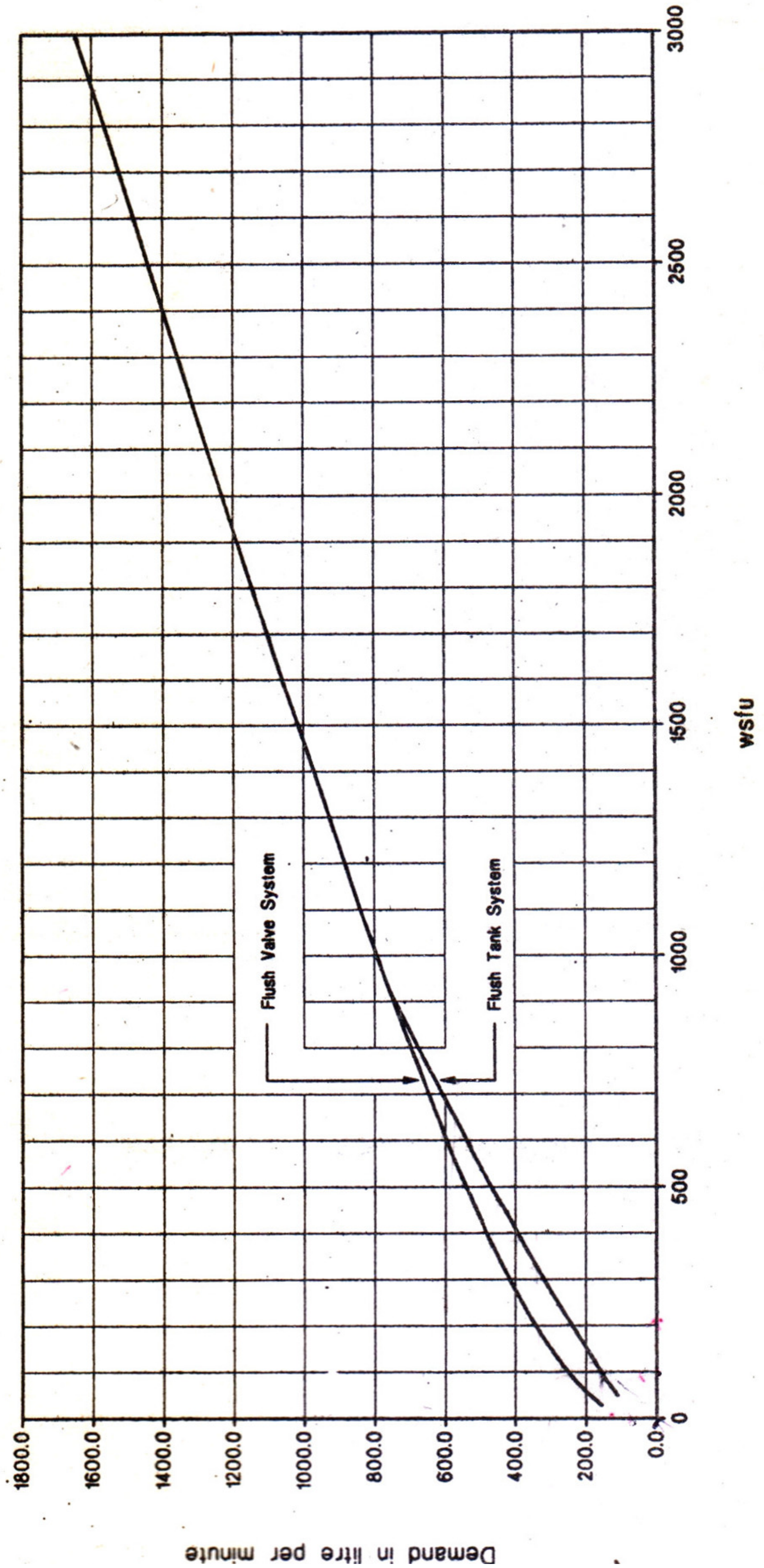


Fig. P 1 Water Supply Demand for Various Loads in Water Supply Fixture Units (wsfu)

Table 1: Water Supply Fixture Unit (wsfu) Values for Various Plumbing Fixtures (BNBC Table P1)

Fixtures of Group	Supply Control	wsfu		
		Cold	Hot	Total
Bath Group	Flush tank	4.5	3	6
Bath Group	Flush valve	6	3	8
Bathtub	Faucet	1.5	1.5	2
Bidet	Faucet	1.5	1.5	2
Combination	Faucet	2	2	3
Kitchen sink	Faucet	1.5	1.5	2
Laundry tray	Faucet	2	2	3
Laundry	Faucet	1.5	1.5	2
Pedestal urinal	Flush valve	10	-	10
Restaurant sink	Faucet	3	3	4
Service sink	Faucet	1.5	1.5	2
Shower head	Mixing Valve	3	3	4
Stall or wall urinal	Flush tank	3	-	3
Stall or wall urinal	Flush valve	5	-	5
Water closet	Flush tank	5	-	5
Water closet	Flush valve	10	-	10

* Fixture with both cold and hot water supplies, the weight for maximum separate demands may be considered 75% of total wsfu.

Table 2: Equivalent Length of Pipe for Friction Loss in Valves and Fittings (BNBC Table P2)

Valves or Fittings	Equivalent Length (m) of Pipes Against Diameter (mm) of Fittings												
	10	13	19	25	32	38	50	63	75	88	100	125	150
Angle Valve	1.22	2.44	3.66	4.57	5.49	6.71	8.53	10.36	12.19	15.24	16.76	21.34	24.38
Gate Valve	0.06	0.12	0.15	0.18	0.24	0.30	0.40	0.49	0.61	0.73	0.82	1.01	1.22
Glove Valve	2.44	4.57	6.10	7.62	10.67	13.72	16.76	19.81	24.38	30.48	38.10	42.67	50.29
90° Standard Elbow	0.30	0.61	0.76	0.91	1.22	1.52	2.13	2.44	3.05	3.66	4.26	5.18	6.10
45° Standard Elbow	0.18	0.37	0.46	0.55	0.73	0.91	1.22	1.52	1.83	2.13	2.44	3.05	3.66
90° Side Tee Coupling	0.46	0.91	1.22	1.52	1.83	2.13	3.05	3.66	4.57	5.49	6.40	7.62	9.14
Straight Run of Tee	0.09	0.18	0.24	0.27	0.37	0.46	0.61	0.76	0.91	1.10	1.22	1.52	1.83

Table 8.7.14
Fixture Units for Different Sanitary Appliances or Groups

Type of Fixture	Fixture Unit Value as Load Factors
One bathroom group consisting of water closet, wash basin and bath tub or shower stall :	
a) Flush Tank water closet	6
b) Flush-valve water closet	8
Bathtub*	3
Bidet	3
Combination sink and tray (drain board)	3
Drinking fountain	0.5
Floor traps†	1
Kitchen sink, domestic	2
Wash basin, ordinary‡	1
Wash basin, surgeon's	2
Shower stall, domestic	2
Shower (group) per head	3
Urinal, wall lip	4
Urinal, stall	4
Water closet, tank operated	4
Water closet, valve operated	8

* A shower head over a bath tub does not increase the fixture unit value.
† Size of floor trap shall be determined by the area of surface water to be drained.
‡ Wash basin with 32 mm and 40 mm trap have the same load value.

Table 8.7.16 [BNBC]:
Maximum number of Fixture Units that can be Connected to Branches and Stacks

Diameter of Pipe (mm)	Maximum Number of Fixture Units that can be Connected			
	Any Horizontal Fixture Branch	One Stack of 3 Storeys in Height or 3 Intervals	More than 3 Storeys in Height	
			Total for stack	Total at One Storey or Branch Interval
30	1	2	2	1
40	3	4	8	2
50	6	10	24	6
65	12	20	42	9
75	20	30	60	16
100	160	240	500	90
125	360	540	1100	200
150	620	960	1900	350
200	1400	2200	3600	600
250	2500	3800	5600	1000
300	3900	6000	8400	1500
375	7000	b	b	b

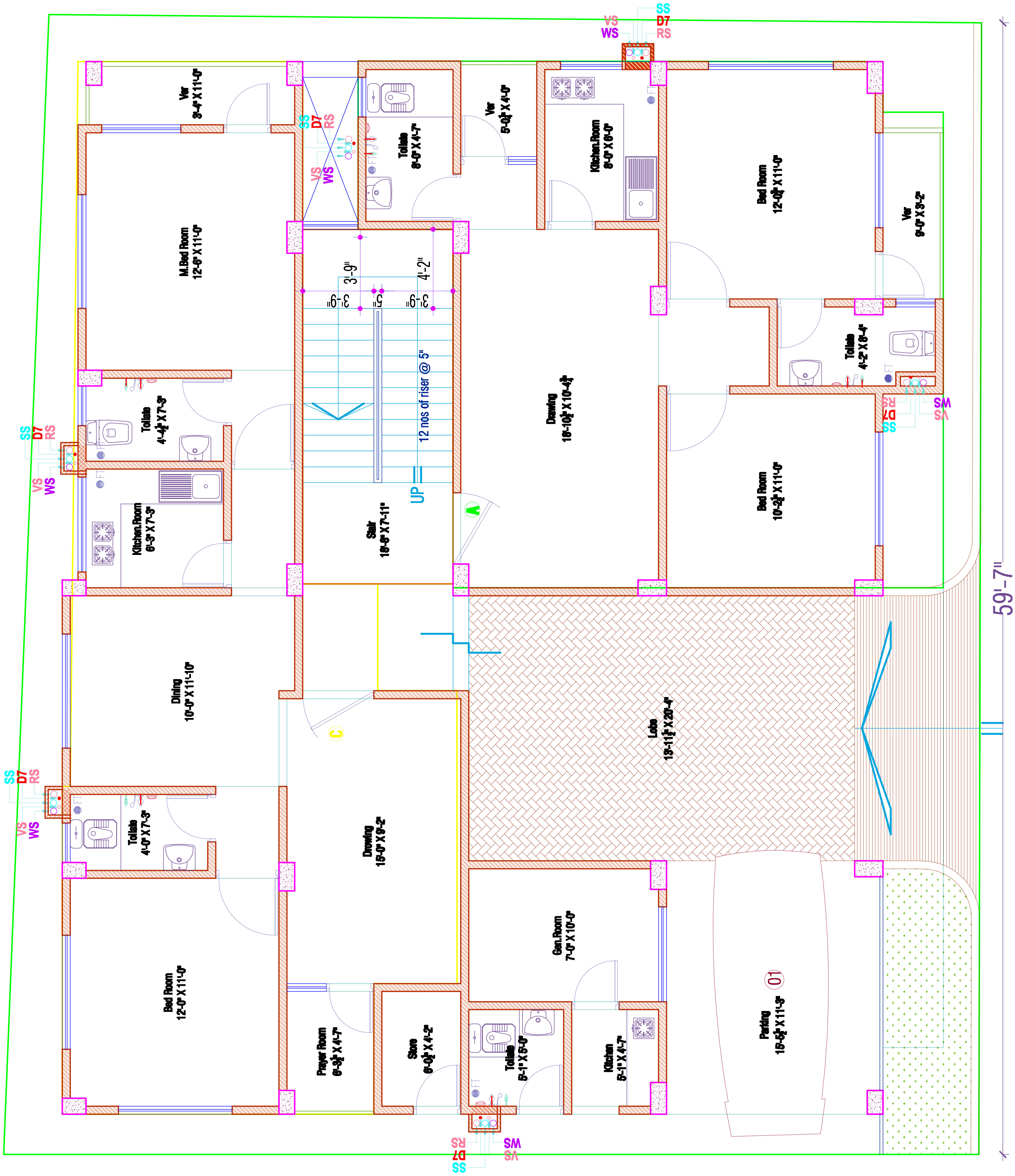
a Does not include branches of the building sewer.
b Sizing load based on design criteria.

Table 8.7.17 [BNBC]: Maximum number of Fixture Units that can be Connected to Building Drains and Sewers

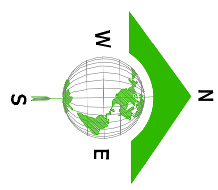
Diameter of Pipe (mm)	Maximum Number of Fixture Units that can be Connected to any Portion* of the Building Drain or the Building Sewer for Various Slopes			
	1/200	1/100	1/50	1/25
100	-	180	216	250
150	-	700	840	1000
200	1400	1600	1900	2300
250	2500	2900	3500	4200
300	2900	4600	5600	6700
375	7000	8300	10000	12000

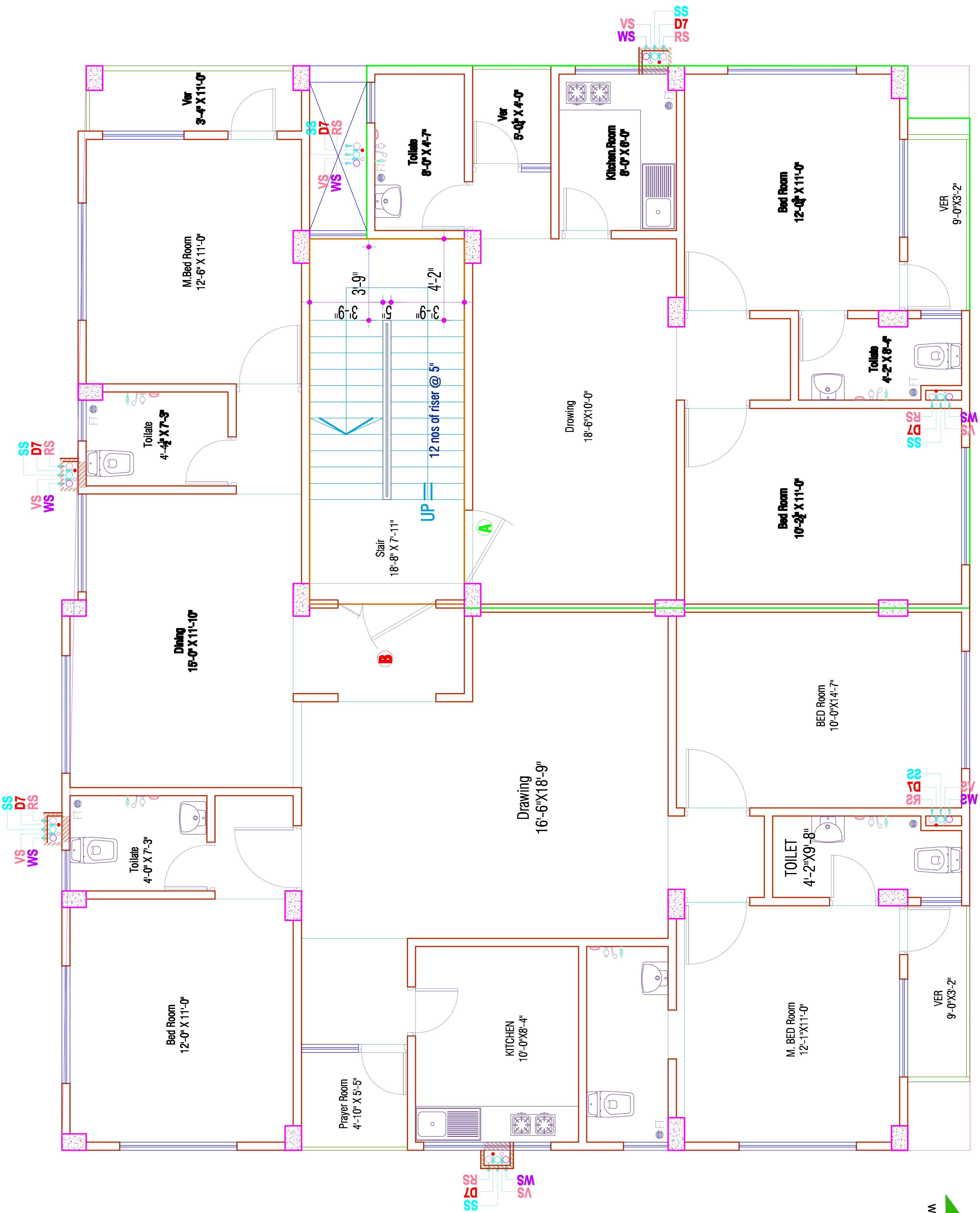
* Includes branches of building sewer

Appendix: CAD Files

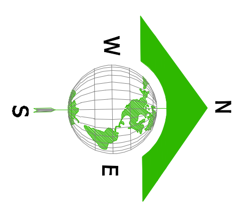


GROUND FLOOR DRAINAGE & WATER SUPPLY PLAN





FIRST FLOOR DRAINAGE & WATER SUPPLY PLAN



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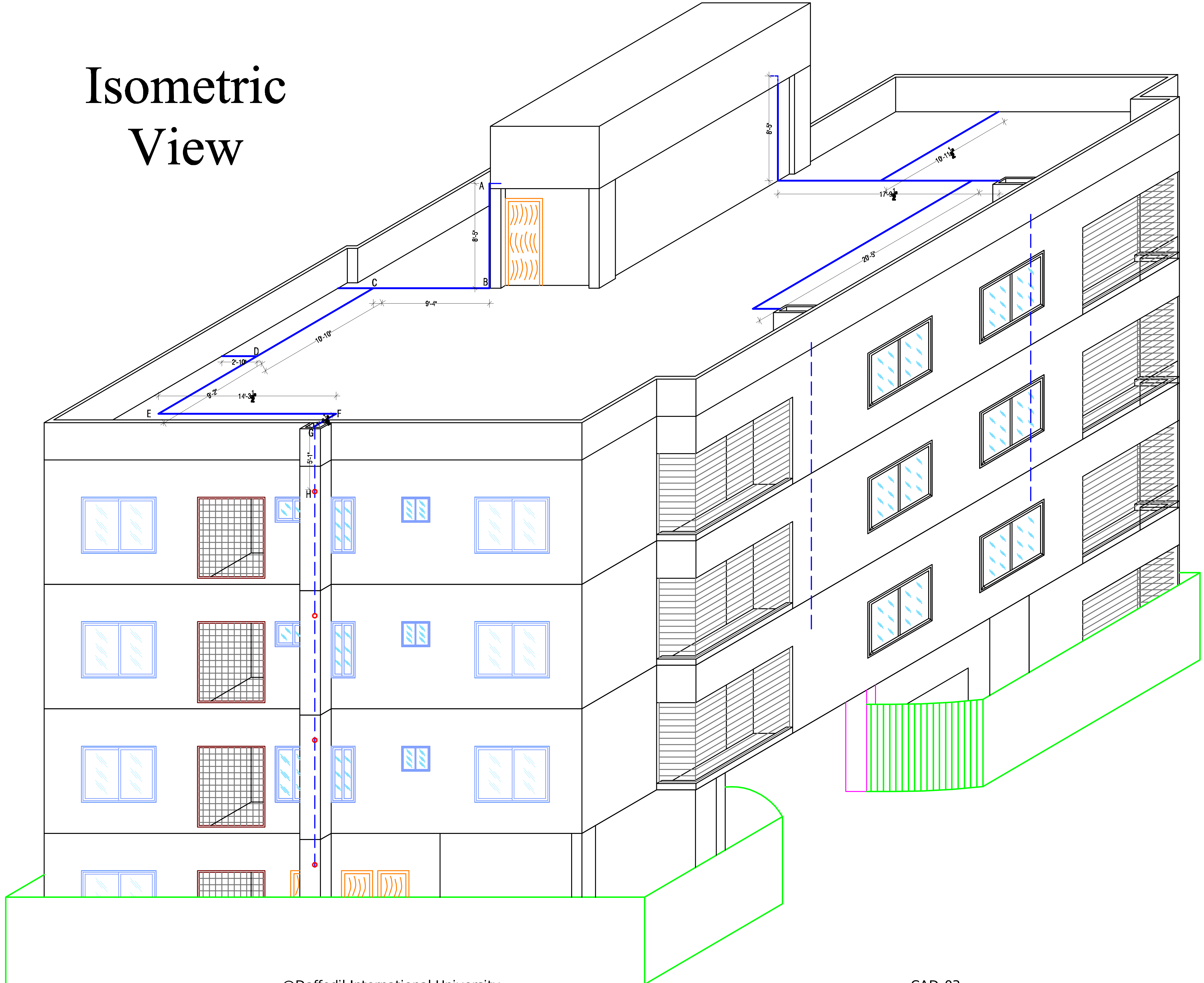
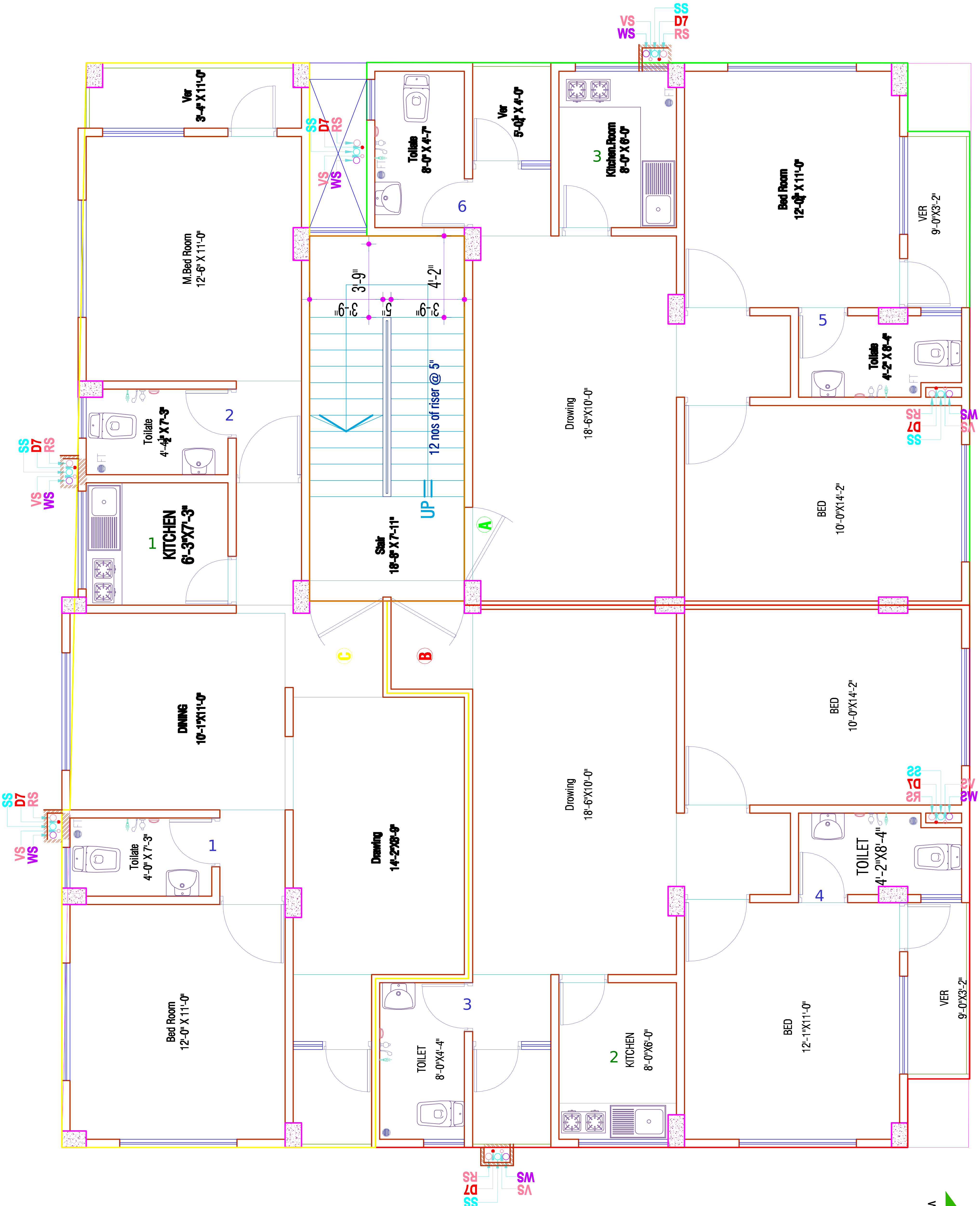
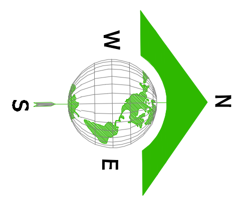
CAD-02

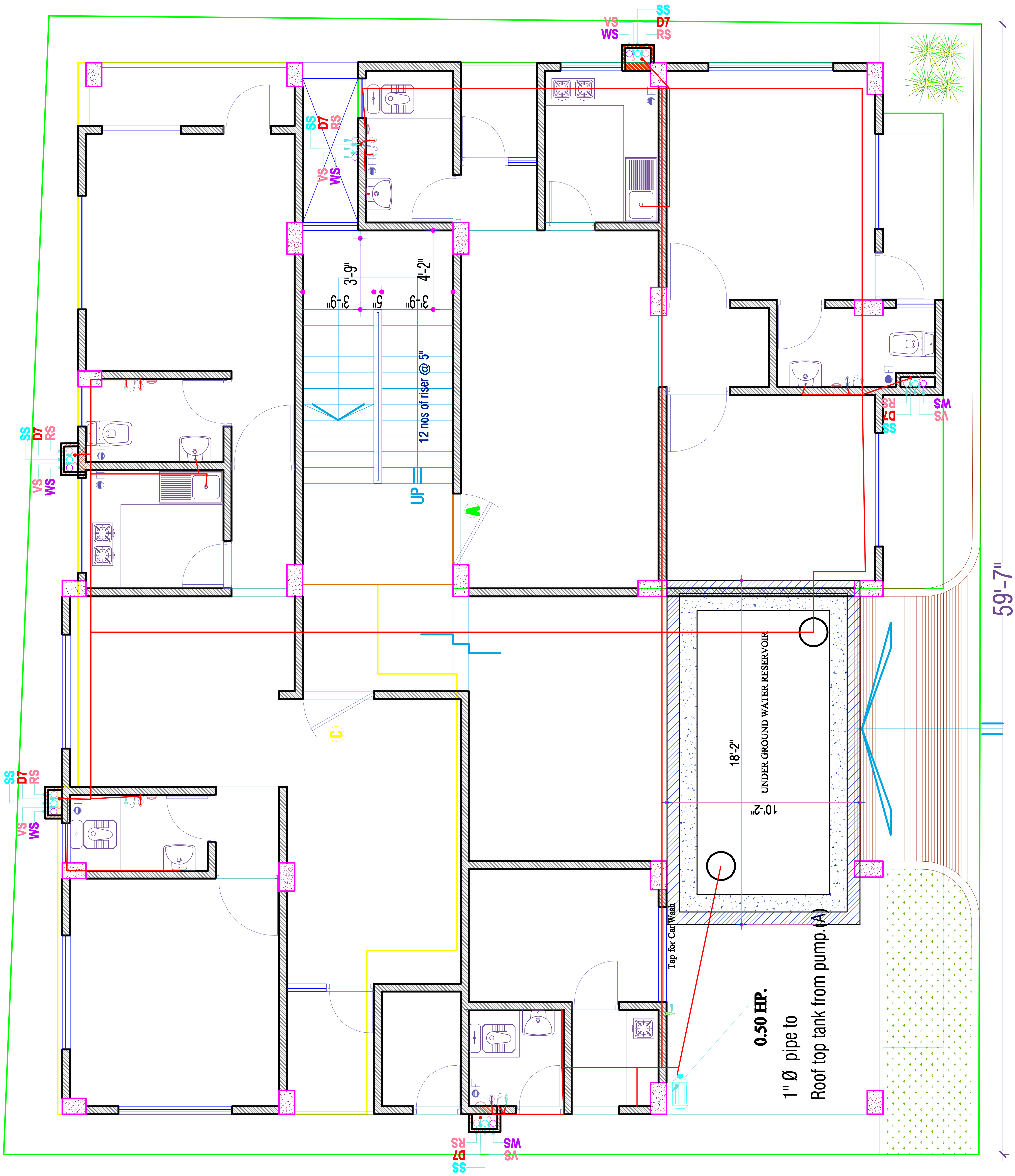
Isometric View



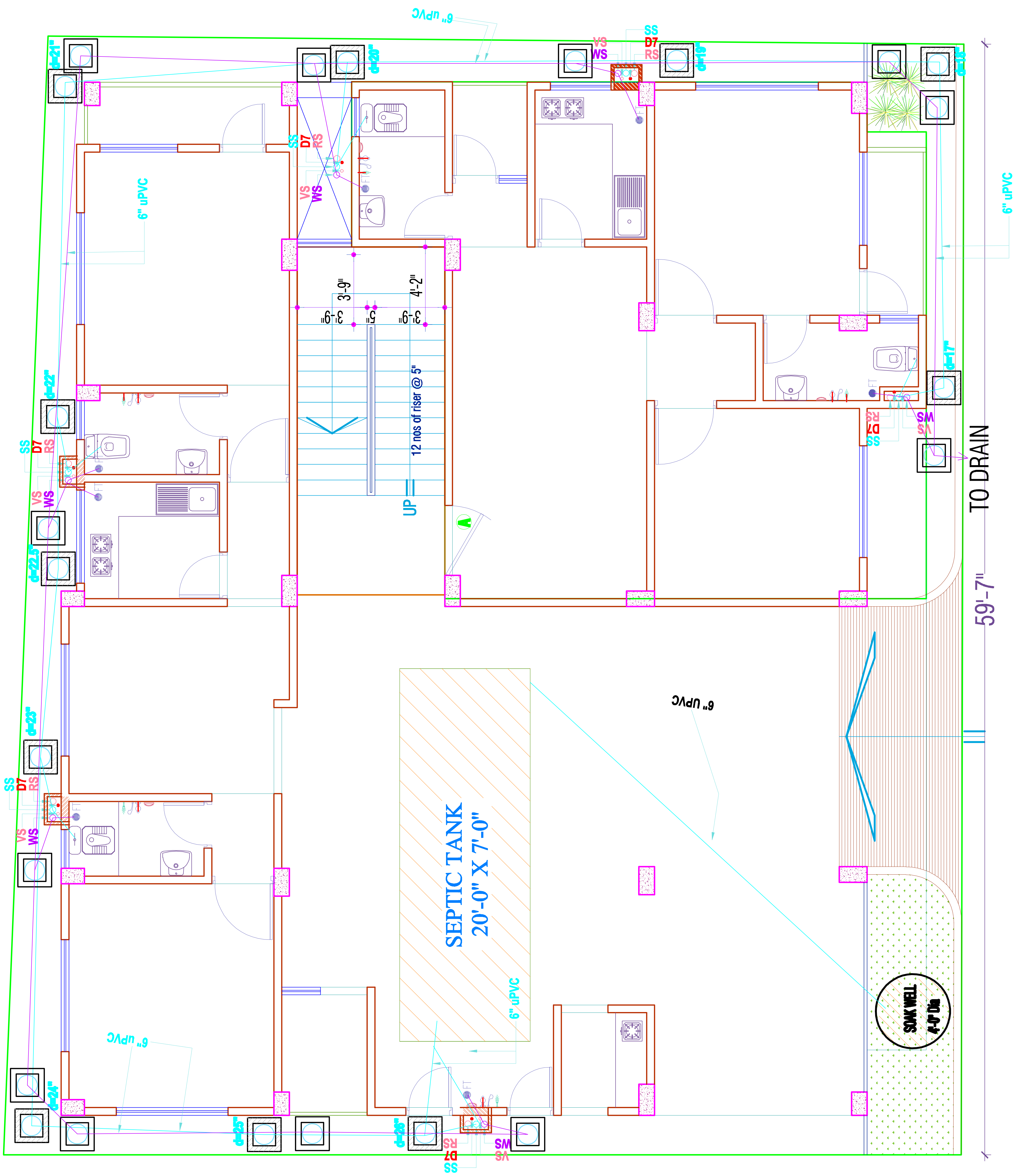


SECOND TO THIRD FLOOR DRAINAGE & WATER SUPPLY PLAN

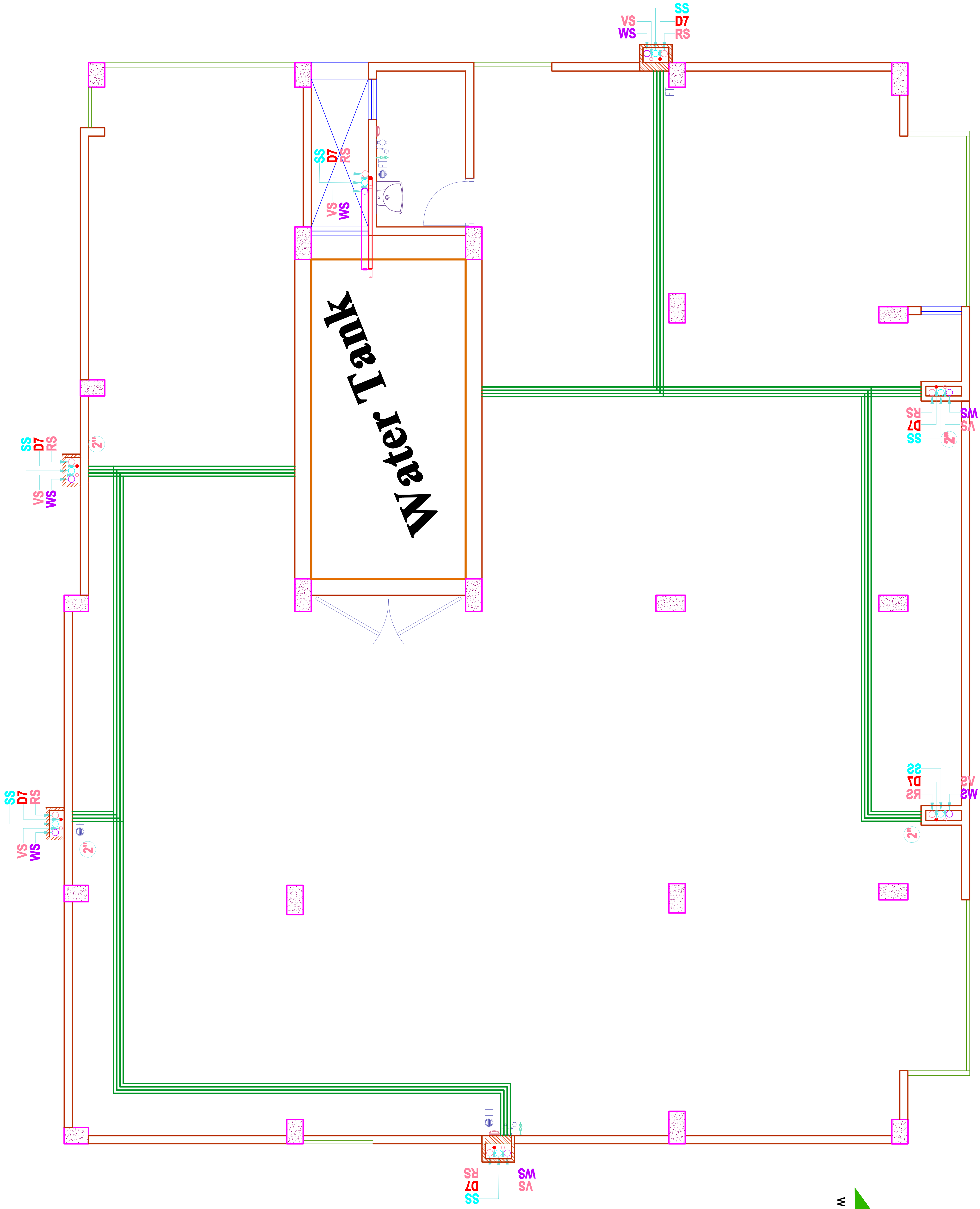




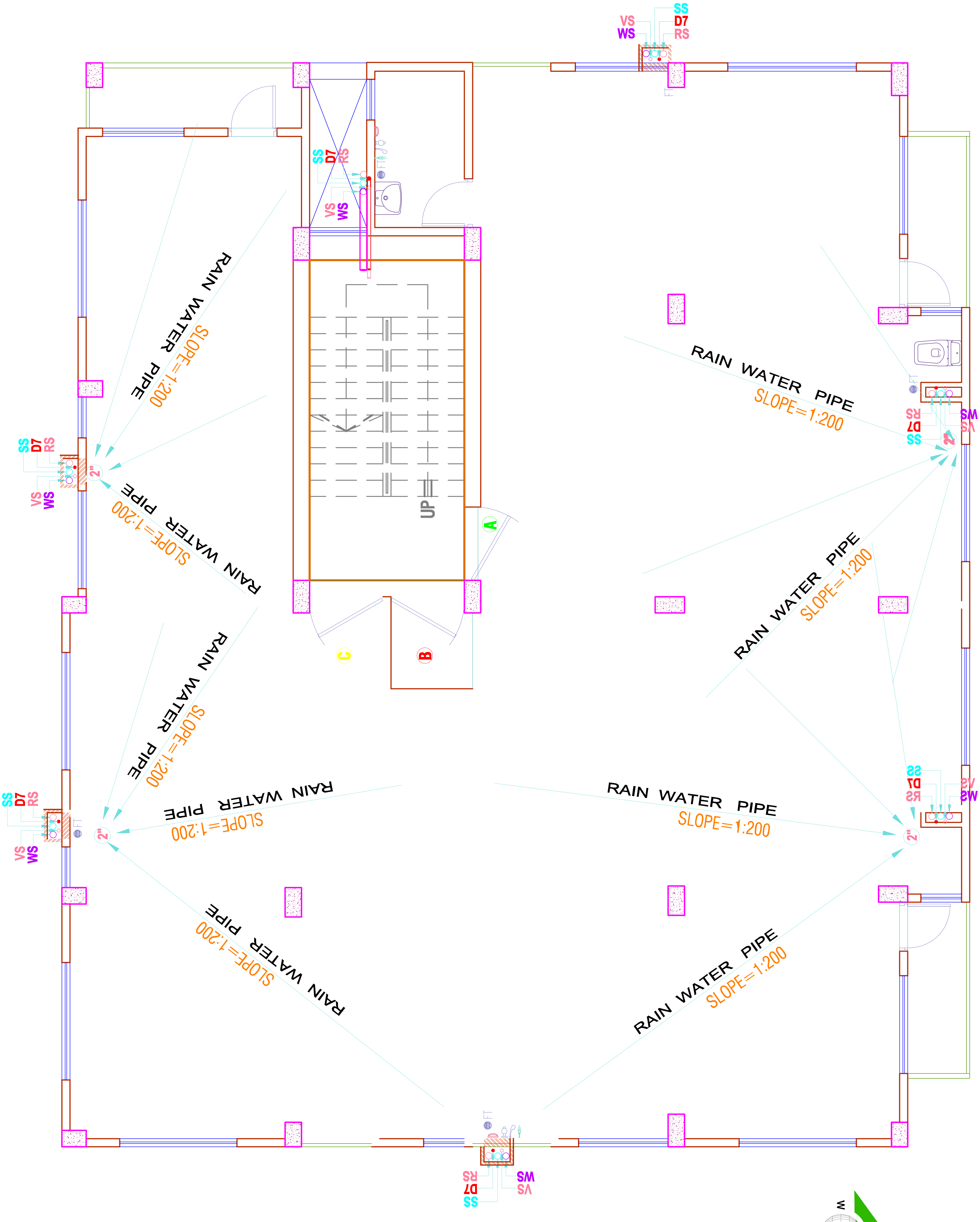
GR. FLOOR DRAINAGE & WATER SUPPLY PLAN



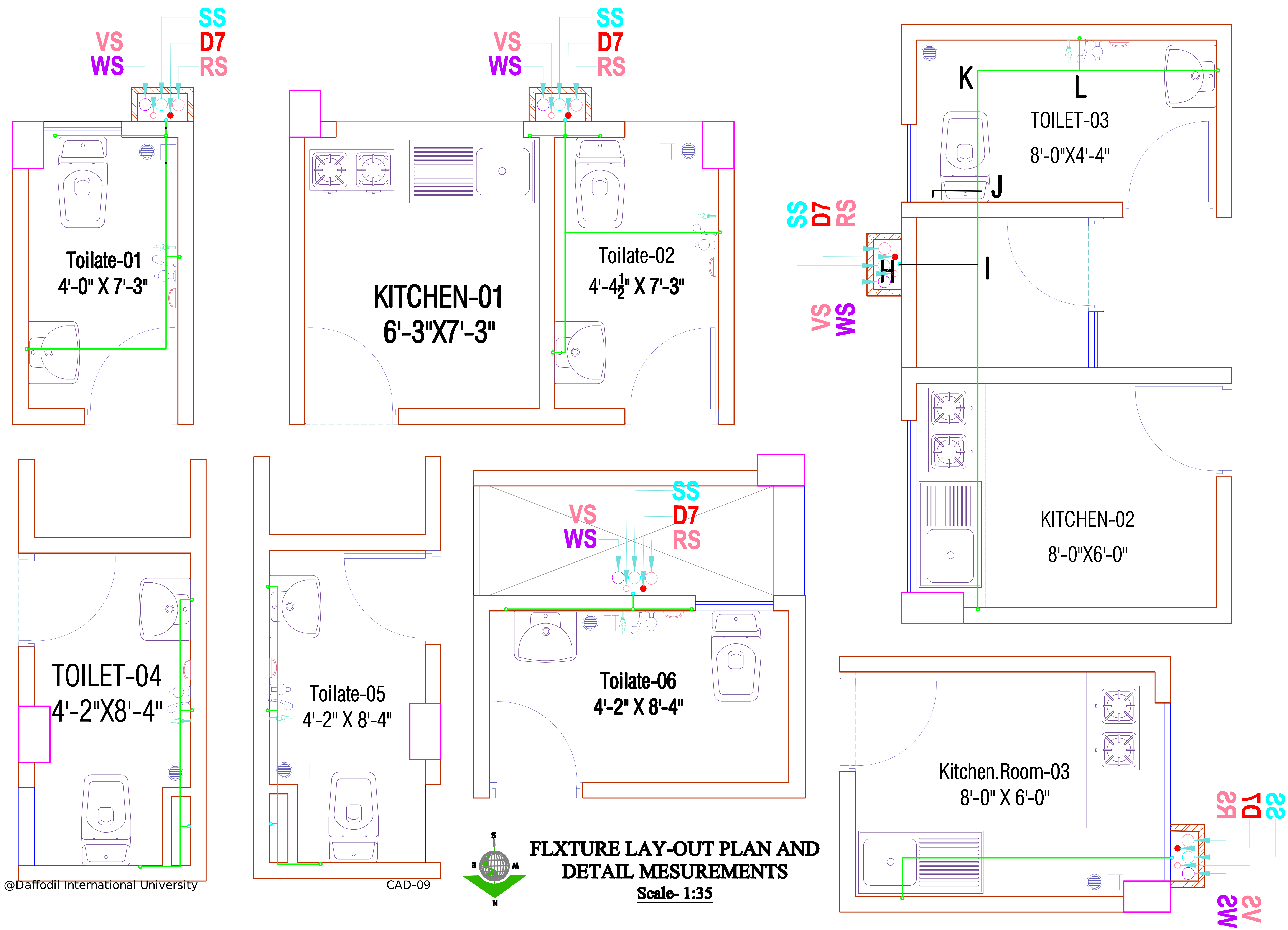
TOTAL DRAINAGE & PLUMBING SYSTEM



ROOF DRAINAGE & WATER SUPPLY PLAN



ROOF DRAINAGE & WATER SUPPLY PLAN



VS
WS
SS
D7
RS
Toilate-01
4'-0" X 7'-3"
FT
KITCHEN-01
6'-3"X7'-3"
Toilate-02
4'-4½" X 7'-3"
K
L
J
I
H
TOILET-03
8'-0"X4'-4"
KITCHEN-02
8'-0"X6'-0"
TOILET-04
4'-2"X8'-4"
Toilate-05
4'-2" X 8'-4"
Toilate-06
4'-2" X 8'-4"
Kitchen.Room-03
8'-0" X 6'-0"
FLXTURE LAY-OUT PLAN AND
DETAIL MESUREMENTS
Scale- 1:35
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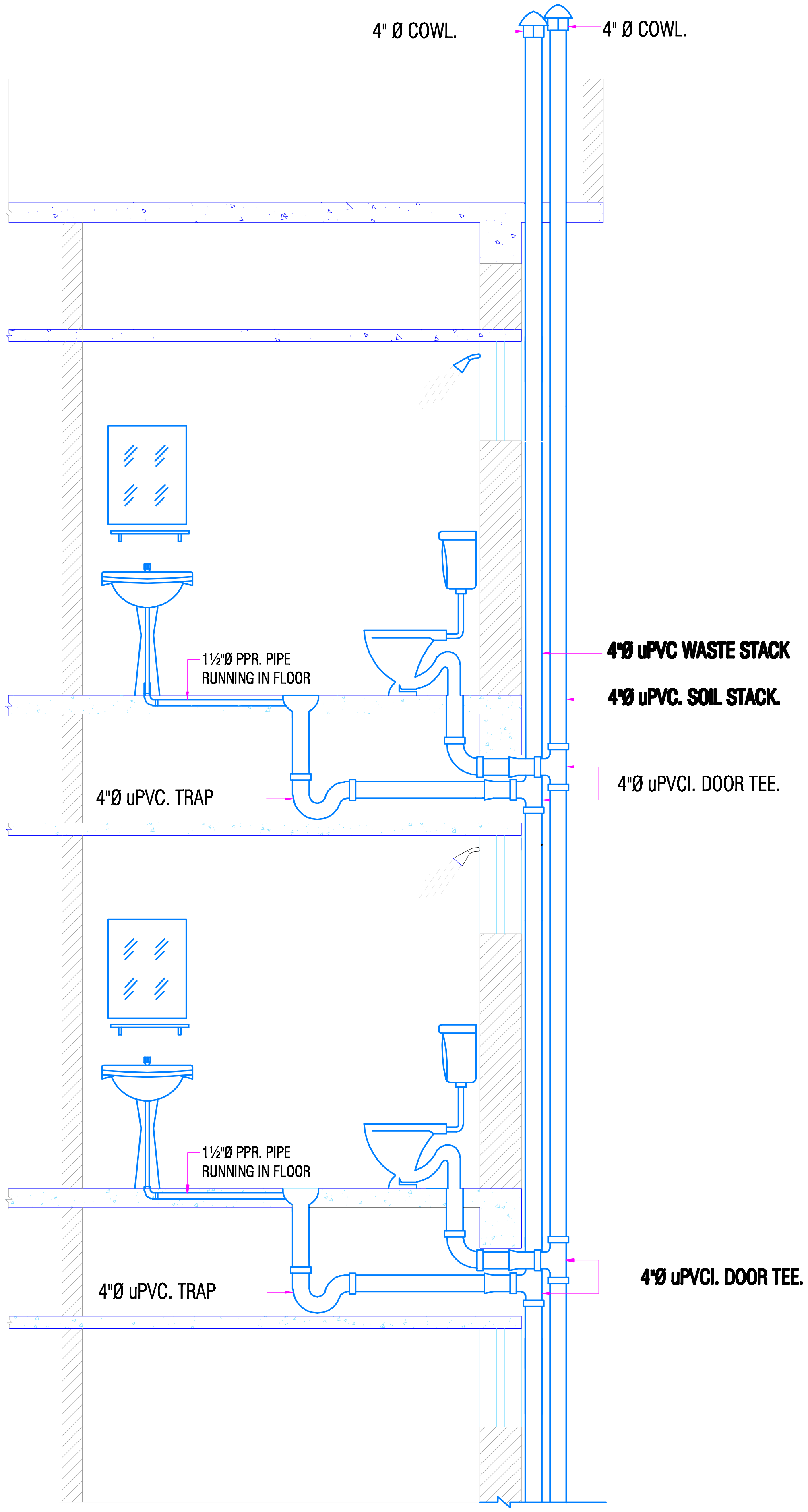
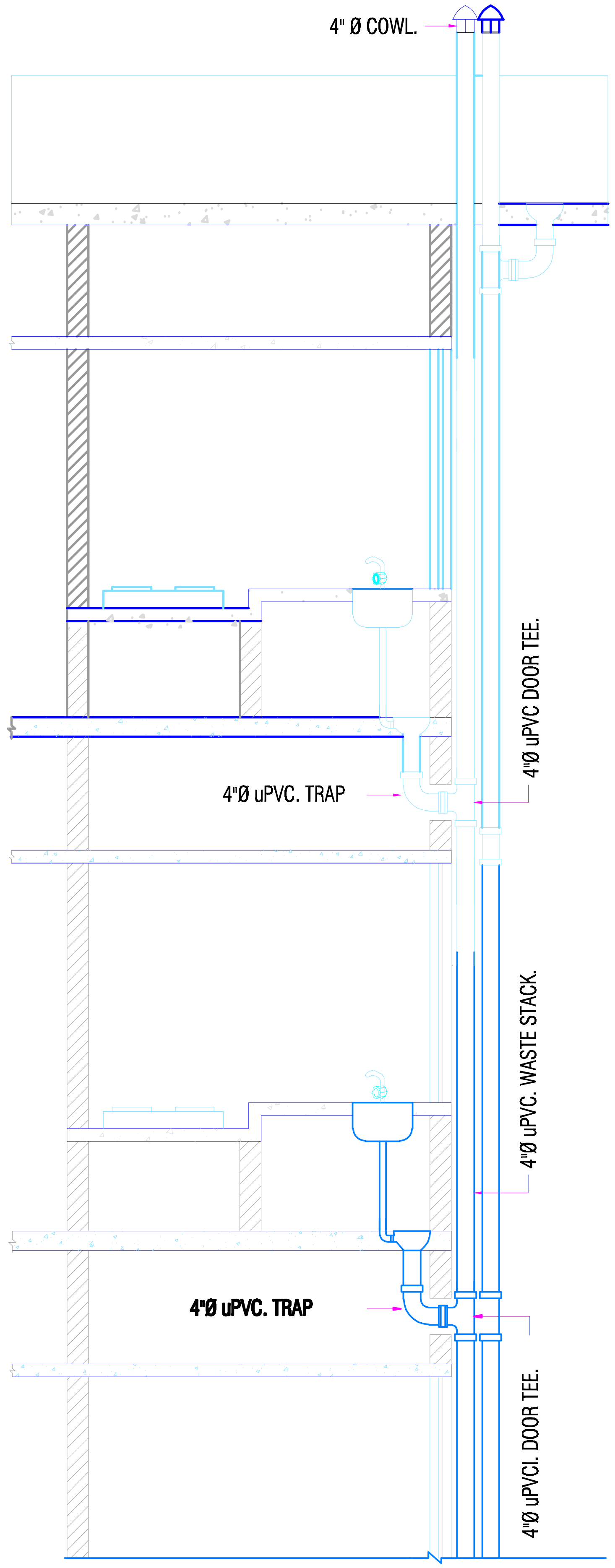
CAD-09

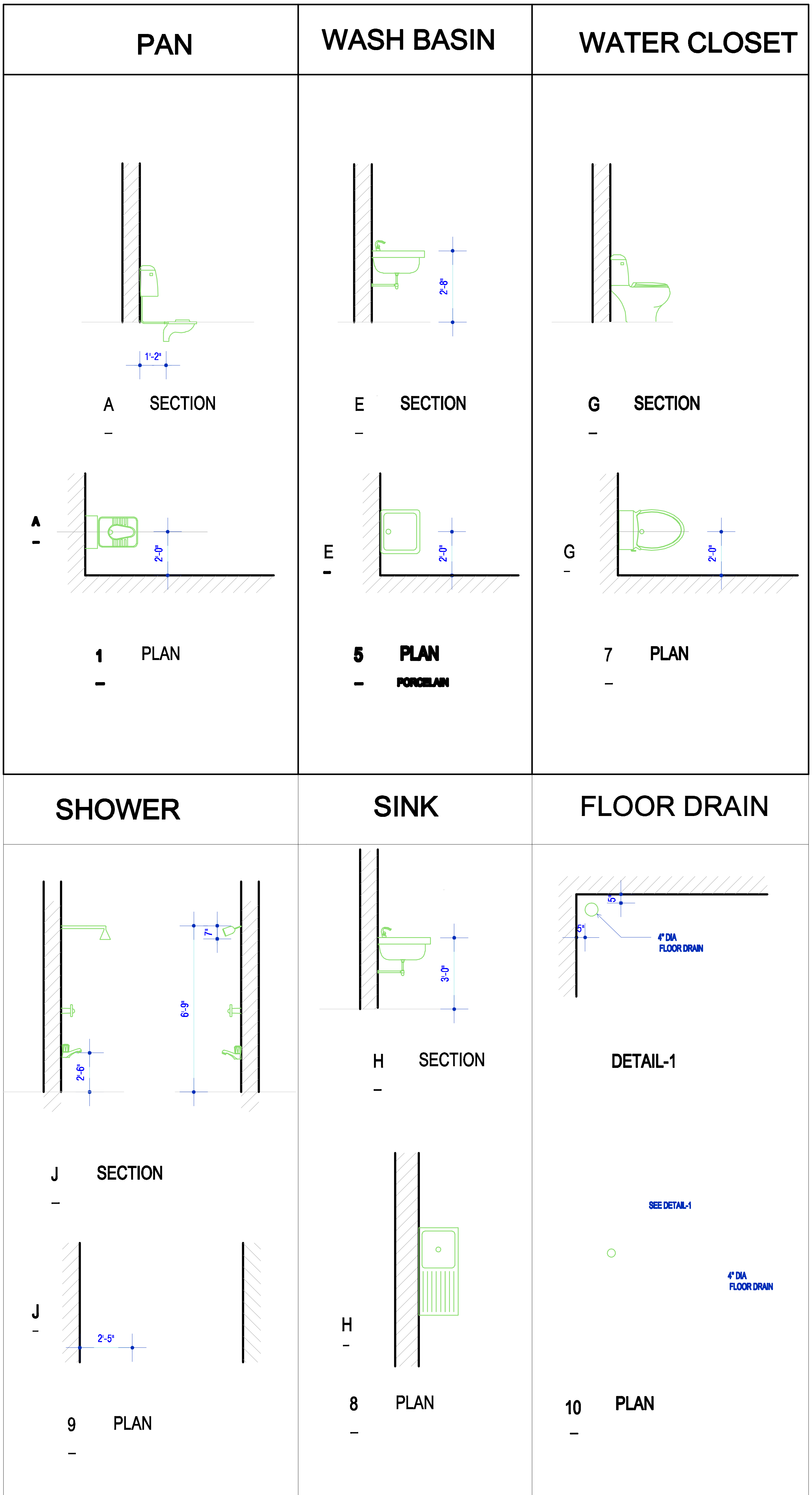


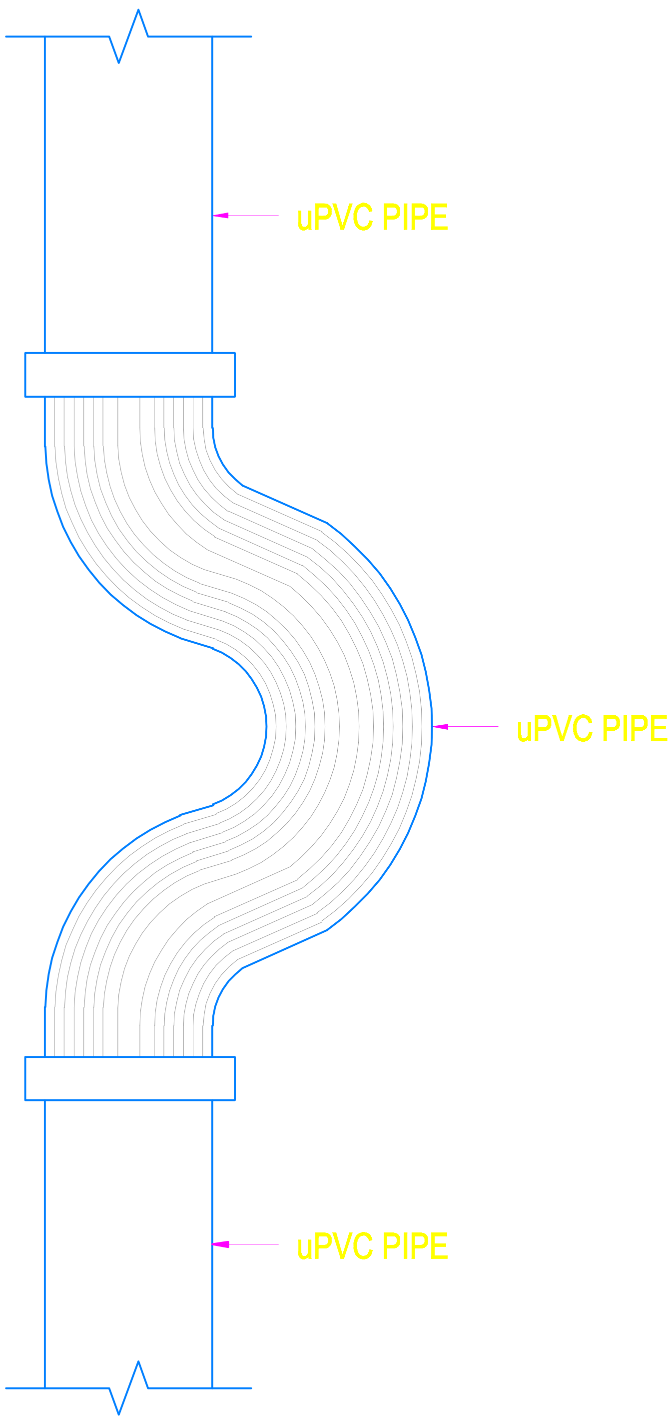
Details of Soil & Waste Pipe Connection



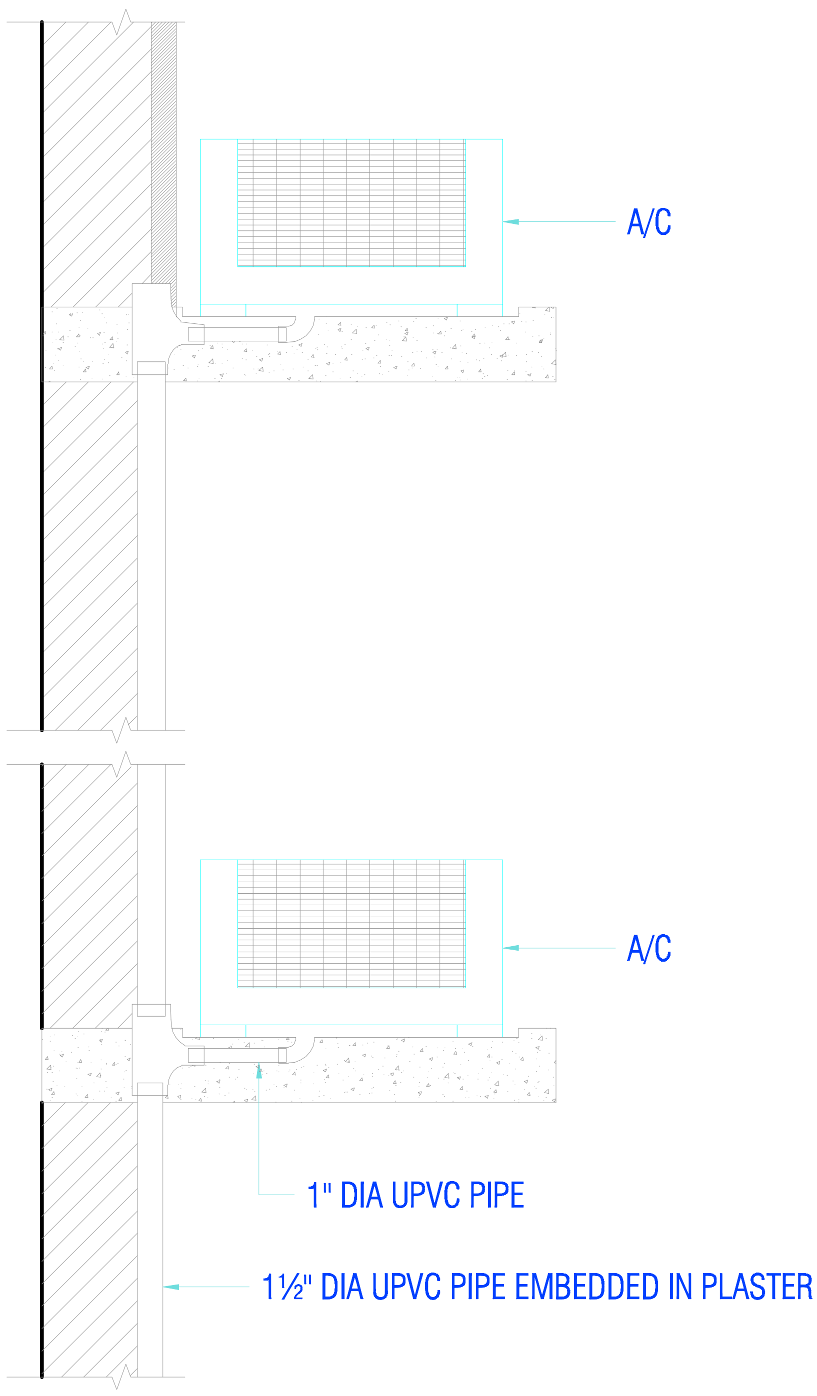
Details of Waste & Rain Pipe Connection

SECTIONAL DETAILS OF FIXTURE

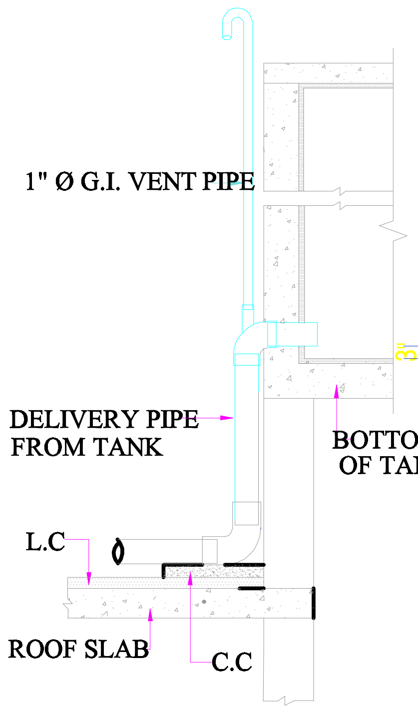




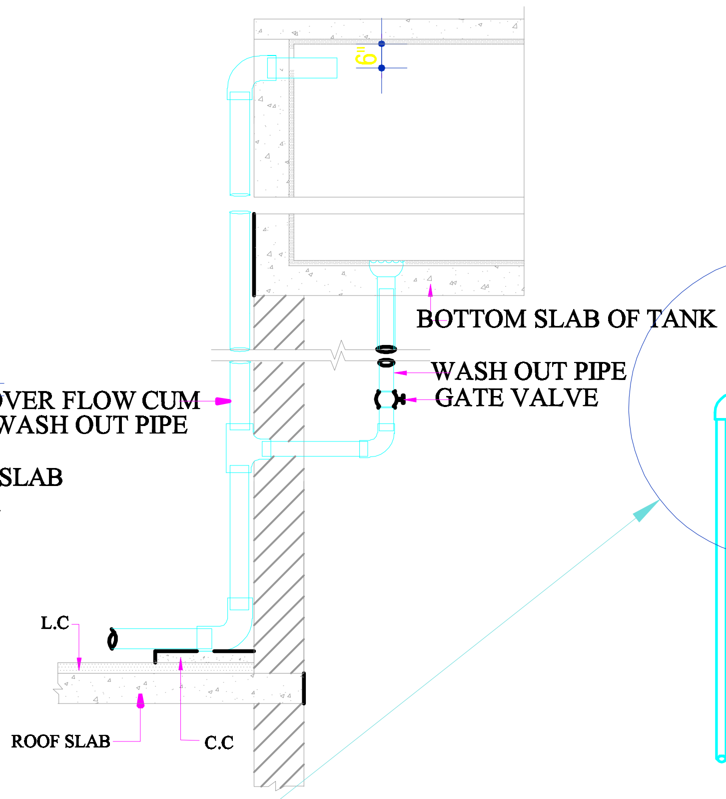
VELOCITY REDUCER



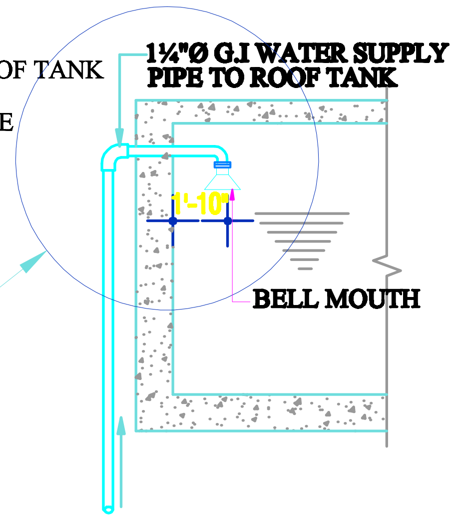
DETAIL-A (A/C WASTE WATER SYSTEM)



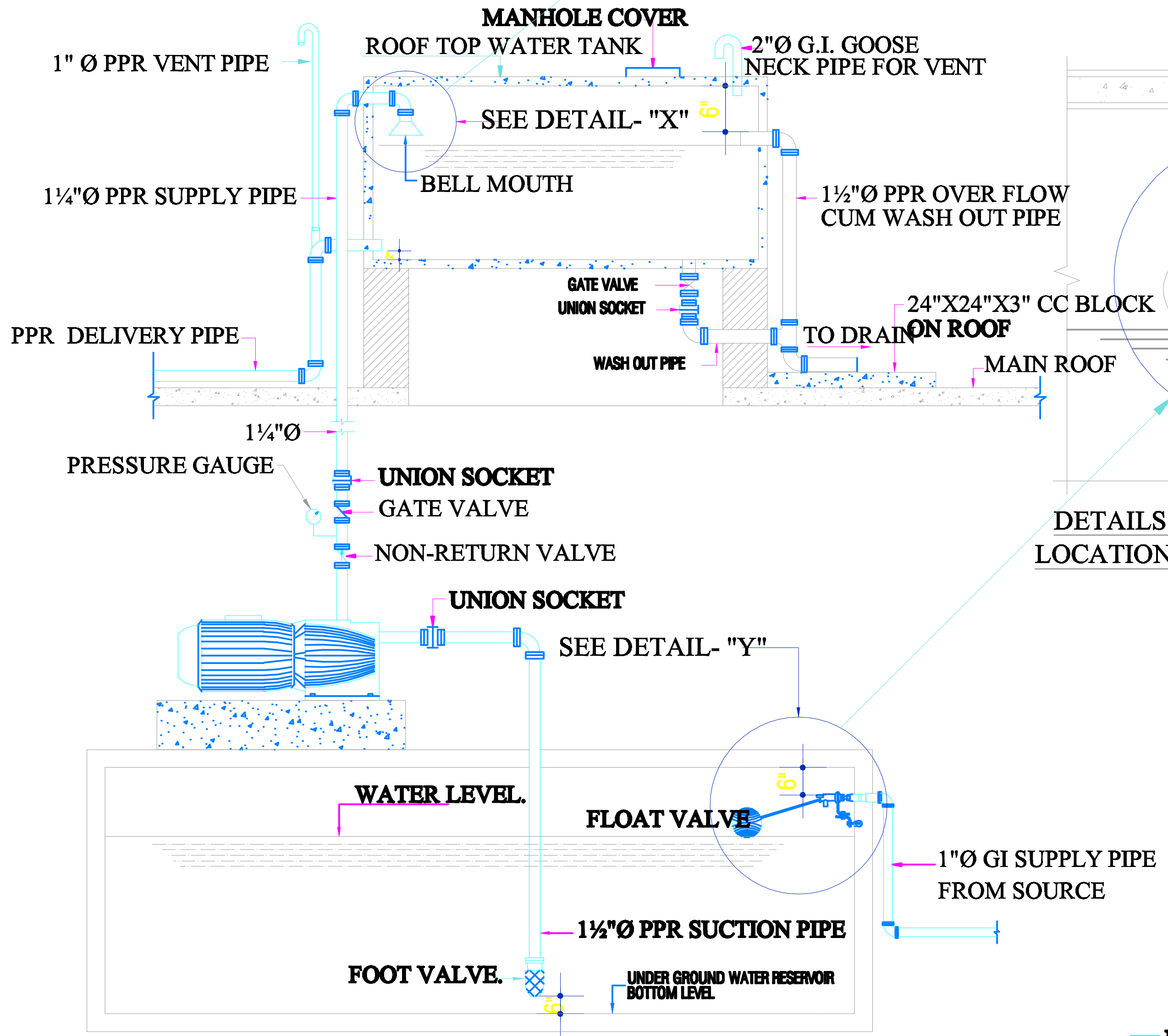
LOCATION OF DELIVERY PIPE
IN ROOF TOP TANK



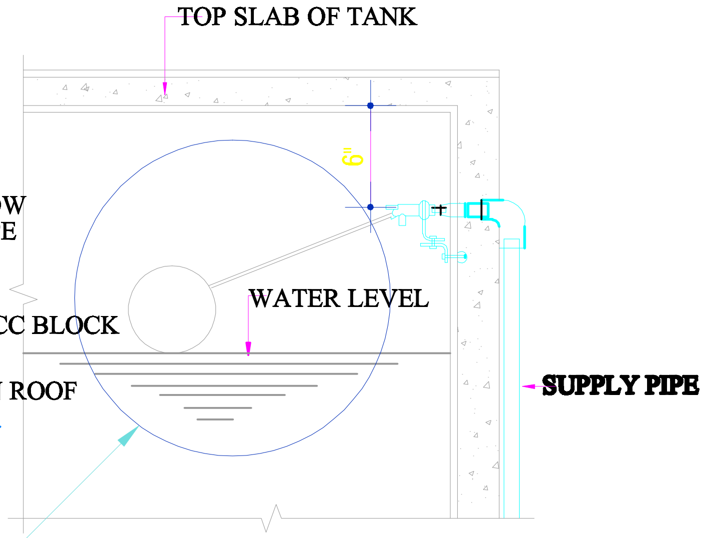
LOCATION OF OVER FLOW CUM
WASH OUT PIPE IN ROOF TOP TANK



DETAILS OF "X"
WATER RISER TO TANK

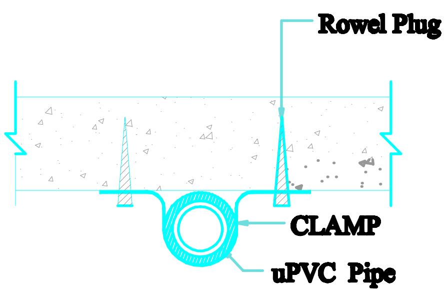


INSTALLATION OF WATER SUPPLY PUMP & PIPE WORK

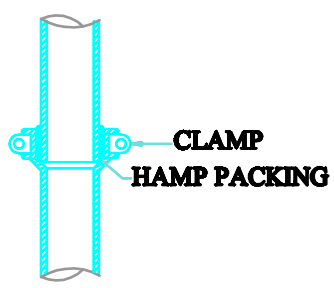


DETAILS OF "Y"
LOCATION OF SUPPLY PIPE IN TANK

*PUMP
5.50 HP.
SIZE : 1½"X1¼"
Head (H)=200'-0"
Discharge : 30.00 gpm



uPVC PIPE FIXING DETAILS
BELOW SLAB



PIPE JOINING DETAILS

LEGEND : (For Sewerage Disposal)

SS = 4"Ø uPVC SOIL STACK

WS= 4"Ø uPVC WASTE STACK.

RS= 4"Ø uPVC RAIN STACK.

RS1= 1¼"Ø uPVC RAIN STACK./AC WASTE WATER

VS = 2"Ø uPVC VENT STACK.

FT = FLOOR TRAP.

P = 1½"Ø uPVC CONDUIT CONCEALED IN FLOOR.

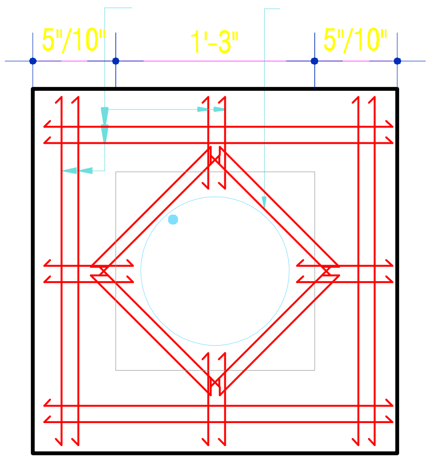
D = DEPTH OF INSPECTION CHAMBER FOR SOIL from FGL

d = DEPTH OF INSPECTION CHAMBER FOR
RAIN & WASTE WATER from FGL

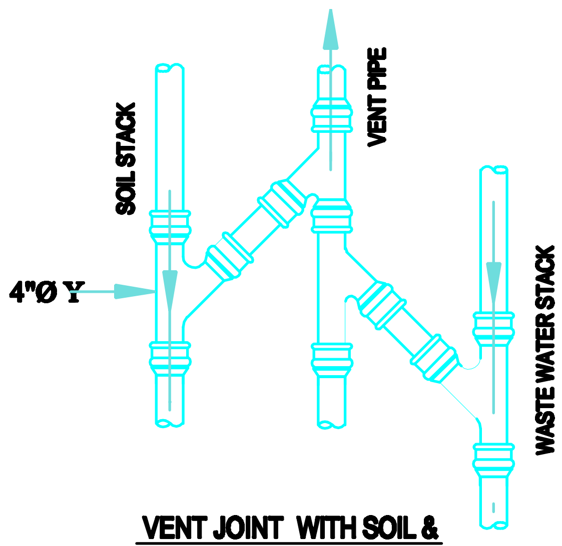
= INSPECTION CHAMBER FOR SOIL

= INSPECTION CHAMBER FOR WASTE WATER

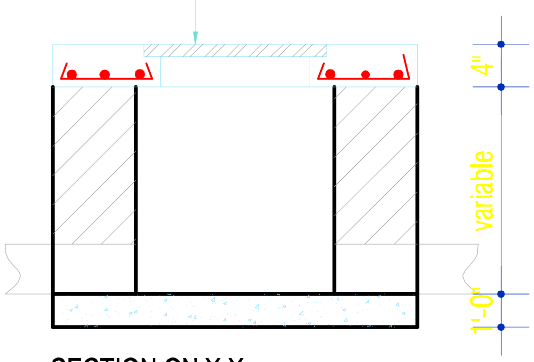
= 24"Ø CI. MANHOLE COVER (HEAVY TYPE)



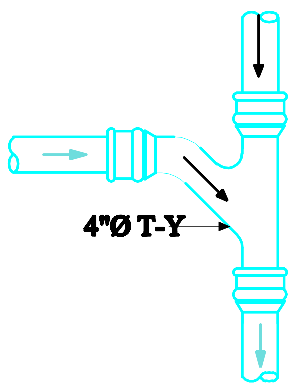
RE-BAR PLAN OF INSPECTION PIT



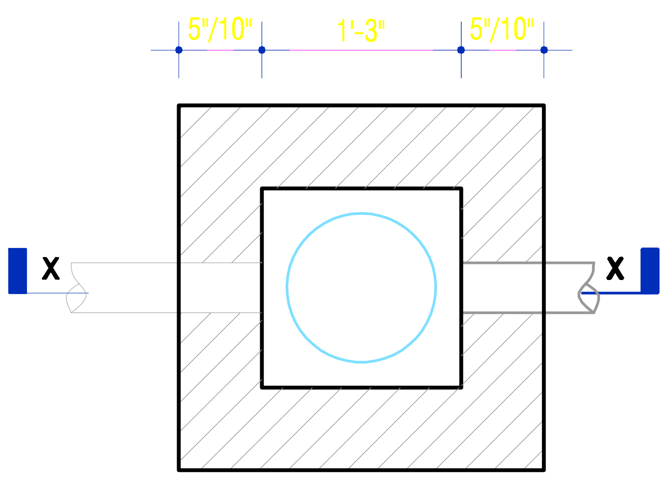
VENT JOINT WITH SOIL &
WASTE WATER STACK DETAIL



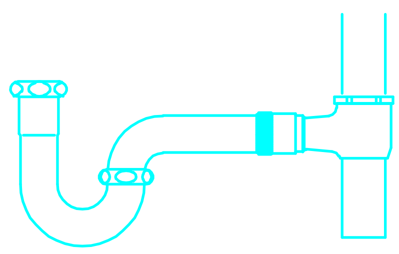
SECTION ON X-X



T OR Y JOINT DETAIL

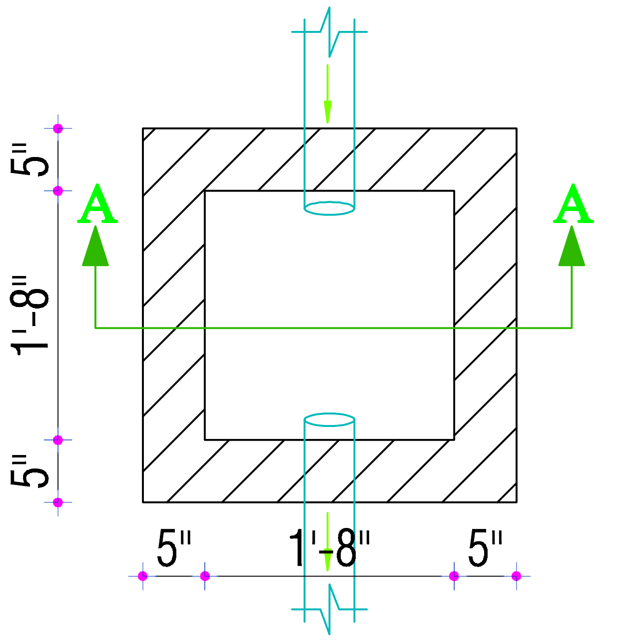
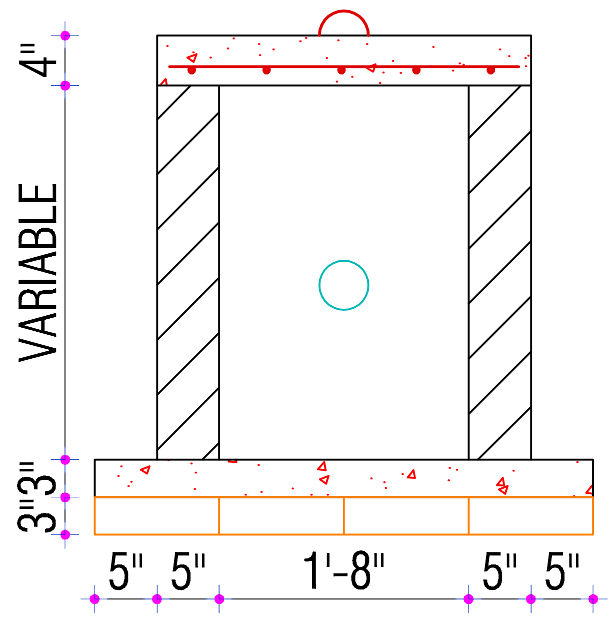
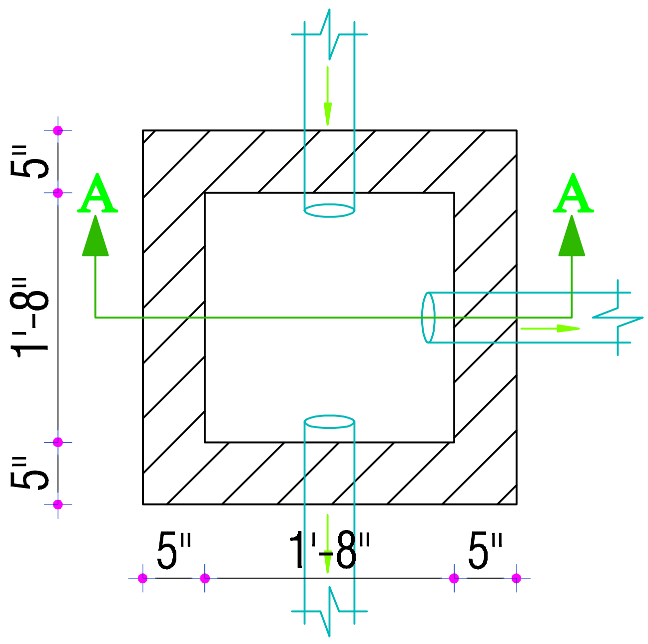
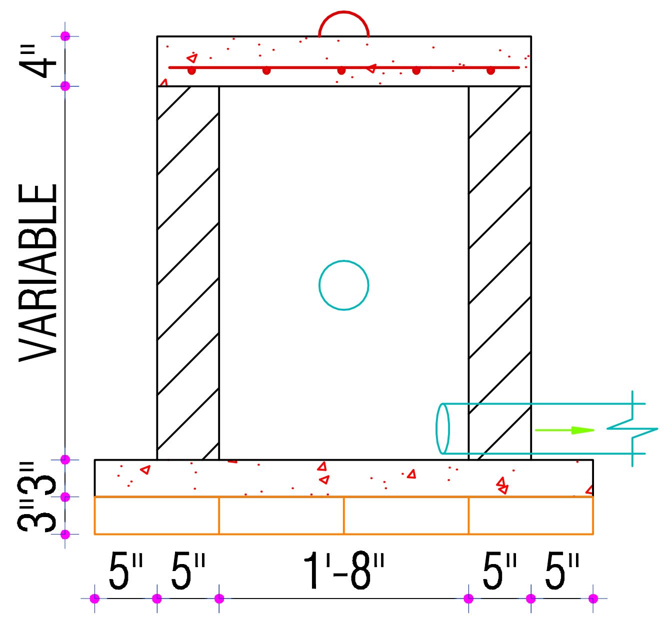
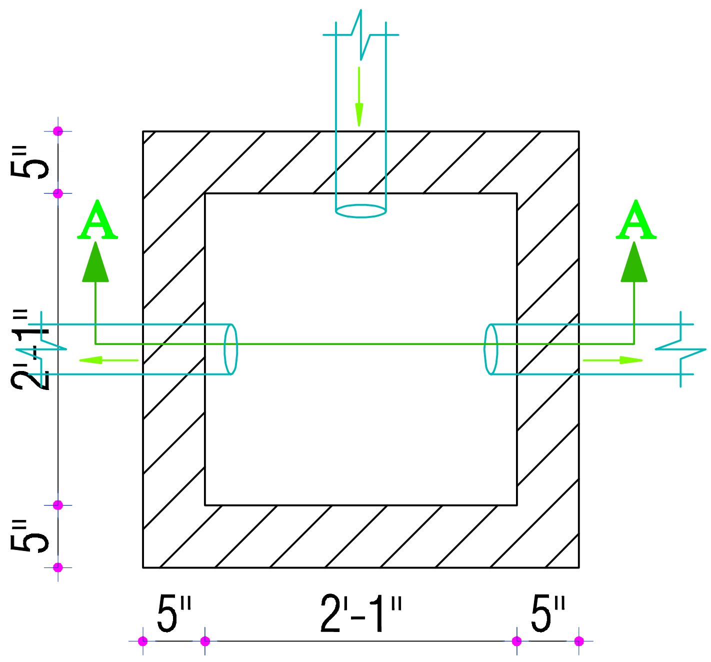
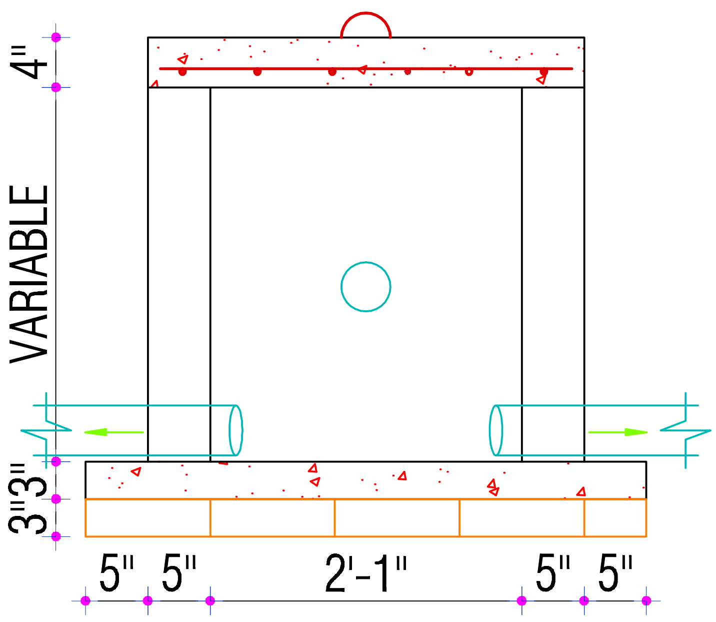


PLAN OF INSPECTION PIT



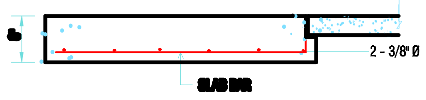
VENT JOINT WITH SOIL PIPE.

SECTIONAL DETAILS OF PIT

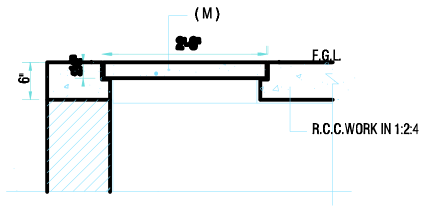
PLAN	SECTION
	
	
	

SCHEDULE OF SEPTIC TANK

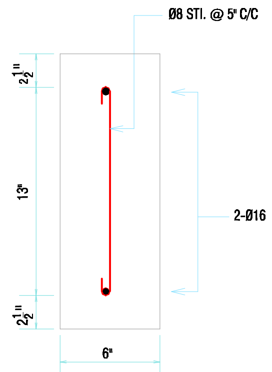
DIMENSION	
LENGTH = L	20'-0"
BREATH = B	7'-0"
[illegible]	8'-6"



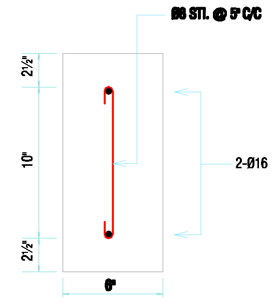
DETAILS OF "X"



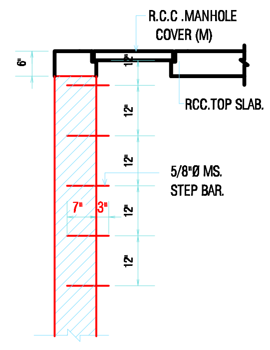
PART SEC OF Y-Y



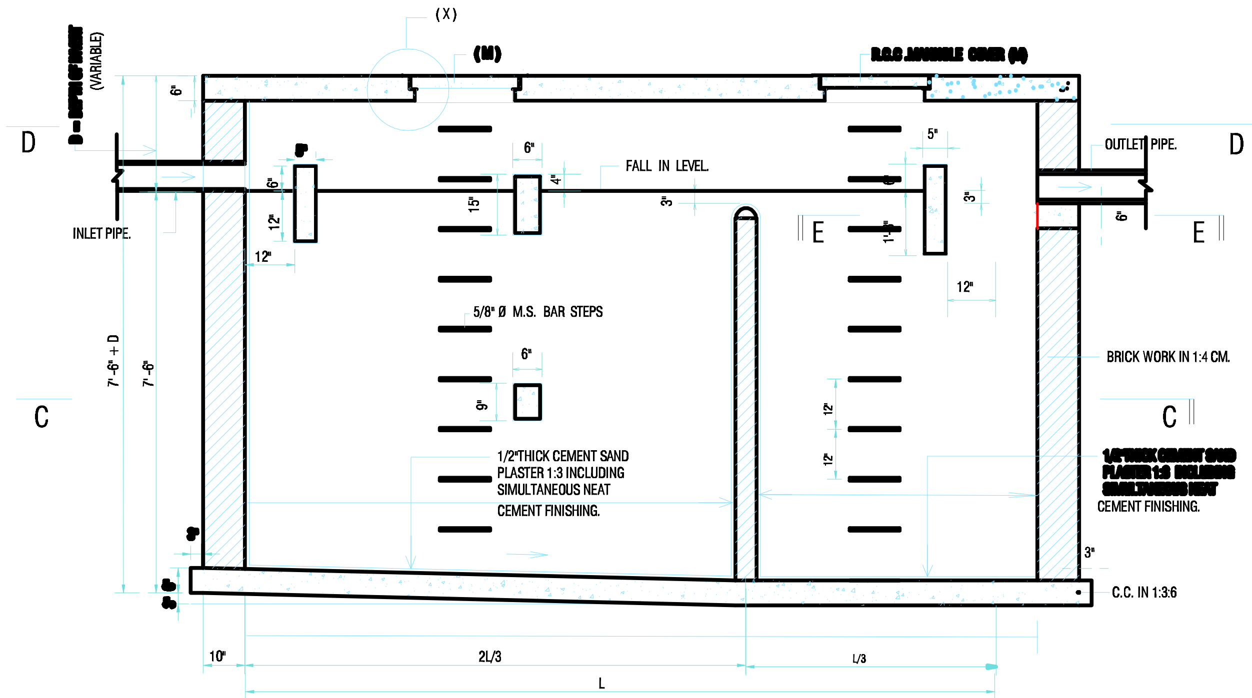
DETAILS OF BAFFEL WALL'



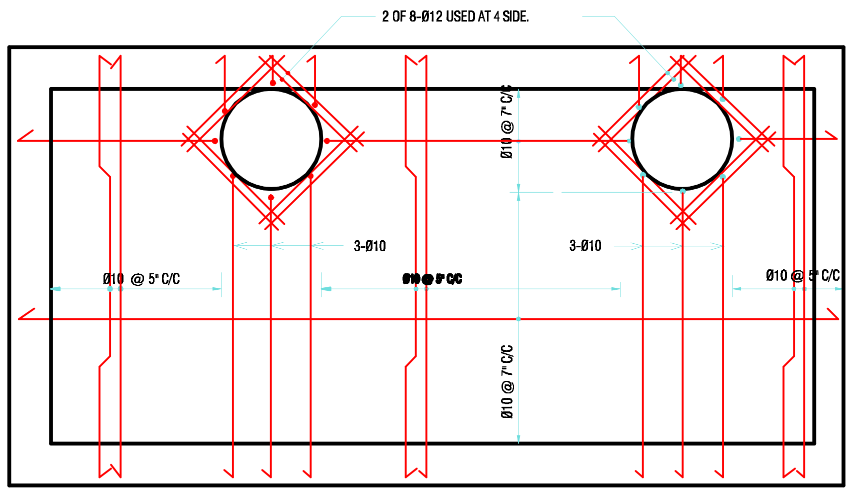
DETAILS OF STRUT.



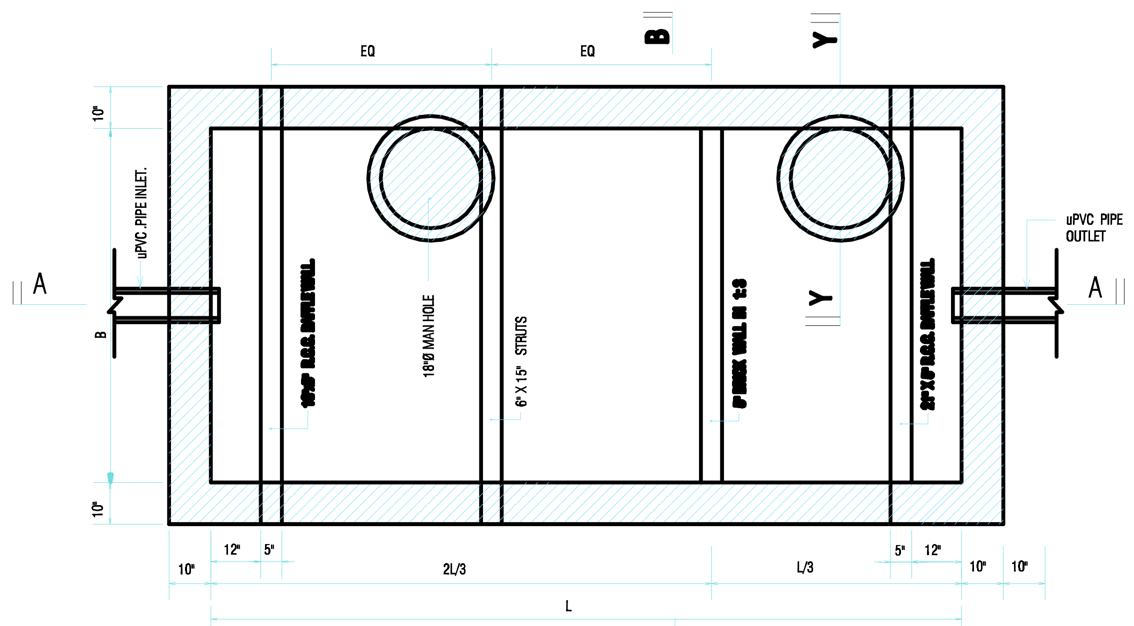
PART CROSS SEC.
OF SEPTIC TANK
THROUGH MANHOLE.



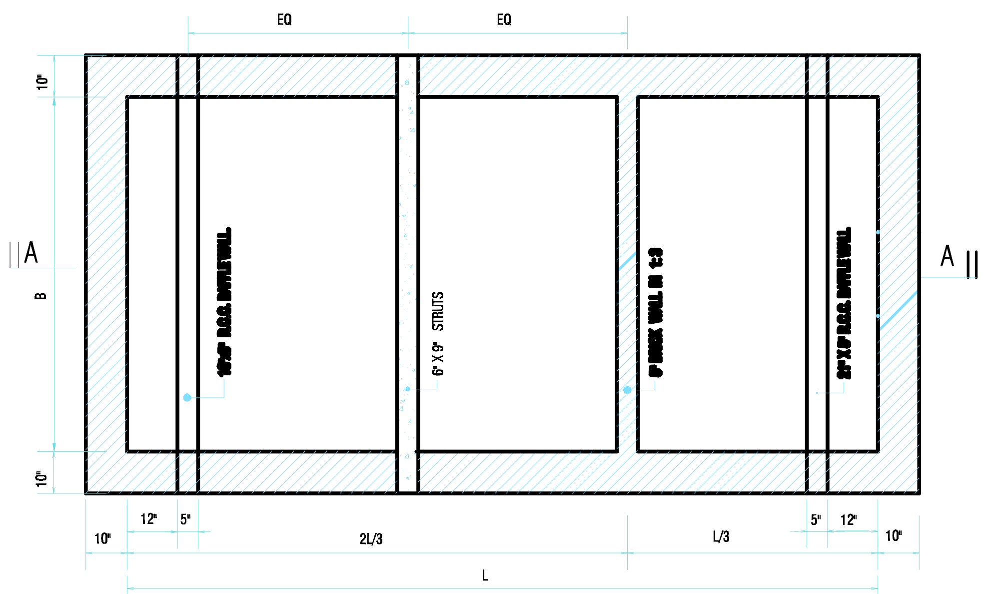
SECTION ON A-A



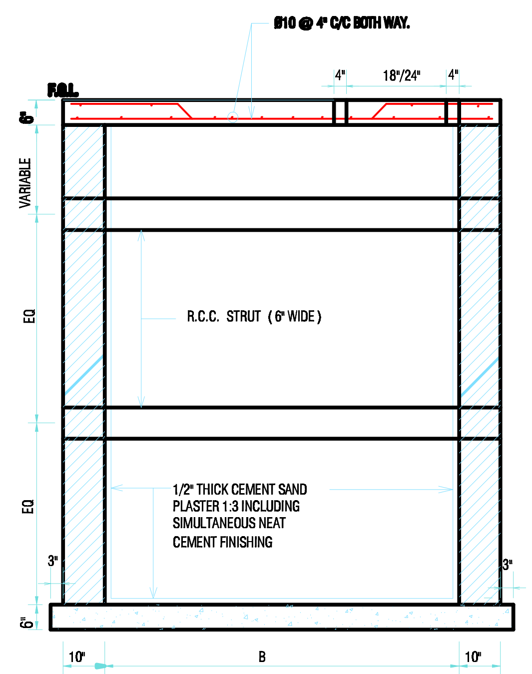
TOP SLAB REINFORCEMENT PLAN.



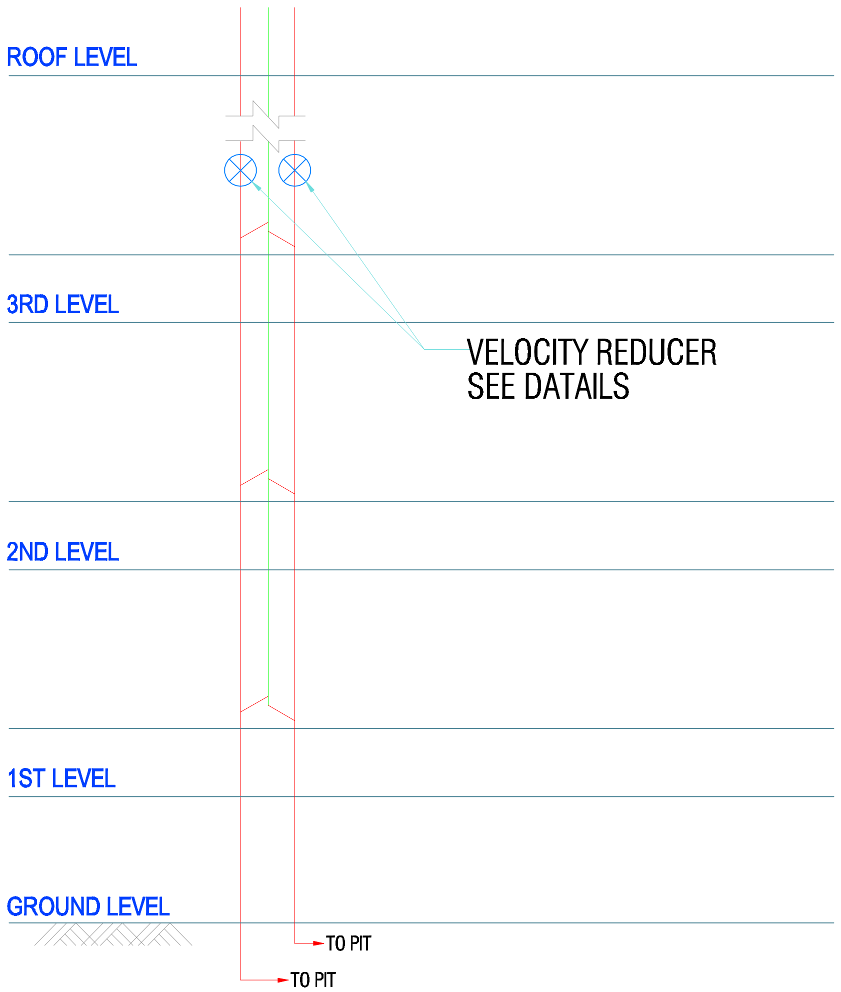
SECTIONAL PLAN OF D-D.



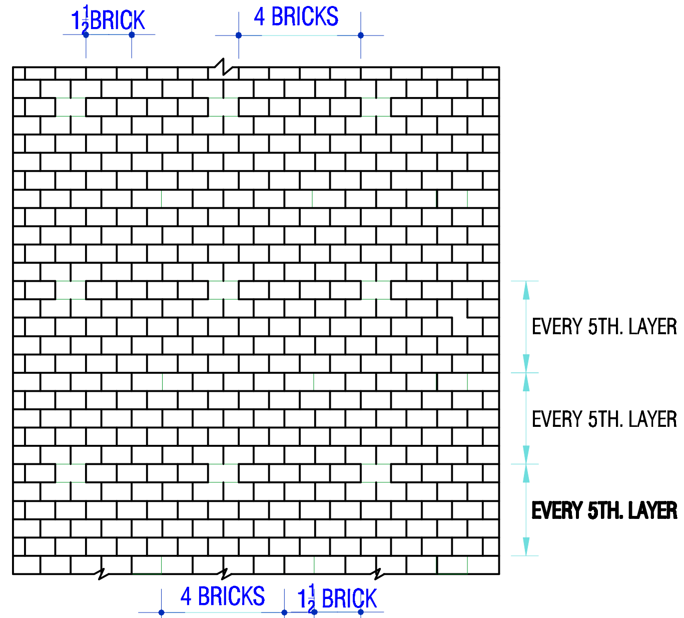
SECTIONAL PLAN ON C-C



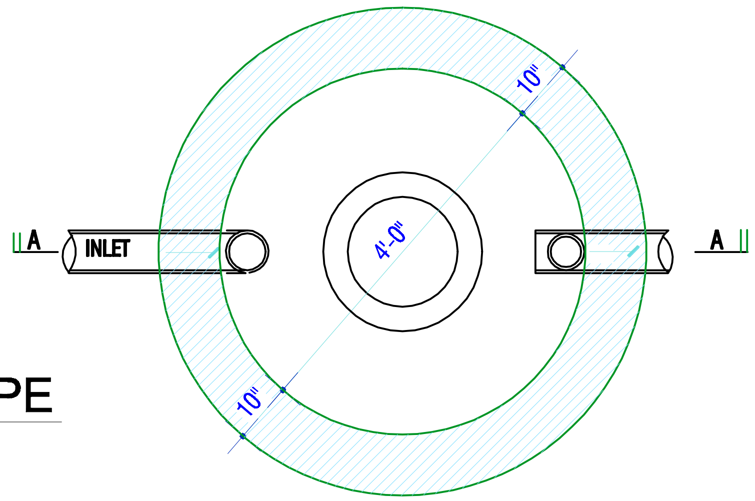
SECTION ON B-B



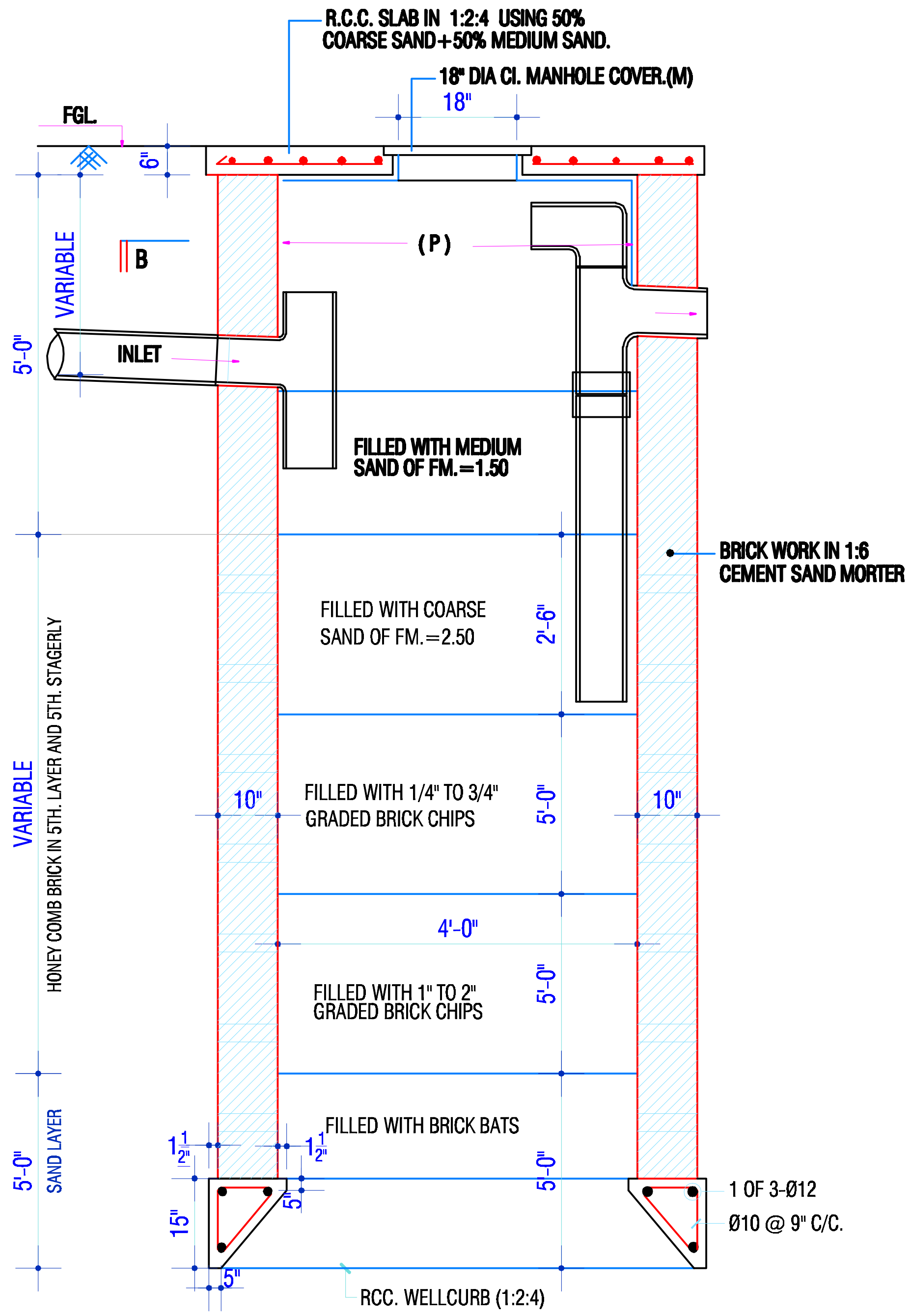
RAIN, WASTE & SOIL WITH VENT PIPE



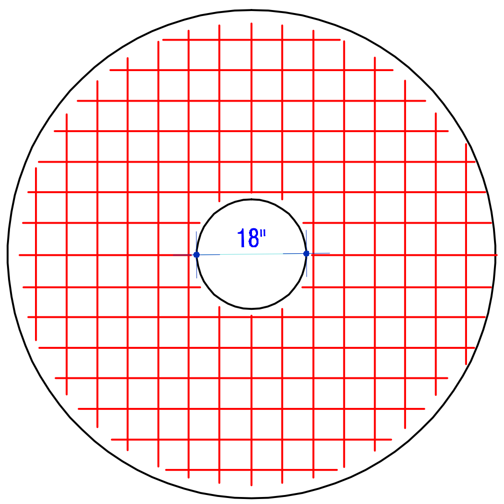
ELEVATION OF SOAK WELL(PART)



PLAN OF SOAK WELL & OUT LET OF SOAK WELL



SEC ON A-A



REINF. PLAN OF TOP SLAB