TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

PULCHOWK CAMPUS

DEPARTMENT OF CIVIL ENGINEERING

FINAL YEAR PROJECT REPORT on
DESIGN OF GRAVITY WATER SUPPLY SYSTEM, PHEDI, TARAKESHWOR

IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR DEGREE IN CIVIL ENGINEERING

(Course Code: CE755)

By:

Keshav Bishwokarma (075BCE071)
Rajan Bhusal (075BCE113)
Sandesh Tiwari (075BCE141)
Sujan Ghimire (075BCE175)
Suman Shrestha (075BCE176)

Supervisor:

Assoc. Prof. Shukra Raj Paudel

April, 2023

TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

PULCHOWK CAMPUS

DEPARTMENT OF CIVIL ENGINEERING

CERTIFICATE

This is to certify that this project work entitled "Design of gravity water supply system,Phedi Tarakeshwor" has been examined and declared successful for the fulfilment of academic requirement towards the completion of Bachelor Degree in Civil Engineering.

.....

Assoc. Prof. Shukra Raj Paudel

Project Supervisor

.....

Prof. Dr. Gokarna Bahadur Motra

HOD, Department of Civil Engineering

.....

Er. Arun Parajuli

External Examiner

.....

Er. Rabin Maharjan

Internal Examiner

ACKNOWLEDGEMENT

First of all, We want to thank our supervisor Assoc. Prof. Shukra Raj Paudel from the bottom of our hearts for his unwavering support and guidance throughout our project. His dedication and expertise in the field were instrumental in shaping our ideas and helping us to complete the project goals. We want to thank Dr. Vijay Yadav, Asst. Prof of English at Department of Applied Science, Pulchowk Campus for his edit in this report. We also want to thank Er. Arun Parajuli and Er. Rabin Maharjan for their suggestions on this report. We would also like to thank the Institute of Engineering (IOE) for including the final year project as a part of curriculum. Special thanks goes to the Department of Civil Engineering, Pulchowk Campus for making this project available which was beneficial for us to enhance our understanding of civil engineering.

We also want to express our gratitude to all of the direct and indirect collaborators who helped us finish the project on time. Last but not the least, we express our sincere gratitude to the community people, laboratory instructors, teachers and friends for their valuable ideas and co-operation.

Keshav Bishwokarma (075BCE071)
Rajan Bhusal (075BCE113)
Sandesh Tiwari (075BCE141)
Sujan Ghimire (075BCE175)
Suman Shrestha (075BCE176)

ABSTRACT

The final year project of a four-year bachelor's degree aims to give students a smooth transition between the academic and professional worlds. It allows students to demonstrate a wide range of skills learned during the period of four years of study and put them into practice in real world applications. It encourages them to get involved in team work and learn to interact in a professional setting. We, a group of five students, undertook a water supply project entitled "**Design of Gravity Water Supply System, Phedi Tarakeshwor**" and completed the work by the end of the final semester.

The project area lies in Phedi of Tarakeshwor Municipality, Kathmandu of central region of Nepal. The area is surrounded by hills on three sides and by Kathmandu Metropolitan City on the remaining side. Currently, there are around 150 houses with a total population of 735. This project's primary goal is to design a water supply system that will suffice the water demand in the area. Design period of 20 years is taken with an annual growth rate of 1.846% (based on the census of 2038 to 2078). Daily demand of 110 lpcd is assumed considering institutions, farms, and health posts. AutoCAD software is used for drawing of the designed structures and EPANET software is used for analysis of pipe networks.

Surveying of the site, laboratory water tests, and design of spring intake sedimentation tank, filtration tank, reservoir tank and pipe networks with their estimation was done. The reservoir tank is designed based on the capacity calculated, considering an intermittent water supply system.

TABLE OF CONTENTS

LIST OF ABBREVIATIONS

GI	Galvanised Iron
HDPE	High Density Polyethylene Pipe
LPCD	Litre per Capita Per Day
LPS	Litre Per Second
NDWQS	National Drinking Water Quality Standard
NRS	Nepalese Rupees
NTU	Nephelometric Turbidity Unit
pH	Potential Hydrogen
PPM	Parts Per Million
RVT	Reservoir Tank
SOR	Surface Overflow Rate
TCU	True Colour Unit
WHO	World Health Organisation
BOD	Biological Oxygen Demand
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
FRC	Free Residual Chlorine
CFU	Colony Forming Unit

LIST OF FIGURES

SALIENT FEATURES

S.No.	Items	Description
1	Name of the Project	Phedi Water Supply Project
2	Project Type	Design of water treatment and distribution network
3	Location	Phedi,Tarakeshwor
4	Available facilities	
	Road	Yes
	Supply water system	Yes (partial)
	Electricity	Yes
	Communication	Yes
	Health Services	Yes
	Banking Facilities	Yes
5	Current Population	735
6	Source Characteristics	Gravity type
7	Design Period	20 years
8	Design Discharge	2.60 LPS

EXECUTIVE SUMMARY

This report is prepared after completion of works under the project of "**Phedi Water Supply System, Tarakeshwor**" undertaken to meet water demand in the locality. Our work involved surveying of the site, calculation of water demand with the design population, water quality analysis and design of individual components involved in the supply system like intake,treatment plant, reservoir tank and pipe networks.

The designed water supply system operates on gravity, meaning that water flows naturally through the system without the need for additional energy. The water first enters the system through an intake and is then directed to the treatment plant. The treatment plant includes a plain sedimentation tank and filtration tank with a rapid sand filter and disinfection system to remove impurities and ensure the water is safe for consumption. Once the water is treated, it is stored in a reservoir tank and distributed through a piping system to provide access to clean water for the community. The gravity-based design of the system offers a cost-effective and efficient way to deliver clean water without the need for additional pumps or energy sources.

Water quality testing is an essential step in ensuring that water is safe for consumption. Laboratory tests are conducted to detect the presence of harmful contaminants such as Total Suspended Solids (TSS) and E-coli bacteria. Based on the test results, a suitable treatment plant must be designed to purify the water.One component of the treatment plant is the plain sedimentation tank. This tank has been designed to have a dimension of 9m X 2m X 3.5m, a sludge depth of 0.5m, and a free board of 0.5m.Another critical component is the filtration tank. This tank features a rapid sand filter, with a length of 1.8m, breadth of 1.4m, and total depth of 2.6m. There are two units of the rapid sand filter, each with a diameter of the central manifold of 20cm, and 12 laterals on each side of the manifold. The filtration tank also contains a chlorination unit, which requires 0.45 kg/d of bleaching powder.

Finally, the reservoir tank has a dimension of 5.0m X 5.0m X 3m and is used to store the purified water. The total cost of the project is estimated to be Rs. 1,70,70144.88. The project cost includes all of the necessary components and equipment, as well as the labour and expertise required to design and build the treatment plant.

INTRODUCTION

1.1 Background :

Among the five essential requirements for survival, mainly air, water, food, heat, light or shelter, Drinking water is one of the basic needs of human beings. Lack of a water supply system can result in many problems in human life like lack of productivity and increase in pollution of surroundings. To cope up with this situation, A managed water supply system in Phedi, Tarakeshwar is in need. These days the supplied water system is unmanaged, and the supply is not met according to demand. This project aims to have a complete managed and functional water supply system in that area to supply the water according to the demand.

1.2 Objectives:

The main objectives of the project work is to design an implementation level design and estimation report on gravity water supply system for the fulfilment of academic requirements towards bachelor's degree in civil engineering. The specific objectives are:

- To perform design and estimation of each component of the gravity water supply system.
- To prepare an implementation level report.

1.3 Relevancy of the Project Work:

It is said that health is wealth. Good health can contribute to the well being of not only the individual but also to the nation. Insufficient water in a community reduces the productivity of an individual and also contributes to bad health. In a locality called Phedi of Tarakeshwor municipality, the water supply system is unmanaged and insufficient to fulfil the needs of the community. Sometimes, water received by the community seems to be contaminated with faeces which contributes to poor health of individuals. The project undertaken by us is relevant in solving these current problems of the community.

1.4 Limitations of the Project Work:

The limitations of our project work are:

- Project Work is limited to a smaller part of Tarakeshwor Municipality.
- It was carried out under time and budget constraints.

- It doesn't follow Water Supply Design Guidelines of Nepalese Context like Rural Water Supply and Sanitation Fund Development Board, 2012.
- Cost of Transportation of materials is not considered.
- EPANET software is used where the network is designed based on trial and error methods.

1.5 Organization of the Report:

The report consists of five chapters as follows:

Chapter 1: Introduction

This chapter includes background, objectives, relevancy and limitations of the work.

Chapter 2: Literature Review

This chapter includes information related to the water supply system based on literature, guidelines, policies, act and regulations.

Chapter 3: Methodology

This chapter describes the method adopted in the project work

Chapter 4: Outcomes and Discussions

This chapter consists of outcomes after the design and estimation of project work and discussions related to the outcomes.

Chapter 5: Conclusion

This chapter concludes the work and gives recommendations.

LITERATURE REVIEW

2.1 Location and Accessibility of Area:

The area lies in Tarakeswar Municipality, a neighbouring municipality of Kathmandu Metropolitan City. The area lies at a latitude of 27.79 and longitude of 85.29. Project area can be accessed directly through public or private transportation from Kathmandu Metropolitan City.

Project Map

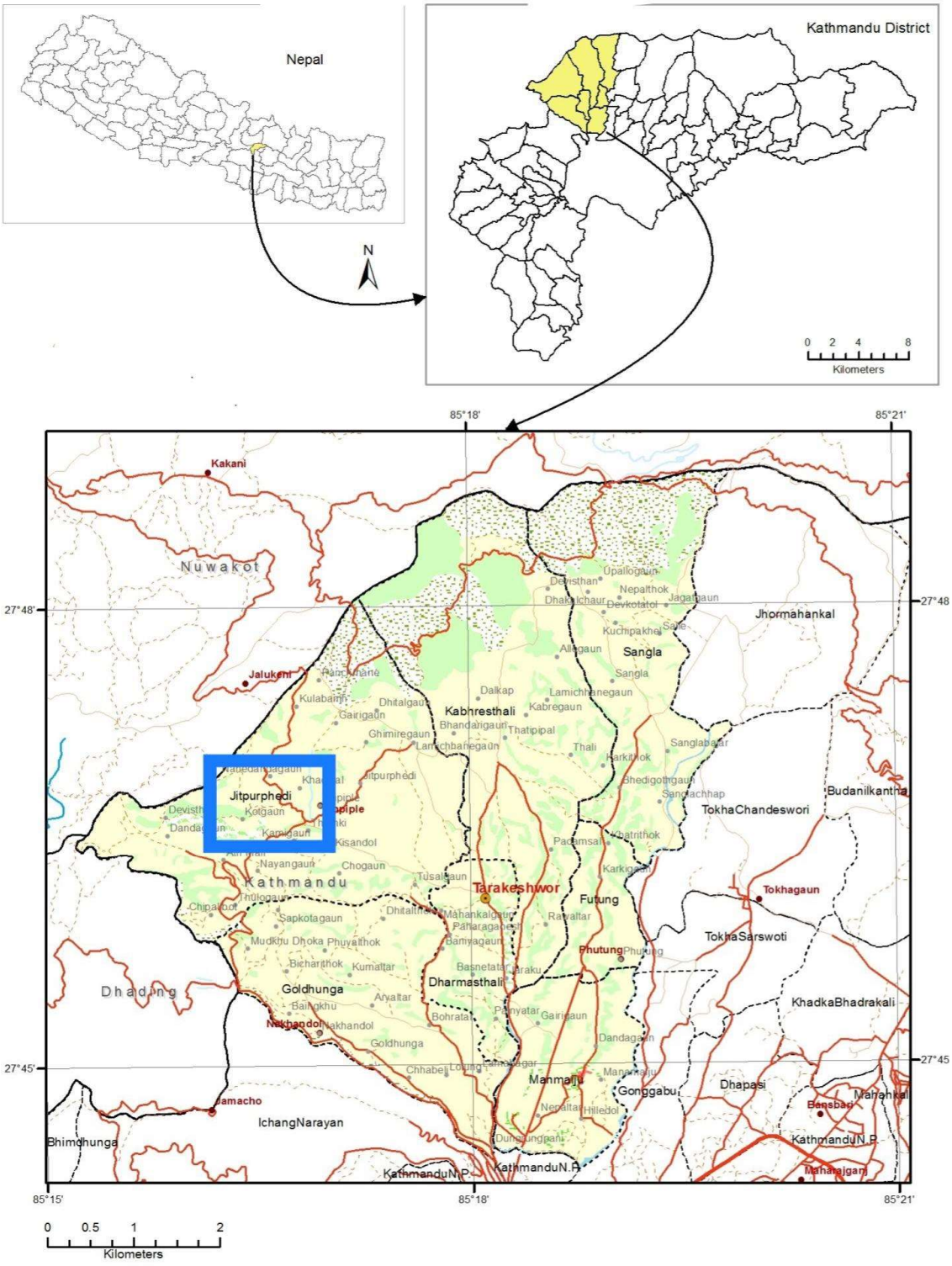


Fig 2-1: Study Area Map

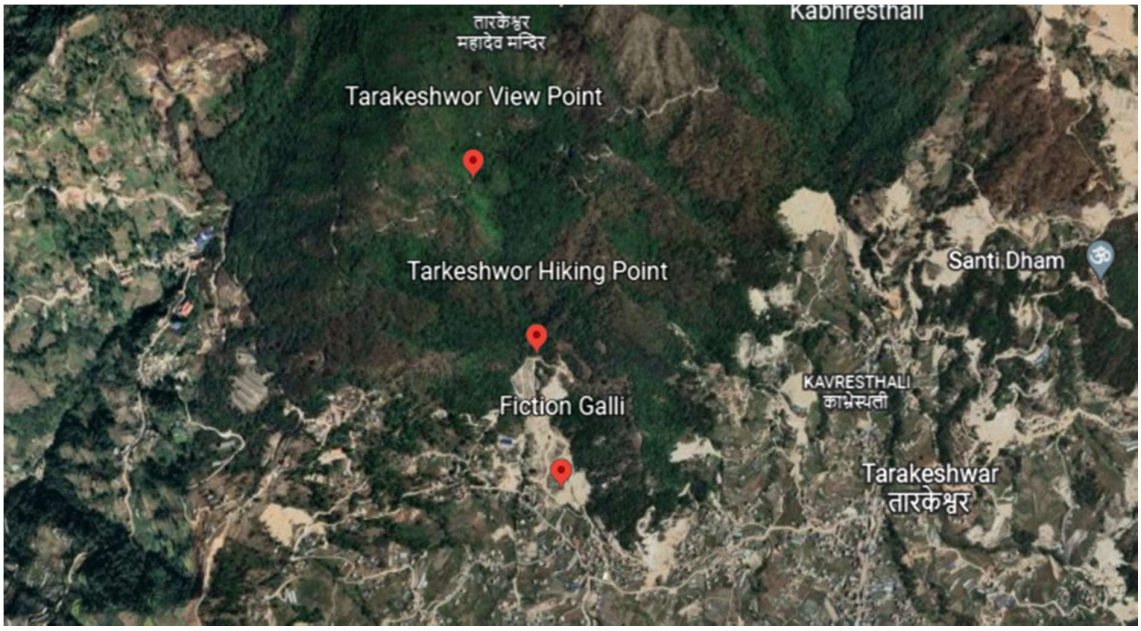


Fig 2-2-: Map of Village

Fig 2-3: Map of Source

2.2 Sources of Water:

Design of gravity water supply system,Phedi Tarakeshwor by Keshav,Rajan,Sandesh,Sujan,Suman [5]

The following two categories can be used to categorise the many water sources that are accessible for water supply. (a) Surface sources of water (b) Sub-surface or Underground sources of water.

Surface Sources are those sources of water which are available at the ground surface. The various sources of water included in this category are (i) Lakes and Ponds (ii) Streams or Rivers (iii) Storage Reservoirs (iv) Oceans

Sub-Surface or Underground Sources of Water are those sources of water which exist below the ground surface. The various sources of water included in this category are as indicated below. (i) Infiltration gallery (ii)Infiltration wells (iii) Springs (iv) Wells and Tube-wells
The water source involved in our project is the spring water source.Spring is a water source formed by the intersection of hill slope or a valley bottom with flowing body of groundwater at or below its groundwater table. The quantity of water in the spring depends on the size of rock voids, pressure of water in the aquifer, amount of rainfall and more.

2.3 Intake:

An intake is a structure or mechanism put in a water source to allow water to be drawn from it,and discharge it to the treatment plant; or discharge it into an intake well from where it is pumped to the treatment plant.
The site for intake should be selected such that:

1. The location should be chosen such that water can enter even at the lowest water level.
2. In order to reduce the cost of conveying, it should be as close as possible to the treatment facility.
3. It should be placed where it can accept relatively clean water that is free of dirt, sand, and other floating debris.
4. It shouldn't obstruct any river traffic that might be there.
5. Good foundation conditions and the least amount of scouring are ideal for the site.
6. Site should have sufficient space for future expansion and construction.
7. Site should not be located in curves for meandering sources like rivers.

Types of intake include Submerged intake or Exposed intake, Wet intake or dry intake and depending on sources: river intake ,reservoir intake, lake intake, spring intake etc.

The criteria for design of intake:

(i) It is important to take enough safety factors to ensure that the intake work can withstand the external forces brought about by strong waves and currents, the impact of floating and submerged bodies, and pressure from ice, among other things.

(ii) A significant amount of self-weight should be present in the intake so that it can float on the water's upthrust and be swept away by the stream. Massive masonry construction should be done, and the bottom should be tilled with broken stones, to prevent the intake structure from floating.

(iii)The foundations of intakes should be taken sufficiently deep so that they may not be undermined, and current may overturn the structure.

(iv)To avoid the entrance of large and medium objects and fishes, screens should be provided on the inlets, sides.

(v)The inlets of intakes should be of sufficient size and allow the required quantity of water to enter.

(vi)The placement of inlets should be such that water can be admitted at all times close to the water's surface, where the water quality is good. There should be multiple inlets so that water may be collected from other sources if one is blocked. In order to prevent air from getting inside the suction pipe, the inlets must be entirely submersible.

2.4 Water Quality Analysis:

Following tests are to be done to analyse the quality of water:

Physical Parameters: Turbidity (NTU), Temperature, Colour, Taste and Odour,Solids,

Electrical Conductivity

Chemical Parameters: Hardness, pH, Arsenic, Chlorides, Iron,Chromium, Copper, Fluoride, Chlorine, Calcium, Mercury

Microbiological Parameters: Coliform, E-coli

2.4.1 Physical Parameters:

2.4.1.1 Turbidity:

Colloidal matters present in the water provide turbidity to the water. The turbidity is a gauge of a liquid's reluctance to let light through. Hence, the usual suspension of siliceous materials like fuller's earth is used to quantify turbidity. The standard unit of turbidity is the turbidity produced by one part of fuller's earth in one million parts of distilled water. Part of suspended matter per million parts of water by weight, or ppm, is how it is expressed. Typically, a nephelometer's measurement of turbidity is represented in NTU units (Nephelometric Turbidity Unit).

2.4.1.2 Temperature:

Temperature is a measure of the degree of hotness of water. It is generally measure in degree celsius.Measurements of temperature are crucial for determining the levels of water's density, viscosity, vapour pressure, and surface tension. Other factors such as BOD and biological activities of water are dependent on the temperature.

2.4.1.3 Colour:

Water gets colour due to organic matters in true solution colloidal

Suspension. Colour is generally measured in Hazen scale. The range of colour in drinking water should be within the specific range as specified by governing agencies of respective countries.

2.4.1.4 Taste and Odour:

Mineral salts, tarry substances, home sewage, industrial wastes, organic materials, and certain chemical compounds can all cause taste and odour to develop in water. Odour intensity is quantified using a threshold odour number.

2.4.1.5 Electrical Conductivity:

An electrolyte solution's conductivity (or specific conductance) is a gauge of how well it conducts electricity. Conductivity is measured in SI units called Siemens per metre (S/m).

As a quick, low-cost, and accurate method of determining the amount of ions in a solution, conductivity measurements are frequently employed in a variety of industrial and environmental applications.

For instance, measuring product conductivity is a popular method for tracking trends in the performance of water purification systems over time.

Due to the increased dissociation of H2O in H+ and OH with T, When the temperature(T) rises, ultra-high purity water's electrolytic conductivity also rises .Conductivity frequently has a direct relationship with the total dissolved solids (TDS).

2.4.2 Chemical Parameters:

2.4.2.1 pH:

The concentration of hydrogen ions in water is gauged by pH. It is scaled from 0-14 where 0 represents highly acidic and 14 represents highly basic water. pH is measured by the methods: i) Electrometric method(with the help of potentiometer) ii) Colorimetric method(Water is treated with chemicals or indicators, and the resulting colour is compared to the known pH values' standard colours.)

2.4.2.2 Hardness:

Hardness is a property of water that prevents soap from creating lather or froth. Bicarbonates, sulphates, chlorides, and nitrates along with calcium and magnesium contribute to hardness. The sum of the carbonate and noncarbonate hardness in water is known as the total hardness.

2.4.3 Microbiological Parameters:

2.4.3.1 E-coli:

E-coli is a coliform bacteria inhabiting the intestines of human beings and animals and are thus excreted in large amounts with faeces. Water contaminated with sewage will contain E-coli bacteria.According to Drinking Water Quality Standard of Nepal 2062, the quantity of E-coli bacteria in drinking water should be zero. The water with the presence of E-coli bacteria should undergo disinfection and chlorination treatment.

2.5 Sedimentation Tank:

The sedimentation tanks,for settlement of sediments, are typically constructed of reinforced cement concrete and it could have a circular or rectangular shape. Depending upon the method of operation the sedimentation tanks are of two types. (1) Fill and draw type sedimentation tanks (2) Continuous flow type sedimentation tanks.

Design Considerations for sedimentation tank are :

1. Velocity of flow
2. Relationship between a particle's settling speed and the rate of surface overflow (or overflow rate or surface loading)
3. Detention period
4. Flowing-through period
5. Settling tank efficiency
6. Inlet and outlet arrangements
7. Sludge removal

There are two types of sedimentation: plain sedimentation and sedimentation with coagulation (coagulation, flocculation and sedimentation). In our project, plain sedimentation is used, where heavy sediment loads are removed from water by the action of natural forces like gravity prior to subsequent treatment processes like filtration.

Plain Sedimentation:

The process of plain sedimentation involves using gravity to remove suspended materials from water.

Principle of plain sedimentation*:* Discrete particles are those particles that do not change in size, shape, or weight while rising or settling in any fluid. Due to gravitational force, all particles with specific gravities greater than liquid will migrate vertically downward.

Any discrete particle will accelerate as it passes through a quiescent fluid until gravitational forces acting on the particle are balanced by the frictional resistance or drag force. The particle will settle at a uniform velocity at this point. This constant velocity, often known as "Settling Velocity," is a crucial element

.

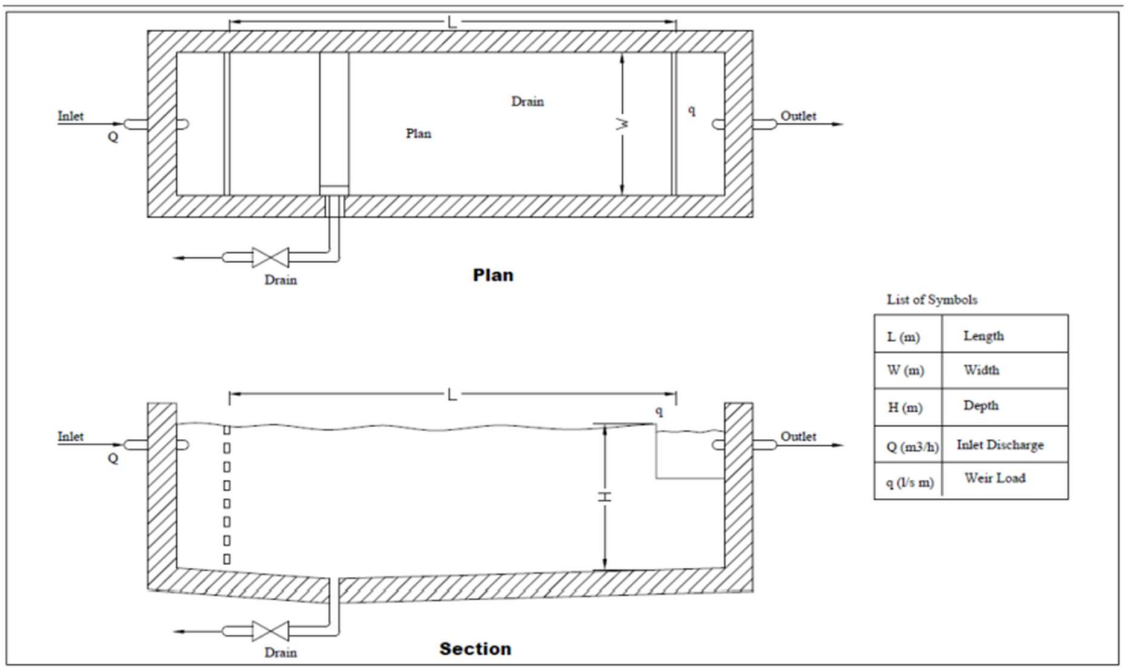


Fig 2-4: Plain Sedimentation Tank

Design criteria for Plain Sedimentation Tank:

Detention time = 4 – 8 hours

Surface overflow rate = 12 – 18 □^{3} /d/□^{2}

Horizontal flow velocity = 0.2 – 0.4 m/min

2.6 Filtration Tank:

2.6.1 Filtration:

Filtration changes the chemical properties of water, removes some of the suspended and colloidal debris present in it, and decreases the amount of bacteria in the water. The four acts listed below can be used to describe the effects that filtration has on water in the ways previously mentioned. Mechanical straining is one of the causes, followed by sedimentation and adsorption,cellular metabolism and changes in electrolyte.

i) Mechanical Straining: Because the particles of suspended material are too large to fit through the spaces or voids between the sand grains, mechanical straining prevents and

eliminates them. It cannot, however, remove colloidal particles or microscopic microorganisms.

(ii) Adsorption and sedimentation: The sand grains act as little sedimentation tanks for the particles of suspended materials.

The edges of the sand grains become covered with the suspended particles. These particles stick to the sand grains due to the following two reasons: (a) The sand grains and suspended particles are physically attracted to one another.

(b) As a result of previously deposited colloidal debris and bacteria creating a gelatinous covering on the sand grains.

Therefore, colloids, tiny particles of suspended debris, and bacteria are eliminated by the processes of sedimentation and adsorption.

(iii) Biological Metabolism: Biological metabolism is the process through which living cells develop and maintain their existence. The bacteria that are trapped in the sand grain holes need organic impurities like algae, plankton, etc. as food to survive. Therefore, these organisms make use of the organic contaminants in the water and transform them into innocuous molecules through intricate metabolic processes. The sand's surface is covered with a layer of the innocuous substances that have been created, which contains a zoological jelly where biological activity is at its peak. The name of this stratum is schmutzdecke (dirty skin). This layer also aids in absorbing and removing pollutants.The bacteria also consume one another and maintain the balance of life in the filter in addition to removing the organic impurities and converting them into harmless compounds.

(iv)Electrolytic action : Ionic theory also provides an explanation for how filters work. According to this theory, new chemical compounds are created when two chemicals that have opposing electric charges come into contact with one another. It has been noticed that some of the filter's sand grains have polarised electrical charges. As a result, when particles of dissolved and suspended materials with oppositely polarised electricity come into touch with such sand grains, they neutralise one another and change the chemical composition of water. After some time, the sand grains' electrical capacity is depleted. It is therefore required to clean the filter and restore this property to it.

2.6.2 Filter :

2.6.2.1 Introduction: A media filter is a type of filter that filters water using a bed of anthracite, crushed granite, peat, shredded tires, foam, crushed glass, geo-textile fabric, or other material.

2.6.2.2 Types of filter: The two criteria used to categorise filters are their filtering rate and their ability to push water past filler despite frictional resistance.

The filters are divided into two categories based on their rate of filtration:

I. Slow sand filter and
II. Rapid sand filter

Rapid gravity filters and pressure filters are further classifications of rapid sand filters.

Either the force of gravity or the force of the applied pressure force can be used to push against the frictional resistance that the water encounters as it passes through the filter. As a result, the fillers are divided into two categories based on the driving force:

I. Gravity filters and
II. Pressure filters.

There are two further categories for gravity filters: (a) Slow sand filters, and (b) Rapid sand filters.

Combining the two categories mentioned above, the three different types of filters are as follows.

Sluggish sand filters

II. Rapid gravity filters, or Rapid sand filters (gravity type),

III.Pressure filters, third

2.6.2.3 Rapid Sand Filter:

The quick sand filter or rapid gravity filter is a popular type of filter used in municipal drinking water facilities as part of a multi-stage treatment system. In the case of these filters, the raw water is often only supplied to the filters after it has undergone sedimentation treatment. The rapid sand filter consists of following components:

(i) Enclosure Tank (ii)Filter Media (iii) Base Material (iv)Under drainage System (v)Appurtenances

i) Enclosure Tank : A stone, brick, or concrete rectangular open waterproof tank may be used.The tank is between 2.5 and 3.5 metres deep. The tank's surface area can range from 10

to 50 m2. Therefore, a variety of tiny filter units are offered based on the overall amount of filter surface area required.

The placement of these filter units is in series. Additionally, for operational flexibility, bigger water treatment facilities should include a minimum of four filter units, while smaller facilities should have a minimum of two filter units. The length to breadth ratio of the tank is normally kept between 1.25 and 1.35.

ii) Filter Media: Sand layer, also known as sand bed, is the filter material and is 60 to 75 cm thick. The sand's effective size ranges from 0.45 to 0.70 mm. Sand's uniformity coefficient, Cu, ranges from 1.3 to 1.7, with a typical value of 1.5. The void space in the filter media is raised as a result of a bigger effective size and a lower uniformity coefficient, increasing the rate of filtration for this filter.

iii)Base Material: The base material, which is a 45–60 cm thick gravel bed, supports the sand layer. Gradually graded and layered gravel is used for the bed. Gravel of different sizes should be layered with little gravel at the top and large gravel at the bottom.

iv)Under Drainage System: The under drainage system has two functions in the case of quick sand filters (gravity type): (a) It collects the filtered water uniformly over the gravel bed area.

(b) It distributes backwash water uniformly without disrupting the gravel bed or the filter medium.

v) Appurtenances: The important appurtenances in rapid sand filter include wash water troughs, air compressors, rate control devices, other devices like head loss indicators etc.

Rate of Filtration: The rate of filtration for a rapid sand filter (gravity type) varies from 3000 to 6000 litres per hour per m2 of filter area (or 50 to 100 litres per minute per m2 of filter area). The high rate of filtration results in considerable saving of space for the installation of filter as well as filter materials

Efficiency of rapid sand filters (gravity type): Bacterial burden I The gravity-type fast sand filters are less effective at removing bacterial load. It is anticipated that they will eliminate between 80 and 90 percent of the water-borne bacterial load.

Turbidity, (ii) The gravity-type fast sand filters may reduce turbidity by 35 to 40 ppm. As the water passing through these filters is always treated in a coagulation sedimentation tank, its turbidity is usually between 35 and 40 parts per million.

Color (iii). Rapid sand filters (gravity type) are very effective in removing colour. On the cobalt scale, the colour intensity can be reduced to less than 3.

Standards of performance for rapid sand filters (gravity type): The following performance requirements for gravity-type fast sand filters have been suggested.

(a) The filtrate must be transparent and have a turbidity of no more than 1 NTU.

(b) The filtrate must be colourless (3 or less on the cobalt scale).

(c) The filter runs should typically last at least 24 hours and have a maximum head loss of 2 m.

(d) For a filter to be effective, the amount of water used for washing should not be more than 2% of the amount filtered between washings.

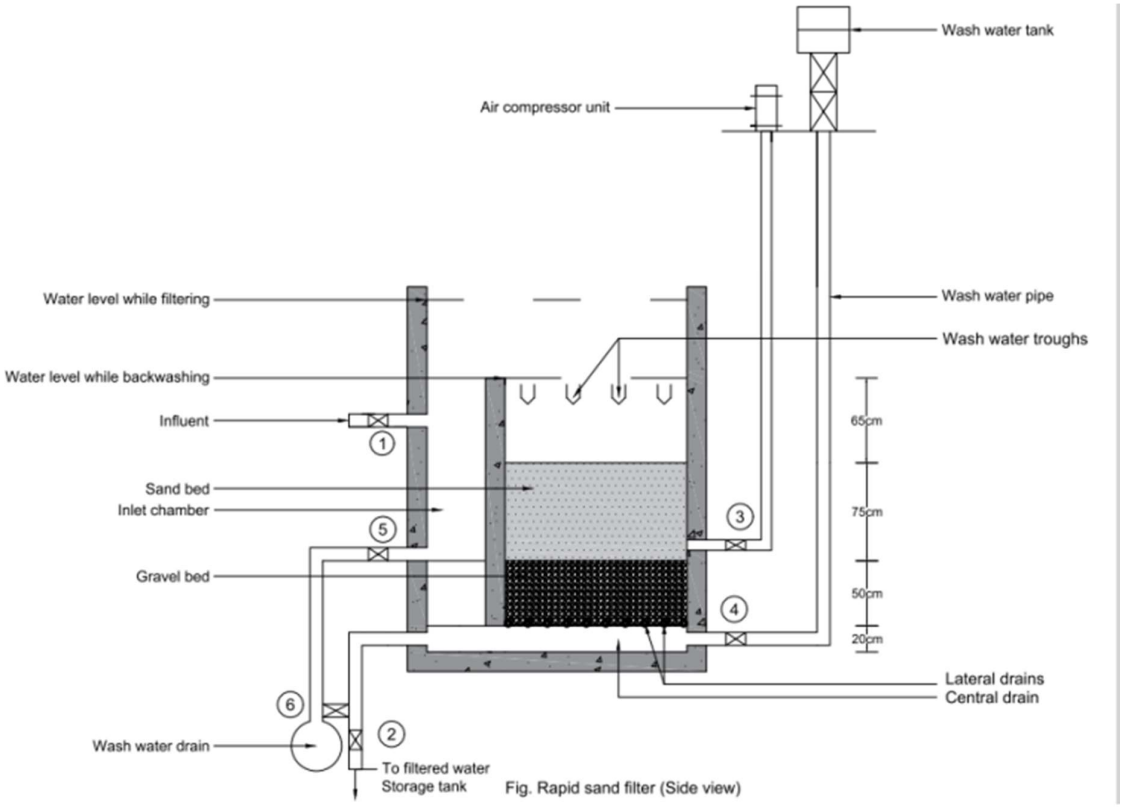


Fig 2-5: Rapid Sand Filter

Design Criteria for Rapid Sand Filter:

Rate of filtration = 3000-6000 litre/hr/m

Enclosure tank:

Depth: 2.5 to 3.5 m

Surface Area : 10 to 50 m^2

Length/breadth ratio: 1.25-1.35

Filter media:

Depth :0.6m-0.75m

Effective size of sand: 0.45 to 0.70 mm.

Uniformity coefficient, Cu: 1.3 to 1.7

Provide at least 2 units (1functioning+1 spare)

Estimation of thickness of sand bedby Hudson formula:

$(Q*(d^3)*h)/l=B_i*29393$

in which

Q = rate of filtration in m^3/hr/m^2;

d = sand size in mm

h = terminal loss of head in m

l = thickness of sand bed in m

B_i= break through index whose value ranges between 4×10^4 to 6×10^{-3} depending on response to coagulation and degree of Pretreatment in filter influent.

Estimation of gravel size gradation

l=2.54klogd

Taking k=12 (12-14)

d= dia. Of gravel (2mm,5mm, 10mm,20mm,50mm) from top to bottom and depth

total depth= up to 60 mm

Under drainage system

· Length/diameter of the lateral <60.

· Spacing of the laterals = 15 to 30 cm.

· Cross-sectional area of the manifold=(1.5 to 2)* cross-sectional areas of the laterals.

· Diameter of perforations in the laterals= 5-12mm

·Angle of perforations is at a slight angle (usually 30°) with the vertical axis of the pipe

- Spacing of perforations along the laterals= 80 mm (perforations of 5 mm dia) to 200 mm (for perforations of 12 mm dia)

·Total area of perforations / area of the entire filter area =0.003.

·Total area of perforations in the underdrainage system /cross-sectional area of the laterals <0.5 for perforations of 12 mm diameter and should decrease to 0.25 for perforations of

· for 5 mm diameter, Total area of perforations/ Total area of perforations < 0.25

Wash water trough

· Horizontal distance travelled by the dirty water over the surface of the sand bed is kept between 0.6 to 1.0 m before entering the trough.

· spacing of the troughs =1.2 to 2 m

· bottom of the trough >= 5 cm above the top surface of the expanded sand

· minimum freeboard of 5 cm

Following expression is used for fixing the size of the trough.

$$Q = 1.376\, bh^{3/2}$$

in which

Q = total water received by the trough in m3/s ;

b = width of the trough in m; and

h = depth of water in the trough in m.

Backwashing

Backwashing is done when loss of head = 2.5 to 3m.

2-4% of filtered water is used in backwashing

2.7 Disinfection:

Disinfection is a technique used to destroy or render inactive the majority of microorganisms found in wastewater, including virtually all pathogenic ones.Bacteria, viruses, and cysts are examples of pathogenic organisms that can harm a host. Pathogens can be eliminated using a variety of treatment methods:

Table: Various Treatment Processes

Treatment Process	Microorganism Removal	Type
Screening	10-20%	Physical Removal
Grit Removal	10-25%	Physical Removal
Primary Sedimentation	25-75%	Physical Removal
Chemical Precipitation	40-80%	Physical Removal
Trickling Filters	90-95%	Physical Removal
Activated Sludge	90-98%	Physical Removal
Chlorination	98-99%	Disinfection

The substance or agent used for disinfection of water is called disinfectant.

Criteria for a good disinfectant

i) The pathogenic organisms that are present in water should be able to be killed within the contact time allotted, the range of water temperatures encountered, and the vast range of pH values. Additionally, the mineral composition of the water that needs to be treated shouldn't have an impact on its effectiveness.

ii) It should not render the water toxic, or impart colour, or make it unportable.

iii) It should be readily available at a reasonable cost.

iii) It should be simple to use, safe to handle, and easy to implement.

iv) In order to prevent recontamination, it must be able to remain in residual concentrations.

v) To allow for the control of the disinfection process, it should be susceptible to detection by practical, quick, and easy analytical procedures in the small concentration ranges.

2.7.1 Chlorination

Chlorine and its forms, being strong oxidants, kill many pathogenic organisms that are dangerous to humans and animals. The most used method of disinfection for treating wastewater is chlorination.With an atomic weight of 35.45, the symbol Cl, a melting point of -101.5°C, and a boiling point of 34.5°C, chlorine is an element. Its gaseous state is somewhat heavier than air and has a greenish yellow colour. It is a pressurised amber-coloured, oily liquid that is nearly 15 times heavier than water. Cleaning, sanitising, and compressing chlorine gas to 35 kg/cm2 allows it to be liquefied. At 0°C and 20°C, it dissolves in water at a rate of 4.61 and 2.26 volumes per volume, respectively, the solution being known as chlorine-water.

Action of chlorine. The following reaction occurs when chlorine is applied to water:

$Cl2 + H2O \leftrightarrow HOCl + H+ + Cl–$ (Hydrolysis)

This hydrolysis reaction is reversible.

As seen below, the hypochlorous acid (HOCl) separates into hypochlorite ions (OCl-) and hydrogen ions (H+).

$HOCl \leftrightarrow H+ + OCl–$ (Ionisation)

This reaction is also reversible

The disinfection of water is carried out by hypochlorous acid (HOCl) and hypochlorite ions (OCl-).

Chlorine Demand: Because of their oxidising abilities, chlorine and chlorine compounds must first interact with organic and inorganic substances in water in order to disinfect it. The chlorine requirement of water refers to the quantity of chlorine utilised in the oxidation of various substances contained in water. Residual chlorine, which is the quantity of chlorine left over after satisfying the demand, disinfects water by eradicating germs. As a result, the chlorine demand of water is the difference between the amount of chlorine added and the amount of residual chlorine after a particular contact period.

Dosage of Chlorine: By applying different chlorine dosages to equal amounts of the water sample and measuring the quantity of residual chlorine after 10 minutes of contact, it is possible to calculate how much chlorine has to be applied. The amount of chlorine that produces the best results for the particular water sample is chosen to leave a residual chlorine level of roughly 0.2 mg/litre after a 10-minute contact duration. Thus, the chlorine requirement of the water sample is represented by this total dose of chlorine in mg/litre minus the residual chlorine (i.e.0.2 mg/litre).

Forms of application of Chlorine: Chlorine can be used in a variety of ways to treat water, as follows: a) As a bleaching powder or hypochlorite b) As chloramines
c) As chlorine gas or liquid chlorine d) As chlorine dioxide gas

CT factor: It evaluates any disinfectant's effectiveness at killing germs. The CT factor is calculated as the product of the residual disinfectant's concentration (C), measured in mg/L, and its contact time (T), measured in minutes, with the water.

For design of internal dimensions of chlorine contact tank,following dimensions are needed to be found out:

1) CT factor required is found out from the table with help of PH and temperature.
2) The peak hourly flow rate
3) The minimum disinfectant residual allowed in the permit to operate
4) The baffling factor for the chlorine contact tank
5) Minimum operating volume
6) Contact time is found out by multiplying detention time with a baffling factor.
7) CT factor calculated is found out by multiplying residual chlorine concentration and contact time.
8) Inactivation ratio is calculated which is ratio of CT calculated to CT required which should be greater than unity.

2.8 Reservoir Tank:

Distribution or service reservoirs are used in a distribution system to offer storage to accommodate changes in water demand, to allow storage for fire fighting and emergencies such as breakdowns, repairs, etc., and to stabilise pressures in the distribution system. These reservoirs may be constructed of brick masonry, stone masonry, cement concrete-plain, reinforced or prestressed and steel. According to the situation with respect to ground, the distribution reservoirs are classified in the following three types.

1. Surface reservoirs
2. Elevated reservoirs
3. Standpipe

2.8.1 Surface Reservoir:

Circular or rectangular shapes are typical for surface reservoirs. Since these reservoirs are built at or below ground level, they are often referred to as ground reservoirs or non-elevated reservoirs. The treated water is pumped to elevated reservoirs, where it is held until it is distributed to consumers. However, water can be delivered to consumers straight from surface reservoirs by gravity if they are situated at elevated points in the distribution system. As much as is practicable, surface reservoirs should be placed at high points in the distribution system.

Location of Distribution Reservoir:

Distribution reservoirs should be located centrally or as close as possible to the areas to be served by them. A central location of a distribution reservoir will reduce friction losses in the distribution pipes due to reduction in the length of pipes. Additionally, in this scenario, the pressure will be constant throughout the whole distribution area during times of both high and low demand.

On the other hand, if a distribution reservoir is not positioned in the middle of the area it serves, there will be significant head loss and the pressure will not be sufficient to supply water to the area's final customers.

The storage capacity of a distribution reservoir depends on balancing storage(to meet fluctuating demand of water), breakdown storage(to take care of emergencies) and fire storage(for fire fighting purposes).

2.9 Distribution System:

2.9.1 Systems of Supply:

The water supply system is a Continuous system or Intermittent System.

Consumers of a continuous system receive water delivery throughout the day, but those of an intermittent system only receive it during specific times of the day.

2.9.2 Layout of the Distribution System:

There are four different types of distribution system depending upon the layout:

i)Dead end system or tree system

ii) Grid iron system or Reticulation system or Interlaced system

iii)Circular system or Ring system

iv)Radial system

i) Dead end system or tree system:

In the Dead End system, the region to be serviced is provided by a single main pipe line, from which sub mains branch out on both sides. Consumers are divided among the branch lines from which service connections are made to the submains.. Thus, a network of pipelines that run like tree branches covers the entire distribution region.

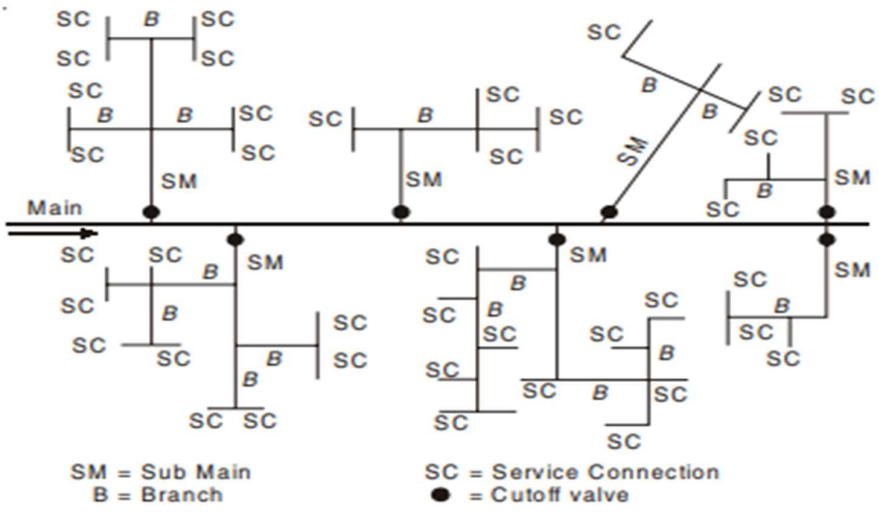


Fig 2-6 : Dead End system or Tree System

ii) Grid Iron System:

The mains, submains, and branches are all connected to one another in this layout arrangement.

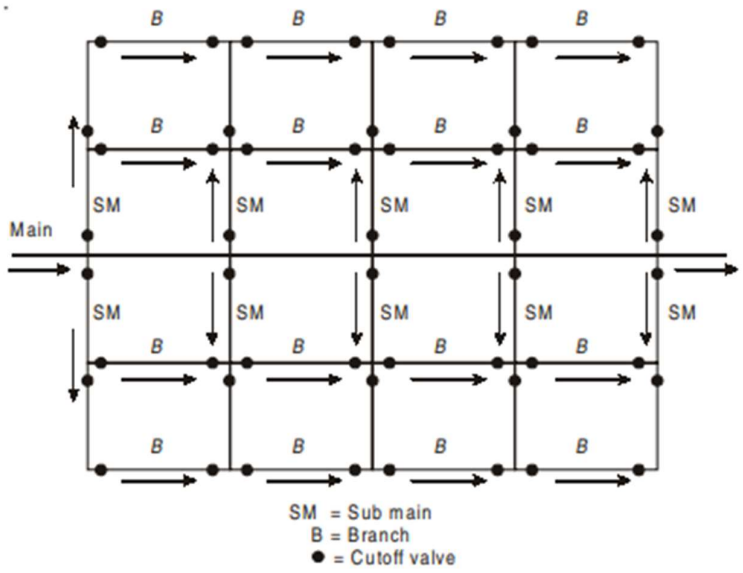


Fig 2-7 : Grid Iron System

iii) Circular or Ring System:

This system of arrangement places the main pipe line in the form of a closed ring around the area to be served that can be either circular or rectangular.

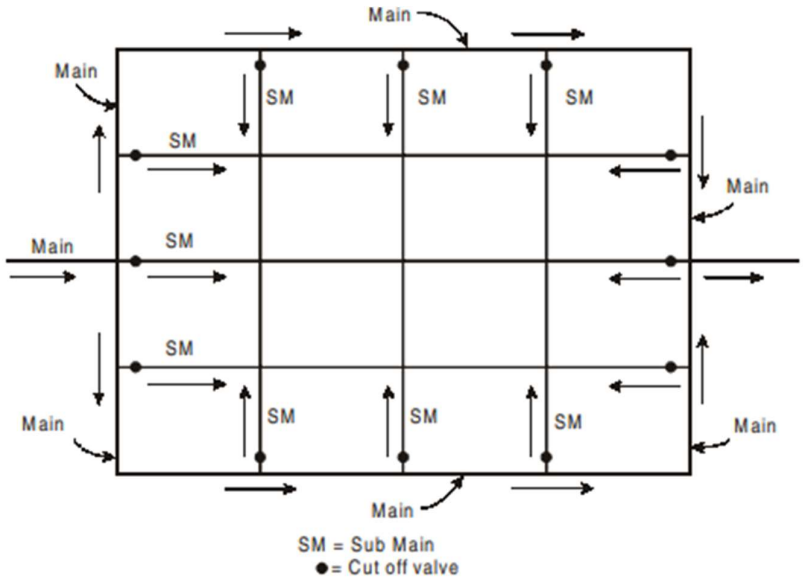


Fig 2-8 : Circular or Ring System

iv) Radial System:

This layout style is exactly the opposite of the circular or ring layout system in that the water flows toward the outer periphery rather than away from it. Using this

technique, a distribution reservoir is positioned in the centre of each tiny distribution zone, which are broken up into the total distribution region.

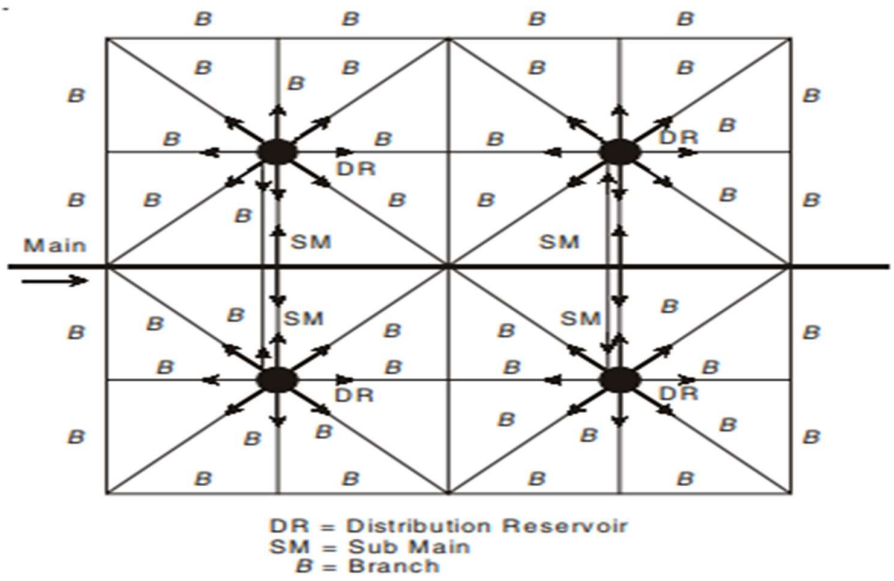


Fig 2-9 : Radial System

2.10 Pipe Fitting Materials:

To unite straight pipes or any piece of tubes, fittings are fitted in the plumbing system. Water supply fittings, such as elbows, tees, sockets, reducers, etc.,are installed to distribute the water supply from the main pipe to additional pipes of equal or lower size, modify the flow direction, etc.

Any component utilised in connection with the supply, distribution, measurement, control, use, and disposal of water is referred to as a pipe fitting.

Types of fittings

1. Collar
2. Elbow
3. Gasket
4. Union
5. Reducer
6. Tee
7. Nipple
8. Trap

2.11Sensor

Electrical or optical signals are frequently recognized and responded to using sensitive apparatus referred to as sensors. A sensor converts the physical property into an electrically quantifiable signal. In our case, the variable is water depth. Temperature sensors, infrared sensors, touch sensors, and proximity sensors are among the different types of sensors.

Proximity Sensor: A proximity sensor can identify objects that are nearby even without any contact. Because there is no direct physical contact between the sensors and the object being detected, these sensors have a long working life and high reliability. When the water level rises or falls below the critical depth, the sensor detects it. The data is transmitted to the control area, where it is used to regulate the pumps as necessary.

METHODOLOGY

3.1 Survey of Site

To take the length of pipes and RL of nodes in a water supply distribution system, a GPS device was used. The GPS device was an essential tool for accurately measuring the length and RL of the pipes and nodes. We started by identifying the starting point of the network and marked it with a flag or a permanent marker. Then, we walked along the length of the pipe segment while holding the GPS device, which helped us to track our position and record the distance covered. At the end of each segment, the endpoint was marked with another flag or marker. This process was repeated for all the pipe segments in the water supply network.

To measure the RL of nodes, the GPS device was placed on a levelled tripod and coordinates of the nodes were recorded. This process enabled us to capture the elevation of each node, which was critical in determining the RL of the nodes. The GPS device was also used to record the coordinates of all the markers and flags along the network, which helped to create an accurate map of the water supply distribution system.

Overall, using a GPS device to measure the length of pipes and RL of nodes in a water supply distribution system was an efficient and accurate method. It enabled us to record the data easily, reduce the chances of errors, and ensured that the measurements were precise. This information was essential in designing and implementing an effective water supply distribution system.

3.2 Design of Pipelines

The Design of Pipelines was conducted based on the textbooks of Garg, S.K. (2004), Modi, P.N (2018), and Punmia, B.C. & Jain A.K. (Dec 2005).

Population was estimated from the census of 2020 with the Geometric Increase Method taking a base period of 2 years and design period of 20 years.

Design Discharge is calculated in 'Water Demand Calculation Sheet' with livestock demand as 20% of domestic demand.

Pipe Diameter was assumed based on trial and Error in EPANET software.

All hydraulic parameters like friction factor, unit head loss, HGL etc were calculated from the EPANET software.

3.3 Selection of Structures:

Structures are selected based on Garg, S.K. (2004), Modi, P.N (2018) and Punmia, B.C. & Jain A.K. (Dec 2005).

3.4 Cost Estimation:

The overall cost estimation was based on the district rate of Kathmandu District(DAO-Kathmandu,2022).

3.5 Report Preparation, Review and Approval:

Report Preparation is done based on the suggestions provided by our supervisor and our examiners Er. Arun Parajuli and Er. Rabin Maharjan. The report got approval from the Department of Civil Engineering, Pulchowk Campus.

OUTCOMES AND DISCUSSIONS

4.1 Surveying and Data Collection:

Survey Data after collection is listed in Annex-A. The plotted layout of transmission and distribution line after survey is presented in Annex-B.

4.2 Design of Structures:

Population taken is 735 based on census, 2020 with annual growth rate of 1.846%. Taking the Base Period of 2 years and Design Period of 20 years, the design population is 1100.

The plain sedimentation tank designed has dimensions of 9m X 2m X 3.5m, with sludge depth of 0.5m, and a free board of 0.5m.

Rapid Sand Filter has a dimensions of length 1.8m, breadth 1.4m and total depth of 2.6m. There are two units of rapid sand filter each with a diameter of central manifold of 20 cm and 12 laterals on each side of manifold.

The chlorination tank designed required 0.45 kg/d of bleaching powder whose concentration is 30-35%.

The reservoir tank is a surface type RCC reservoir with dimensions 5m X 5m X 3m.

4.3 Design of Pipelines:

The design of pipelines is done on EPANET software which is presented in Annex-A.

4.4 Cost Estimation:

The overall cost of the project is found to be Rs. 1,70,70,145. The cost of civil works i.e intake, chlorination tank, filter etc is Rs. 11303040. Cost of Pipe Procurement is Rs. 12336168 and remaining cost involves contingencies, overhead and VAT.Cost Estimation is presented in Annex-C.

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion:

The works performed under this project made us familiar with detailed design, survey and estimate of gravity water supply systems. It helped us to apply the theoretical knowledge gained during four years of study into practice. Following conclusions are drawn from the project work:

- Project Work under the "Design of Gravity Water Supply System, Phedi Tarakeshwar" was successfully completed in coordination with supervisor, locals , Department of Civil Engineering, Pulchowk Campus and laboratory instructors.
- Project report was prepared with a total estimated cost to be Rs. 17070145.
- Project report was submitted to the Department of Civil Engineering , Pulchowk Campus after review from supervisors and examiners.

5.2 Recommendations:

After completion of project work, we recommend following things:

- Count actual population of households in field by taking a small sample
- Use softwares like SW WSP and SW MAPS to design the water supply network which can be implemented in the context of Nepal.
- Use guidelines of Nepalese Context like Rural Water Supply and Sanitation Fund Development Board(RWSSFDB).
- Take photographs of data collection and survey, and include them in the project report.

REFERENCES

1. Garg, S.K. (2004) Water Supply Engineering. 33rd Edition, Khanna Publishers

2. Modi, P.N (2018), Water Supply Engineering, Standard Book House

3. Punmia, B.C. & Jain A.K. (Dec 2005), Water Supplying Engineering, Laxmi Publications

4. Varandini, N.S. (2017) Environmental Engineering Principles and Practices Volume-I, Pearson India Education Services Pvt. Ltd

5. A, S. (2017, March 21). *Plain Sedimentation of Water | Water Treatment | Water Engineering*. Engineering Notes India. https://www.engineeringenotes.com/water-engineering-2/water-treatment/plain-sedimentation-of-water-water-treatment-water-engineering/16014

6. *EPANET 2.2.0: An EPA and Water Community Collaboration | US EPA*. (2020, June 22). US EPA. https://www.epa.gov/sciencematters/epanet-220-epa-and-water-community-collaboration

ANNEX-A

SURVEY DATA AND DESIGN CALCULATIONS

Survey Data

SN	Pipe Line		Length (m)	Reduced Level (RL)	
	From	To		From	To
1	Intake	ST	40	1540	1527
2	ST	FT	61	1527	1516
3	FT	RVT	71	1516	1505
4	RVT	J1	60	1505	1497
	J1	T73			
5	J1	T74	50	1497	1495
6	T74	T73	50	1495	1493
	J1	T78			
7	J1	T75	50	1497	1496
8	T75	T76	50	1496	1494
9	T76	T77	50	1494	1492
10	T77	T78	50	1492	1490
	J1	J2			
11	J1	J2	161	1497	1469
	J2	T80			

12	J2	T79	200	1469	1468
13	J2	T80	50	1469	1466
	J2	J3			
14	J2	J3	82	1469	1457
	J3	T86			
15	J3	T83	68	1457	1456
16	T83	T84	100	1456	1455
17	T84	T85	50	1455	1454
18	T85	T86	50	1454	1452
	J3	T82			
19	J3	T81	81	1457	1456
20	T81	T82	50	1456	1455
	J3	J4			
21	J3	J4	127	1457	1442
	J4	T72			
22	J4	T71	43	1442	1441
23	T71	T72	50	1441	1440
	J4	J5			
24	J4	J5	35	1442	1433

	J5	T70			
25	J5	T70	53	1433	1432
	J5	T68			
26	J5	T69	48	1433	1431
27	T69	T68	50	1431	1429
	J5	J6			
28	J5	J6	99	1433	1423
	J6	T4			
29	J6	T1	109	1423	1421
30	T1	T2	108	1421	1420
31	T2	T3	137	1420	1419
32	T3	T4	93	1419	1418
	J6	T65			
33	J6	T67	69	1423	1422
34	T67	T66	50	1422	1421
35	T66	T65	50	1421	1420
	J6	J7			
35	J6	J7	132	1423	1407
	J7	J59			

36	J7	T61	50	1407	1405
37	T61	T60	50	1405	1403
38	T60	T59	50	1403	1402
	J7	T64			
39	J7	T62	50	1407	1406
40	T62	T63	50	1406	1404
41	T63	T64	50	1404	1403
	J7	J8			
42	J7	J8	164	1407	1397
	J8	T43			
43	J8	T43	100	1397	1395
	J8	T46			
44	J8	T46	200	1397	1394
	T46	T48			
45	T46	T47	50	1394	1393
46	T47	T48	50	1393	1392
	T46	T44			
47	T46	T45	50	1394	1391
48	T45	T44	50	1391	1389

	T46	T51			
50	T46	T51	200	1394	1393
	T51	T49			
51	T51	T50	50	1393	1392
52	T50	T49	50	1392	1391
	T51	T53			
53	T51	T52	50	1393	1390
54	T52	T53	50	1390	1388
	T51	T56			
55	T51	T56	200	1393	1392
	T56	T54			
56	T56	T55	50	1392	1390
57	T55	T54	50	1390	1388
	T56	T58			
58	T56	T57	50	1392	1391
59	T57	T58	50	1391	1390
	J8	J9			
60	J8	J9	161	1397	1392
	J9	T37			

61	J9	T33	50	1392	1390
62	T33	T34	50	1390	1388
63	T34	T35	50	1388	1386
64	T35	T36	50	1386	1384
65	T36	T37	50	1384	1382
	J9	T42			
66	J9	T38	50	1392	1391
67	T38	T39	50	1391	1390
68	T39	T40	50	1390	1389
69	T40	T41	50	1389	1388
70	T41	T42	50	1388	1387
	J9	J10			
71	J9	J10	170	1392	1385
	J10	T6			
72	J10	T5	62	1385	1382
73	T5	T6	72	1382	1380
	J10	T32			
74	J10	T28	50	1385	1384
75	T28	T29	50	1384	1383

76	T29	T30	50	1383	1382
77	T30	T31	50	1382	1381
78	T31	T32	50	1381	1380
	J10	J11			
79	J10	J11	115	1385	1378
	J11	T18			
80	J11	T22	50	1378	1375
81	T22	T21	50	1375	1372
82	T21	T20	50	1372	1369
83	T20	T19	50	1369	1366
84	T19	T18	50	1366	1363
	J11	T27			
85	J11	T23	50	1378	1376
86	T23	T24	50	1376	1374
87	T24	T25	50	1374	1372
88	T25	T26	50	1372	1370
89	T26	T27	50	1370	1368
	J11	J12			
90	J11	J12	122	1378	1376

	J12	T12			
91	J12	T8	50	1376	1375
92	T8	T9	50	1375	1374
93	T9	T10	50	1374	1373
94	T10	T11	50	1373	1372
95	T11	T12	50	1372	1371
	J12	T7			
96	J12	T7	92	1376	1375
97	J12	T17			
98	J12	T13	50	1376	1374
99	T13	T14	50	1374	1372
100	T14	T15	50	1372	1370
101	T15	T16	50	1370	1368
102	T16	T17	50	1368	1366

Discharge Measurement Sheet

Date: 2079-09-18

S.No	Height of water in rectangular notch(cm)
1	3.5
2	3.6
3	3.5
4	3.4
5	3.6

Using discharge formula;

Q_{act}= 2/3 C_d L $(2g)^{1/2}$ $H^{1/3}$

Where Cd = 0.61+0.08H/P

P = 5cm

L = 30 cm

Measured discharge of source= 3.89 litres/sec

Design Discharge(Q)= 2.60 Litres/sec

DESIGN CALCULATIONS

1. Population Forecast:

Present no. of houses = 150 (assumed)

Considering average household size =4.9 (according to 2020 A.D in Nepal)

Total present population = 150X4.9 = 735

Average Annual population growth rate in percentage = 1.846% (average of population growth rate from 2038 to 2078)

Base period is taken as 2 years and design period as 20 years.

i.e. Base year = 2079+2 = 2081

i.e., design year = 2081+20 = 2101

Hence total no. of years for which future population is to be forecasted

= 2+20 = 22 years

From geometric increase formula;

$P_n = P_o (1+r/100)^n$

Where;

P_n = Design year population

P_o = Current or last count population

r = Annual population growth rate in percentage

n = number of future years for which population is to be forecasted

$P_{2101} = P_{2079} (1+1.846/100)^{22}$

$= 735(1+1.846/100)^{22} = 1099.14=1100$

Hence the water supply system is designed based on the 1100 population.

2. Water Quality Test Result:

Public Health Laboratory, Pulchowk Campus

Date: 2079-04-18

2.1 Physical Parameters:

S.No	Parameters	Observed Values	NDWQS
1	pH	7.3	6.5-8.5
2	Electrical Conductivity(µS/cm)	78.402	1500
3	Turbidity(NTU)	1	5(10)
4	Taste and Odour	-	Non objectionable
5	Colour(TCU)	5	5(15)
6	TDS(mg/lit)	47	1000
7	TSS(mg/lit)	200	-
8	Temperature (^{0}C)	16^0 C	10-20^0C

2.2 Chemical Parameters:

S.NO	Parameters	Observed Values	NDWQS
1	Total Hardness as CaCO3(mg/lit)	13	500
2	Calcium(mg/lit)	-	200
3	Chloride(mg/lit)	14.9	250
4	Fluoride(mg/lit)	-	0.5-1.5
5	Ammonia(mg/lit)	<0.1	1.5
6	Nitrate(mg/lit)	-	50
7	Cyanide(mg/lit)	-	0.07
8	Iron(mg/lit)	<0.1	0.3(3)
9	manganese	<0.01	0.2
10	Arsenic(mg/lit)	-	0.05
11	Sulphate(mg/lit)	-	250
12	FRC(mg/lit)	-	0.1-0.2

2.3 Microbiological Parameters:

S.No	Parameters	Observed Values	NDWQS
1	E-coli(CFU/100ml)	>300	NIL
2	Coliform(CFU/100ml)	>300	NIL

3.Design of Plain Sedimentation Tank:

Water demand = 121000 l/d

Considering maximum daily demand =1.8 times average daily demand, (Garg, 2004)

Volume of water to be treated = 1.8 ×121000 l/d = 217.8 m^3 /d

Assuming detention time of 4 hours (range= 4 to 8 hrs);

Volume of tank required = 4 × 217.8 /24 = 36.3 m^3

Assuming surface overflow rate of 15 m^3 / m^2 /d,

Plan area of tank required = 217.8/15 = 14.52 m^2

Depth of tank = 36.3/14.52=2.5m

Let, length/width = 4.5 (Range= 3 to 5)

i.e. $4.5B^2=14.52$

B = 1.79m (say 2.0m)

L = 4.5×2.0 =9.0 m (range up to 30 m generally)

Providing an extra depth of 0.5 m for sludge zone and 0.5 m for free board,

Total depth to be provided = 2.5+0.5+0.5 =3.5m

Hence, provide a settling tank of size 9m×2m×3.5m

Provide a bottom slope of 1 % for easy cleaning and removing sludge.

4.Design of Rapid Sand Filter

Average water demand =121,000lit/day

Taking peak factor of 1.8 ,

Peak demand= 1.8*121000= 217800 lit/day (Garg 2004)

Step 1

Design of filtered units

Let us consider 2% of water used for backwashing

Hence, filtered water per day considering 30 min. is lost on backwashing

$= (1 + 0.02)/(24 - 0.5) * 217800$

=9453.44 lit/hr

Assuming filtration rate

of 4000 lit/h/m2 of filter area,

Filter Area, A= =2.363 m2

Let l/b=1.3

1.3b^2=2.363

b=1.35 m and l=1.3*1.35=1.76m

Provide 2 filter units of area 2.52 m2 each (1 functioning+1 spare filter unit) with length and breadth of $1.8m \times 1.4\ m$

Step 2

Design of Underdrainage System

Area of perforations= 0.3%*(1.4*1.8)=0.00756m2=75.6 cm2

For minimising frictional losses and best distribution of filtered water;

Area of laterals=2*75.6 cm2=151.2cm2

Keeping area of manifold twice of area of laterals;

Area of manifold=2*151.2=302.4cm2

Diameter of manifold=19.6cm $\approx$ 20 cm

Let us provide a 20cm manifold laid along the length of the filter unit providing laterals at 15 cm spacing.

No. of laterals at either side of manifold=12

Length of each laterals=0.6m

Total no. of laterals=24 laterals

Let n be the total no. of perforations, of 8 mm in 24 laterals. then we have;

$n^*=0.00756*10002$

$n \approx 152$

no of perforations per lateral$=6.33 \approx 7$

Area of perforations in each lateral=7*351.86mm2

Area of each laterals=2* 351.85 mm2=703.7mm2

Diameter of lateral=30mm

Hence, provide 32 mm dia. Laterals at 15 cm c/c spacing having 7 perforations of 8 mm dia.

Angle 30◦ to vertical for a unit of rapid sand filter.

Spacing of perforations=8.6cm

Step 3

Wash water discharge and velocity

= 0.6*60*1=36m3/hr/m2

Wash water discharge in a filter

=36*1.8*1.4

= 90.72m3/h=0.0252m3/s

Velocity of flow of wash water in laterals

==1.48m/s

Velocity of flow of wash water in manifold

==0.802m/s<1.8m/s (OK)

Wash Water Troughs

Discharge per trough=0.0252m^3/s

Width of trough=0.3m

Water depth at upper end is given by

Q=1.376by1.5

y=15.5cm=16cm

provide freeboard of 6cm,hence total depth is y=22cm

provide a wash water trough of 30cm×22cm.

(Providing an equivalent area of trough bottom section triangular for ease of cleaning with height of triangular section 7 cm.)

step 4

Determination of depth of sand

Assuming 60cm of sand having effective size of 0.5mm,

By Hudson formula,

(Q*d^3*h)/l $=B_i$*29393 where,

Q=rate of filtration=4m3/h/m2

d=0.5mm

h=2.5m(assumed terminal head loss)

B_i=4*10-4(breakthrough index)

So from above,

L=18.4≈19 cm<60cm(ok)

Step 6

Estimation of gravel size gradation

l=2.54klogd

taking k=12 (12-14)

for d=2mm

l=9.2cm

Gravel size(mm)	2	5	10	20	40
Gravel Depth(cm)	9.2	21.3	30.5	39.7	48.8
Increment (cm)	9.2	12.1	9.2	9.2	9.1

Total Depth

= depth of underdrains+depth of gravel+depth of filter media+water depth+freeboard

=0.2+0.5+0.6+1.0+0.3=2.6m

Dimension of rapid sand filter is **1.8m*1.4m*2.6m**

5.Disinfection

Design of Rectangular Chlorine Contact Tank

From laboratory test the chlorine demand of water was found to be 0.5 mg/l

Let us provide residual chlorine concentration as 0.2 mg/l

Total chlorine dose required = Chlorine demand + Chlorine residual

= 0.5+0.2 = 0.7 mg/l

Providing commercial bleaching powder having chlorine content of 35 % (30-35)the total amount of bleaching powder required is = (0.7×1.8*121000)/0.35 = 0.436 kg/d

Provide 0.45 kg/d.

Considering Peak demand= 1.8*121000= 217800 lit/day= 151.25 lit/min (Garg 2004)
Temperature = 16◦C
PH= 7.3
Thus, Corresponding CT required=4mg/l-min for log 4.0 inactivation (99.99% *Giardia lamblia* cysts deactivation.)
Let us consider, Detention time= 60 min
Lowest Operating Volume=60*151.25=9075 lit=9.075 m^3

Baffling Factor=0.5(With some intra-basin baffles, the entrance or outflow is baffled)

Contact time= baffling Factor* detention time= 0.5*60= 30 min

CT calculated= Residual chlorine concentration* contact time= 0.2mg/l * 30=6mg/l-min

Inactivation Ratio=CT calculated/CT required=6/4=1.5> 1 (so, ok)

Designing of cuboidal tank

V= l*b*h

9.075=5b*b*b

b=1.22 m =1.3m

Hence, provide a contact tank of **6.5m*1.3m*1.3m** (10.985 m^3>9.075 m^3 OK.)with wall thickness 0.2 m. and baffles of 0.10 m along its width at distance interval 1.3m from inlet wall to its length .

Calculation of Chlorine dose rate:

Chlorine dose required (mg/L) = Chlorine demand (mg/L) + Desired residual chlorine (mg/L)

=0.5+0.2 =0.7 (mg/L)

Weight of bleaching powder required (g)= 1000 x Quantity of liquid chlorine necessary (L) x Chlorine liquid concentration desired (%) / Concentration of active chlorine in chlorine powder(%)

Provide liquid chlorine concentration (%) = 2%

Volume of chlorine liquid required (L) = 0.45 X1000 X35%/(1000 X 2 %) = 7.875 L/day

= 7.9 L/day

Chlorine dose rate (mL/h) = Chlorine dose required (mg/L) x Flow rate (m3/h) /(Concentration of Chlorine in liquid (%) ÷ 100)

= 0.7 mg/L X 9.075 m^3 / (2%÷ 100)

= 317.625 mL/h =5.239 mL/min.

Hence Chlorine dose rate =5.239 mL/min.

As the application of bleaching powder may increase the PH of water; so care should be taken to check the PH of water. To avoid production of sludge other methods of chlorination like application of liquid chlorine, chloramines etc. can be adopted.

6. Design of Reservoir Tank

Capacity of Reservoir Tank =67 m^3

Take height of 3 m

Base area = $\frac{67}{3}$=22.33 m^2

Take L=B $\approx 5\,m$

Take RVT of Dimension 5 m X 5 m X 3m

ANNEX-B : DESIGN DRAWING

ANNEX-C: ESTIMATION AND COSTING

ANNEX-D: PIPELINE PROFILE

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

Water Demand Calculation											
Water Demand Calculation is done based on the fact that each tap fulfills the requirement of two households and remaining taps are designed for schools, offices and institutions											
Tap No.	**Tap Name**	**Population per HH**			**Water Demand**			**Tap Flow (lps)**			
		N0	**(2022)**	**(2044)**	**Domestic**	**Livestock**	**Total**	**Avg. Tap Flow**	**Peak Factor**	**Peak Flow**	**Design Flow**
	RVT										
1	T1	2	5	8	1760	352	2112	0.024	2	0.048	0.05
2	T2	2	5	8	1760	352	2112	0.024	2	0.048	0.05
3	T3	2	5	8	1760	352	2112	0.024	2	0.048	0.05
4	T4	2	5	8	1760	352	2112	0.024	2	0.048	0.05
5	T5	2	5	8	1760	352	2112	0.024	2	0.048	0.05
6	T6	2	5	8	1760	352	2112	0.024	2	0.048	0.05
7	T7	2	5	8	1760	352	2112	0.024	2	0.048	0.05
8	T8	2	5	8	1760	352	2112	0.024	2	0.048	0.05
9	T9	2	5	8	1760	352	2112	0.024	2	0.048	0.05
10	T10	2	5	8	1760	352	2112	0.024	2	0.048	0.05
11	T11	2	5	8	1760	352	2112	0.024	2	0.048	0.05
12	T12	2	5	8	1760	352	2112	0.024	2	0.048	0.05
13	T13	2	5	8	1760	352	2112	0.024	2	0.048	0.05
14	T14	2	5	8	1760	352	2112	0.024	2	0.048	0.05
15	T15	2	5	8	1760	352	2112	0.024	2	0.048	0.05
16	T16	2	5	8	1760	352	2112	0.024	2	0.048	0.05
17	T17	2	5	8	1760	352	2112	0.024	2	0.048	0.05
18	T18	2	5	8	1760	352	2112	0.024	2	0.048	0.05
19	T19	2	5	8	1760	352	2112	0.024	2	0.048	0.05
20	T20	2	5	8	1760	352	2112	0.024	2	0.048	0.05

21	T21	2	5	8	1760	352	2112	0.024	2	0.048	0.05
22	T22	2	5	8	1760	352	2112	0.024	2	0.048	0.05
23	T23	2	5	8	1760	352	2112	0.024	2	0.048	0.05
24	T24	2	5	8	1760	352	2112	0.024	2	0.048	0.05
25	T25	2	5	8	1760	352	2112	0.024	2	0.048	0.05
26	T26	2	5	8	1760	352	2112	0.024	2	0.048	0.05
27	T27	2	5	8	1760	352	2112	0.024	2	0.048	0.05
28	T28	2	5	8	1760	352	2112	0.024	2	0.048	0.05
29	T29	2	5	8	1760	352	2112	0.024	2	0.048	0.05
30	T30	2	5	8	1760	352	2112	0.024	2	0.048	0.05
31	T31	2	5	8	1760	352	2112	0.024	2	0.048	0.05
32	T32	2	5	8	1760	352	2112	0.024	2	0.048	0.05
33	T33	2	5	8	1760	352	2112	0.024	2	0.048	0.05
34	T34	2	5	8	1760	352	2112	0.024	2	0.048	0.05
35	T35	2	5	8	1760	352	2112	0.024	2	0.048	0.05
36	T36	2	5	8	1760	352	2112	0.024	2	0.048	0.05
37	T37	2	5	8	1760	352	2112	0.024	2	0.048	0.05
38	T38	2	5	8	1760	352	2112	0.024	2	0.048	0.05
39	T39	2	5	8	1760	352	2112	0.024	2	0.048	0.05
40	T40	2	5	8	1760	352	2112	0.024	2	0.048	0.05
41	T41	2	5	8	1760	352	2112	0.024	2	0.048	0.05
42	T42	2	5	8	1760	352	2112	0.024	2	0.048	0.05
43	T43	2	5	8	1760	352	2112	0.024	2	0.048	0.05
44	T44	2	5	8	1760	352	2112	0.024	2	0.048	0.05
45	T45	2	5	8	1760	352	2112	0.024	2	0.048	0.05
46	T46	2	5	8	1760	352	2112	0.024	2	0.048	0.05
47	T47	2	5	8	1760	352	2112	0.024	2	0.048	0.05
48	T48	2	5	8	1760	352	2112	0.024	2	0.048	0.05
49	T49	2	5	8	1760	352	2112	0.024	2	0.048	0.05
50	T50	2	5	8	1760	352	2112	0.024	2	0.048	0.05
51	T51	2	5	8	1760	352	2112	0.024	2	0.048	0.05
52	T52	2	5	8	1760	352	2112	0.024	2	0.048	0.05
53	T53	2	5	8	1760	352	2112	0.024	2	0.048	0.05
54	T54	2	5	8	1760	352	2112	0.024	2	0.048	0.05

55	T55	2	5	8	1760	352	2112	0.024	2	0.048	0.05
56	T56	2	5	8	1760	352	2112	0.024	2	0.048	0.05
57	T57	2	5	8	1760	352	2112	0.024	2	0.048	0.05
58	T58	2	5	8	1760	352	2112	0.024	2	0.048	0.05
59	T59	2	5	8	1760	352	2112	0.024	2	0.048	0.05
60	T60	2	5	8	1760	352	2112	0.024	2	0.048	0.05
61	T61	2	5	8	1760	352	2112	0.024	2	0.048	0.05
62	T62	2	5	8	1760	352	2112	0.024	2	0.048	0.05
63	T63	2	5	8	1760	352	2112	0.024	2	0.048	0.05
64	T64	2	5	8	1760	352	2112	0.024	2	0.048	0.05
65	T65	2	5	8	1760	352	2112	0.024	2	0.048	0.05
66	T66	2	5	8	1760	352	2112	0.024	2	0.048	0.05
67	T67	2	5	8	1760	352	2112	0.024	2	0.048	0.05
68	T68	2	5	8	1760	352	2112	0.024	2	0.048	0.05
69	T69	2	5	8	1760	352	2112	0.024	2	0.048	0.05
70	T70	2	5	8	1760	352	2112	0.024	2	0.048	0.05
71	T71	2	5	8	1760	352	2112	0.024	2	0.048	0.05
72	T72	2	5	8	1760	352	2112	0.024	2	0.048	0.05
73	T73	2	5	8	1760	352	2112	0.024	2	0.048	0.05
74	T74	2	5	8	1760	352	2112	0.024	2	0.048	0.05
75	T75	2	5	8	1760	352	2112	0.024	2	0.048	0.05
76	T76						2112	0.024	2	0.048	0.05
77	T77						2112	0.024	2	0.048	0.05
78	T78						2112	0.024	2	0.048	0.05
79	T79						2112	0.024	2	0.048	0.05
80	T80						2112	0.024	2	0.048	0.05
81	T81						2112	0.024	2	0.048	0.05
82	T82						2112	0.024	2	0.048	0.05
83	T83						2112	0.024	2	0.048	0.05
84	T84						2112	0.024	2	0.048	0.05
85	T85						2112	0.024	2	0.048	0.05
86	T86						2112	0.024	2	0.048	0.05

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

Determination of Size of Reservoir Tank

Design Demand	2.29lps	8250 l/hr
Design Discharge	2.60lps	9360 l/hr

Time		**Consumption(%)**	**Hrs**	**Supply (litres)**	**Demand (litres)**	**Surplus (litres)**	**Deficit (litres)**
From	**To**						
05:00	07:00	25	2	18720	49500		30780
07:00	12:00	35	5	46800	69300		22500
12:00	17:00	20	5	46800	39600	7200	
17:00	19:00	20	2	18720	39600		20880
19:00	05:00	0	10	93600	0	93600	
					Total	100800	74160

Capacity(litres)	66960
	66.96 cu.m

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

PIPELINE DESIGN
(HYDRAULIC CALCULATIONS)

SN	Pipe Line		Length (m)	Design Discharge Q(lps)	Reduced Level (RL)		Level Diff. (m)	Pipe Used			friction factor (f)	Unit Headloss (m/km)	Residual Head (m)	Flow Velocity (m/s)	HGL (m)		Soil Type
	From	To			From	To		Nominal Dia (mm)	Thickness (mm)	Class (kg/sq.cm)					From	To	
1	Intake	ST	40	2.60	1540	1527	13	180	16.4	10	0.069	20.31	5.88	0.10	1540.00	1532.88	OS
2	ST	FT	61	2.60	1527	1516	11	180	16.4	10	0.069	20.31	4.50	0.10	1532.88	1520.50	OS
3	FT	RVT	71	2.60	1516	1505	11	180	16.4	10	0.069	20.31	1.08	0.10	1520.50	1506.08	OS
4	RVT	J1	60	4.30	1505	1497	8	90	12.5	16	0.042	10.84	10.38	0.66	1508.00	1507.35	OS
	J1	**T73**															
5	J1	T74	50	0.10	1497	1495	2	20	2.8	16	0.060	15.55	11.57	0.32	**1507.35**	1506.57	OS
6	T74	T73	50	0.05	1495	1493	2	20	2.8	16	0.067	4.73	13.36	0.16	1506.57	1506.36	OS
	J1	**T78**															
7	J1	T75	50	0.20	1497	1496	1	25	2.3	10	0.056	18.93	10.40	0.41	**1507.35**	1506.40	OS
8	T75	T76	50	0.15	1496	1494	2	25	2.3	10	0.058	11.11	11.85	0.31	1506.40	1505.85	OS
9	T76	T77	50	0.10	1494	1492	2	25	2.3	10	0.062	5.24	13.59	0.20	1505.85	1505.59	OS
10	T77	T78	50	0.05	1492	1490	2	20	2.8	16	0.067	4.31	15.37	0.16	1505.59	1505.37	OS
	J1	**J2**															
11	J1	J2	161	4.00	1497	1469	28	90	5.1	6	0.042	9.48	36.82	0.63	**1507.35**	1505.82	OS
	J2	**T80**															
12	J2	T79	200	0.05	1469	1468	1	20	2.8	16	0.067	4.31	36.96	0.16	**1505.82**	1504.96	OS
13	J2	T80	50	0.05	1469	1466	3	20	1.9	10	0.067	4.31	39.61	0.16	**1505.82**	1505.61	OS

	J2	**J3**															
14	J2	J3	82	3.90	1469	1457	12	90	8.2	10	0.043	9.05	48.08	0.61	**1505.82**	1505.08	OS
	J3	**T86**															
15	J3	T83	68	0.20	1457	1456	1	32	3	10	0.058	5.69	48.69	0.25	**1505.08**	1504.69	OS
16	T83	T84	100	0.15	1456	1455	1	32	3	10	0.060	3.34	49.36	0.19	1504.69	1504.36	OS
17	T84	T85	50	0.10	1455	1454	1	32	3	10	0.064	1.57	50.28	0.12	1504.36	1504.28	OS
18	T85	T86	50	0.05	1454	1452	2	20	1.9	10	0.067	4.31	52.07	0.16	1504.28	1504.07	OS
	J3	**T82**															
19	J3	T81	81	0.10	1457	1456	1	32	3	10	0.064	1.57	48.95	0.12	**1505.08**	1504.95	OS
20	T81	T82	50	0.05	1456	1455	1	20	1.9	10	0.067	4.31	49.74	0.16	1504.95	1504.74	OS
	J3	**J4**															
21	J3	J4	127	3.60	1457	1442	15	90	8.2	10	0.043	7.80	62.09	0.57	**1505.08**	1504.09	OS
	J4	**T72**															
22	J4	T71	43	0.10	1442	1441	1	20	2.8	16	0.060	15.55	62.42	0.32	**1504.09**	1503.42	OS
23	T71	T72	50	0.05	1441	1440	1	20	2.8	16	0.067	4.31	63.21	0.16	1503.42	1503.21	OS
	J4	**J5**															
24	J4	J5	35	3.50	1442	1433	9	90	8.2	10	0.043	7.41	70.83	0.55	**1504.09**	1503.83	OS
	J5	**T70**															
25	J5	T70	53	0.05	1433	1432	1	20	2.8	16	0.067	4.31	71.60	0.16	**1503.83**	1503.60	OS
	J5	**T68**															
26	J5	T69	48	0.10	1433	1431	2	20	2.8	16	0.060	15.55	72.08	0.32	**1503.83**	1503.08	OS
27	T69	T68	50	0.05	1431	1429	2	20	2.8	16	0.067	4.31	73.87	0.16	1503.08	1502.87	OS
	J5	**J6**															
28	J5	J6	99	3.35	1433	1423	10	90	8.2	10	0.044	6.83	80.15	0.53	**1503.83**	1503.15	OS
	J6	**T4**															
29	J6	T1	109	0.20	1423	1421	2	32	3	10	0.058	5.69	81.53	0.25	**1503.15**	1502.53	OS
30	T1	T2	108	0.15	1421	1420	1	32	3	10	0.060	3.34	82.17	0.19	1502.53	1502.17	OS

31	T2	T3	137	0.10	1420	1419	1	32	3	10	0.064	1,58	82.96	0.12	1502.17	1501.96	OS
32	T3	T4	93	0.05	1419	1418	1	20	2.8	16	0.067	4.31	83.56	0.16	1501.96	1501.56	OS
	J6	**T65**															
33	J6	T67	69	0.15	1423	1422	1	32	4.5	16	0.060	3.34	80.92	0.19	**1503.15**	1502.92	OS
34	T67	T66	50	0.10	1422	1421	1	32	3	10	0.064	1.57	81.85	0.12	1502.92	1502.85	OS
35	T66	T65	50	0.05	1421	1420	1	20	2.8	16	0.067	4.31	82.63	0.16	1502.85	1502.63	OS
	J6	**J7**															
36	J6	J7	132	3.00	1423	1407	16	75	5.6	10	0.043	13.53	94.37	0.68	**1503.15**	1501.37	OS
	J7	**J59**															
37	J7	T61	50	0.15	1407	1405	2	32	3	10	0.060	3.34	96.20	0.19	**1501.37**	1501.20	OS
38	T61	T60	50	0.10	1405	1403	2	32	4.5	16	0.064	1.57	98.12	0.12	1501.20	1501.12	OS
39	T60	T59	50	0.05	1403	1402	1	20	2.8	16	0.067	4.31	98.91	0.16	1501.12	1500.91	OS
	J7	**T64**															
40	J7	T62	50	0.15	1407	1406	1	32	3	10	0.060	3.34	95.20	0.19	**1501.37**	1501.20	OS
41	T62	T63	50	0.10	1406	1404	2	32	4.5	16	0.064	1.57	97.12	0.12	1501.20	1501.12	OS
42	T63	T64	50	0.05	1404	1403	1	20	2.8	16	0.067	4.31	97.91	0.16	1501.12	1500.91	OS
	J7	**J8**															
43	J7	J8	164	2.70	1407	1397	10	75	10.4	16	0.044	11.13	102.54	0.61	**1501.37**	1499.54	OS
	J8	**T43**															
44	J8	T43	100	0.05	1397	1395	2	20	2.8	16	0.067	4.31	104.11	0.16	**1499.54**	1499.11	OS
45	J8	T46															
46	J8	T46	200	0.75	1397	1394	3	40	3.7	10	0.049	22.18	101.11	0.60	**1499.54**	1495.11	OS
	T46	**T48**															
47	T46	T47	50	0.10	1394	1393	1	20	2.8	16	0.060	15.55	101.33	0.32	1495.11	1494.33	OS
48	T47	T48	50	0.05	1393	1392	1	20	2.8	16	0.067	4.31	102.11	0.16	1494.33	1494.11	OS
	T46	**T44**															
49	T46	T45	50	0.10	1394	1391	3	20	2.8	16	0.060	15.55	103.33	0.32	1495.11	1494.33	OS

50	T45	T44	50	0.05	1391	1389	2	20	2.8	16	0.067	4.31	105.11	0.16	1494.33	1494.11	OS
	T46	**T51**															
51	T46	T51	200	0.50	1394	1393	1	40	3.7	10	0.052	10.47	100.01	0.40	1495.11	1493.01	OS
	T51	**T49**															
52	T51	T50	50	0.10	1393	1392	1	20	2.8	16	0.060	15.55	100.24	0.32	1493.01	1492.24	OS
53	T50	T49	50	0.05	1392	1391	1	20	2.8	16	0.067	4.31	101.02	0.16	1492.24	1492.02	OS
	T51	**T53**															
54	T51	T52	50	0.10	1393	1390	3	20	2.8	16	0.060	15.55	102.24	0.32	1493.01	1492.24	OS
55	T52	T53	50	0.05	1390	1388	2	20	2.8	16	0.067	4.31	104.02	0.16	1492.24	1492.02	OS
	T51	**T56**															
56	T51	T56	200	0.25	1393	1392	1	40	5.6	16	0.058	2.90	100.43	0.20	1493.01	1492.43	OS
	T56	**T54**															
57	T56	T55	50	0.10	1392	1390	2	20	2.8	16	0.060	15.55	101.66	0.32	1492.43	1491.66	OS
58	T55	T54	50	0.05	1390	1388	2	20	2.8	16	0.067	4.31	103.44	0.16	1491.66	1491.44	OS
59	**T56**	**T58**															
59	T56	T57	50	0.10	1392	1391	1	20	2.8	16	0.060	15.55	100.66	0.32	1492.43	1491.66	OS
60	T57	T58	50	0.05	1391	1390	1	20	2.8	16	0.067	4.31	101.44	0.16	1491.66	1491.44	OS
	J8	**J9**															
61	J8	J9	161	1.90	1397	1392	5	50	4.6	10	0.044	41.84	100.81	0.97	**1499.54**	1492.81	OS
	J9	**T37**															
62	J9	T33	50	0.25	1392	1390	2	32	4.5	16	0.056	8.60	102.38	0.31	**1492.81**	1492.38	OS
63	T33	T34	50	0.20	1390	1388	2	32	4.5	16	0.058	5.69	104.09	0.25	1492.38	1492.09	OS
64	T34	T35	50	0.15	1388	1386	2	20	2.8	16	0.057	32.95	104.45	0.48	1492.09	1490.45	OS
65	T35	T36	50	0.10	1386	1384	2	20	2.8	16	0.060	15.55	105.67	0.32	1490.45	1489.67	OS
66	T36	T37	50	0.05	1384	1382	2	20	2.8	16	0.067	4.31	107.45	0.16	1489.67	1489.45	OS
	J9	**T42**															
67	J9	T38	50	0.25	1392	1391	1	32	4.5	16	0.056	8.60	101.38	0.31	**1492.81**	1492.38	OS

68	T38	T39	50	0.20	1391	1390	1	32	3	10	0.058	5.69	102.09	0.25	1492.38	1492.09	OS
69	T39	T40	50	0.15	1390	1389	1	20	2.8	16	0.057	32.95	101.45	0.48	1492.09	1490.45	OS
70	T40	T41	50	0.10	1389	1388	1	20	2.8	16	0.060	15.55	101.67	0.32	1490.45	1489.67	OS
71	T41	T42	50	0.05	1388	1387	1	20	2.8	16	0.067	4.31	102.45	0.16	1489.67	1489.45	OS
	J9	**J10**															
72	J9	J10	170	1.40	1392	1385	7	50	6.9	16	0.046	23.77	103.77	0.71	**1492.81**	1488.77	OS
	J10	**T6**															
73	J10	T5	62	0.10	1385	1382	3	25	2.3	10	0.062	5.24	106.44	0.20	**1488.77**	1488.44	OS
74	T5	T6	72	0.05	1382	1380	2	20	2.8	16	0.067	4.31	108.13	0.16	1488.44	1488.13	OS
	J10	**T32**															
75	J10	T28	50	0.25	1385	1384	1	32	4.5	16	0.056	8.60	104.34	0.31	**1488.77**	1488.34	OS
76	T28	T29	50	0.20	1384	1383	1	32	4.5	16	0.058	5.69	105.05	0.25	1488.34	1488.05	OS
77	T29	T30	50	0.15	1383	1382	1	20	2.8	16	0.057	32.95	104.41	0.48	1488.05	1486.41	OS
78	T30	T31	50	0.10	1382	1381	1	20	2.8	16	0.060	15.55	104.63	0.32	1486.41	1485.63	OS
79	T31	T32	50	0.05	1381	1380	1	20	2.8	16	0.067	4.31	105.41	0.16	1485.63	1485.41	OS
	J10	**J11**															
80	J10	J11	115	1.05	1385	1378	7	50	4.6	10	0.048	13.95	109.16	0.53	**1488.77**	1487.16	OS
	J11	**T18**															
81	J11	T22	50	0.25	1378	1375	3	32	4.5	16	0.056	8.60	111.73	0.31	**1487.16**	1486.73	OS
82	T22	T21	50	0.20	1375	1372	3	32	4.5	16	0.058	5.69	114.45	0.25	1486.73	1486.45	OS
83	T21	T20	50	0.15	1372	1369	3	20	2.8	16	0.057	32.95	115.80	0.48	1486.45	1484.80	OS
84	T20	T19	50	0.10	1369	1366	3	20	2.8	16	0.060	15.55	118.02	0.32	1484.80	1484.02	OS
85	T19	T18	50	0.05	1366	1363	3	20	2.8	16	0.067	4.31	120.81	0.16	1484.02	1483.81	OS
	J11	**T27**															
86	J11	T23	50	0.25	1378	1376	2	32	4.5	16	0.056	8.60	110.73	0.31	**1487.16**	1486.73	OS
87	T23	T24	50	0.20	1376	1374	2	32	4.5	16	0.058	5.69	112.45	0.25	1486.73	1486.45	OS
88	T24	T25	50	0.15	1374	1372	2	20	2.8	16	0.057	32.95	112.80	0.48	1486.45	1484.80	OS

89	T25	T26	50	0.10	1372	1370	2	20	2.8	16	0.060	15.55	114.02	0.32	1484.80	1484.02	OS
90	T26	T27	50	0.05	1370	1368	2	20	2.8	16	0.067	4.31	115.81	0.16	1484.02	1483.81	OS
	J11	**J12**															
91	J11	J12	122	0.55	1378	1376	2	50	6.9	16	0.053	4.21	110.65	0.28	**1487.16**	1486.65	OS
	J12	**T12**															
92	J12	T8	50	0.25	1376	1375	1	32	4.5	16	0.056	8.60	111.22	0.31	**1486.65**	1486.22	OS
93	T8	T9	50	0.20	1375	1374	1	32	4.5	16	0.058	5.69	111.93	0.25	1486.22	1485.93	OS
94	T9	T10	50	0.15	1374	1373	1	20	2.8	16	0.057	32.95	111.29	0.48	1485.93	1484.29	OS
95	T10	T11	50	0.10	1373	1372	1	20	2.8	16	0.060	15.55	111.51	0.32	1484.29	1483.51	OS
96	T11	T12	50	0.05	1372	1371	1	20	2.8	16	0.067	4.31	112.29	0.16	1483.51	1483.29	OS
	J12	**T7**															
97	J12	T7	92	0.05	1376	1375	1	20	2.8	16	0.067	4.31	111.25	0.16	**1486.65**	1486.25	OS
	J12	**T17**															
98	J12	T13	50	0.25	1376	1374	2	32	4.5	16	0.056	8.60	112.22	0.31	**1486.65**	1486.25	OS
99	T13	T14	50	0.20	1374	1372	2	32	4.5	16	0.058	5.69	113.93	0.25	1486.25	1485.93	OS
100	T14	T15	50	0.15	1372	1370	2	25	3.5	16	0.058	11.11	115.38	0.31	1485.93	1485.38	OS
101	T15	T16	50	0.10	1370	1368	2	20	2.8	16	0.060	15.55	116.60	0.32	1485.38	1484.60	OS
102	T16	T17	50	0.05	1368	1366	2	20	2.8	16	0.067	4.31	118.39	0.16	1484.60	1484.39	OS

ANNEX-B : DESIGN DRAWING

PROJECT NAME: Phedi Water Supply Project

PROJECT LOCATION: Phedi, Tarkeshwor

DRAWING TITLE: Site Plan

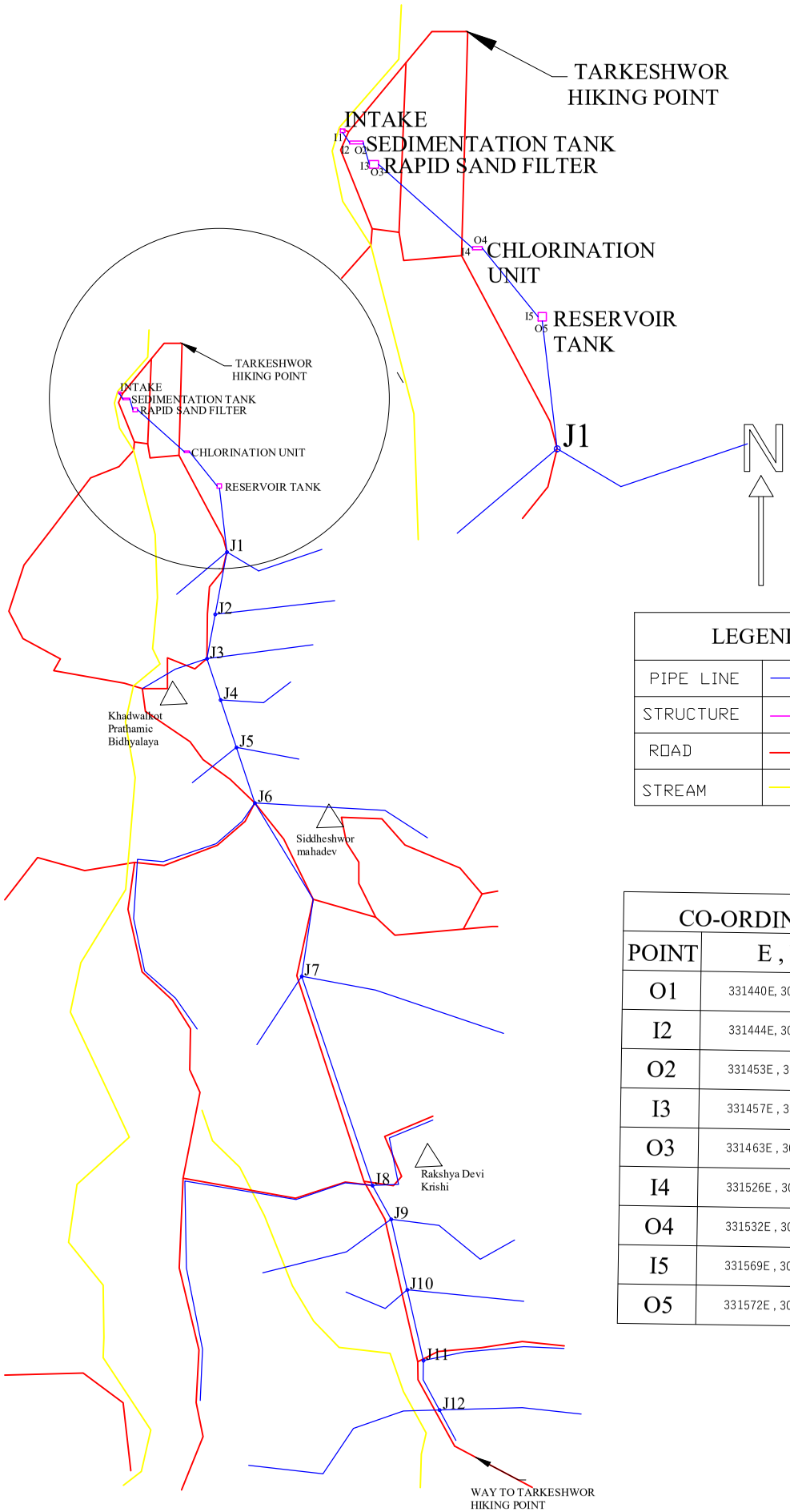
DRAWING NO.:01

SCALE: 1: 8

DATE:2079-11-15

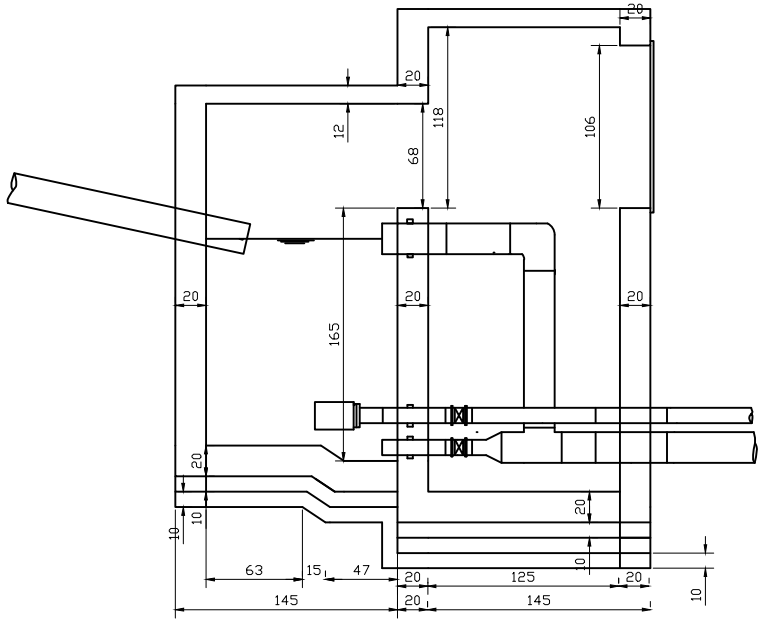
PULCHOWK CAMPUS

DEPARTMENT OF CIVIL ENGINEERING

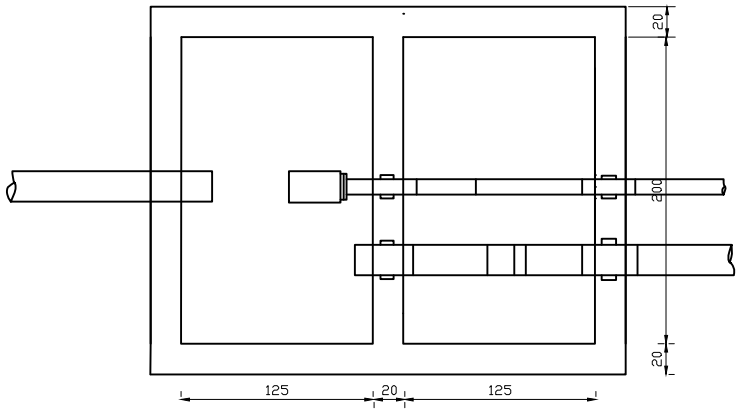


LEGENDS	
PIPE LINE	
STRUCTURE	
ROAD	
STREAM	

CO-ORDINATE	
POINT	E , N
O1	331440E, 3075118N
I2	331444E, 3075112N
O2	331453E , 3075112N
I3	331457E , 3075097N
O3	331463E , 3075097N
I4	331526E , 3075042N
O4	331532E , 3075042N
I5	331569E , 3074997N
O5	331572E , 3074994N

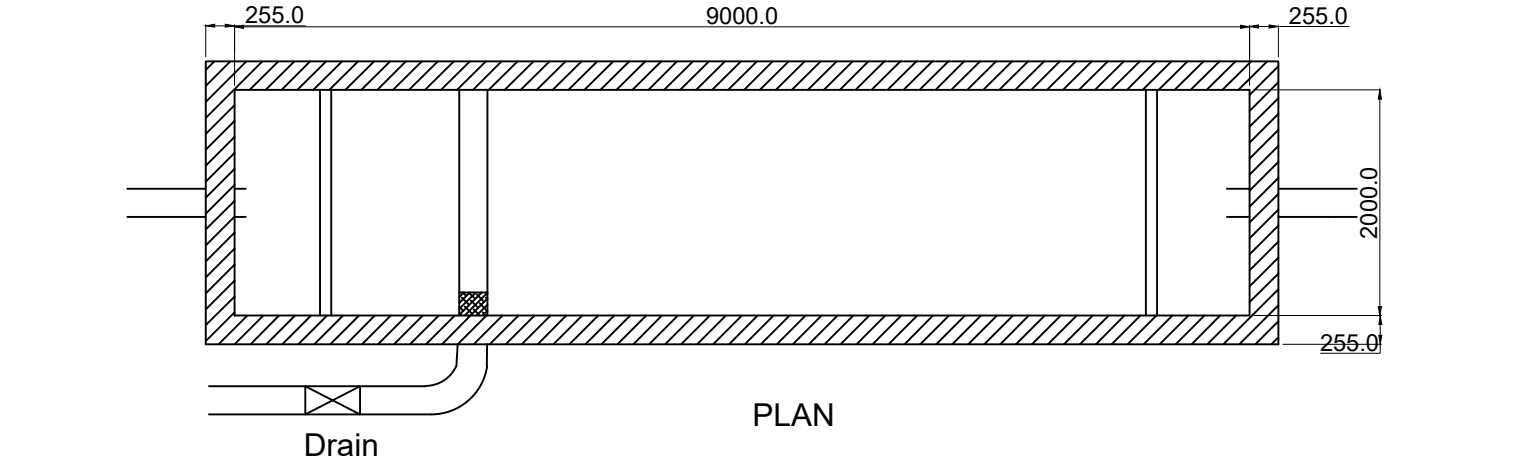


SECTION

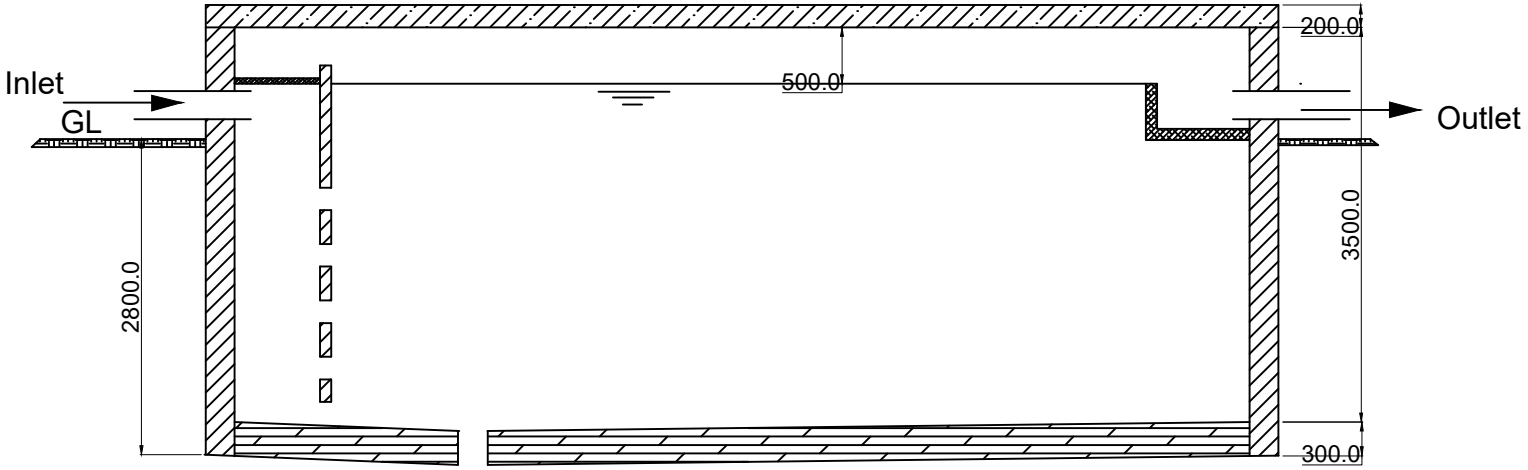


TOP VIEW

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Intake	SCALE:Fit to paper	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 02	DATE:2079-04-30	



PLAN



SECTION

Fig: Sedimentation Tank

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Sedimentation Tank	SCALE:Fit to paper	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 03	DATE:2079-04-30	

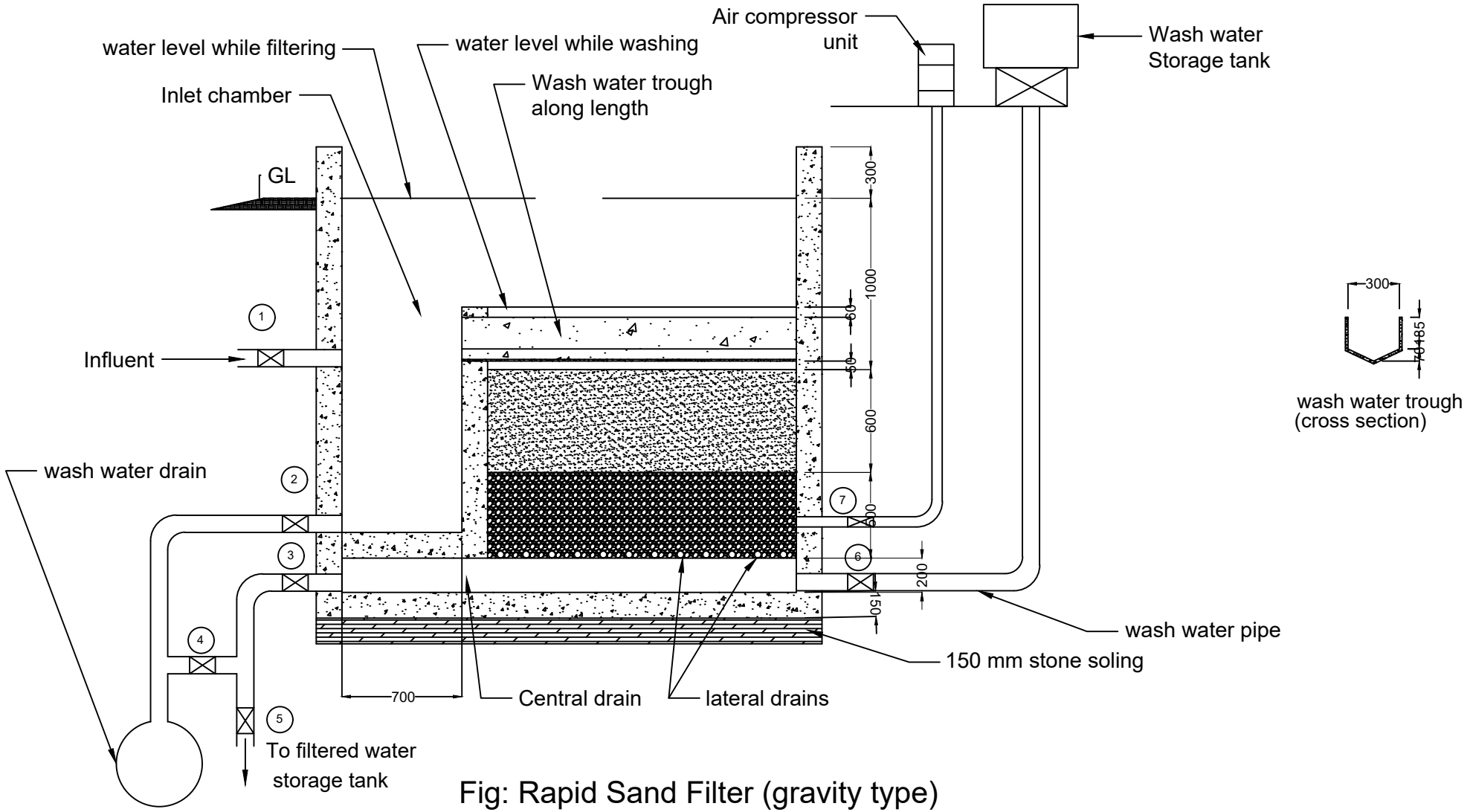


Fig: Rapid Sand Filter (gravity type)
(Sectional front view)

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Rapid Sand Filter	SCALE: Fit to Paper	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 04 (1)	DATE:2079-10-15	

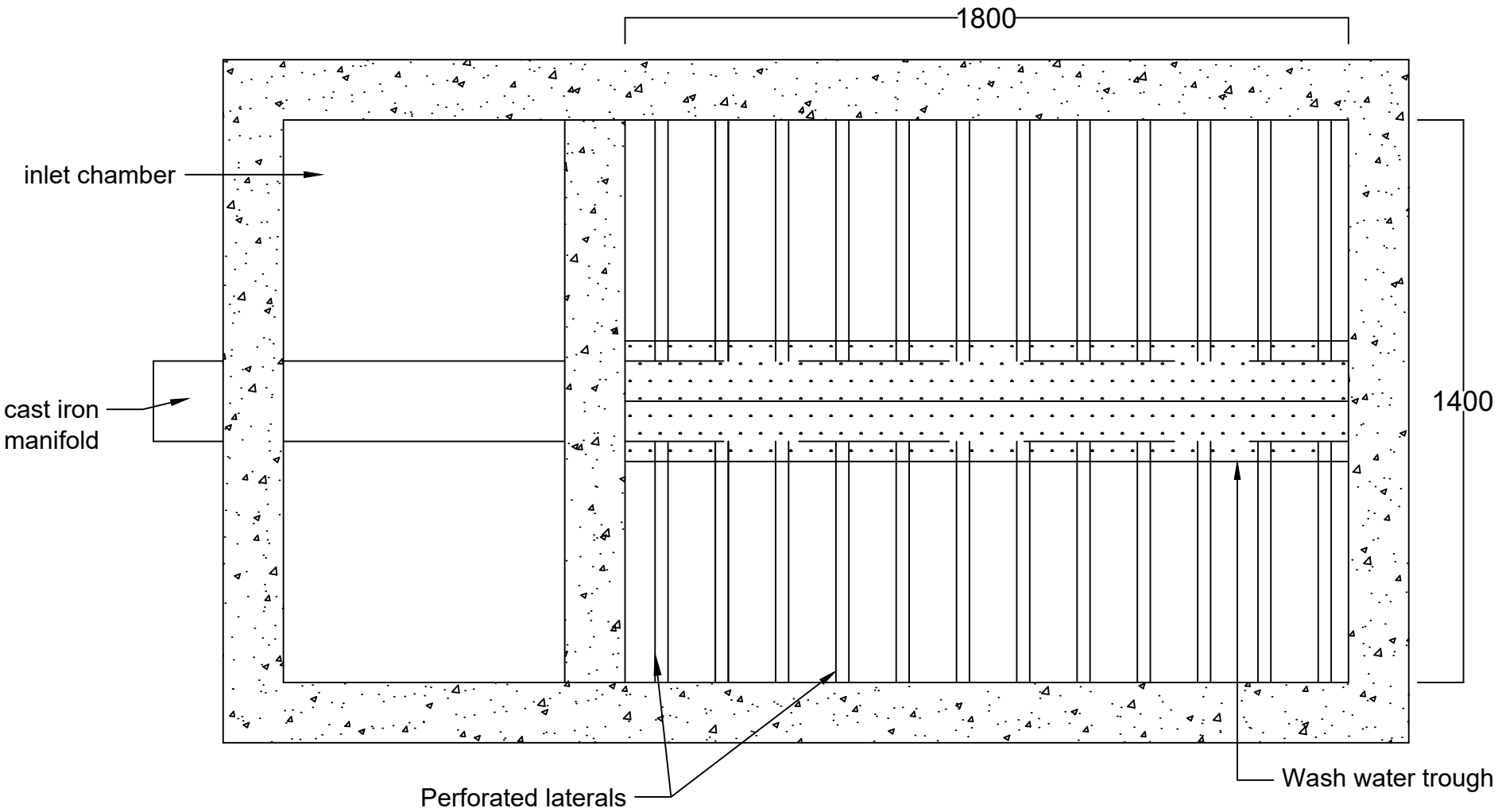
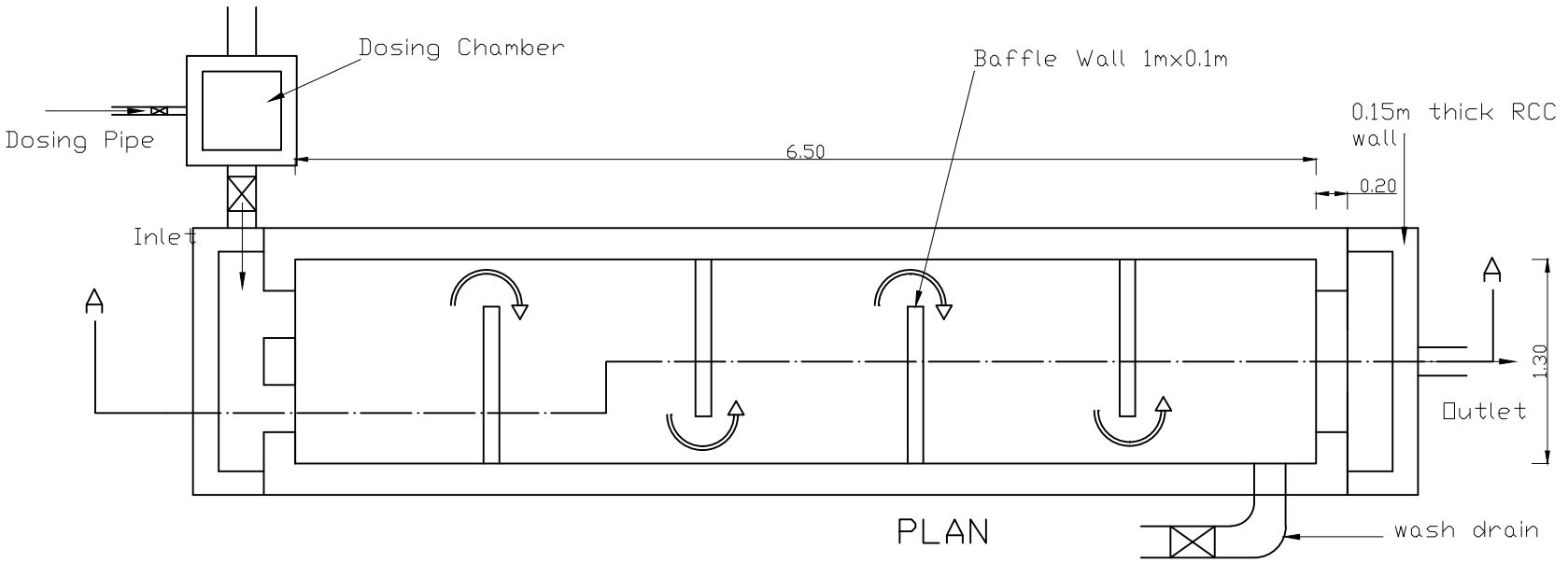


Fig: Rapid Sand Filter
Top view

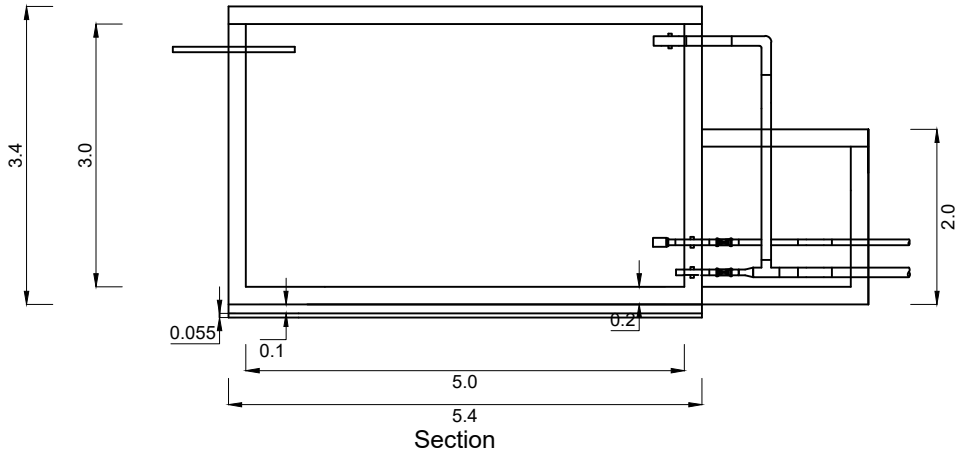
PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Rapid Sand filter	SCALE: Fit to Paper	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 04 (2)	DATE:2079-10-15	



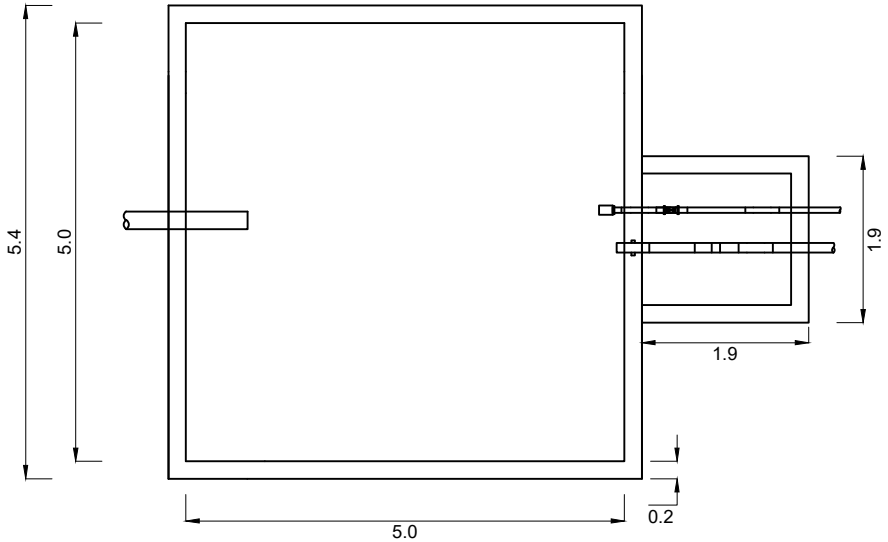
SECTION through A-A

CHLORINATION UNIT

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Chlorination Unit	SCALE: Fit to paper	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 05	DATE:2079-10-15	



Section



Plan

RCC Tank with Valve Chamber

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: RCC Tank	SCALE: Fit to paper	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 06	DATE:2079-10-15	

ANNEX-C : ESTIMATION AND COSTING

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

SPRING INTAKE

Quantity and Cost Estimate

S.No	Description	No.	Length	Breadth	Height	Quantity	Unit	Rate	Amount
1	Earthwork in excavation	1	3.1	2.2	3.65	24.893			
						24.893	cu.m	721.36	17956.81
2	1:1.5:3 PCC								
	for RCC work								
2.1	Base Slab	1	3.1	2.2	0.2	1.364			
2.2	Walls	1	10.8	0.2	1.97	4.2552			
2.3	Cover	1	3.1	1.4	0.12	0.5208			
						6.14	cu.m	27,539.0	169089.5
3	Reinforcement		0.8% of RCC			378.224		220.35	83341.66
	Works								
4	12.5 mm plaster								
	in 1:3 cement								
	sand mortar								
4.1	Wall Chamber	1	10.6		1.97	20.882			
4.2	Base slab	1	2.5		1.45	3.625			
						24.507	sq.m	472.24	11573.19
5	Installation of								
	pipes and fittings					Assume	2	575	1150
						Total			283111.1

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

Sedimentation Tank

Inner side of tank = 9m X 2m
Thickness of wall = 0.255 m (10 in)
Total tank height = 3.5m
Thickness of cover slab 0.2m
bottom slope of tank = 1H:100V (N.S varandani EE vol 1)

SN	Description of Work	No.	length(m)	Breadth(m)	Height(m)	Quantity	Unit	Remarks
1	Earthwork in excavation for foundation of							
	Sedimentaton Tank	1	9.51	2.51	2.8	66.84	m^3	below GL
	Total Earthwork					**66.84**	**m^3**	
2	Stone Soling Works in foundation	1	9.51	2.51	0.1	2.39	m^3	
	Total stone soling					**2.39**	**m^3**	
3	PCC (1:3:6) in foundation	1	9.51	2.51	0.1	2.39	**m^3**	
	Total PCC					**2.39**	**m^3**	
4	PCC (1:1½:3) for RCC work							
	in tank wall	1	23.02	0.255	3.6	21.13	**m^3**	23.02=(9+.255 +2+.255)X2
	in base slab	**1**	9	2	0.1	1.80	**m^3**	
	in cover slab	1	9.51	2.51	0.2	4.77	**m^3**	
	Total PCC					**27.71**	**m^3**	
5	Total reinforcement(1.15% of PCC for RCC)					2787.95	**Kg**	
	Binding Wire (1% of steel reinfocement)					27.88	**Kg**	
	Total reinforcement					**2815.83**	**Kg**	
6	12.5 mm thick 1:3 cement-sand plaster							
	base of tank	1	9	2		18.00	**m2**	
	inner wall of tank	1	22		3.5	77.00	**m2**	
	outer wall of tank	1	24.04		3.8	91.35	**m2**	
	at the top of tank wall	1	23.02	0.255		5.87	**m2**	
	in inner & outer portion of slab	2	9.51	2.51		47.74	**m2**	
	Total plaster work					**239.96**	**m2**	

Rate Analysis for Sedimentation tank Water Supply project at Tarakeshwor municipality

1	**Earthwork excavation in soil including hauling disposal of soilupto 10m amd lift upto 1.5m(rate per cu.m)**						
S.N	Description	Unit	Quantity(m^3)	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	Unskilled	md	0.7	870	609	609	
			cost including 3% for tools and plants			18.27	
				sub total		627.27	
				15% contractor overhead		94.09	
				Grand total		721.36	
	per unit rate						
	721.36	Rs					
2	**Stone Soling work in foundation with free hauling upto 30m (rate per 1 cum.)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	unskilled	md	1.5	870	1305	1,305.00	
2	Materials						
	blockstone	cum	1	2755	2755	2755	
	bondstone	cum	0.2	1553	310.6	310.6	
			cost including 3% for tools and plants			39.15	
				sub total		4,409.75	
				15% contractor overhead		661.4625	
				Grand total		5,071.21	
	per unit rate						
	5,071.21	Rs					
3	**plain cement concrete(pcc) 1:3:6 ratio for flooring and foundations(rate analysis: 1 cum)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	skilled	md	1	1185	1185	1185	
	Unskilled labour	md	4	870	3480	3480	
2	Material						
	OPC Cement	bags	4.4	700	3080	3080	
	Aggregate(20mm)	cum	0.85	3602	3061.7	3061.7	
	Sand	cum	0.47	3460	1626.2	1626.2	
	Water	ltr	130	0.33	42.9	42.9	

				hire of tools@3%		104.4	
				sub total		12580.2	
				15% contractor overhead		1887.03	
				Grand Total		14467.23	
	per unit rate						
	14467.23	Rs					
4	**PCC in for RCC work in 1:1.5:3 ratio(rate analysis:1 cum)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	skilled	md	0.5	1185	592.5	592.5	
	unskilled	md	3.5	870	3045	3045	
2	Material						
	OPC Cement	bags	8	700	5600	5600	
	aggregate(10mm)	cum	0.29	3460	1003.4	1003.4	
	Aggregate(20mm)	cum	0.57	3602	2053.14	2053.14	
	Sand	cum	0.425	3460	1470.5	1470.50	
	Water	ltr	200	0.33	66	66.00	
				hire of tools@3%		91.35	
				sub total		13921.89	
				15% contractor overhead		2088.28	
				Grand Total		16010.17	
	per unit rate						
	16010.17	Rs					
5	**Steel Reinforcement bar of Fe 500 grade including supplying,straightening,cleaning,cutting,binding,fixing in position with annealed tying binding wire(Rate analysis:1 MT)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	labour cost						
	skilled	md	12	1185	14220	14220	
	unskilled	md	12	870	10440	10440	
2	material						
	MS bar	mt	1.05	99000	103950	103950	
	Binding wire	kg	10	106	1060	1060	
				hire of tools@3%		313.2	
				sub total		129983.2	

				15% contractor overhead		19497.48	
				Grand total		149480.68	
	per unit MT						
	149480.68	Rs					
	Pcc for Rcc with reinforcements		1cum requires 78.6 kg reinforcement		**27759.35**		
7	**12.5 mm thick plaster ratio(per 10 sqm)(1:3)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	labour						
	skilled	md	1.2	1185	1422	1422	
	unskilled	md	1.6	870	1392	1392	
2	material						
	ppc cement	bags	1.287	600	772.2	772.20	
	sand	cum	0.134	3460	463.64	463.64	
	water	ltr	45	0.33	14.85	14.85	
			cost including3% tools and plant			41.76	
					sub total	4106.45	
				15% contractor overhead		615.97	
				Grand total		4722.42	
	per 10 sqm rate						
	4722.42	Rs					

TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

PULCHOWK CAMPUS

BILL OF QUANTITY

SEDIMENTATION TANK

S.N	Description/Particulars	Qty.	Unit	Rate(Rs.)	Unit of rate	Amount(Rs.)
1	earthwork in excavation	66.84	cum			
2	stone soling work in foundation	2.39	cum			
3	PCC for foundation work	2.39	cum			
4	PCC for RCC work(1:1.5:3) with reinforcements including steel reinforcement	27.71	cum			
5	12.5 thick mm(1:3) cement sand plaster	239.96	10sqm			

TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

PULCHOWK CAMPUS

ABSTRACT OF COST

SEDIMENTATION TANK

SN	Description of Items	Qty.	unit	Rate	Amount
1	Excavation of Earthwork	66.84	cum.	721.36	48215.7024
2	soling work in foundation	2.39	cum.	5071.21	12120.1919
3	PCC for foundation work	2.39	cum.	14467.23	34576.6797
4	PCC for RCC work(1:1.5:3) including steel reinforcement	27.71	cum.	27759.35	769211.589
5	12.5 thick mm(1:3) cement sand plaster	239.96	1 sqm.	472.24	113318.71
	Subtotal				977442.873
	VAT @13%				127067.573
	Grand total		Rs		**1104510.45**

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

Filtration Unit

SN	Description	No.	length(m)	breadth(m)	height(m)	quantity	unit
1	Earthwork in excavation	1	3.1	1.85	2.5	14.3375	cum.
2	Stone soling	1	2.95	1.7	0.15	0.75225	cum.
3	RCC work in wall						
3.1	External wall						
3.1.a	Long wall	2	2.8	0.15	2.8	2.352	cum.
3.1.b	Short wall	2	1.25	0.15	2.8	1.05	cum.
3.2	Internal wall	1	1.25	0.15	1.465	0.27469	cum.
3.3	Slab	1	0.7	1.4	0.15	0.147	cum.
3.4	base	1	2.65	1.4	0.15	0.5565	cum.
				total		4.38019	cum.
4	12.5 thick mm(1:3) cement sand plaster						
4.1	internal wall	2	1.25	-	1.39	3.475	m*m
4.2	slab	1	0.7	1.4	-	0.98	m*m
4.3	External wall						
4.3.a	long wall	2	2.8	-	2.65	14.84	m*m
4.3.b	Short wall	2	1.25		2.65	6.625	m*m
4.4	base	1	2.65	1.4	-	3.71	m*m
				total		29.63	m*m
5	Shuttering and formwork	1	3.15	1.7	2.8	27.16	m*m
6	Wash water through	1	1.8	A=0.3*0.22		0.1188	cum.
7	Lateral Drain	24	0.6	-	-	14.4	m
8	manifold	1	1.8	-	-	1.8	m
9	Influent pipe	1	2	-	-	2	m
10	Wash Water drain pipe	1	4	-	-	4	m
11	Pipe to the storage tank	1	4	-	-	4	m
12	Pipe from wash water storage tank to filter	1	10	-	-	10	m
13	Pipe from air compression unit to filter	1	8	-	-	8	m
14	Gravel as Filter Media	1	1.8	1.4	0.5	1.26	cum.
15	sand as filter media	1	1.8	1.4	0.6	1.512	cum.
16	valves	7	-	-	-	7	nos.

TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

PULCHOWK CAMPUS

Rate Analysis for Filtration Unit in Water Supply project at Tarakeshwor municipality

1	**Earthwork excavation in soil including hauling disposal of soilupto 10m amd lift upto 1.5m(rate per cu.m)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	Unskilled	md	0.7	870	609	609	
			cost including 3% for tools and plants			18.27	
				sub total		627.27	
				15% contractor overhead		94.09	
				Grand total		721.36	
	per unit rate						
	721.36	Rs					
2	**Stone Soling work in foundation with free hauling upto 30m (rate per 1 cum.)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	unskilled	md	1.5	870	1305	1,305.00	
2	Materials						
	blockstone	cum	1	2755	2755	2755	
	bondstone	cum	0.2	1553	310.6	310.6	
			cost including 3% for tools and plants			39.15	
				sub total		4,409.75	
				15% contractor overhead		661.4625	
				Grand total		5,071.21	
	per unit rate						
	5,071.21	Rs					
3	**PCC in for RCC work in 1:1.5:3 ratio(rate analysis:1 cum)**						

S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	skilled	md	0.5	1185	592.5	592.5	
	unskilled	md	3.5	870	3045	3045	
2	Material						
	OPC Cement	bags	8	700	5600	5600	
	Aggregate(10mm)	cum	0.29	3460	1003.4	1003.4	
	Aggregate(20mm)	cum	0.57	3602	2053.14	2053.14	
	Sand	cum	0.425	3460	1470.5	1470.5	
	Water	ltr	200	0.33	66	66	
				hire of tools@3%		91.35	
				sub total		13921.89	
				15% contractor overhead		2088.28	
				Grand Total		16010.17	
	per unit rate						
	16010.17	Rs					
4	**Steel Reinforcement bar of Fe 500 grade including supplying,straightening,cleaning,cutting,binding,fixing in position with annealed tying binding wire(Rate analysis:1 MT)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	labour cost						
	skilled	md	12	1185	14220	14220	
	unskilled	md	12	870	10440	10440	
2	material						
	MS bar	mt	1.05	99000	103950	103950	
	Binding wire	kg	10	106	1060	1060	
				hire of tools@3%		313.2	
				sub total		129983.2	
				15% contractor overhead		19497.48	
				Grand total		149480.7	
	per unit rate						
	149480.68	Rs					

	Pcc for Rcc with reinforcements		1cum requires 78.6 kg reinforcement		**27759.35**		
5	**Shuttering and formwork including selection of mat.,measuring cutting,fixing nailing as per specified drawings & hauling up to 30m and placing in piles(Rate analysis:10 sqm.)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	labour cost						
	skilled	md	1.5	1185	1777.5	1777.5	
	unskilled	md	2.5	870	2175	2175	
2	formwork						
	plywood 12 mm thick	sqm	11	990	10890	10890	
	nails	kg	2	132	264	264	
	rafters,beams,battens	cum.	0.1	23590.1974	2359.02	2359.02	
			hire of tools@3%			65.25	
			sub total			17465.52	
			15% contractor overhead			2619.828	
			Grand total			20085.35	
	per 10 sqm.						
	20085.35						
6	**sand as filter media (per cum)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	sand	cum.	1	3460	3460	3460	
			sub total			3460	
			15% contractor overhead			519	
			Grand total			3979	
	per unit rate						
	3979						
7	**graded gravel as filter media(per cum)**						
1	gravel	cum.	1	3602	3602	3602	
			sub total			3602	
			15% contractor overhead			540.3	
			grand total			4142.3	
	per unit rate						
	4142.3						

8	**12.5 mm thick plaster ratio(per 10 sqm)(1:3)**						
1	labour						
	skilled	md	1.2	1185	1422	1422	
	unskilled	md	1.6	870	1392	1392	
2	material						
	ppc cement	bags	1.287	600	772.2	772.20	
	sand	cum	0.134	3460	463.64	463.64	
	water	ltr	45	0.33	14.85	14.85	
			cost including3% tools and plant			41.76	
					sub total	4106.45	
				15% contractor overhead		615.97	
				Grand total		4722.42	
	per 10 sqm rate						
	4722.42	Rs					

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

BILL OF QUANTITY
FILTRATION UNIT

S.N	Description/Particulars	Qty.	Unit	Rate(Rs.)	Unit of rate	Amount(Rs.)
1	earthwork in excavation	14.34	cum.			
2	stone soling work in foundation	0.752	cum.			
3	PCC for RCC work(1:1.5:3) with reinforcements including steel reinforcement	4.38	cum.			
4	12.5 mm thick plaster ratio(per 10 sqm)(1:3)	29.63	10sqm			
5	Shuttering and formwork including selection of mat.,measuring cutting,fixing nailing as per specified drawings & hauling up to 30m and placing in piles	27.16	10 sqm			
6	pcc for washwater trough	0.119	cum.			
7	manifold(dia=20 cm)	1.8	m			
8	lateral drains(dia=32mm)	14.4	m			
9	valves	7	nos.			
10	Gravel for filter media	1.26	cum.			
11	Sand for filter media	1.512	cum.			
12	Influent pipe	2	m			
13	Wash Water drain pipe	4	m			
14	Pipe to the storage tank	4	m			
15	Pipe from wash water storage tank to filter	10	m			
16	Pipe from air compression unit to filter	8	m			

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

ABSTRACT OF COST
FILTRATION UNIT

SN	Description of Items	Qty.	unit	Rate	Amount
1	Excavation of Earthwork	66.84	cum.	721.36	48215.7
2	soling work in foundation	2.39	cum.	5071.21	12120.19
3	PCC for RCC work(1:1.5:3) including steel reinforcement	4.38	cum.	27759.35	121586
4	12.5 mm thick plaster ratio(per 10 sqm)(1:3)	29.63	sqm.	472.24	13992.47
5	Shuttering and formwork including selection of mat.,measuring cutting,fixing nailing as per specified drawings & hauling up to 30m and placing in piles	27.71	sqm.	2008.53	55656.37
6	pcc for washwater trough	239.96	1 sqm.	472.24	113318.7
7	manifold(dia=200mm)	1.8	m.	1485	2673
8	lateral drains(dia=32mm)	14.4	m.	411	5918.4
9	valves	7	nos	12050	84350
10	Gravel for filter media	1.26	cum.	4142.3	5219.298
11	Sand for filter media	1.512	cum.	3979	6016.248
12	Influent pipe(90 HDPE6kg/sqcm)	2	m	468	936
13	Wash water drain pipe(75 HDPE6kg/sqcm)	4	m	330.2	1320.8
14	Pipe to the storage tank(50HDPE6kg/sqcm)	4	m	94.9	379.6
15	Pipe from wash water storage tank to filter (75HDPE6kg/sqcm)	10	m	330.2	3302
16	Pipe from air compresion unit to filter 32HDPE10kg/sqcm)	8	m	54.08	432.64
	sub total				475437.4
	13% VAT				61806.86
	Total				537244.3
	Grand Total		Rs		**537244.3**

TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

DEPARTMENT OF CIVIL ENGINEERING

PULCHOWK CAMPUS

Chlorination Unit

SN	Description	No.	length(m)	breadth(m)	height(m)	quantity	unit	remarks
1	Earthwork in excavation							
1.1	contact chamber	1	7.4	2.2	1.2	19.536	cum.	
1.2	outlet	1	0.5	2.2	0.2	0.22	cum.	
1.3	inlet	1	0.5	2.2	0.2	0.22	cum.	
	total					**19.976**	**cum.**	
2	Stone soling	1	6.9	1.9	0.15	**1.9665**	cum.	
3	RCC work in wall							
3.1	contact chamber							
	Long wall	2	6.9	0.2	1.3	3.588	cum.	
	Short wall	2	0.2	1.3	1.3	0.676	cum.	
	deduction inlet	2	0.2	0.3	0.45	0.054	cum.	
	deduction outlet	1	0.2	0.9	0.2	0.036	cum.	
	total					4.174	cum.	
	baffles	4	0.1	1	1.3	0.52	cum.	
	base	1	6.5	1.3	0.2	1.69	cum.	
3.2	inlet							
	base	1	0.3	1.3	0.15	0.0585	cum.	
	wall	1	2.2	0.15	0.65	0.2145	cum.	
3.3	outlet							
	base	1	0.3	1.3	0.15	0.0585	cum.	
	wall	1	2.2	0.15	0.65	0.2145	cum.	
3.4	slab	1	7.3	1.6	0.2	2.336	cum.	
	total					**9.266**	cum.	
4	plastering 12.5 mm (1:3) CS mortar							
4.1	floor of chlorination unit							
4.2	internal walls	1	15.6	-	1.3	20.28	sqm.	
	deductions							
	to inlet	2	0.3	-	0.45	0.27	sqm.	
	to outlet	1	0.9		0.45	0.405	sqm.	
	total					19.605	sqm.	
4.3	inlet							

	floor	1	1.3	0.3	-	0.39	sqm.	
	internal walls	1	3.2	-	0.45	1.44	sqm.	
4.4	outlet							
	floor	1	1.3	0.3	-	0.39	sqm.	
	internal walls	1	3.2	-	0.45	1.44	sqm.	
4.5	slab internal							
	contact chamber	1	6.5	-	1.3	8.45	sqm.	
	inlet and outlet	2	0.3	-	1.3	0.78	sqm.	
4.6	baffles	4	1	-	1.3	5.2	sqm.	
	total					**37.695**	sqm.	
5	plastering 12.5 mm (1:4) CS mortar							
5.1	external wall							
	contact chamber	1	13.8	-	0.6	8.28	sqm.	
	inlet and outlet	2	2.2	-	0.45	1.98	sqm.	
5.2	slab external	1	9.8	1.6	-	15.68	sqm.	
	Total					**25.94**	sqm.	

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

Rate Analysis for Chlorination Unit in Water Supply project at Tarakeshwor municipality

1	**Earthwork excavation in soil including hauling disposal of soilupto 10m amd lift upto 1.5m(rate per cu.m)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	Unskilled	md	0.7	870	609	609	
			cost including 3% for tools and plants			18.27	
				sub total		627.27	
				15% contractor overhead		94.09	
				Grand total		721.36	
	per unit rate						
	721.36	Rs					
2	**Stone Soling work in foundation with free hauling upto 30m (rate per 10 sqm.)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	unskilled	md	1.5	870	1305	1305	
2	Materials						
	Blockstone	cum	1	2755	2755	2755	
	bondstone	cum	0.2	1553	310.6	310.6	
			cost including 3% for tools and plants			39.15	
				sub total		4,409.75	
				15% contractor overhead		661.4625	
				Grand total		5,071.21	
	per 10 sqm rate						
	5,071.21	Rs					
3	**PCC in for RCC work in 1:1.5:3 ratio(rate analysis:1 cum)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	skilled	md	0.5	1185	592.5	592.5	
	unskilled	md	3.5	870	3045	3045	
2	Material						
	OPC Cement	bags	8	700	5600	5600	
	Aggregate(10mm)	cum	0.29	3460	1003.4	1003.4	

	Aggregate(20mm)	cum	0.57	3602	2053.14	2053.14	
	Sand	cum	0.43	3460	1470.5	1470.5	
	Water	ltr	200	0.33	66	66	
				hire of tools@3%		91.35	
				sub total		13921.89	
				15% contractor overhead		2088.28	
				Grand Total		16010.17	
	per unit rate						
	16010.17	Rs					
4	**Steel Reinforcement bar of Fe 500 grade including supplying,straightening,cleaning,cutting,binding,fixing in position with annealed tying binding wire(Rate analysis:1 MT)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	labour cost						
	skilled	md	12	1185	14220	14220	
	unskilled	md	12	870	10440	10440	
2	material						
	MS bar	mt	1.05	99000	103950	103950	
	Binding wire	kg	10	106	1060	1060	
				hire of tools@3%		313.2	
				sub total		129983.2	
				15% contractor overhead		19497.48	
				Grand total		149480.68	
	per 1 MT						
	149480.68	Rs					
	Pcc for Rcc with reinforcements		1cum requires 78.6 kg reinforcement		**27759.35**		
5	**12.5 mm thick plaster ratio(per 100 sqm)(1:3)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	labour						
	skilled	md	12	1185	14220	14220	
	unskilled	md	16	870	13920	13920	

2	material						
	ppc cement	bags	21.7	600	13020	13020.00	
	sand	cum	1.28	3460	4428.8	4428.80	
	water	ltr	450	0.33	148.5	148.50	
			cost including3% tools and plant			417.60	
					sub total	46154.90	
				15% contractor overhead		6923.24	
				Grand total		53078.14	
	per 100 sqm rate						
	53078.14	Rs					
6	**12.5 mm thick plaster ratio(per 100 sqm)(1:4)**						
1	labour						
	skilled	md	12	1185	14220	14220	
	unskilled	md	16	870	13920	13920	
2	material						
	ppc cement	bags	18.7	600	11208	11208.00	
	sand	cum	1.46	3460	5051.6	5051.60	
	water	ltr	450	0.33	148.5	148.50	
			cost including3% tools and plant			417.60	
					sub total	44965.70	
				15% contractor overhead		6744.86	
				Grand total		51710.56	
	per 100 sqm rate						
	51710.56	Rs					

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

BILL OF QUANTITY FOR CHLORINE CONTACT CHAMBER

S. N	Description/Particulars	Qty.	Unit	Rate(Rs.)	Unit of rate	Amount(Rs.)
1	earthwork in excavation	19.976	cum.			
2	stone soling work in foundation	13.110	10sq m.			
3	PCC in for RCC work in 1:1.5:3 ratio	9.266	cum.			
4	Steel Reinforcement bar of Fe 500 grade including supplying,straightening,cleaning,cutting,binding,fixing in position with annealed tying binding wire	0.72831	MT			
5	plastering 12.5 mm (1:3) CS mortar	37.695	10 sqm.			
6	plastering 12.5 mm (1:4) CS mortar	25.94	10 sqm.			

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

ABSTRACT OF COST
Chlorine Contact Chamber

SN	DESCRIPTION	QUANTITY	UNIT	RATE	AMOUNT
1	earthwork in excavation	19.976	cum.	721.36	14409.89
2	Stone soling work in foundation	13.110	1 sqm	1300.41	17048.32
3	PCC in for RCC work in 1:1.5:3 ratio	9.266	cum.	16010.17	148350.3
4	Steel Reinforcement bar of Fe 500 grade including supplying,straightening,cleaning,cutting,binding,fixing in position with annealed tying binding wire	0.728	1 MT	149480.68	108867.9
5	plastering 12.5 mm (1:3) CS mortar	37.695	1 sqm	530.78	20007.8
6	plastering 12.5 mm (1:4) CS mortar	25.94	1 sqm	517.11	13413.72
	sub total				322097.9
	13% VAT				41872.73
	Total				363970.6
	Grand Total		Rs		**363970.6**

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

Reinforcement Cement Concrete Tank With Valve Chamber

Inner side of tank= 5m*5m
Thickness of wall= 0.2m
Total tank height= 3m
Thickness of cover slab= 0.2m

S.N.	Description	No.	Length (m)	Breadth (m)	Height (m)	Quantity	Unit	Remarks
1	**Earthwork in excavation for foundation in**							
	Storage tank	1	6.4	6.4	2.9	118.784	m3	
	Valve Chamber	1	1.9	1.9	1.8	6.498	m3	
	Total earth work					**125.282**	**m3**	
2	**Brick Soling Works**							
	Storage tank	1	5.4	5.4	0.055	1.6038	m3	
	Valve Chamber	1	1.9	1.9	0.055	0.19855	m3	
	Total soling work					**1.80235**	**m3**	
3	**Brick Masonry in 1:4 c-s mortar**							
	Valve Chamber							
	floor	1	1.7	1.7	0.2	**0.578**	m3	
	walls	1	5.3	0.2	1.6	**1.696**	m4	
	total					**2.274**	**m3**	
4	**PCC (1:3:6) in foundation**							
	tank foundation	1	5.4	5.4	0.1	**2.916**	m3	
5	**PCC (1:1½:3) for RCC work**							
	for tank base slab	1	5.4	5.4	0.2	5.832	m3	
	for wall portion							
	long wall	1	5.4	0.2	3	3.24	m3	
	short wall	1	5	0.2	3	3	m3	
	Total PCC for RCC works					**12.072**	**m3**	
6	**PCC (1:2:4) for RCC work**							
	cover slab	1	5.4	5.4	0.2	4.23	m3	
	cover slab of VC	1	1.9	1.9	0.2	0.36	m3	
	Total PCC workS					**4.59**	**m3**	
7	**Steel reinforcement**							
	Total	1	v=	1309.6332		1309.63	kg	
	Total reinforcement work					**1309.63**	**kg**	
8	**12.5 mm thick 1:3 cement-sand plaster**							
	floor of tank	1	5	5		25	m2	
	inner wall portion	1	20		3	60	m2	
	Total plaster work					**85**	**m2**	
9	**12.5 mm thick 1:4 cement-sand plaster**							

	Top of slab	1	5.4	5.4		29.16	m2	
	inner side of VC	1	7.2		1.8	7.2	m2	
	Total					**36.36**	**m2**	

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

Rate Analysis for Reservoir Tank Water Supply project at Tarakeshwor municipality

1	**Earthwork excavation in soil including hauling disposal of soilupto 10m amd lift upto 1.5m(rate per cu.m)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	Unskilled	md	0.7	870	609	609	
			cost including 3% for tools and plants			18.27	
				sub total		627.27	
				15% contractor overhead		94.09	
				Grand total		721.36	
	per unit rate						
	721.36	Rs					
2	**brick Soling work in foundation with free hauling upto 30m (rate per 10 sqm.)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	unskilled	md	1	870	870	870	
	skilled	md	0.5	1185	592.5	592.50	
2	Materials						
	bricks	nos	420	17.55	7371	7371	
	sand	cum	0.71	3460	2456.6	2456.6	
			cost including 3% for tools and plants			17.78	
				sub total		11,307.88	
				15% contractor overhead		1696.18125	
				Grand total		13,004.06	
	per 10 sqm rate						
	13,004.06	Rs					
3	**Brick Masonry in 1:4 c-s mortar (per cum.)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	unskilled	md	2.2	870	1914	1914	

	skilled	md	1.5	1185	1777.5	1777.5	
2	Materials						
	sand	cum	0.27	3460	934.2	934.2	
	cement	bags	3.47	700	2429	2429	
	bricks	nos	530	17.55	9301.5	9301.5	
			cost including 3% for tools and plants			57.42	
				sub total		16413.62	
				15% contractor overhead		2462.043	
				Grand total		18875.663	
	per 1 cum. Rate						
	18875.663	Rs					
4	**PCC (1:3:6) in foundation (per 1 cum.)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	skilled	md	1	870	870	870	
	unskilled	md	4	1185	4740	4740	
2	Materials						
	opc cement	bags	7.64	700	5348	5348	
	agg (40mm)	cum	0.65	3602	2341.3	2341.3	
	agg (20mm)	cum	0.24	3602	864.48	864.48	
	sand	cum	0.47	3460	1626.2	1626.2	
	water	ltr	120	0.33	39.6	39.6	
			cost including 3% for tools and plants			142.2	
				sub total		15829.58	
			15% contractor overhead			2374.437	
				Grand total		18204.017	
	per 1 cum						
	18204.017	Rs					
5	**PCC in for RCC work in 1:1.5:3 ratio(rate analysis:1 cum)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	skilled	md	0.5	1185	592.5	592.5	
	unskilled	md	3.5	870	3045	3045	
2	Material						
	OPC Cement	bags	8	700	5600	5600	
	Aggregate(10mm)	cum	0.29	3460	1003.4	1003.4	
	Aggregate(20mm)	cum	0.57	3602	2053.14	2053.14	
	Sand	cum	0.425	3460	1470.5	1470.5	
	Water	ltr	200	0.33	66	66	
				hire of tools@3%		91.35	
				sub total		13921.89	

				15% contractor overhead		2088.28	
				Grand Total		16010.17	
	per unit rate						
	16010.17	Rs					
6	**Steel Reinforcement bar of Fe 500 grade including supplying,straightening,cleaning,cutting,binding,fixing in position with annealed tying binding wire(Rate analysis:1 MT)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	labour cost						
	skilled	md	12	1185	14220	14220	
	unskilled	md	12	870	10440	10440	
2	material						
	MS bar	mt	1.05	99000	103950	103950	
	Binding wire	kg	10	106	1060	1060	
				hire of tools@3%		313.2	
				sub total		129983.2	
				15% contractor overhead		19497.48	
				Grand total		149480.68	
	per 1 MT						
	149480.68	Rs					
	Pcc for Rcc with reinforcements		1cum requires 78.6 kg reinforcement		**27759.35**		
7	**PCC (1:2:4) for RCC work(1 cum.)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	Labour cost						
	skilled	md	0.5	1185	592.5	592.5	
	unskilled	md	3.5	870	3045	3045	
2	Material						
	OPC Cement	bags	11.11	700	7777	7777	
	Aggregate(10mm)	cum	0.11	3460	380.6	380.6	
	Aggregate(20mm)	cum	0.22	3602	792.44	792.44	
	Aggregate(40mm)	cum	0.52	3602	1873.04	1873.04	
	Sand	cum	0.445	3460	1539.7	1539.7	
	Water	ltr	150	0.33	49.5	49.5	

				hire of tools@3%		91.35	
				sub total		16141.13	
				15% contractor overhead		2421.1695	
				Grand total		18562.2995	
	unit rate						
	18562.30	Rs					
8	**12.5 mm thick plaster ratio(per 10 sqm)(1:3)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	labour						
	skilled	md	12	1185	14220	14220	
	unskilled	md	16	870	13920	13920	
2	material						
	ppc cement	bags	21.7	600	13020	13020.00	
	sand	cum	1.28	3460	4428.8	4428.80	
	water	ltr	450	0.33	148.5	148.50	
			cost including3% tools and plant			417.60	
					sub total	46154.90	
				15% contractor overhead		6923.24	
				Grand total		53078.14	
	per 100 sqm rate						
	53078.14	Rs					
9	**12.5 mm thick plaster ratio(per 100 sqm)(1:4)**						
S.N	Description	Unit	Quantity	rate(Rs/unit)	Amount	Total amount	Remarks
1	labour						
	skilled	md	12	1185	14220	14220	
	unskilled	md	16	870	13920	13920	
2	material						
	ppc cement	bags	18.68	600	11208	11208.00	
	sand	cum	1.46	3460	5051.6	5051.60	
	water	ltr	450	0.33	148.5	148.50	
			cost including3% tools and plant			417.60	
					sub total	44965.70	
				15% contractor overhead		6744.86	
				Grand total		51710.56	
	per 100 sqm rate						
	51710.56	Rs					

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

BILL OF QUANTITY FOR RESERVOIR TANK

S.N	Description/Particulars	Qty.	Unit	Rate (Rs.)	Unit of rate	Amount(Rs.)
1	earthwork in excavation	125.282	cum.			
2	brick soling work in foundation	32.770	10 sqm			
3	Brick Masonry in 1:4 c-s mortar	2.274	cum.			
4	PCC (1:3:6) in foundation	2.916	cum.			
5	PCC in for RCC work in 1:1.5:3 ratio	12.072	cum.			
6	Steel Reinforcement bar of Fe 500 grade Including supplying,straightening,cleaning,cutting, binding,fixing in position with annealed tying binding wire	1.310	1 MT			
7	PCC (1:2:4) for RCC work	4.590	cum.			
8	12.5 mm thick plaster ratio(1:3)	85.000	100 sqm			
9	12.5 mm thick plaster ratio(per 100 sqm)(1:4)	36.360	100 sqm			

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

ABSTRACT OF COST
Reinforcement Cement Concrete Tank With Valve Chamber

SN	DESCRIPTION	QUANTITY	UNIT	RATE	AMOUNT
1	earthwork in excavation	125.282	cum.	721.36	90373.42
2	brick soling work in foundation	32.770	1 sqm	1300.41	42614.29
3	Brick Masonry in 1:4 c-s mortar	2.274	cum.	18875.663	42923.26
4	PCC (1:3:6) in foundation	2.916	cum.	18204.017	53082.91
5	PCC in for RCC work in 1:1.5:3 ratio	14.954	cum.	16010.17	239416.1
6	Steel Reinforcement bar of Fe 500 grade including supplying,straightening,cleaning,cutting,binding,fixing in position with annealed tying binding wire	1.310	1 MT	149480.68	195764.4
7	PCC (1:2:4) for RCC work	4.590	cum.	18562.30	85200.95
8	12.5 mm thick plaster ratio(1:3)	85.000	1 sqm	530.78135	45116.41
9	12.5 mm thick plaster ratio(per 100 sqm)(1:4)	36.360	1 sqm	517.10	18801.76
	sub total				813293.5
	13% VAT				105728.2
	Total				919021.7
	Grand Total		Rs		**919021.7**

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

Earthwork in excavation and Backfilling for Pipeline Works								
S.N.	**Description**	**Length**	**Breadth**	**Height**	**Quantity**	**Unit**	**Rate**	**Amount**
1	Transmission Line							
	EW in excavation	1570.8	0.45	0.9	636.174	cub.metres	1030.515	655586.8496
	EW in backfilling	1570.8	0.45	0.9	636.174	cub.metres	515.275	327804.5579
	Total cost of transmission pipeline works							983391.4075
2	Distribution Line							
	EW in excavation	5167.8	0.45	0.9	2092.959	cub.metres	1030.515	2156825.644
	EW in backfilling	5167.8	0.45	0.9	2092.959	cub.metres	515.275	1078449.449
	Total cost of Distribution pipeline works							3235275.093
	Total Cost of Pipeline works							4218666.5

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

Analysis of Rates						
Earthworks for Pipeline Trenches						
A	**Earthwork in excavation(1 cub.metre) and Site Clearance(1 sq.m)**					
	Earthwork in excavation with 10m lead and 1.5m lift					
	Items	Unit	Unit Rate	Quantity	Cost	
	Unskilled Labour	Rs/day	870	1	870	
	Tools and Plants	%		3%	26.1	
	Subtotal				896.1	
	Contractor's Overhead and Profit	%		15%	134.415	
	Rate/cub.m (without VAT)				1030.515	
B	**Earthwork in backfilling for pipeline trench with compaction in layers of 20cm with water sprinkling and site clearance**					
	Items	Unit	Unit Rate	Quantity	Cost	
	Unskilled	Rs/day	870	0.5	435	
	Tools and Plants	%		3%	13.05	
	Subtotal				448.05	
	Contractor's Overhead and Profit	%		15%	67.2075	
	Rate/cub.m (without VAT)				515.2575	

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

Pipe Line Estimate					
				length	
Pipe Type	**Nominal Dia**	**Class**	**Pipe Code**	**Transmission**	**Distribution**
HDPE pipe	20	16 kg/sq.cm	HP16-32	-	2201
HDPE pipe	20	10 kg/sq.cm	HP10-32	-	150
HDPE pipe	25	10 kg/sq.cm	HP10-25	-	212
HDPE pipe	25	16 kg/sq.cm	HP16-25	-	50
HDPE pipe	32	10 kg/sq.cm	HP10-32	-	716
HDPE pipe	32	16 kg/sq.cm	HP16-32	-	769
HDPE pipe	40	10 kg/sq.cm	HP10-40	-	400
HDPE pipe	40	16 kg/sq.cm	HP16-40	-	200
HDPE pipe	50	10 kg/sq.cm	HP10-50	276	-
HDPE pipe	50	16 kg/sq.cm	HP16-50	292	-
HDPE pipe	75	10kg/sq.cm	HP8-75	132	-
HDPE pipe	75	16kg/sq.cm	HP16-75	164	-
HDPE pipe	90	6kg/sq.cm	HP6-90	161	-
HDPE pipe	90	10kg/sq.cm	HP10-90	343	-
HDPE pipe	90	16kq/sq.cm	HP16-90	60	-
			Total	1428	4698
			Grand Total		6126
			Total Design Length		6738.6

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

Laying and Jointing of HDPE and GI Pipes					
S.N	**Items**	**Unit**	**Unit Rate**	**Quantity**	**Amount**
A	HDPE Pipes				
1	Laying and Joining of 16,20 and 25 mm dia HDPE pipes	m	45.56	2874.3	130953.108
2	Laying and Joining of 32 mm dia HDPE pipes	m	56.72	1633.5	92652.12
3	Laying and Joining of 40,50 mm dia HDPE pipes	m	68.83	1284.8	88432.784
4	Laying and Joining of 63,75 and 90 mm dia HDPE pipes	m	103.16	946	97589.36
	Total				409627.372

TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

Analysis of Rates										
HDPE Pipe Jointing(1m)										
Items	**Unit**	**Unit Rate**	**20,25 mm dia for 100m**		**32 mm dia for 100m**		**40,50mm dia for 100m**		**63,75,90mm dia for 50m**	
			Quantity	**Cost (Rs.)**	**Quantity**	**Cost(Rs.)**	**Quantity**	**Cost(Rs.)**	**Quantity**	**Cost(Rs.)**
Plumber	no.	1185	1	1185	1	1185	1.5	1777.5	1	1185
Helper	no.	870	1	870	1	870	1.5	1305	1.5	1305
Coolis	no.	870	2	1740	3	2610	3	2610	2	1740
Subtotal				3795		4665		5692.5		4230
Contigencies	%		2.50%	94.875		116.625		142.3125		105.75
Tools and Plants	day	150	1	150	1	150	1	150	1	150
Subtotal				4039.875		4931.625		5984.8125		4485.75
Contractor's Overhead	%		15%	605.98125		739.74375		897.721875		672.8625
Grand Total				4645.85625		5671.36875		6882.534375		5158.6125
Rate/m				45.46		56.72		68.83		103.16

GI Fittings(1 No.)						
Items	**Unit**	**Unit Rate**	**For 15mm dia**		**For 20mm dia**	
			Quantity	Cost(Rs.)	Quantity	Cost(Rs.)
Plumber	no.	1185	0.003	3.555	0.003	3.555
Helper	no.	870	0.006	5.22	0.006	5.22
Coolis	no.	870	0.006	5.22	0.006	5.22
Jointing Materials % of 10m cost of pipe	%	0.50%	1407	7.035	1785	8.925
Subtotal				21.03		22.92
Contractor's Overhead	%	15%		3.1545		3.438
Grand Total				24.1845		26.358

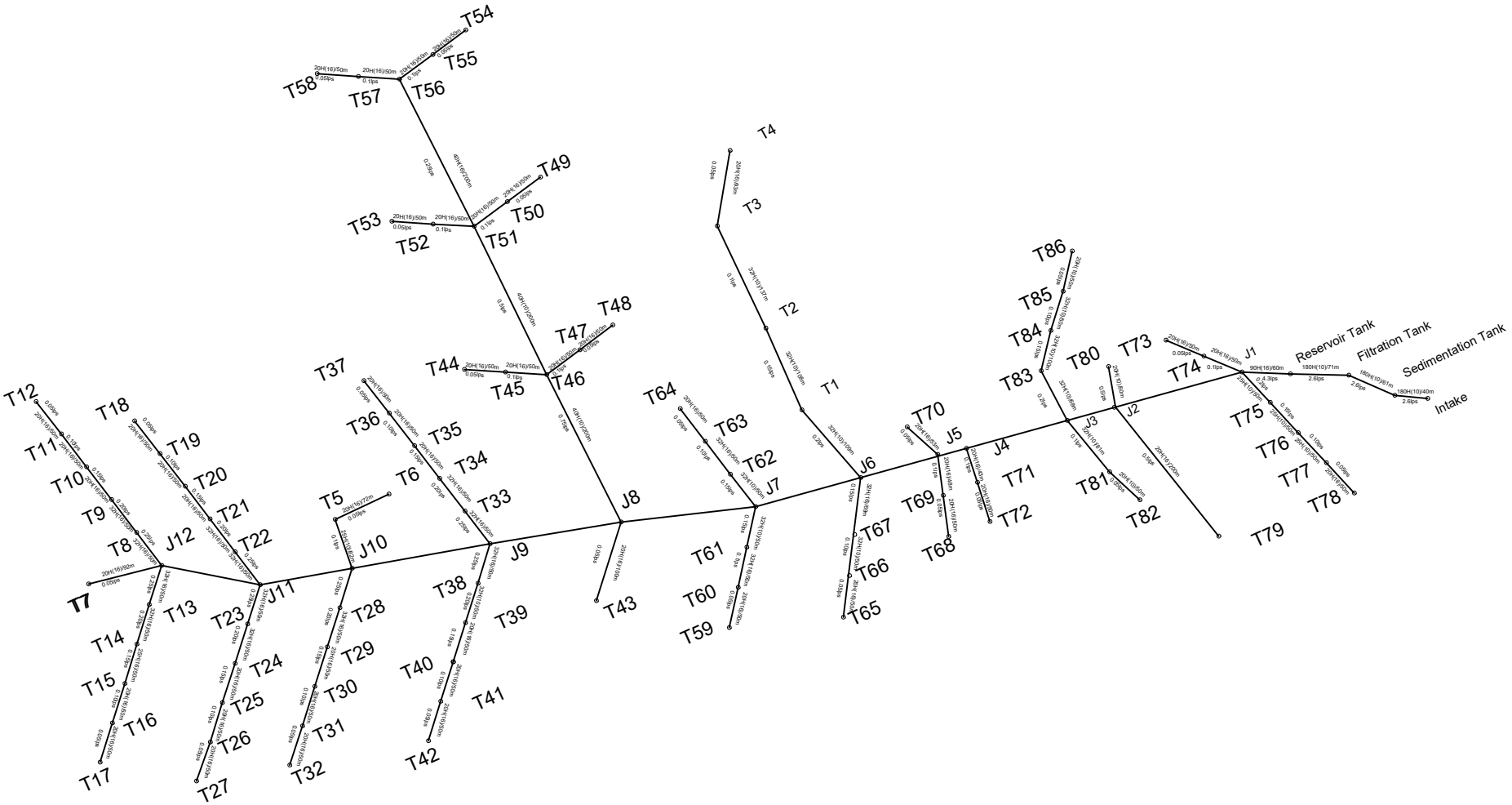
TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

HDPE Pipe Procurement							
S.N.	**Nominal Dia**	**Pipe**	**per meter**		**Design Length**	**Kg**	**Rs.**
			Kg	Rs.			
1	20	10 kg/sq.cm	0.113	22.4	165	18.645	3696
2	20	16 kg/sq.cm	0.154	35.1	2421.1	372.8494	84980.61
3	25	10 kg/sq.cm	0.171	40	233.2	39.8772	9328
4	25	16 kg/sq.cm	0.241	54.08	55	13.255	2974.4
5	32	10 kg/sq.cm	0.279	60.84	787.6	219.7404	47917.584
6	32	16 kg/sq.cm	0.397	87.88	845.9	335.8223	74337.692
7	40	10 kg/sq.cm	0.431	93.6	440	189.64	41184
8	40	16 kg/sq.cm	0.61	135.98	220	134.2	29915.6
9	50	10 kg/sq.cm	0.667	94.9	303.6	202.5012	28811.64
10	50	16 kg/sq.cm	0.938	210.08	321.2	301.2856	67477.696
11	75	10kg/sq.cm	1.491	324.48	145.2	216.4932	47114.496
12	75	16kg/sq.cm	2.116	468	180.4	381.7264	84427.2
13	90	6kg/sq.cm	1.39	298.48	177.1	246.169	52860.808
14	90	10kg/sq.cm	2.126	464.42	377.3	802.1398	175225.666
15	90	16kq/sq.cm	3.042	673.66	66	200.772	44461.56
	Subtotal				6738.6	3675.1165	794712.952

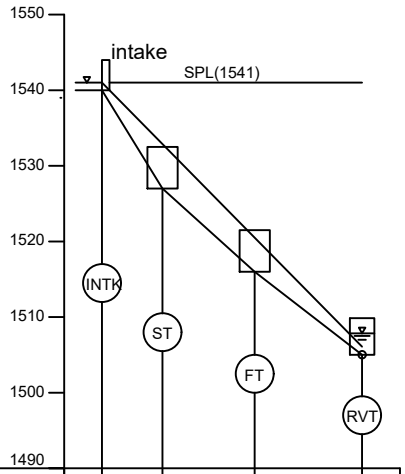
TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING
PULCHOWK CAMPUS

Summary of Cost					
S.N.	**Items**	**Unit**	**Unit Rate**	**Quantity**	**Amount(Rs.)**
A	**Water Supply and Sanitation**				
A1	**Civil Works**				
1	chlorine contact chamber	No	363970.6	1	363970.6
2	Reservoir Tank	No	919021.7	1	919021.7
3	Sand Filter				
3.1	Rapid Sand Filter	No	537244.265	1	537244.265
3.2	Sedimentation Tank	No.	1104510.45	1	1104510.45
3.3	Spring Intake	No.			
4	House Connection	No.	25000	150	3750000
5	Pipeline Works(EW and joining)				
5.1	Transmission	Km		1.5708	983391.4075
5.2	Distribution	Km		5.1678	3235275.093
5.3	Laying and Jointing	Km		6.7386	409627.373
	Subtotal(A1)				11303040.89
A2	**Pipes Procurement**				
1	Pipes Procurement	km		6.7386	794712.952
2	Tools and Plants(15%)			1	119206.9428
3	Other Fittings(15%)				119206.9428
	Subtotal(A2)				1033126.838
	Total B(A1+A2)				12336167.73
	Total(A)				12336167.73
B	**Contingencies and Overhead**				
	Contingencies(15% of A)				1850425.159
C	**13% of VAT(A2+B)**				2883551.997
	Total Cost of Scheme(A+B+C)				17070144.88
	Total Cost of Project				**17070144.88**

ANNEX-D : PIPELINE PROFILE



PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Distribution System	SCALE: Fit to paper	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 07	DATE:2079-10-15	

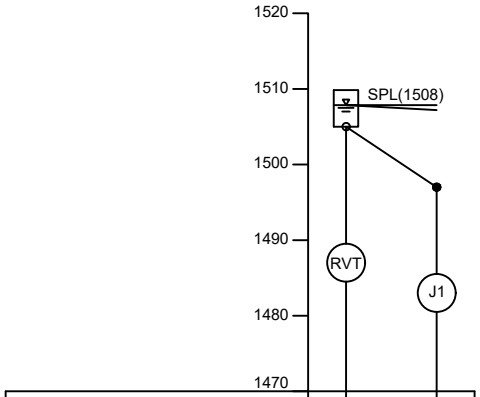


GROUND ELEVATION (m)	1540.0	1527.0	1516.0	1505.0
TOTAL DISTANCE (m)	0	40	101	172
PARTIAL DISTANCE (m)		40	61	71
RESIDUAL HEAD (m)	0.0	5.88	4.50	1.08
DISCHARGE (lps)		2.6	2.6	2.6
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		180H(10)	**180H(10)**	180H(10)
SOIL TYPE	OS			

INTAKE- RVT

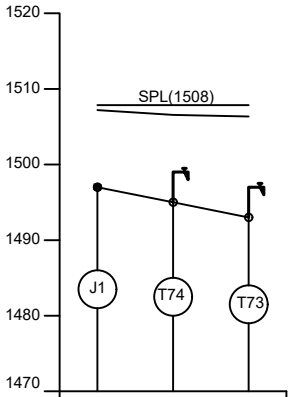
SCALE: [H 1:5000, V 1:1000

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Pipe Line Design Profile	SCALE: 1:1	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 1/13	DATE:2079-10-15	



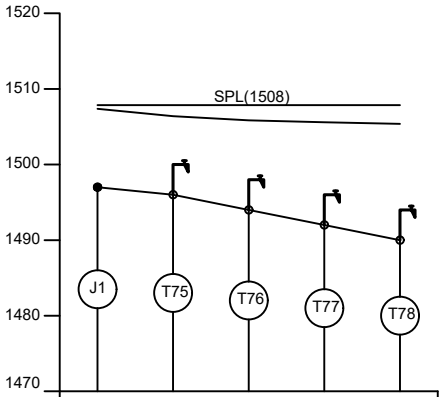
GROUND ELEVATION (m)	1505.0	1497.0
TOTAL DISTANCE (m)	0	60
PARTIAL DISTANCE (m)	60	
RESIDUAL HEAD (m)	0.0	10.38
DISCHARGE (lps)	4.3	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2	90H(16)	
SOIL TYPE	OS	

RVT - J1



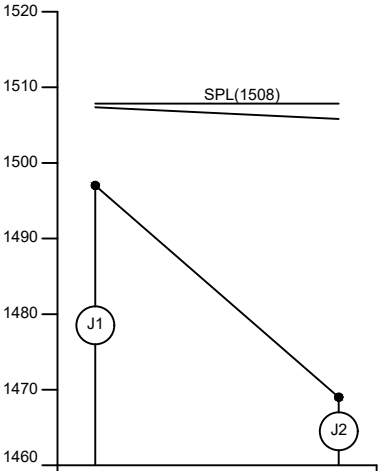
GROUND ELEVATION (m)	1497.0	1495.0	1493.0
TOTAL DISTANCE (m)	0	50	100
PARTIAL DISTANCE (m)	50	50	
RESIDUAL HEAD (m)	10.38	11.57	13.36
DISCHARGE (lps)	0.10	0.05	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2	20H(16)	20H(16)	
SOIL TYPE	OS		

J1 - T73



GROUND ELEVATION (m)	1497.0	1496.0	1494.0	1492.0	1490.0
TOTAL DISTANCE (m)	0	50	100	150	200
PARTIAL DISTANCE (m)	50	50	50	50	
RESIDUAL HEAD (m)	10.38	10.40	11.85	13.59	15.37
DISCHARGE (lps)	0.20	0.15	0.10	0.05	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2	25H(10)	25H(10)	25H(10)	20H(16)	
SOIL TYPE	OS				

J1 - T78

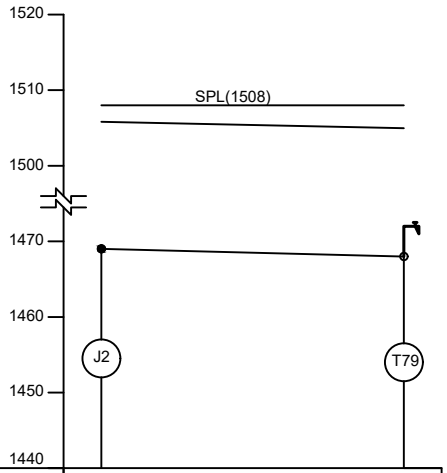


GROUND ELEVATION (m)	1497.0	1469.0
TOTAL DISTANCE (m)	0	161
PARTIAL DISTANCE (m)	161	
RESIDUAL HEAD (m)	10.38	36.82
DISCHARGE (lps)	4.00	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2	90H(6)	
SOIL TYPE	OS	

J1 - J2

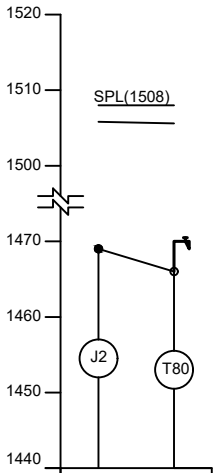
SCALE: [H 1:5000, V 1:1000

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Pipe Line Design Profile	SCALE: 1:1	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 2/13	DATE:2079-10-15	



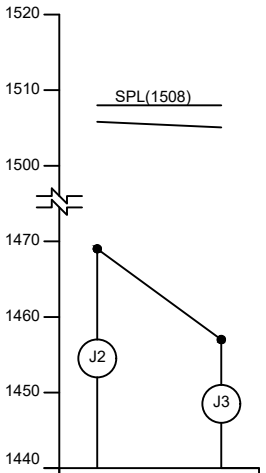
GROUND ELEVATION (m)	1469.0	1468.0
TOTAL DISTANCE (m)	0	200
PARTIAL DISTANCE (m)	200	
RESIDUAL HEAD (m)	36.82	36.96
DISCHARGE (lps)	0.05	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2	20H(16)	
SOIL TYPE	OS	

J2 - T79



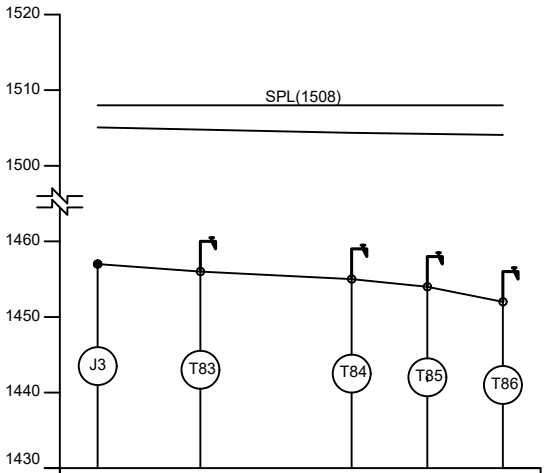
GROUND ELEVATION (m)	1469.0	1466.0
TOTAL DISTANCE (m)	0	50
PARTIAL DISTANCE (m)	50	
RESIDUAL HEAD (m)	36.82	39.61
DISCHARGE (lps)	0.05	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2	20H(10)	
SOIL TYPE	OS	

J2 - T80



GROUND ELEVATION (m)	1469.0	1457.0
TOTAL DISTANCE (m)	0	82
PARTIAL DISTANCE (m)	82	
RESIDUAL HEAD (m)	36.82	48.08
DISCHARGE (lps)	3.90	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2	90H(10)	
SOIL TYPE	OS	

J2 - J3

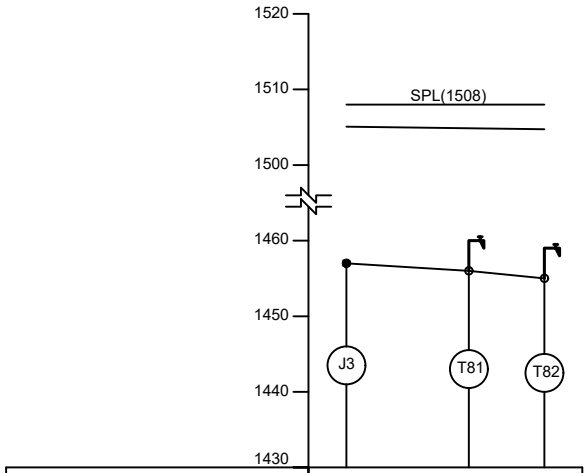


GROUND ELEVATION (m)	1457.0	1456.0	1455.0	1454.0	1452.0
TOTAL DISTANCE (m)	0	68	168	218	268
PARTIAL DISTANCE (m)	68	100	50	50	
RESIDUAL HEAD (m)	48.08	48.69	49.36	50.28	52.07
DISCHARGE (lps)	0.2	0.15	0.1	0.05	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2	32H(10)	32H(10)	32H(10)	20H(10)	
SOIL TYPE	OS				

J3 - T86

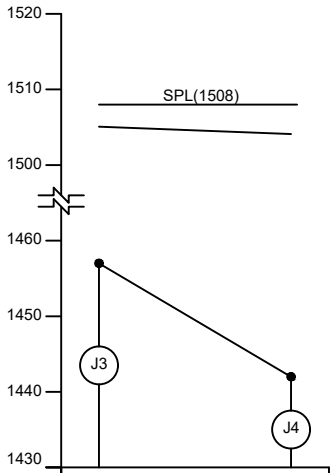
SCALE: [H 1:5000, V 1:1000

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Pipe Line Design Profile	SCALE: 1:1	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 3/13	DATE:2079-10-15	



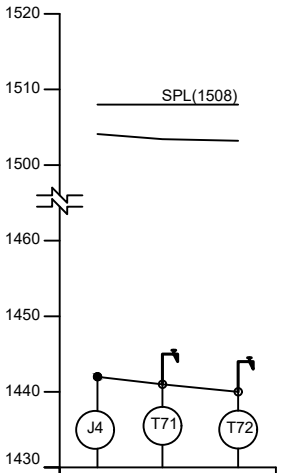
GROUND ELEVATION (m)	1457.0	1456.0	1455.0
TOTAL DISTANCE (m)	0	81	131
PARTIAL DISTANCE (m)		81	50
RESIDUAL HEAD (m)	48.08	48.95	49.74
DISCHARGE (lps)		0.10	0.05
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		32H(10)	20H(10)
SOIL TYPE		OS	

J3 - T82



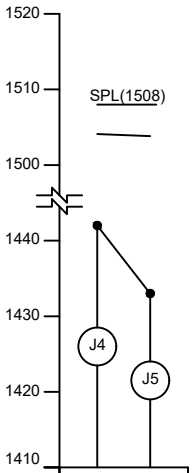
GROUND ELEVATION (m)	1457.0	1442.0
TOTAL DISTANCE (m)	0	127
PARTIAL DISTANCE (m)		127
RESIDUAL HEAD (m)	48.08	62.09
DISCHARGE (lps)		3.6
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		90H(10)
SOIL TYPE		OS

J3 - J4



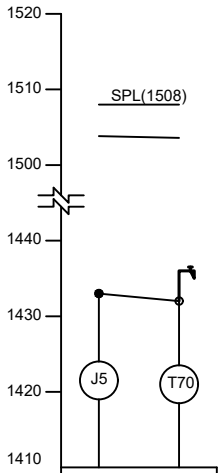
GROUND ELEVATION (m)	1442.0	1441.0	1440.0
TOTAL DISTANCE (m)	0	43	93
PARTIAL DISTANCE (m)		43	50
RESIDUAL HEAD (m)	62.09	62.42	63.21
DISCHARGE (lps)		0.10	0.05
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		20H(16)	20H(16)
SOIL TYPE		OS	

J4-T72



GROUND ELEVATION (m)	1442.0	1433.0
TOTAL DISTANCE (m)	0	35
PARTIAL DISTANCE (m)		35
RESIDUAL HEAD (m)	62.09	70.83
DISCHARGE (lps)		3.50
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		90H(10)
SOIL TYPE		OS

J4 - J5

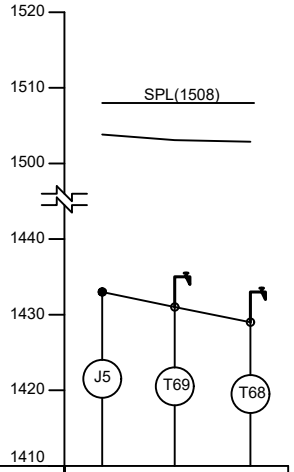


GROUND ELEVATION (m)	1433.0	1432.0
TOTAL DISTANCE (m)	0	53
PARTIAL DISTANCE (m)		53
RESIDUAL HEAD (m)	70.83	71.60
DISCHARGE (lps)		0.05
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		20H(16)
SOIL TYPE		OS

J5-T70

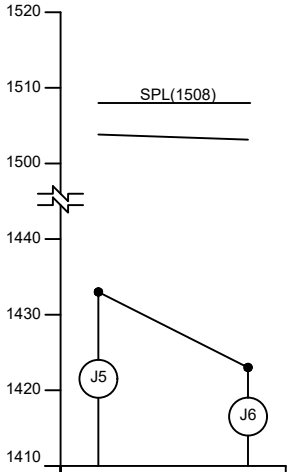
SCALE: [H 1:5000, V 1:1000

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Pipe Line Design Profile	SCALE: 1:1	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 4/13	DATE:2079-10-15	



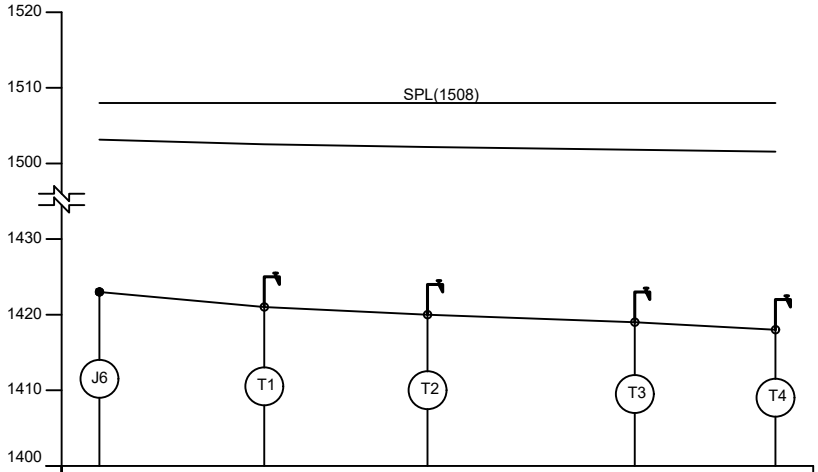
GROUND ELEVATION (m)	1433.0	1431.0	1429.0
TOTAL DISTANCE (m)	0	48	98
PARTIAL DISTANCE (m)		48	50
RESIDUAL HEAD (m)	70.83	72.08	73.87
DISCHARGE (lps)		0.10	0.05
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		20H(16)	20H(16)
SOIL TYPE		OS	

J5-T68



GROUND ELEVATION (m)	1433.0	1423.0
TOTAL DISTANCE (m)	0	99
PARTIAL DISTANCE (m)		99
RESIDUAL HEAD (m)	70.83	80.15
DISCHARGE (lps)		3.35
PIPE SIZE & TYPE (mm)		90H(10)
SOIL TYPE		OS

J5-J6

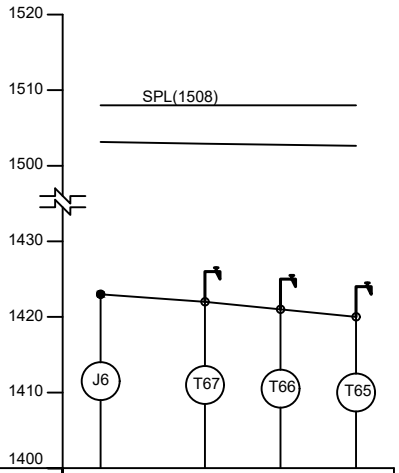


GROUND ELEVATION (m)	1423.0	1421.0	1420.0	1419.0	1418.0
TOTAL DISTANCE (m)	0	109	217	354	447
PARTIAL DISTANCE (m)		109	108	137	93
RESIDUAL HEAD (m)	80.15	81.53	82.17	82.96	83.56
DISCHARGE (lps)		0.20	0.15	0.10	0.05
PIPE SIZE & TYPE (mm)		32H(10)	32H(10)	32H(10)	20H(16)
SOIL TYPE		OS			

J6-T4

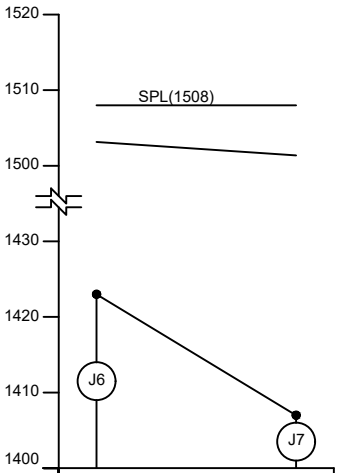
SCALE: [H 1:5000, V 1:1000

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Pipe Line Design Profile	SCALE: 1:1	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 5/13	DATE:2079-10-15	



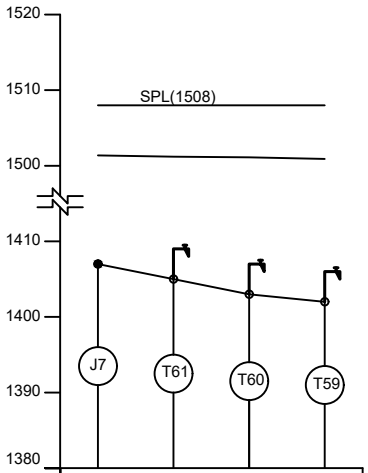
GROUND ELEVATION (m)	1423.0	1422.0	1421.0	1420.0
TOTAL DISTANCE (m)	0	69	119	169
PARTIAL DISTANCE (m)		69	50	50
RESIDUAL HEAD (m)	80.15	80.92	81.85	82.63
DISCHARGE (lps)		0.15	0.10	0.05
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		32H(16)	32H(10)	20H(16)
SOIL TYPE	OS			

J6-T65



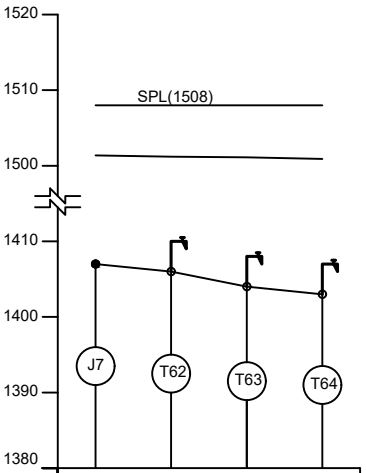
GROUND ELEVATION (m)	1423.0	1407.0
TOTAL DISTANCE (m)	0	132
PARTIAL DISTANCE (m)		132
RESIDUAL HEAD (m)	80.15	94.37
DISCHARGE (lps)		3.00
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		75H(10)
SOIL TYPE	OS	

J6-J7



GROUND ELEVATION (m)	1407.0	1405.0	1403.0	1402.0
TOTAL DISTANCE (m)	0	50	100	150
PARTIAL DISTANCE (m)		50	50	50
RESIDUAL HEAD (m)	94.37	96.2	98.12	98.91
DISCHARGE (lps)		0.15	0.10	0.05
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		32H(10)	32H(16)	20H(16)
SOIL TYPE	OS			

J7-T59

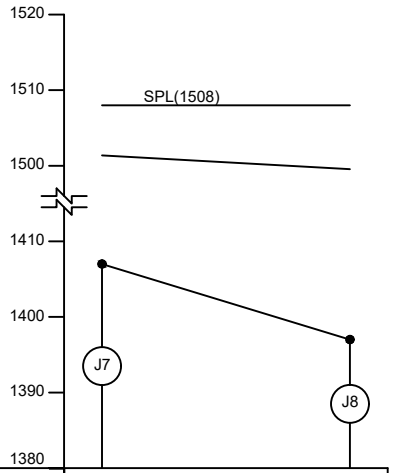


GROUND ELEVATION (m)	1407.0	1406.0	1404.0	1403.0
TOTAL DISTANCE (m)	0	50	100	150
PARTIAL DISTANCE (m)		50	50	50
RESIDUAL HEAD (m)	94.37	95.2	97.12	97.91
DISCHARGE (lps)		0.15	0.10	0.05
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		32H(10)	32H(16)	20H(16)
SOIL TYPE	OS			

J7-T64

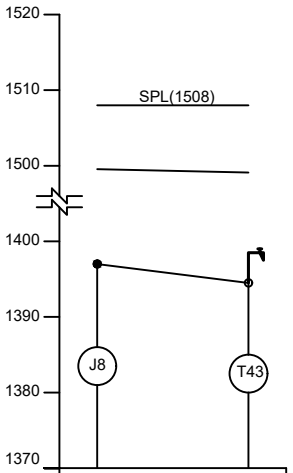
SCALE: [H 1:5000, V 1:1000

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Pipe Line Design Profile	SCALE: 1:1	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 6/13	DATE:2079-10-15	



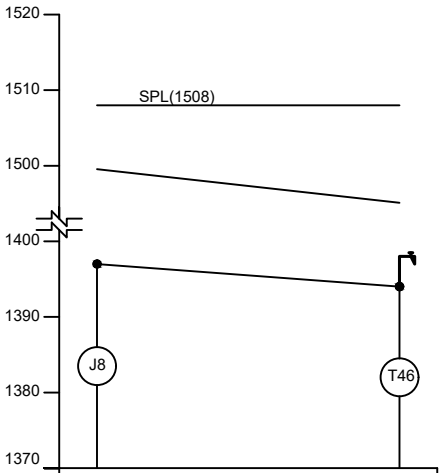
GROUND ELEVATION (m)	1407.0	1397.0
TOTAL DISTANCE (m)	0	164
PARTIAL DISTANCE (m)	164	
RESIDUAL HEAD (m)	94.37	102.54
DISCHARGE (lps)	2.70	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2	75H(16)	
SOIL TYPE	OS	

J7-J8



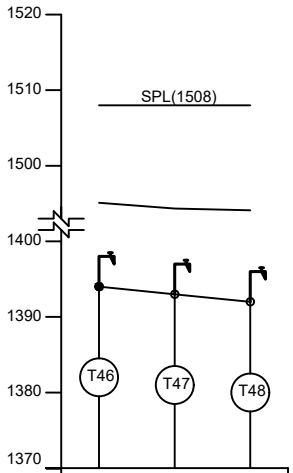
GROUND ELEVATION (m)	1397.0	1395.0
TOTAL DISTANCE (m)	0	100
PARTIAL DISTANCE (m)	100	
RESIDUAL HEAD (m)	102.54	104.11
DISCHARGE (lps)	0.05	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2	20H(16)	
SOIL TYPE	OS	

J8-T43



GROUND ELEVATION (m)	1397.0	1394.0
TOTAL DISTANCE (m)	0	200
PARTIAL DISTANCE (m)	200	
RESIDUAL HEAD (m)	102.54	101.11
DISCHARGE (lps)	0.75	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2	40H(10)	
SOIL TYPE	OS	

J8-T46

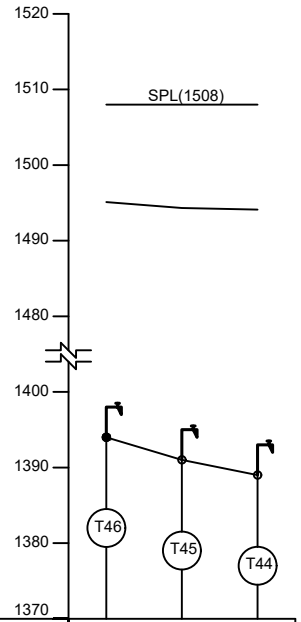


GROUND ELEVATION (m)	1394.0	1393.0	1392.0
TOTAL DISTANCE (m)	0	50	100
PARTIAL DISTANCE (m)	50	50	
RESIDUAL HEAD (m)	101.11	101.33	102.11
DISCHARGE (lps)	0.10	0.05	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2	20H(16)	20H(16)	
SOIL TYPE	OS		

T46-T48

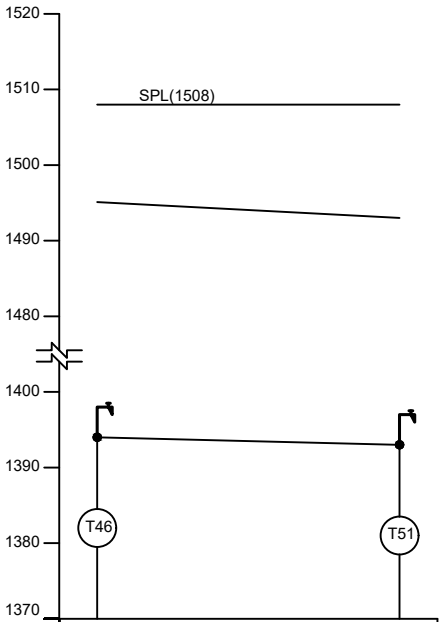
SCALE: [H 1:5000, V 1:1000

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Pipe Line Design Profile	SCALE: 1:1	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 7/13	DATE:2079-10-15	



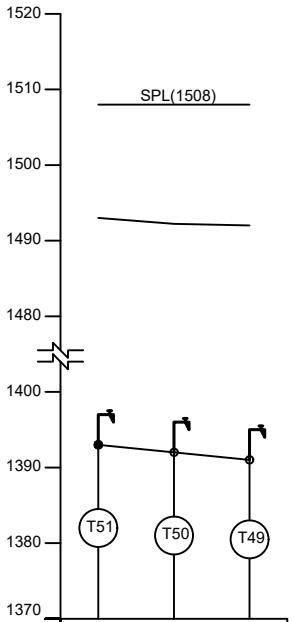
GROUND ELEVATION (m)	1394.0	1391.0	1389.0
TOTAL DISTANCE (m)	0	50	100
PARTIAL DISTANCE (m)		50	50
RESIDUAL HEAD (m)	101.11	103.33	105.11
DISCHARGE (lps)		0.10	0.05
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm2		20H(16)	20H(16)
SOIL TYPE		OS	

T46-T44



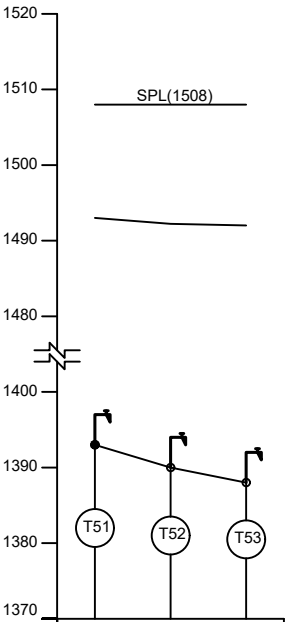
GROUND ELEVATION (m)	1394.0	1393.0
TOTAL DISTANCE (m)	0	200
PARTIAL DISTANCE (m)		200
RESIDUAL HEAD (m)	101.11	100.01
DISCHARGE (lps)		0.50
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm2		40H(10)
SOIL TYPE		OS

T46-T51



GROUND ELEVATION (m)	1393.0	1392.0	1391.0
TOTAL DISTANCE (m)	0	50	100
PARTIAL DISTANCE (m)		50	50
RESIDUAL HEAD (m)	100.01	100.24	101.02
DISCHARGE (lps)		0.10	0.05
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm2		20H(16)	20H(16)
SOIL TYPE		OS	

T51-T49

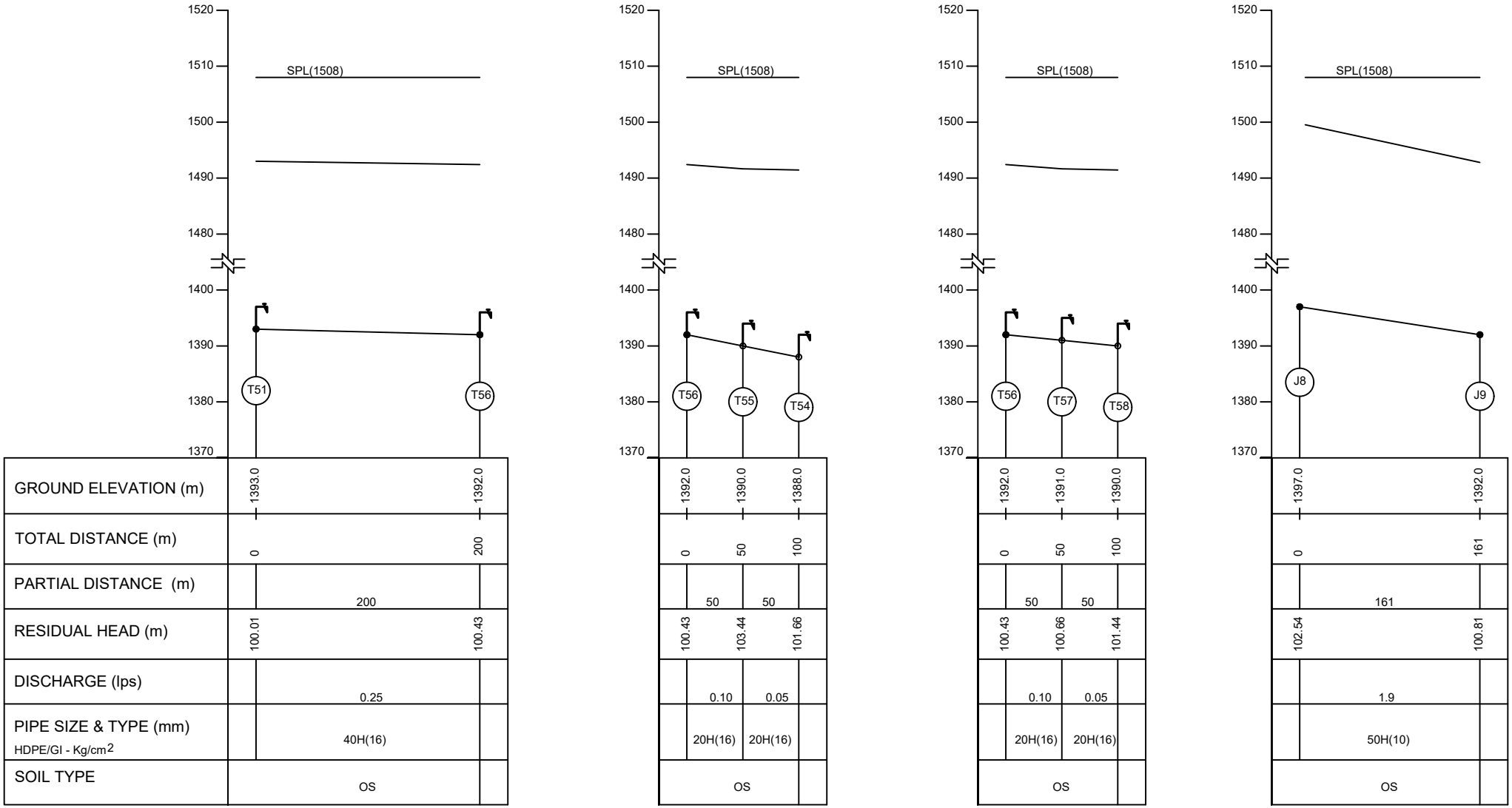


GROUND ELEVATION (m)	1393.0	1390.0	1388.0
TOTAL DISTANCE (m)	0	50	100
PARTIAL DISTANCE (m)		50	50
RESIDUAL HEAD (m)	101.11	102.24	104.02
DISCHARGE (lps)		0.10	0.10
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm2		20H(16)	20H(16)
SOIL TYPE		OS	

T51-T53

SCALE: [H 1:5000, V 1:1000

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Pipe Line Design Profile	SCALE: 1:1	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 8/13	DATE:2079-10-15	



GROUND ELEVATION (m)	1393.0	1392.0	
TOTAL DISTANCE (m)	0	200	
PARTIAL DISTANCE (m)		200	
RESIDUAL HEAD (m)	100.01	100.43	
DISCHARGE (lps)		0.25	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		40H(16)	
SOIL TYPE		OS	

T51-T56

GROUND ELEVATION (m)	1392.0	1390.0	1388.0
TOTAL DISTANCE (m)	0	50	100
PARTIAL DISTANCE (m)		50	50
RESIDUAL HEAD (m)	100.43	103.44	101.66
DISCHARGE (lps)		0.10	0.05
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		20H(16)	20H(16)
SOIL TYPE		OS	

T56-T54

GROUND ELEVATION (m)	1392.0	1391.0	1390.0
TOTAL DISTANCE (m)	0	50	100
PARTIAL DISTANCE (m)		50	50
RESIDUAL HEAD (m)	100.43	100.66	101.44
DISCHARGE (lps)		0.10	0.05
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		20H(16)	20H(16)
SOIL TYPE		OS	

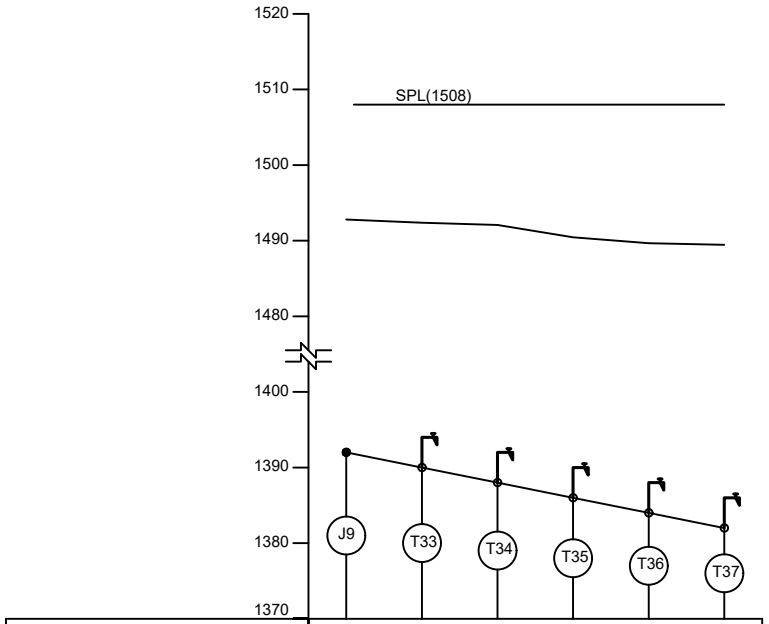
T56-T58

GROUND ELEVATION (m)	1397.0	1392.0
TOTAL DISTANCE (m)	0	161
PARTIAL DISTANCE (m)		161
RESIDUAL HEAD (m)	102.54	100.81
DISCHARGE (lps)		1.9
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		50H(10)
SOIL TYPE		OS

J8-J9

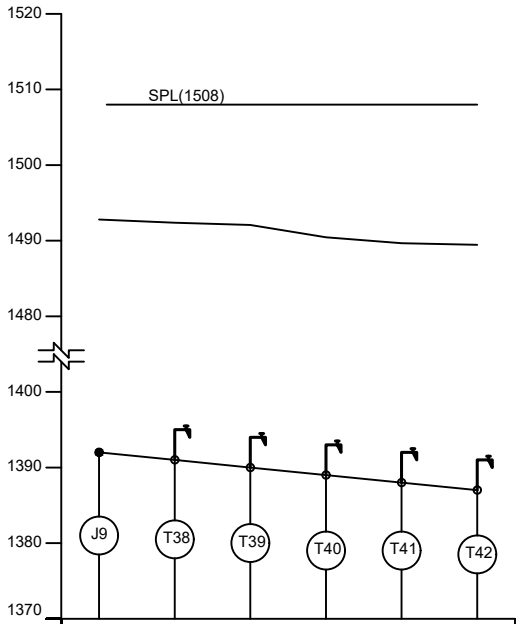
SCALE: [H 1:5000, V 1:1000

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Pipe Line Design Profile	SCALE: 1:1	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 9/13	DATE:2079-10-15	



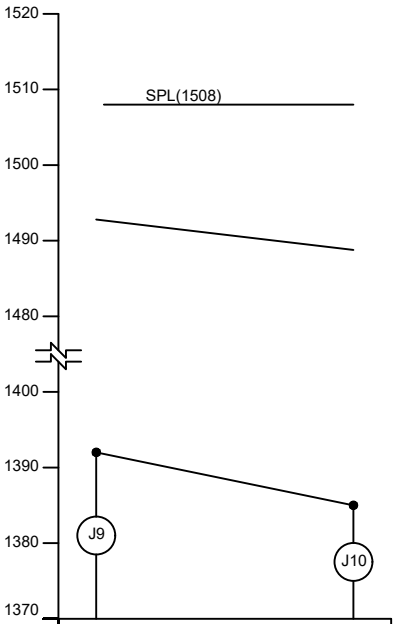
GROUND ELEVATION (m)	1392.0	1391.0	1390.0	1389.0	1388.0	1387.0	
TOTAL DISTANCE (m)	0	50	100	150	200	250	
PARTIAL DISTANCE (m)		50	50	50	50	50	
RESIDUAL HEAD (m)	100.81	102.38	104.09	104.45	105.67	107.45	
DISCHARGE (lps)		0.25	0.20	0.15	0.10	0.05	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm2		32H(16)	32H(16)	20H(16)	20H(16)	20H(16)	
SOIL TYPE		OS					

J9-T37



GROUND ELEVATION (m)	1392.0	1391.0	1390.0	1389.0	1388.0	1387.0	
TOTAL DISTANCE (m)	0	50	100	150	200	250	
PARTIAL DISTANCE (m)		50	50	50	50	50	
RESIDUAL HEAD (m)	100.81	101.38	102.09	101.45	101.67	102.45	
DISCHARGE (lps)		0.25	0.20	0.15	0.10	0.05	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm2		32H(16)	32H(10)	20H(16)	20H(16)	20H(16)	
SOIL TYPE		OS					

J9-T42

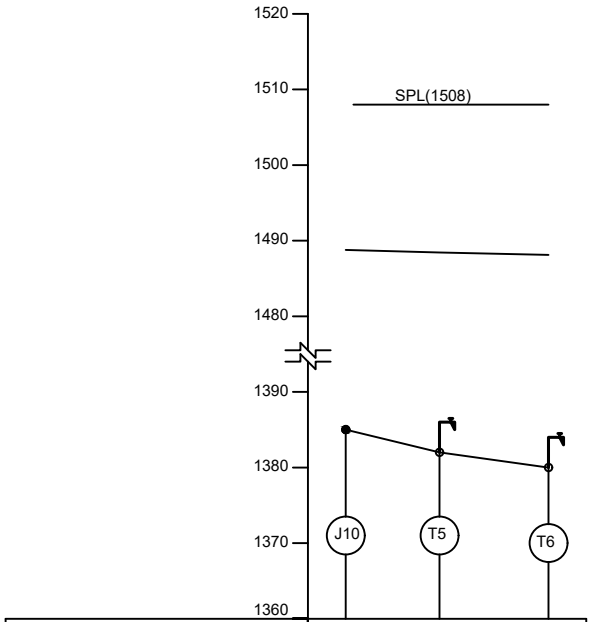


GROUND ELEVATION (m)	1392.0	1385.0
TOTAL DISTANCE (m)	0	170
PARTIAL DISTANCE (m)		170
RESIDUAL HEAD (m)	100.81	103.77
DISCHARGE (lps)		1.4
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm2		50H(16)
SOIL TYPE		OS

J9-J10

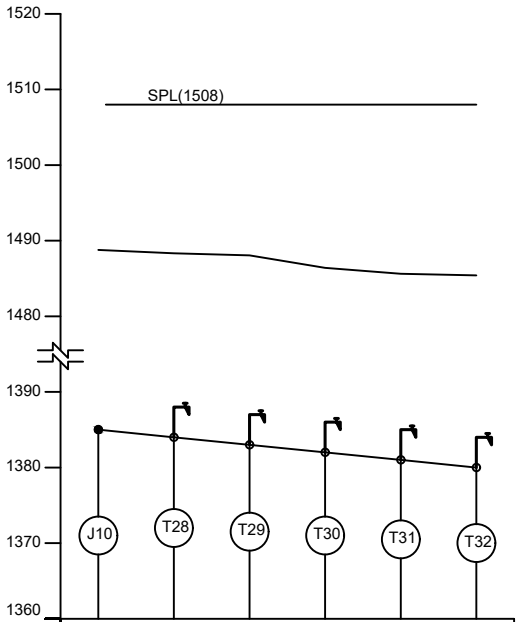
SCALE: [H 1:5000, V 1:1000

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Pipe Line Design Profile	SCALE: 1:1	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 10/13	DATE:2079-10-15	



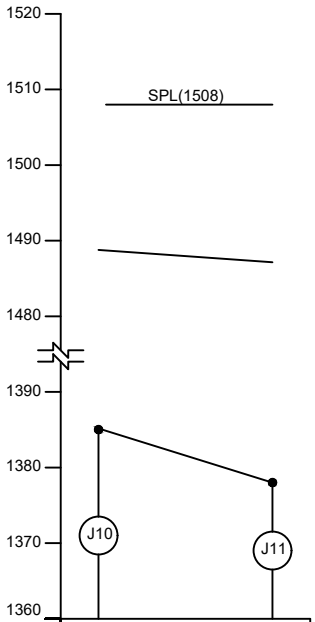
GROUND ELEVATION (m)	1385.00	1382.0	1380.0
TOTAL DISTANCE (m)	0	62	134
PARTIAL DISTANCE (m)		62	72
RESIDUAL HEAD (m)	103.77	106.44	108.13
DISCHARGE (lps)		0.10	0.05
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		25H(10)	20H(16)
SOIL TYPE	OS		

J10-T6



GROUND ELEVATION (m)	1385.0	1384.0	1383.0	1382.0	1381.0	1380.0
TOTAL DISTANCE (m)	0	50	100	150	200	250
PARTIAL DISTANCE (m)		50	50	50	50	50
RESIDUAL HEAD (m)	103.77	104.34	105.35	104.41	104.63	105.41
DISCHARGE (lps)		0.25	0.20	0.15	0.10	0.10
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		32H(16)	32H(16)	20H(16)	20H(16)	20H(16)
SOIL TYPE	OS					

J10-T32

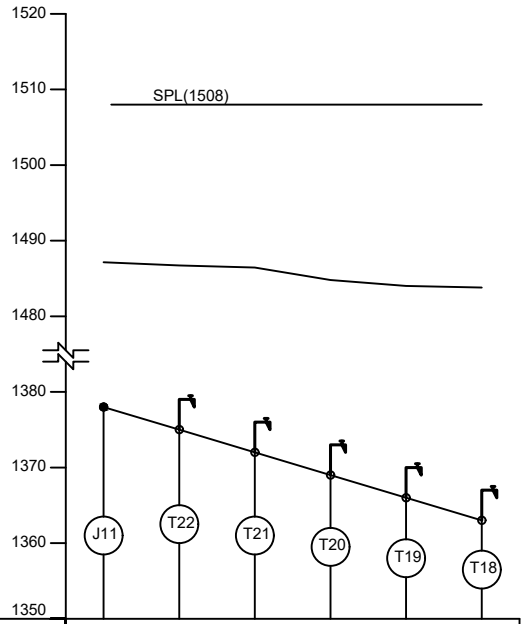


GROUND ELEVATION (m)	1385.0	1378.0
TOTAL DISTANCE (m)	0	115
PARTIAL DISTANCE (m)		115
RESIDUAL HEAD (m)	103.77	109.16
DISCHARGE (lps)		1.05
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		50H(10)
SOIL TYPE	OS	

J10-J11

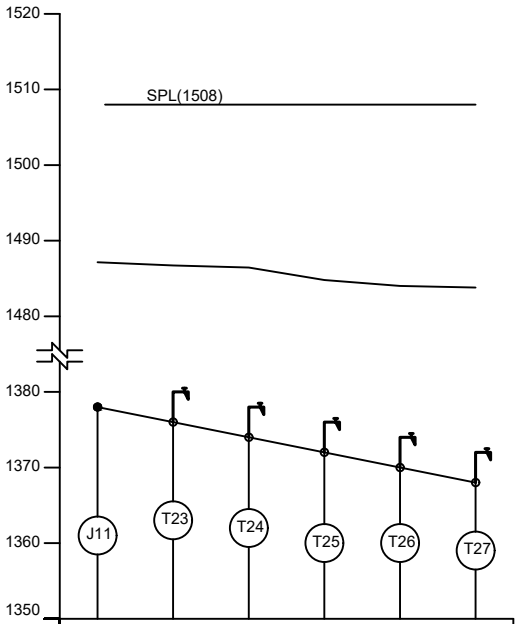
SCALE: [H 1:5000, V 1:1000

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Pipe Line Design Profile	SCALE: 1:1	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 11/13	DATE:2079-10-15	



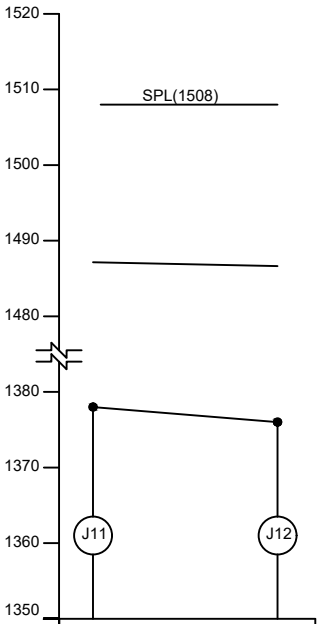
GROUND ELEVATION (m)	1378.0	1375.0	1372.0	1369.0	1366.0	1363.0	
TOTAL DISTANCE (m)	0	50	100	150	200	250	
PARTIAL DISTANCE (m)		50	50	50	50	50	
RESIDUAL HEAD (m)	109.16	111.73	114.45	115.80	118.02	120.81	
DISCHARGE (lps)		0.25	0.20	0.15	0.10	0.05	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm2		32H(16)	32H(16)	20H(16)	20H(16)	20H(16)	
SOIL TYPE		OS					

J11-J18



GROUND ELEVATION (m)	1378.0	1376.0	1374.0	1372.0	1370.0	1368.0	
TOTAL DISTANCE (m)	0	50	100	150	200	250	
PARTIAL DISTANCE (m)		50	50	50	50	50	
RESIDUAL HEAD (m)	109.16	110.73	112.45	112.80	114.02	115.81	
DISCHARGE (lps)		0.25	0.20	0.15	0.10	0.05	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm2		32H(16)	32H(16)	20H(16)	20H(16)	20H(16)	
SOIL TYPE		OS					

J11-T27

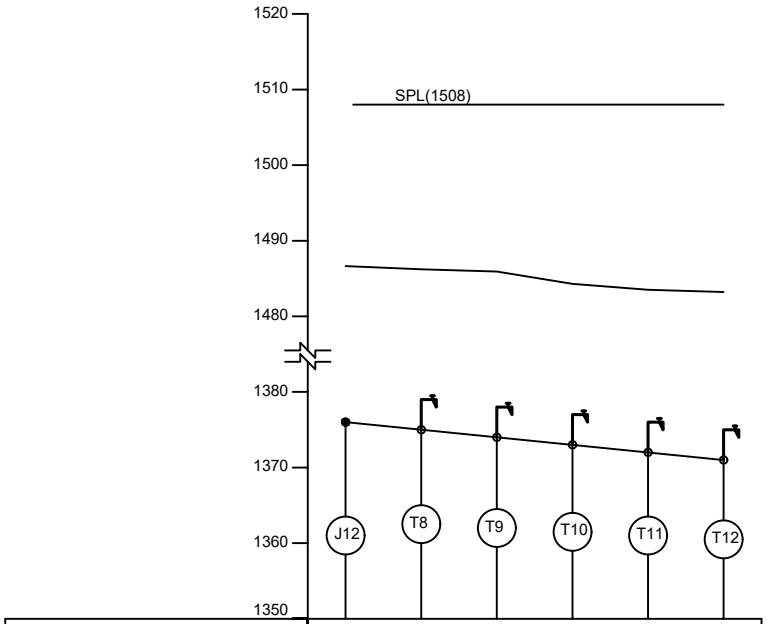


GROUND ELEVATION (m)	1378.0	1376.0	
TOTAL DISTANCE (m)	0	122	
PARTIAL DISTANCE (m)		122	
RESIDUAL HEAD (m)	109.16	110.65	
DISCHARGE (lps)		0.55	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm2		50H(16)	
SOIL TYPE		OS	

J11-J12

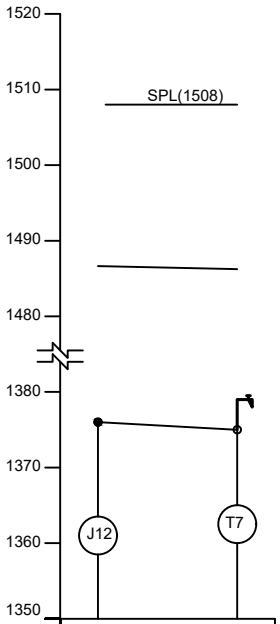
SCALE: [H 1:5000, V 1:1000

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Pipe Line Design Profile	SCALE: 1:1	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 12/13	DATE:2079-10-15	



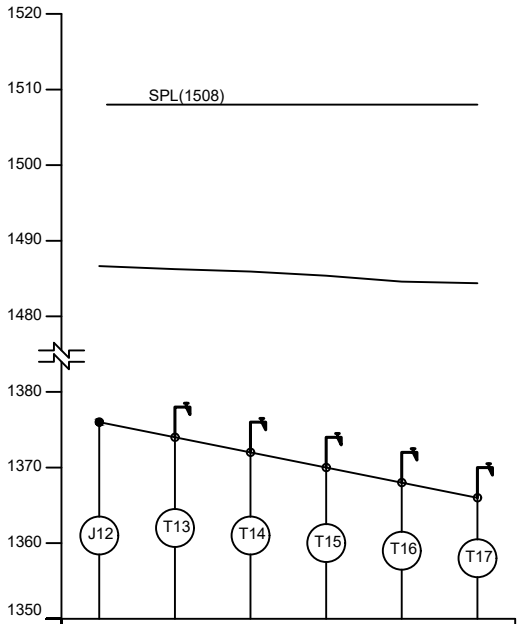
GROUND ELEVATION (m)	1376.0	1375.0	1374.0	1373.0	1372.0	1371.0	
TOTAL DISTANCE (m)	0	50	100	150	200	250	
PARTIAL DISTANCE (m)		50	50	50	50	50	
RESIDUAL HEAD (m)	110.65	111.22	111.93	111.29	111.51	112.29	
DISCHARGE (lps)		0.25	0.20	0.15	0.10	0.05	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		32H(16)	32H(16)	20H(16)	20H(16)	20H(16)	
SOIL TYPE	OS						

J12-T12



GROUND ELEVATION (m)	1376.0	1375.0		
TOTAL DISTANCE (m)	0	92		
PARTIAL DISTANCE (m)		92		
RESIDUAL HEAD (m)	110.65	111.25		
DISCHARGE (lps)		0.05		
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		20H(16)		
SOIL TYPE	OS			

J12-T7



GROUND ELEVATION (m)	1376.0	1374.0	1372.0	1370.0	1368.0	1366.0	
TOTAL DISTANCE (m)	0	50	100	150	200	250	
PARTIAL DISTANCE (m)		50	50	50	50	50	
RESIDUAL HEAD (m)	110.65	112.22	113.93	115.38	116.60	118.39	
DISCHARGE (lps)		0.25	0.20	0.15	0.10	0.05	
PIPE SIZE & TYPE (mm) HDPE/GI - Kg/cm^2		32H(16)	32H(16)	25H(16)	20H(16)	20H(16)	
SOIL TYPE	OS						

J12-T17

SCALE: [H 1:5000, V 1:1000

PROJECT NAME: Phedi Water Supply Project	DRAWING TITLE: Pipe Line Design Profile	SCALE: 1:1	PULCHOWK CAMPUS DEPARTMENT OF CIVIL ENGINEERING
PROJECT LOCATION: Phedi, Tarkeshwor	DRAWING NO.: 13/13	DATE:2079-10-15	