

ANALYSIS AND DESIGN OF PLUMBING SYSTEM FOR A BUILDING

Prepared By

Md. Bajlar Rahman

Md. Abdul Kadir Nadim

Firoz Ali

A Thesis Submitted to the Department of Civil Engineering, Daffodil International University in Partial Fulfillment of the Requirement of the Degree of **Bachelor of Science in Civil Engineering.**

Under the supervision of

Dr. Miah M. Hussainuzzaman

Associate Professor Department
of Civil Engineering Daffodil
International University



**DEPARTMENT OF CIVIL ENGINEERING
DAFFODIL INTERNATIONAL UNIVERSITY**

January 2025

ANALYSIS AND DESIGN OF PLUMBING SYSTEM FOR A BUILDING

Submitted by

Md. Bajlar Rahman

ID:172-47-477

Md. Abdul Kadir Nadim

ID:171-47-332 Firoz

Ali

ID:172-47-453

This Project is submitted to the Department of Civil Engineering, Daffodil International University to Fulfill the Partial Requirements for the Degree of
Bachelor of Science in Civil Engineering

Department of Civil Engineering
Daffodil International University

January 2025

APPROVAL

This certifies that the following students completed the project "ANALYSIS AND DESIGN OF PLUMBING SYSTEM FOR A BUILDING" under my supervision in the Department of Civil Engineering within the Faculty of Engineering at Daffodil International University. This work satisfies the partial requirements for a Bachelor of Science in Civil Engineering degree.

List of Students:

Md. Bajlar Rahman	ID: 172-47-447
Md. Abdul Kadir Nadim	ID: 171-47-332
Firoz Ali	ID: 172-47-453

Signature of the Supervisor

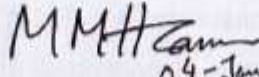


Dr. Miah M. Hussainuzzaman

Associate Professor
Department of Civil Engineering
Daffodil International University

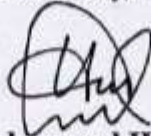
The project titled “ANALYSIS AND DESIGN OF PLUMBING SYSTEM FOR A BUILDING” submitted by Md. Bajlar Rahman ID:172-47-447, Md. Abdul Kadir Nadim ID: 171-47-332, Firoz Ali ID: 172-47-453 has been accepted to fulfill the partial requirement for the degree of Bachelor of Science in Civil Engineering in December 2024.

BOARD OF EXAMINERS


04-Jan-2024

Dr. Miah M. Hussainuzzaman
(Supervisor)

Department of Civil Engineering
Daffodil International University
Daffodil Smart City, Ashulia, Dhaka.



Dr. Mohammad Hannan Mahamud Khan
Chairman

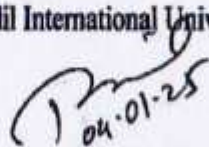
Associate Professor & Head
Department of CE, DIU
Daffodil International University



Md. Masud Alom
Assistant Professor
Department of CE, DIU
Daffodil International University

For, Tahmid

Saurav Barua
Assistant Professor
Department of CE, DIU
Daffodil International University


04-01-25

Md. Tanimul Haque
External Member
Executive Engineer, Roads and Highway
Department, Dhaka

DECLARATION

It is hereby declared that from the work of others, only some specific reference has been made, detailed design exercise in this project report has been supervised by **Dr. Miah M. Hussainuzzaman**, Associate Professor, Department of Civil Engineering, Daffodil International University.

Except for publication no part of this design report has been submitted to any other university or other educational establishments for a degree, diploma, or other qualification.

Signature of the candidates



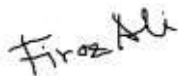
Name: Bajlar Rahman

ID: 172-47-447



Name: Md. Abdul Kadir Nadim

ID: 171-47-332



Name: Firoz Ali

ID: 172-47-453

ACKNOWLEDGMENT

For finishing the project, we are especially grateful to Allah Ta'ala. We are overjoyed to convey our sincere appreciation, respect, kindness, and admiration to our supervisor, **Dr. Miah M. Hussainuzzaman**, Associate Professor Department of Civil Engineering, Daffodil International University. We are also grateful to each group member's friends for contributing their expertise and experience to assist us make the study a success.

Finally, we would especially like to thank our parents, whose support and encouragement gave us the constant drive to complete this project.

DEDICATION

Dedicated
To
Our Families
&
Esteemed Faculties

ABSTRACT

The sanitary and plumbing systems of a structure are essential. To satisfy the occupants' needs for hygiene, the plumbing system has to be appropriately planned and designed. A plumbing system ensures physical separations, air gaps, and adherence to construction codes to maintain the connections of the waste and clean water plumbing elements away. By preventing cross-contamination, plumbing preservation can guarantee that the water in your house is always safe and pure. The plumbing system design for an eight-story residential building is shown in this report. This includes a detailed explanation of each calculation and factor and the required CAD files.

Table of Contents

Chapter 1 - Introduction1	1
1.1 General	1
1.2 Objectives	1
1.3 Limitations.....	1
1.4 Organization of the report.....	1
1.5 Summary.....	2
Chapter 2 -Project Information	3
2.1 General Data	3
2.2 Project Location	3
2.3 Considerations of Plumbing Design	4
Chapter 3 - Water Supply System Design	5
3.1 General.....	5
3.2 Calculation of Demand	5
3.3 Design of Under-Ground (UG) Reservoir	6
3.4 Design of Over-Head Tank (OHT)	7
3.4.1 Selection of Pump	7
3.5 Size of the Riser	8
3.6 Design of Distribution Pipe	8
3.7 Distribution network pressure check	8
3.8 A Typical connection figures10	
Chapter 4 - Sewerage System Design	11
4.1 General.....	11
4.2 Wastewater LOADS	11
4.3 Branch and Stack Pipe Selection	13
4.4 Design of Building Drain.....	13
4.5 Design of Septic Tank.....	13
Chapter 5 - Design of Storm Water Drainage.....	14
5.1 General.....	14
5.2 Stormwater Management System	14
References	16
Appendices	17
Appendix: BNBC Tables.....	17
Appendix: CAD files	23

CHAPTER 1 INTRODUCTION

1.1 General

Every place used as a residence must have basic services such as a water supply and sanitary accommodations. Long-term residents or tenants of commercial or residential buildings require certain amenities to be included in the design of the building. The appropriate design and construction of those services are guaranteed by user safety and economic feasibility. As a result, the building's detailed design includes plumbing design in addition to structural, architectural, and electrical components. An approved design is required by the water supply authority to avail the water and sewage connection. This report incorporates a presentation of such a plan for a 8-storey residence.

1.2 Objectives

The objectives of the analysis and design report includes:

- To show the proper dimensions for each component of the system.
- To ensure each fixture has sufficient water supply.

1.3 Limitations

A complete design requires several features, some of which are not presented in this report are:

- Some available sizes limited by architectural design, that this report validates the sizes that have been given.
- Design details are not provided for the basics that are required to grip the piping rightly.
- Volume and price estimations are not covered.

1.4 Organization's report

There are 5 chapters, an appendix, and a bibliography in this report. The background information, justification, limitations, goals, and format of this project are all covered in the first chapter. Details on the particular project are given in general in the second chapter. All calculations needed for storm water drainage systems, wastewater plumbing, and water supply are included in the third, fourth, and fifth chapters. A complete list of all the references utilized in these computations may be found in the bibliographic section. In the appendices drawings (CAD: Computer Aided Drawing) are referred and discussed from the corresponding chapters.

1.5 Summary

Water and wastewater plumbing system is a crucial component of any residence. This section introduces the project design and report. The description summarizes all of the designs discussed in the study, as well as its objectives and limitations. Information of the relevant project are given in the following chapters.

CHAPTER 2 PROJECT INFORMATION

2.1 General Data

Type of Occupancy	: Residential
Floor Count	: 8 Storied
Basements count	: N/A
Height of the building	: 90 ft / 27.44 m
Population	: 90 Persons
Total Land Area	: (78'-0" * 64'-0") = 4992 ft ²
Building Plinth Area	: (69'-6" * 54'-0") = 3753 ft ²
Total Floor Area	: 30024 ft ²
Category of structure	: RCC frame

2.2 Project Location

Address of the project : Plot no -14, Road no – 01, Block – B, Aftab Nagar, Eastern Housing LTD. Dhaka.

GPS location : 23°10'35.5"N 89°30'05.2"E



Figure 3.1: Map of Project location

2.3 Considerations of Plumbing Design

- The design followed BNBC 2020.

- Although all apartments have balconies, the drainage of rainfall from such areas is not taken into account.
- Water supply:

WAS provides local water supply to the underground reservoir tank.

A

- Water is supplied using a gravity-driven system.
 - The water will be pumped to the overhead tank above the roof using an individual pumping system.
- Hot and cold-water distribution systems are considered for installing geysers as required.
- The overhead tank is used twice to pump water regularly.
- HDPE is used for all piping materials.
- Sewerage system:
 - As sewer systems are available in the area buildings do not have their septic tank facility.
 - Two separate pipes are is applied to drain soil & wastewater.
 - Grey water (from the waste stack) will be diverted into the drain and Blackwater (from the soil stack)
 - Open drain receives overflow and wastewater.
- Storm / Rain Water
 - This location does not have a rainwater collection system.
 - Rainwater will be collected by using a separate stack system from the roof.
 - Rainwater finally flows to buildings for wastewater before it is released into an open drain.

CHAPTER 3 WATER SUPPLY SYSTEM DESIGN

3.1 General

Following factors needs consideration while building a water supply system:

- Estimate the daily demand and required daily water volume.
- The sufficiency of the UGR or underground water reservoir must be determined.
- Compute the pump's capacity to fill the above tank with water in a particular period (let's say 30 minutes). This will cover the size of the pump riser.
- Determine the UGR's capacity.
- The distribution pipeline over the roof and the risers needs to be designed.
- For each structure, construct the distribution pipes. These pipes cross the false slab of the sanitariums and pass the walls.
- It was necessary to calculate the pressure in fixture water that is supposed to have lowest pressure because it is the most vulnerable. Often, the top level has the longest supply pipe network for this device.

3.2 Calculation of Demand

For calculation demand, number of people and demand per capita is used for specified function types.

Overall demand (q) = Population (p)* demand per capita

Here, $P = \text{Flat number} \times 6.00 \text{ persons/flat}$ $q = 180$
Ipcd [BNBC 2020]

8-storey apartment building total demand with 15 flats including 6 persons/ flat:

$$\begin{aligned}\text{Overall demand (q)} &= \text{Population (p)} * \text{demand per capita} \\ &= (15.00 * 6.00) * 180.00 \\ &= 16200.00 \text{ Liters/Day} \\ &= 16.200 \text{ m}^3/\text{day}\end{aligned}$$

However the new BNBC 2021 has lower demand values for such apartments which are shown in Tables 8.5.1(a), 8.5.1(b), 8.5.1(c) and 8.5.1(d) starting from page 4815.

Therefore the calculations with the higher previous value is safe.

3.3 Design of Under-Ground Reservoir (UGR)

These reservoirs are usually structured and maintained by the architect. It is important to ensure that the amount is suitable for this. The volume-to-demand ratio provides security or excess water that can be kept during a water supply interruption. Dead

volumes at the bottom of the reservoir, which will never be pumped out, and freeboard, which will never be filled, should be included in the actual volume of the reservoir.

CAD #15.

Water demand $V = 16.20 \text{ m}^3/\text{day}$

Volume of UG water tank needed,

$$\begin{aligned} V &= (16.20 + 16.20) && [\text{NBC 2021, Table- 5.9.1.2.c (iii)}] \\ &= 32.40 \text{ m}^3 \end{aligned}$$

Depth of UG water tank,

$$H = V^{1/3} = (32.40)^{1/3} = 3.19 \text{ m}$$

Freeboard, F.B = 0.15 m

$$\begin{aligned} \text{Depth, } H &= H + \text{F.B} \\ &= 3.19 + 0.15 \\ &= 3.34 \text{ m} \sim 3.35 \text{ m} \end{aligned}$$

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

$$\begin{aligned} \Rightarrow A &= 32.40 / 3.35 \\ &= 9.67 \text{ m}^2 \end{aligned}$$

A length to width ratio = 2 (assume)

$$\Rightarrow L = 2 * B$$

Area (A) = (L * B)

$$\begin{aligned} \Rightarrow (2B * B) &= 9.67 \text{ m}^2 \\ \Rightarrow B^2 &= 9.67 / 2 = 4.84 \\ \Rightarrow B &= \sqrt{4.84} = 2.20 \text{ m} \end{aligned}$$

Therefore, $L = 2 * B$

$$= (2 * 2.2) = 4.40 \text{ m}$$

Size of UG Water Tank

$$H = 3.35 \text{ m} \qquad B = 2.20 \text{ m} \qquad L = 4.40 \text{ m}$$

The proportions of the ground floor must be taken into consideration when building a UG water tank.

$$L = 4.0 \text{ m} \qquad B = 2.5 \text{ m} \qquad H = 3.0 \text{ m}$$

3.4 Over-Head Tank Design

The report reviews size of overhead tank (OHT) provided by the architect. If no design is provided, the size is calculated. A larger tank can handle a greater live load. Since the plan is to pump water twice a day, the tank should be large enough to hold 50% of the daily water requirement, along with additional space for dead volume and free-board. As a result, the tank's size should be about 60-70% of the total daily water demand.

Demand of daily water (V)= 16.20 m³/day

The users will pump ½ of the regular demand two times a day, it has been accepted.

Thus, the OHT water tank's necessary volume

$$V = 0.5 \times 16.20 = 8.10 \text{ m}^3$$

$$\text{Depth of OHT, } H = V^{1/3} = (8.10)^{1/3} = 2.00 \text{ m}$$

Freeboard, F.B = 0.15 m

$$\text{Depth, } H = \text{FB} + H = 2.00 + 0.15 = 2.15 \text{ m}$$

$$\text{Area of Tank, } A = 8.10 / 2.15 = 3.77 \text{ m}^2$$

$$L = 2 \times B \text{ (assume)}$$

$$A = 2 B \times B = 3.77 \text{ m}^2$$

$$\Rightarrow B^2 = 3.77 / 2 = 1.88$$

$$\rightarrow B = \sqrt{1.88} = 1.37 \text{ m} \sim 1.40 \text{ m}$$

$$\text{Therefore, } L = 2B = 2 \times 1.37 = 2.75 \text{ m}$$

Size of OHT water Tank

$$B = 1.40 \text{ m} \quad H = 2.15 \text{ m} \quad L = 2.75 \text{ m}$$

OTH is designed as per the stair room size. Dimensions of the stair room are,

$$B = 4.67 \text{ m} \quad H = 1.00 \text{ m} \quad L = 5.03 \text{ m}$$

The figure of tank with pump and risers is shown [CAD #16.]

3.4.1 Selection of Pump

The pump should have a capacity equal to the electrical voltage and be able to pump the required volume in around half an hour.

Power needed for the pump Determination

$$K.W = \frac{Q \times \text{Head}(m)}{75 \times \text{Efficiency}} \times 0.746$$

$$\text{Here, } Q = 8.10 \text{ m}^3 / \text{hr.} = \frac{8100 \text{ L}}{1 \times 60 \times 60} = 2.25 \text{ lps}$$

$$\text{Efficiency } (\epsilon) = 50\% \quad \text{and Head(} H) =$$

$$(27.44 + 1.5) = 28.94 \text{ m}$$

$$K.W = \left(\frac{5 \times 28.94}{75 \times 0.5} \right) \times 0.746 = 0.86$$

3.5 Size of Riser

The diameter of the pump delivery pipe and the riser size are related. Head loss is calculated using pipe diameter, pumping rate, and head. The water velocity limit is 1.5 m/s to decrease the water-hammer. UG reservoir, pump figures, and Risers with OHT, are shown in [CAD #13.]

3.6 Distribution Pipe Design

The distribution and riser pipes, together with all of their branches, are shown above the fake ceiling in the associated CAD models. The normal standard diameter for these pipes is provided by BNBC. For instance, all of the fixtures' risers are made of 13 mm (0.5 inch) diameter pipes, but the pipes that cross the false ceiling have a diameter of 19 mm (0.75 inch). But for the pressure drop investigation, these requirements need to be verified.

3.7 Network pressure distribution check

To better comprehend the design and determine head loss, an 3D sketch of the pipe layout was created on the roof. A comprehensive view of the network component that supplies water to the most difficult-to-reach fixture was obtained using CAD #04, CAD #06, and CAD #09. Finding the lowest water pressure in the most challenging configuration—typically at the farthest fixture on the top floor—is the goal of the computation. Additionally, the calculation table aids in identifying any design flaws and offers solutions, including enlarging pipes that lose too much pressure.

Head loss is calculated using Hazen-Williams equation. The equation can be is follows:

$$Q = 3.7 \times 10^{-6} C D^{2.63} (H)^{0.54}$$

L

Q = Flow rate (lps)

C = Roughness coefficient pipe(100 – 140 for rough to smooth pipes)

D = Pipe's Diameter (mm)

H = Head loss (m)

L = Length of pipe (m)

For a definite value of (C), so the equation is:

$$H = 1.39 \times 10^6 \frac{Q^{1.8587}}{L^{4.8587} D^{4.8587}} \text{ {for C = 130}}$$

The head loss or pressure check is calculated using the formula above. WSFU was located in BNBC Table 1 (Appendix: BNBC Tables). For different valves and fittings, the appropriate lengths are used, as shown in BNBC Table 2. BNBC figure P1 illustrates the translation of WSFU data to lpm values. A basic conversion factor is used to generate a reduced range of values because it is hard to get lpm values.

Table 3.1: Design and analysis of distribution pipes, based on head loss calculation

Pipe.	Length L m.	Diameter D mm.	WSFU	lpm	lps	Unit loss H/L m/m.	Loss Hf m.
1 .0	2.0	3.0	4.0	5.0	6.0	7.0	8.0
A-Elbow	2.44	63.0	96	172.8	2.88	0.01699	0.04145
AB	3.65	63.0	96	172.8	2.88	0.01699	0.06200
B-Elbow	2.44	63.0	96	172.8	2.88	0.01699	0.04145

BC	0.5	63.0	96	172.8	2.88	0.01699	0.00849
C-Gate V.	0.49	63.0	96	172.8	2.88	0.01699	0.00832
CD	3.56	63.0	96	172.8	2.88	0.01699	0.06047
D-Elbow	2.44	63.0	96	172.8	2.88	0.01699	0.04145
DE	15	63.0	96	172.8	2.88	0.01699	0.25480
E-Elbow	2.44	63.0	96	172.8	2.88	0.01699	0.04145
EF	3.4	63.0	96	172.8	2.88	0.01699	0.05775
F-Elbow	2.44	63.0	96	172.8	2.88	0.01699	0.04145
FG	0.91	63.0	96	172.8	2.88	0.01699	0.01546
H-Tee, St	0.46	19.0	12	21.6	0.36	0.12435	0.05720
GH	0.08	19.0	12	21.6	0.36	0.12435	0.00995
H-Elbow	0.76	19.0	12	21.6	0.36	0.12435	0.09451
HI	0.15	19.0	12	21.6	0.36	0.12435	0.01865
I-Elbow	0.76	19.0	12	21.6	0.36	0.12435	0.09451
IJ	0.18	19.0	12	21.6	0.36	0.12435	0.02238
J-Elbow	0.76	19.0	12	21.6	0.36	0.12435	0.09451
JK	0.63	19.0	12	21.6	0.36	0.12435	0.07834
K-Elbow	0.76	19.0	12	21.6	0.36	0.12435	0.09451
KL	0.18	19.0	12	21.6	0.36	0.12435	0.02238
L-Elbow	0.76	19.0	12	21.6	0.36	0.12435	0.09451
LM	0.25	19.0	12	21.6	0.36	0.12435	0.03109
M-Elbow	0.76	19.0	12	21.6	0.36	0.12435	0.09451
MN	0.66	19.0	12	21.6	0.36	0.12435	0.08207
N-Tee	1.22	19.0	12	21.6	0.36	0.12435	0.15171
NO	0.66	19.0	10.5	18.9	0.32	0.09713	0.06411
O- Elbow	0.76	19.0	10.5	18.9	0.32	0.09713	0.07382
OP	0.21	19.0	10.5	18.9	0.32	0.09713	0.02040
P-Tee	1.22	19.0	10.5	18.9	0.32	0.09713	0.11850
PQ	0.78	19.0	5.5	9.9	0.17	0.02937	0.02290
Q-Tee	1.22	19.0	5.5	9.9	0.17	0.02937	0.03583
Pipe.	Length L m.	Diameter D mm.	WSFU	lpm	lps	Unit loss H/L m/m	Loss H_f m.

QR	0.49	19.0	1	1.8	0.03	0.00125	0.00061
R	0.76	19.0	1	1.8	0.03	0.00125	0.00095
							2.05246

Total (H) = 5.945 m.

Head loss = 2.053 m.

Head Available = 3.892 m. = 5.532 psi.

3.8 A Typical connection figures

CAD files also include typical standards for joints, valves, clumps etc.

CHAPTER 4

SEWERAGE SYSTEM DESIGN

4.1 General

This chapter explains the detailed calculations for designing the various parts of the system. The sewer pipes for each floor are usually placed below the floor slab, and the vertical pipes (stacks) pass through designated spaces, connecting to the building's main drainage. Several key components need to be considered when designing a wastewater drainage system. Calculate the wastewater load from each bathroom's fixtures or other wastewater-producing devices.

- Choose the adequate size (diameter) of the branch pipes as per BNBC.
- Choose the appropriate diameter (size) for the vertical stack pipes in compliance with [BNBC.]
- Grade determine and building drain diameter.
- Design of Septic Tank.

4.2 Wastewater LOADS

From the first to the sixth stories, each floor has six bathrooms and two kitchen spaces. Each kitchen and bathroom has six vertical pipes (stacks) slots. Wastewater loads are calculated using Fixture Unit system, which allocates each kind of fixture certain load value (e.g., a sink or toilet). Used to get these FU values (BNBC table). This is calculated using each vertical stack using these facts. The following table displays the FU loads for various stacks:

Table 4.1: Fixture unit loads from each toilet and kitchen Listing (1st & 7th floor)

Sl. #	Description	Fixture Unit for Waste Stack	Fixture Unit for Soil Stack	Void Area
1	Toilet 1-	Shower (02) + Floor Trap (01) + Wash Basin (01) + Laundry (03)	Water Closet (06)	1
2	Toilet 2-	Shower (02) + Floor Trap (01) + Wash Basin (1) + Laundry (03)	Water Closet (06)	2
3	Toilet 3-	Shower (02) + Floor Trap (01) + Wash Basin (01) + Laundry (03)	Water Closet (06)	3
4	Toilet 4-	Shower (02) + Floor Trap (01) + Wash	Water Closet (06)	4
Sl. #	Description	Fixture Unit (FU) for Waste Stack (WS)	Fixture Unit (FU) for Soil Stack (SS)	Void Area

		Basin (01) + Laundry (03)		
5	Toilet 5-	Shower (02) + Floor Trap (01) + Wash Basin (01) + Laundry (03)	Water Closet (06)	5
6	Toilet 6-	Shower (02) + Floor Trap (01) + Wash Basin (01) + Laundry (03)	Water Closet (06)	6
7	Toilet 7-	Shower (02) + Floor Trap (01) + Wash Basin (01) + Laundry (03)	Water Closet (06)	7
8	Kitchen 1-	2. Sink	-	2
9	Kitchen 2-	2. Sink	-	5

Typically, these pipes are positioned above the false ceiling and beneath the floor. Because the garage or parking area must be incorporated, the ground level is set up differently. This floor also houses the sewage tank and subterranean water reservoir. Details are given below.

Table 4.2: Listing of fixture unit loads from each toilet and kitchen (Ground floor)

Sl. #	Description	Waste Stack Fixture Unit	Soil Stack Fixture Unit	Void Area
1	Toilet 1-	Floor Trap (01) + Shower (02) + Wash Basin (01) + Laundry (03)	Water Closet (06)	5

The total fixture load on each stack is listed below:

Table 4.3: List of Wastewater fixture loads on different stacks (Ground floor ~ 6th floor)

Void area	Fixture unit load on Waste Stack									Fixture unit load on Soil Stack								
	GF	1F	2F	3F	4F	5F	6F	7F	Total	GF	1F	2F	3F	4F	5F	6F	7F	Total
1	0	7	7	7	7	7	7	7	49	0	6	6	6	6	6	6	6	42
2	0	9	9	9	9	9	9	9	63	0	6	6	6	6	6	6	6	42
3	0	7	7	7	7	7	7	7	47	0	6	6	6	6	6	6	6	42
4	0	7	7	7	7	7	7	7	47	0	6	6	6	6	6	6	6	42
5	7	9	9	9	9	9	9	9	70	6	6	6	6	6	6	6	6	48
6	0	7	7	7	7	7	7	7	47	0	6	6	6	6	6	6	6	42

All the details of section fixtures are included in [CAD #03.]

4.3 Branch and Stack Pipe Selection

The diameter of each branch pipe is selected to be 100 mm. Because multiple pipe sizes are not needed for repairs, using the same size for all pipes eliminates the need for reducers and streamlines maintenance. A 100 mm branch pipe is more than adequate since it can take up to 160 FU, according to BNBC Table 8.7.16 (Appendix: BNBC Tables). This design decision is logical because the table also indicates that vertical stacks of this size can support up to 500 FU. The stack with a velocity reducer is depicted in CAD #01, and CAD #08 contains standard data for the joints of rain and wastewater pipes.

4.4 Design of Building Drain

The total load on the building drains is 222 FU for SS and 283 FU for WS. Based on BNBC Table 8.7.17 (Appendix: BNBC Tables), a 150 mm diameter pipe with a 1/100 slope is chosen. This setup can handle up to 700 FU of load, which is more than enough. The layout of the underground water supply reservoir is shown in CAD #16, and the plan for the building's drain and sewer system is shown in CAD #01. These two are kept far enough apart to prevent cross-contamination. CAD #11, CAD 14, and CAD #12 include detailed descriptions of the stack sections and connections of the typical inspection pits for the building drains.

4.5 Septic Tank Design.

BNBC- 2020, each residential building is required to have a septic tank. However, our project in Aftab Nagar, Dhaka, has access to a good drainage system, so a septic tank is not necessary. Therefore, we did not include a septic tank in the design of this project.

CHAPTER 5

STORM WATER DRAINAGE DESIGN

5.1 General

This building does not have any special systems for storing and managing stormwater. Instead, there are systems in place to drain rainwater easily through multiple rain stacks from the roof into the building drain.

5.2 Stormwater System Management

Each of the building's seven vertical pipe group zones has a or stack rain drainage pipe. Precipitation or storms from the roof, slope directions, and rain pipe locations are shown in CAD #08.

CHAPTER 6 CONCLUSION

This thesis illustrates a comprehensive analysis and design of the plumbing system of the building. Which includes ensuring proper dimensions and adequate water supply to all fixtures. By dealing with the captious aspects of sewerage, water distribution, and stormwater drainage this design attained both compliance and functionality by adhering BNBC 2020.

For reliable and efficient water supply the overhead tank and underground water tanks were designed aligning with the water demand of the building. The available pressure head confirms that there is adequate pressure for supplying the water to the varying operational conditions. To promote sustainable water management and to prevent water logging the storm water management system was designed properly.

The CAD drawings illustrate a pragmatic approach to this study, showing the clear and precise guidelines for implementation. To achieve a robust, effective and efficient plumbing system proper dimensioning of the component is very important, which was highlighted in this thesis. For the advancement of the plumbing design practices this thesis serves the purpose of a valuable reference for similar projects.

REFERENCES

1. Bangladesh National Building Code (BNBC). (2020). *Bangladesh National Building Code 2020: Volume 1.*
2. Bangladesh National Building Code (BNBC). (2020). *Bangladesh National Building Code 2020: Volume 3.*

APPENDICES

Appendix: BNBC Tables

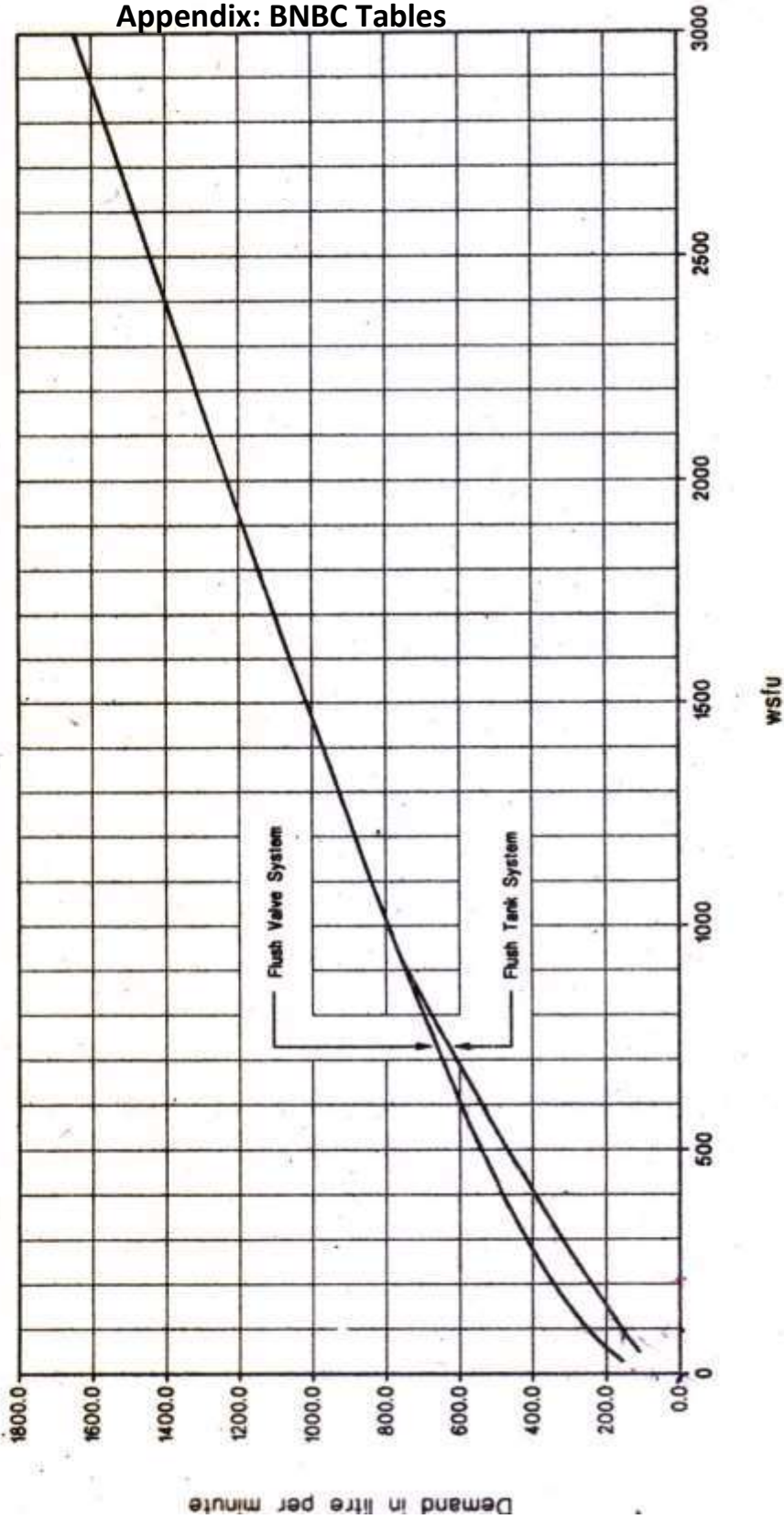


Fig. P 1 Water Supply Demand for Various Loads in Water Supply Fixture Units (wsfu)

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
Globe 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
Bath tub*	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.

[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 Stories in Height or 3 Intervals	More than 3 Stories in Height	
			Total for stack	Total at One Story 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
5	7000	8300	10000	12000

* Includes branches of building sewer

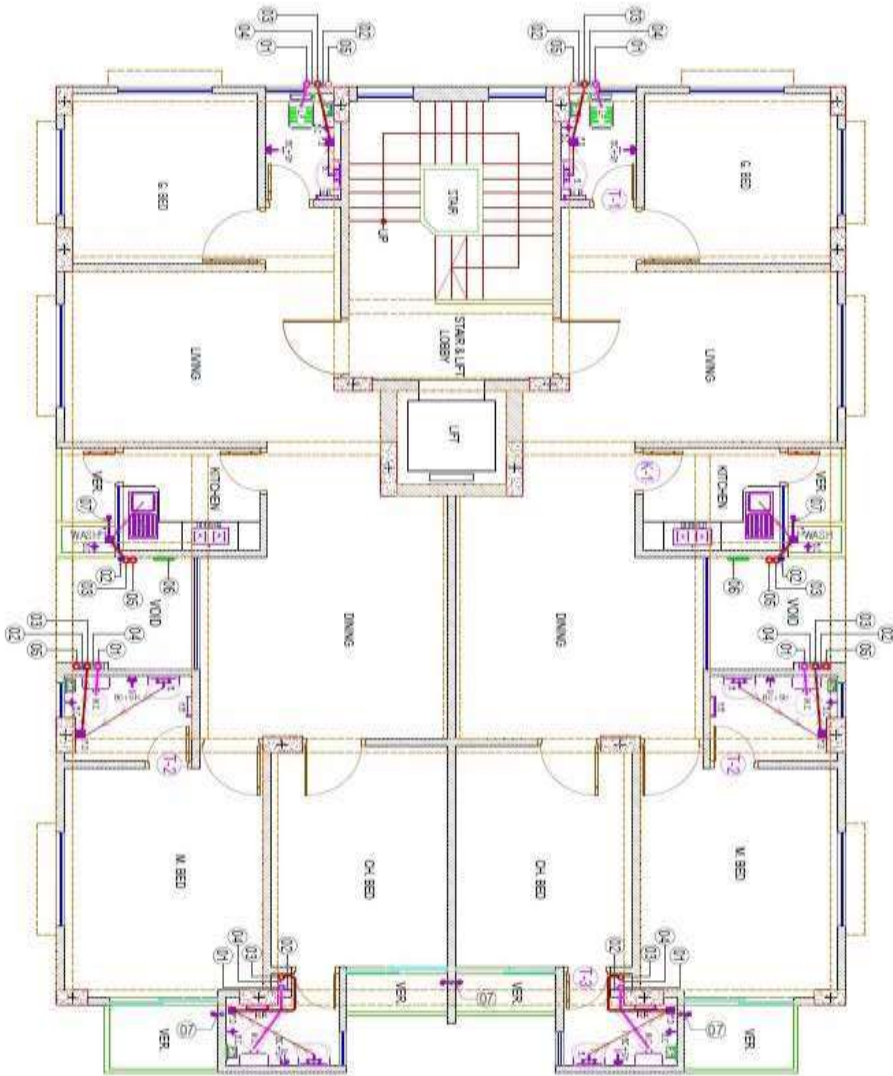
NOTATION :

BNBC	= Bangladesh National Building Code
UGWT	= Under Ground Water Tank
OHT	= Over Head Tank
WSFU	= Water Supply Fixture Unit
HDPE	= High-density polyethylene
FB	= Free Board
ASTM	= American Society for Testing and Materials
ACI	= American Concrete Institute
MPa	= Mega Pascal (N/mm ²)
psi	= Pound per square inch
kN	= Kilo Newton
kg	= Kilogram
mm	= Millimeter
cm	= Centimeter

01			4"ØuPVC Soil Pipe
02			1.½"Ø uPVC Pipe
03			4"ØuPVC Waste Water Pipe
04			2"ØuPVC Vent Pipe
05			4"ØuPVC Rain Pipe
06			1"Ø G.I Gas Supply Pipe
07			1¼"Ø PVC RWD Pipe

CAD-2

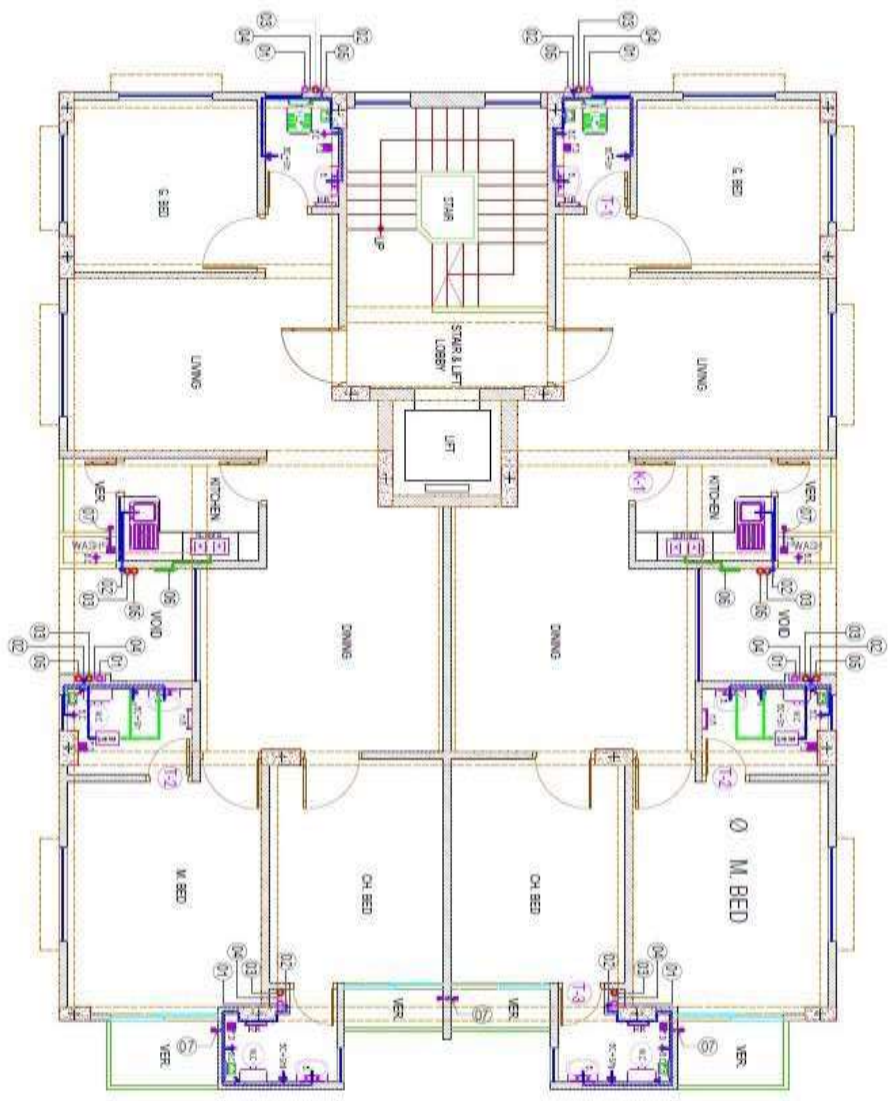
**BATH & KITCHEN FIXTURE LAYOUT WITH SOIL PIPE, WASTE WATER PIPE
AT 1ST TO 7TH FLOOR PLAN**



- 01 4"ØUPVC Soil Pipe
- 02 1.1/2"Ø UPVC Pipe
- 03 4"ØUPVC Waste Water Pipe
- 04 2"ØUPVC Vent Pipe
- 05 4"ØUPVC Rain Pipe
- 06 1"Ø G.I Gas Supply Pipe
- 07 1.1/2"Ø PVC RWD Pipe

	SINK
	BURNER
	BACINI
	W.C. PAN
	LONG PAN
	HAND RAIL
	PAPER HOLDER
	BIB COCK
	SHOWER
	FLOOR DRAIN

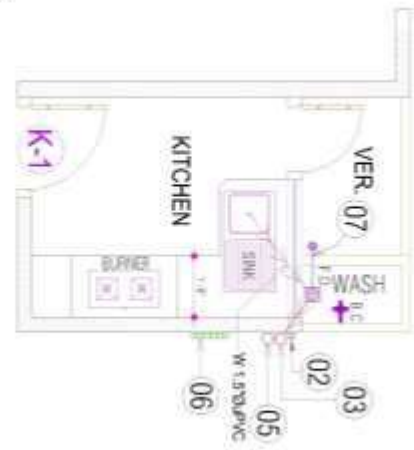
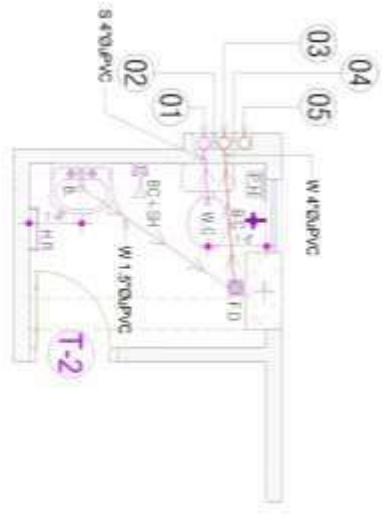
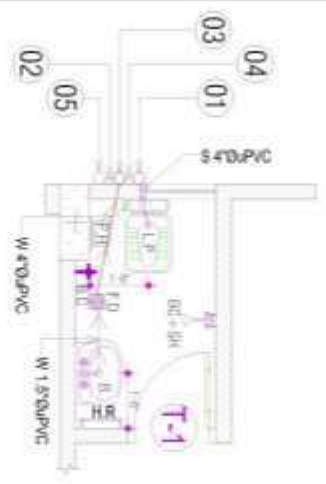
BATH & KITCHEN FIXTURE LAYOUT WITH WATER SUPPLY & GAS PIPE LAYOUT
 AT 1ST TO 7TH FLOOR PLAN

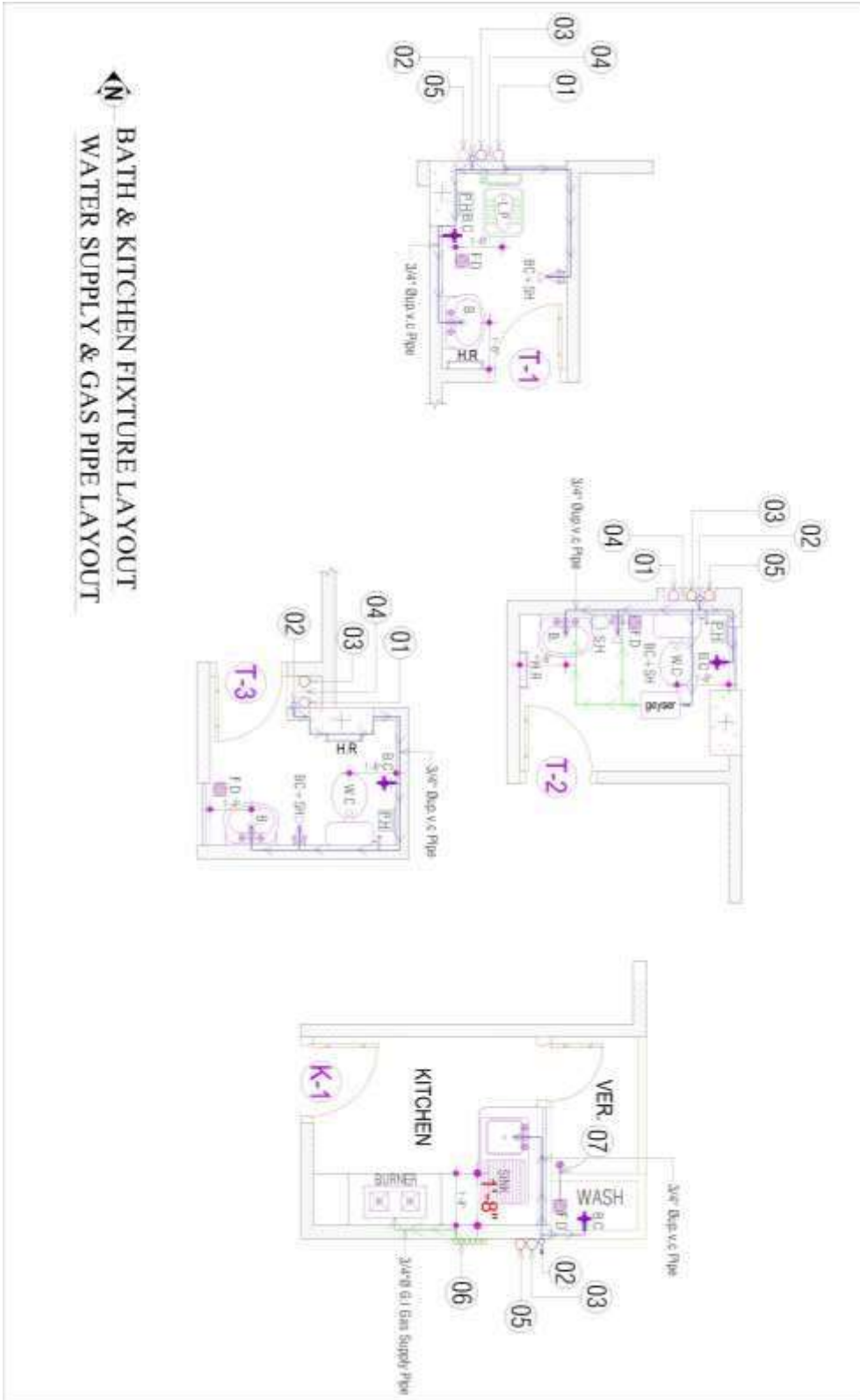


- 01 4"ØUPVC Soil Pipe
- 02 1.1/2"Ø uPVC Pipe
- 03 4"ØUPVC Waste Water Pipe
- 04 2"ØUPVC Vent Pipe
- 05 4"ØUPVC Rain Pipe
- 06 1"Ø G.I Gas Supply Pipe
- 07 1.1/2"Ø PVC RWD Pipe















	SNK
	BU. BURNER
	B. BASIN
	W.C PAN
	LP LONG PAN
	H.R HAND RAIL
	P.H PAPER HOLDER
	+ B.C BIB COCK
	+ S SHOWER
	FD FLOOR DRAIN

**BATH & KITCHEN FIXTURE LAYOUT
WITH SOIL PIPE, WASTE WATER PIPE**

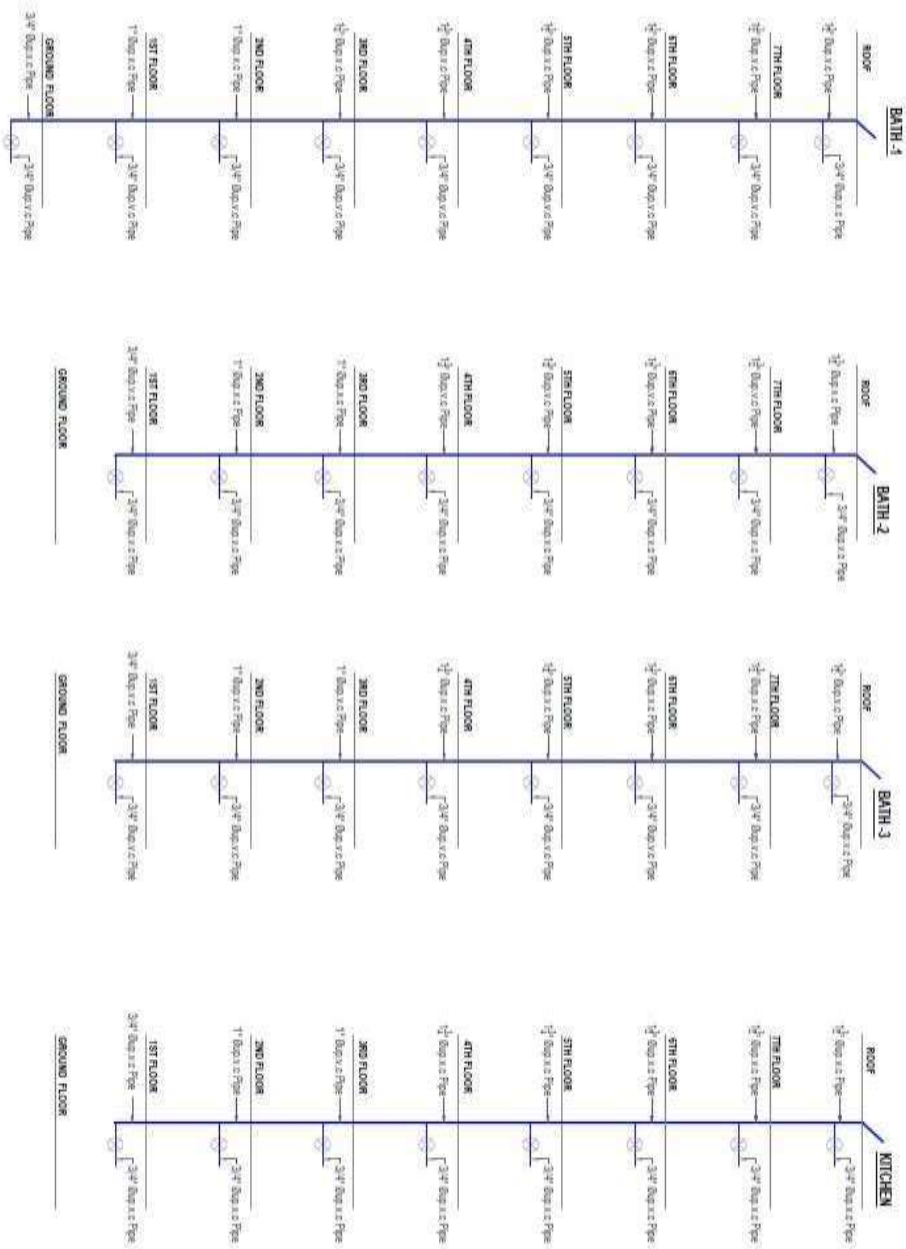




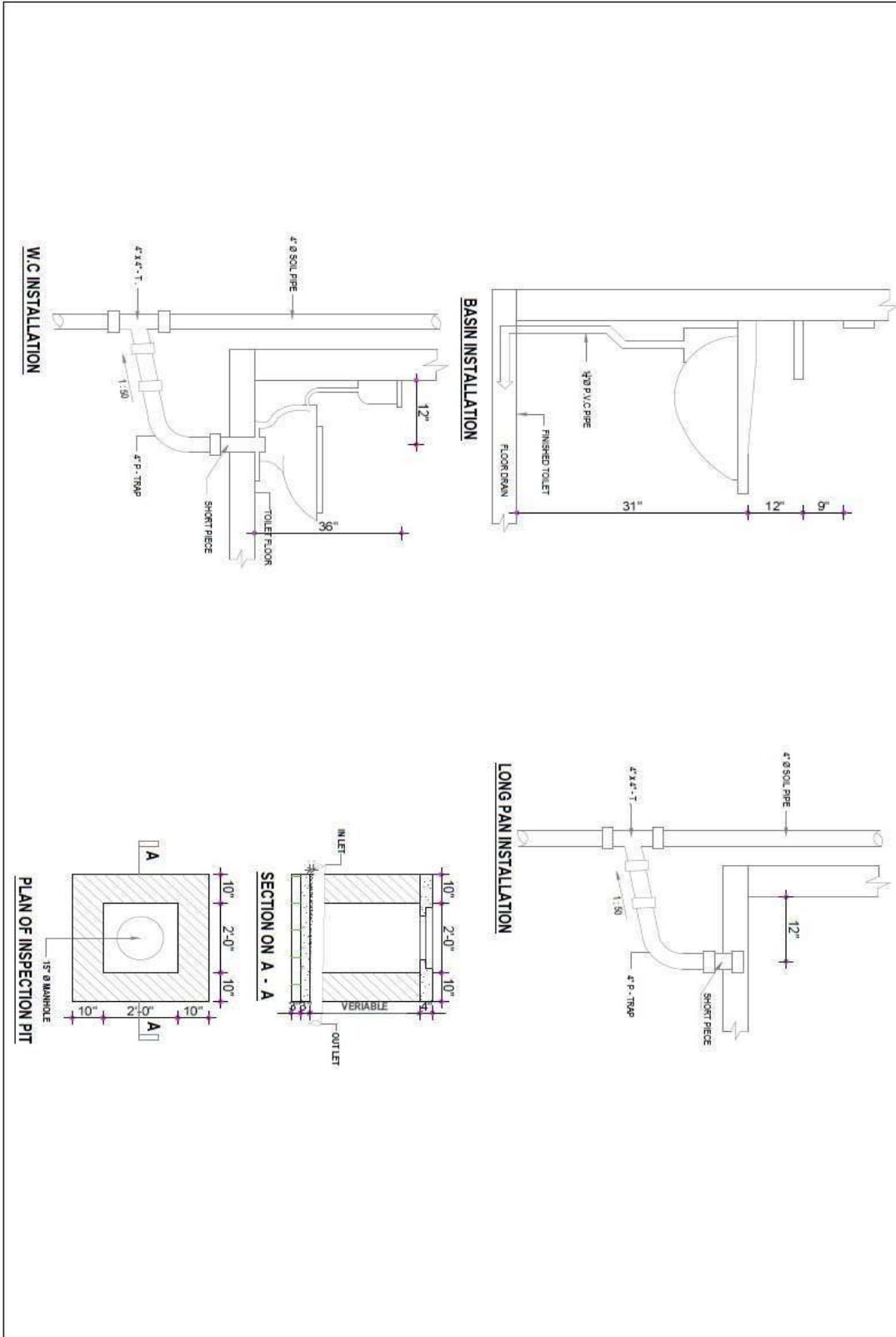
◀N BATH & KITCHEN FIXTURE LAYOUT
WATER SUPPLY & GAS PIPE LAYOUT

①			4"ØuPVC Soil Pipe
②			1.½"Ø uPVC Pipe
③			4"ØuPVC Waste Water Pipe
④			2"ØuPVC Vent Pipe
⑤			4"ØuPVC Rain Pipe
⑥			1"Ø G.I Gas Supply Pipe
⑦			1¼"Ø PVC RWD Pipe

WATER SUPPLY & DISTRIBUTION SYSTEM







LEGEND -1 (For Sewerage Disposal)

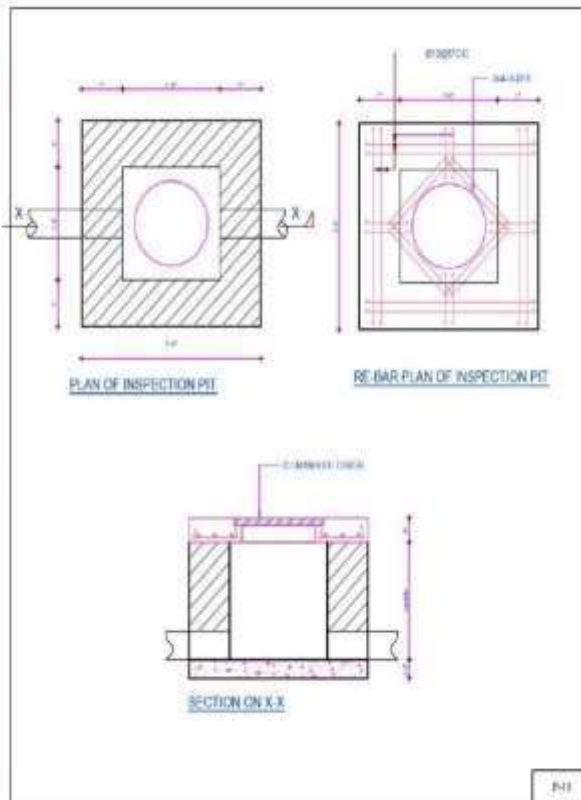
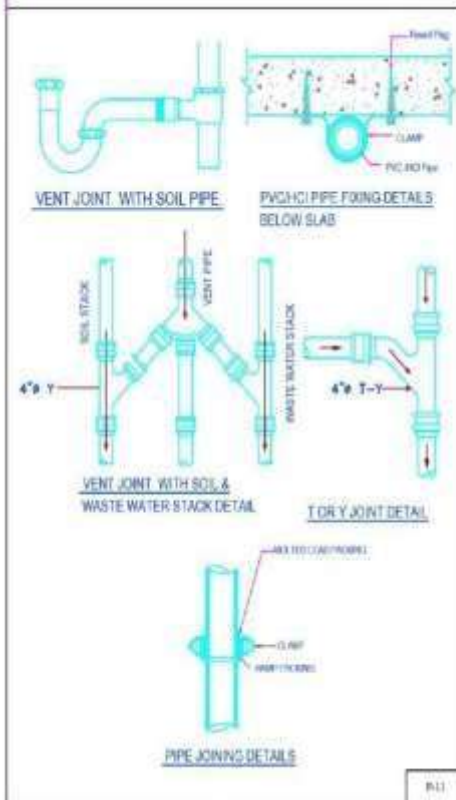
- SS- 4"Ø UPVC SOIL STACK
- WS- 4"Ø UPVC WASTE STACK
- RS- 4"Ø UPVC RAIN STACK
- RS1- 6"Ø UPVC RAIN STACK
- VK - 2"Ø HCL VENT STACK
- FT - FLOOR TRAP
- NT - NAHANI TRAP
- BMC - BELL MOUTH CONE (CONVEN)
- P - 1½"Ø PVC CONDUIT CONCEALED IN FLOOR
- D - DEPTH OF INSPECTION CHAMBER FOR SOIL
- d - DEPTH OF SUBFACE DRAIN FOR RAIN & WASTE WATER
- ☐ - INSPECTION CHAMBER FOR SOIL
- ⊗ - INSPECTION CHAMBER FOR WASTE WATER
- - 18"Ø CI MANHOLE COVER (HEAVY TYPE)

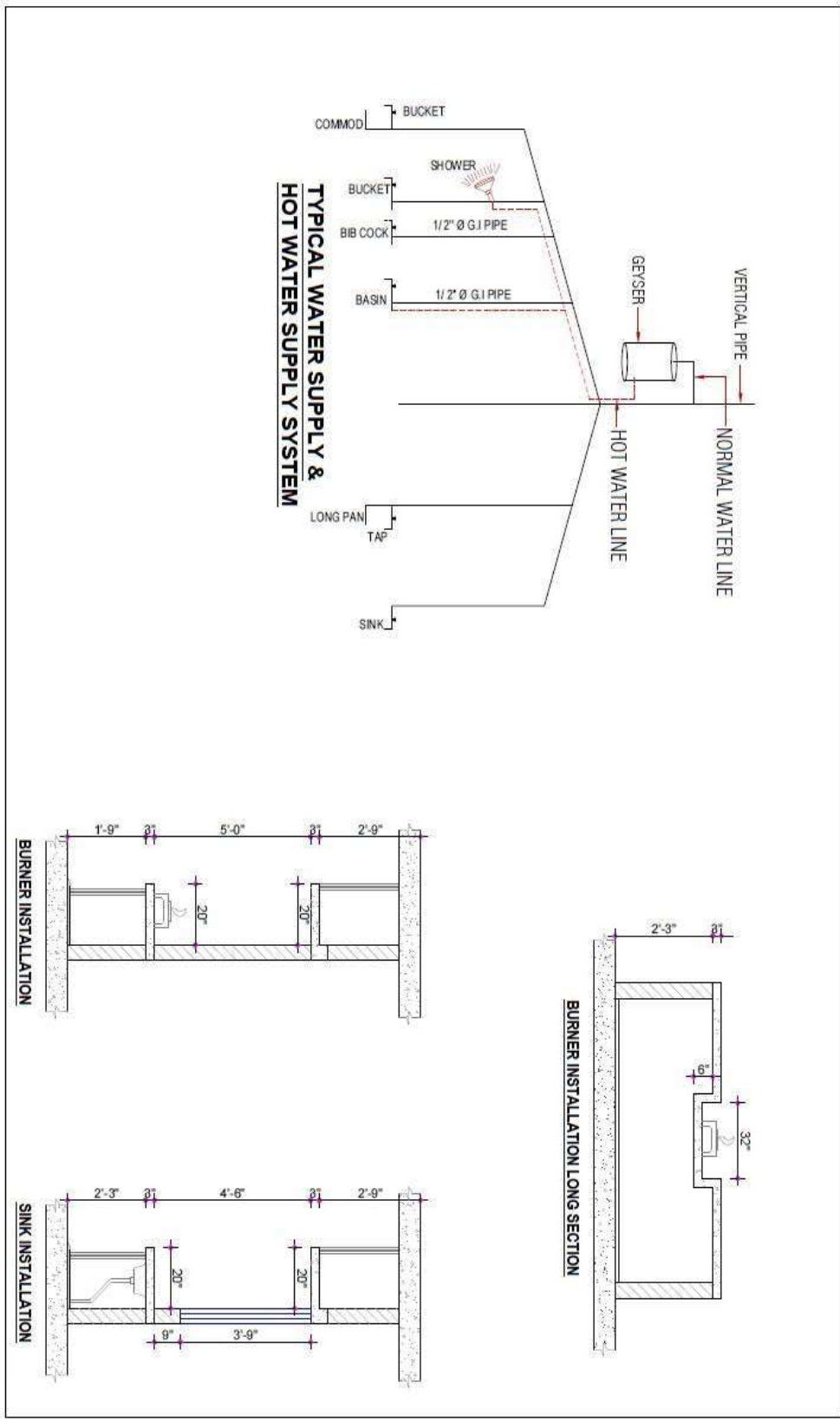
NOTES-1:

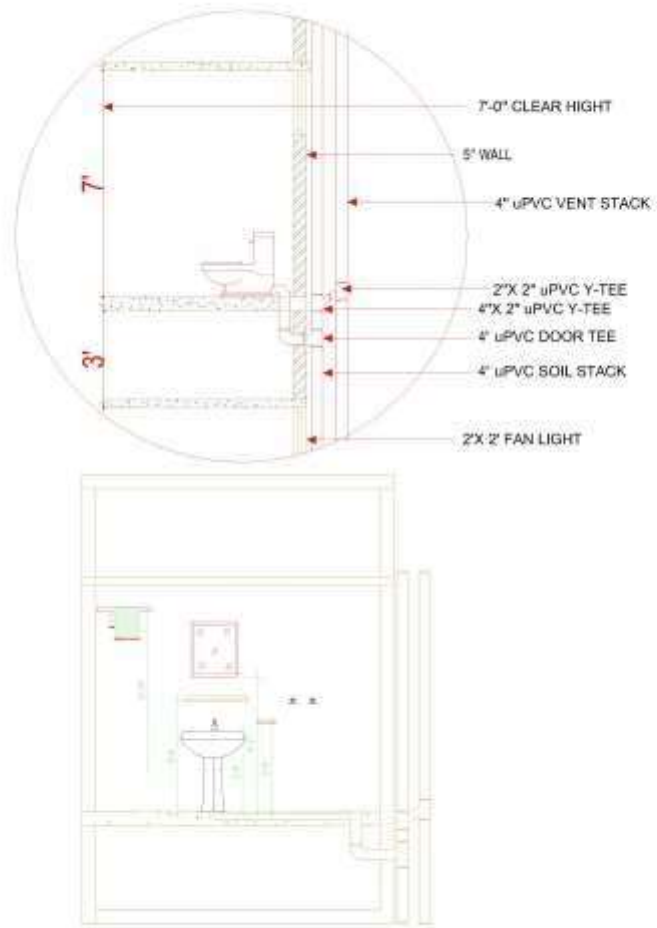
1. ALL STACKS SHOULD BE RAISED 2'-6" ABOVE ROOF LEVEL.
2. SLOPE OF ALL CONNECTION PIPES FROM FIXTURES & STACKS SHALL BE AS FOLLOWS:
 - (a) FOR SOIL 1 IN 40 FOR 4" DIA. 1 IN 60 FOR 6" DIA.
 - (b) FOR RAIN AND WASTE WATER 1 IN 90

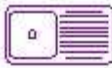





NOTE-2:

- 1) FOR 4"Ø HCL PIPE CONNECTION WITH SS BELOW FLOOR BEAM PROVIDE T-CONNECTION WITH INSPECTION DOOR.
- 2) FOR 4"Ø PVC PIPE CONNECTION WITH WS BELOW FLOOR BEAM PROVIDE T-CONNECTION WITH INSPECTION DOOR.

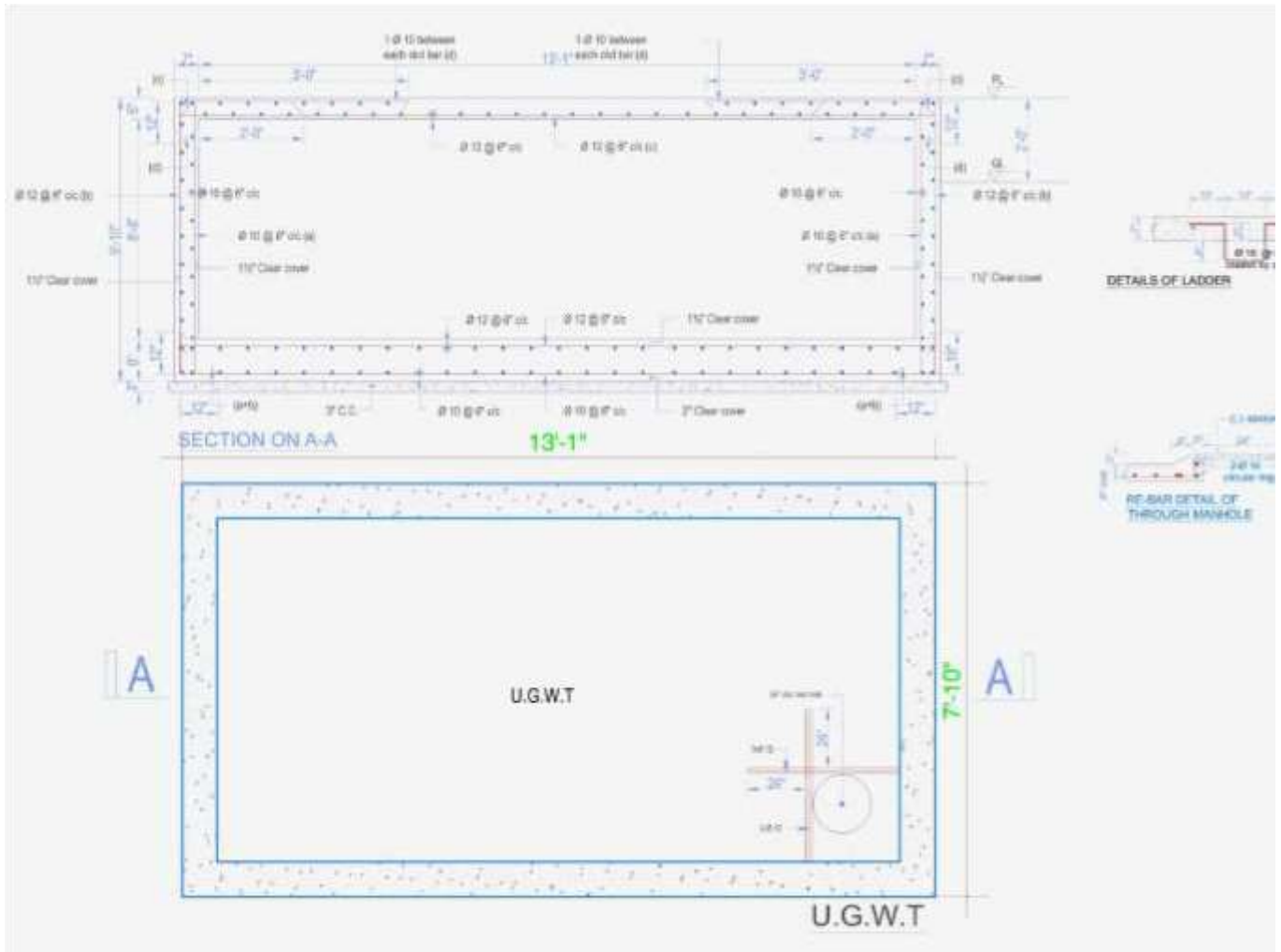






	SINK
 BU.	BURNER
 B.	BASIN
 W.C.	PAN
 L.P.	LONG PAN
 H.R.	HAND RAIL
 P.H.	PAPER HOLDER
 B.C.	BIB COKE
 S.	SHOWER
 F.D.	FLOOR DRAIN

CAD-15



CAD-16

