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# Design, Construction and Standardisation of GRAVITY WATER SUPPLY SYSTEMS

## *in rural villages in Sri Lanka*

Helvetas

Swiss Association for
Development and Cooperation

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**Cover Photo**
Gravity Water Supply System in Hippola Village, Kandy District
(by Sarvodaya Rural Technical Services)

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# PREFACE

In 1978, a fruitful partnership commenced between the Sarvodaya Rural Technical Services (SRTS) and HELVETAS. In the beginning a small but motivated unit supported the Sarvodaya Shramadana Movement by providing training to young men and women in agriculture and artisan skills.

Initially SRTS was engaged mostly in the northern districts of Sri Lanka,but with increasing numbers of skilled staff its activities were successfully extended to the other parts of the island. Over the years there was a shift from training and agricultural activities towards more technical (rural infrastructure) projects. SRTS specialised in assisting the rural communities in improving the infrastructure of their villages through the construction of Gravity Water Supply Schemes, Hand-Dug Wells,Bridges, Culverts, Latrines etc.

The large number of similar projects implemented by SRTS made it advisable to standardize the design and construction procedures. The manuals and standard drawings which were consequently prepared by the senior SRTS staff together with the HELVETAS engineers reflect the experiences gained throughout the years.

In August 1991, HELVETAS decided to update and to revise all these technical papers with the broader aim to make them available not only to SRTS but also to other organisations, institutions or individuals interested and engaged in this field of work. As a result of these efforts the following manuals are now available:

- "**Construction of Latrines in Rural Villages in Sri Lanka**"
  (also available in Sinhala and Tamil)
- "**Construction of Hand-Dug Wells in Rural Villages in Sri Lanka**"
  (also available in Tamil and Sinhala)
- "**Design, Construction and Standardisation of Gravity Water Supply Systems in Rural Villages in Sri Lanka**"
  (available also in Sinhala)

It should be noted that these manuals are technical handbooks for those involved in the planning and construction of hand dug wells, gravity water supply systems and latrines. Other related aspects of such projects, like health education, participatory planning and involvement of the villagers in the construction phase or maintenance of completed projects are only touched or not discussed at all.

We are grateful to all who contributed to the completion of these manuals and would appreciate comments or suggestions for further improvements. For any inquiries you can contact our office under the following address:

HELVETAS, 15/2 Ekanayake Avenue, Nugegoda (Sri Lanka)
Tel. 01-85 24 54; Fax: 01-81 19 92

Nugegoda, March 1994

# PART 1

# DESIGN

# 1 INTRODUCTION

The need of water is common to all living things. Human beings' health and well-being depend upon an adequate water supply. Where water is inadequate, life is a struggle.

Besides the traditional hand-dug wells, gravity-fed water supply schemes are an excellent option to cover the demand for water in rural villages in Sri Lanka. Water supply schemes which necessitate the use of pumps are hardly sustainable in rural areas although they are a necessity in urban areas. Gravity-fed Water Supply Schemes (GWSS) can easily be built in cooperation with local communities. Although this manual is not about community development but about technical matters, it has to be emphasized that the active participation of the future users of a GWSS is a must. But community participation alone cannot guarantee a sustainable project. More important is Operation and Maintenance (O+M) of a running system. Very often villages participated successfully in the construction of a GWSS but they failed to run and maintain it. It needs a well established and efficient organisation at village level to organize O+M.

From our experiences in Sri Lanka we learned that a community contribution of around 20% of the total cost (including overhead and capital cost) can be reasonably expected.

It requires some technical know-how to design a GWSS. Most of this know-how is contained in this manual. Nevertheless, a potential designer of a GWSS should have at least some basic experience in construction works and should have an academic background that allows him/her to do some computations of a medium level of difficulty.

This part of the manual discusses the following points:

- Health Aspect of Water
- Hydrology
- Water Sources (1)
- Hydraulics
- Design Guidelines
- Design Example

In the second part of this manual you find details about construction of GWSS and all standard drawings of the different structures concerned with GWSS.

The Appendix to this manual includes references and a bibliography for further reading

---

1 *The manual is confined only to the tapping of underground springs for GWSS.Water from streams and rivers is usually not safe for drinking. Such water sources require often sophisticated treatment plants which are expensive, difficult to maintain and rarely sustainable in community based GWSS.*

# 2 HEALTH ASPECTS

## 2.1 GENERAL REMARKS

As mentioned in the introduction to this manual, the need of water is common to all living things. Water was always considered to be very important for human beings but its importance to health is a more recent realization. During the last hundred years or so it was discovered that ***inadequate or contaminated water is an important reason for the spread of water-related diseases.***

## 2.2 WATER RELATED DISEASES

Water-related diseases can be listed as follows:

- ***Water-borne diseases*** occur when a pathogen in water is drunk by a person who then becomes infected. Typical diseases are cholera and typhoid but also others such as infectious hepatitis, diarrhoea and dysentery.
- ***Water-washed diseases*** are directly related to domestic and personal hygiene and can be drastically reduced if ample water were available for washing and hygiene. Scabies, tropical ulcers and infantile diarrhoea are examples.
- ***Water-based diseases*** are parasitic diseases, where the organism causing the sickness spends a part of its life cycle in an aquatic host, for example guinea worm or bilharzia (schistosomiasis).
- ***Insect-vector diseases*** are those which are spread by insects that breed in water, for example malaria, dengue, filaria.

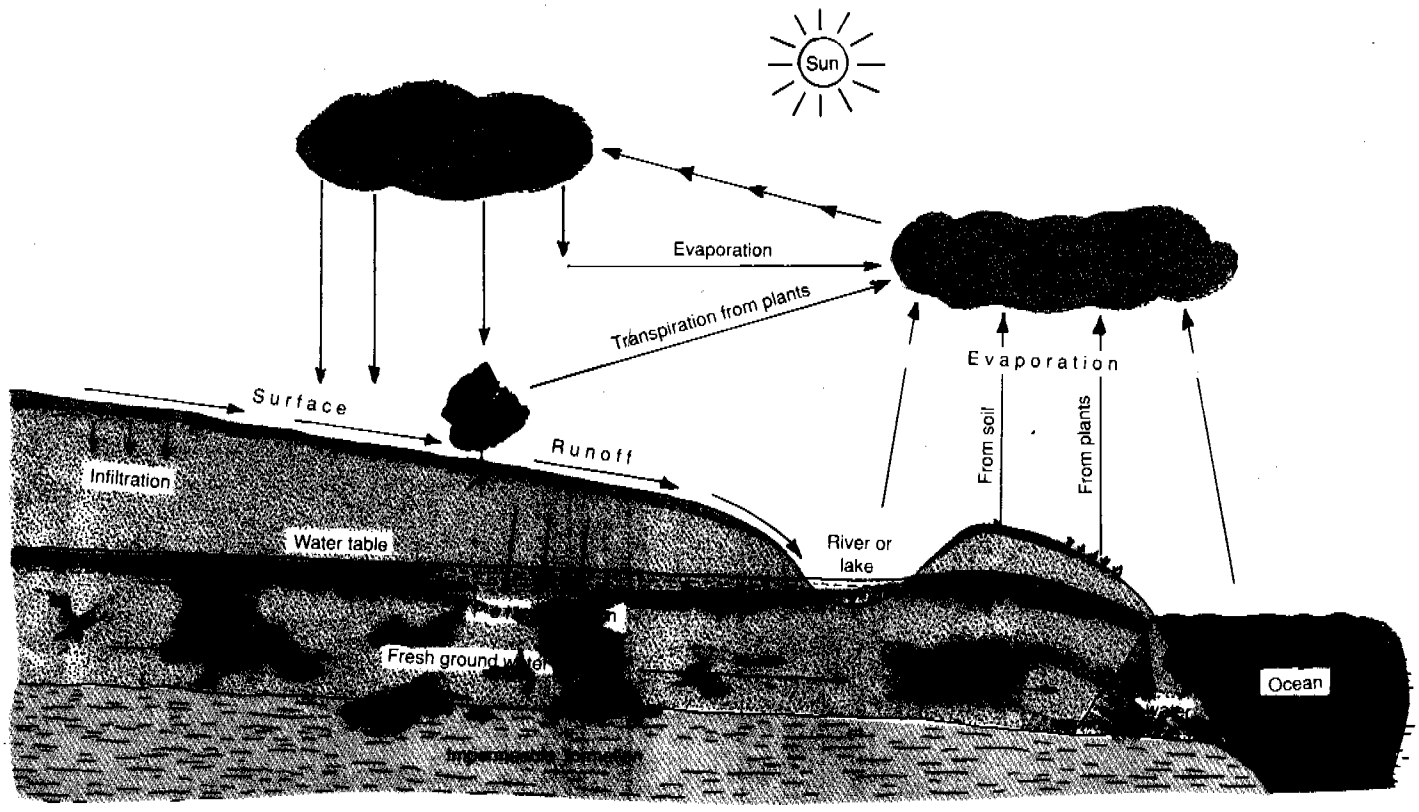
***Water-borne and water-based diseases can be drastically reduced by providing clean and safe drinking water.***

***Water-washed diseases can be prevented by providing sufficient water for domestic hygiene and personal washing.***

Insect-vector diseases cannot be directly affected by the construction of a GWSS, but there can be indirect effects like the cleaning up of infected areas around traditional water holes.
Class two and three of the above diseases can also be reduced/prevented by improved, safe disposal of excreta. Please refer to our manual *"Construction of Latrines in Rural Villages in Sri Lanka".*

Obviously, a GWSS can only benefit its users if it is designed and constructed in a way to protect the water from contamination, and to allow easy maintenance. The technical details of properly designing a GWSS that will benefit its users are dealt with in the following chapters of this manual.

# 3 HYDROLOGIC CYCLE

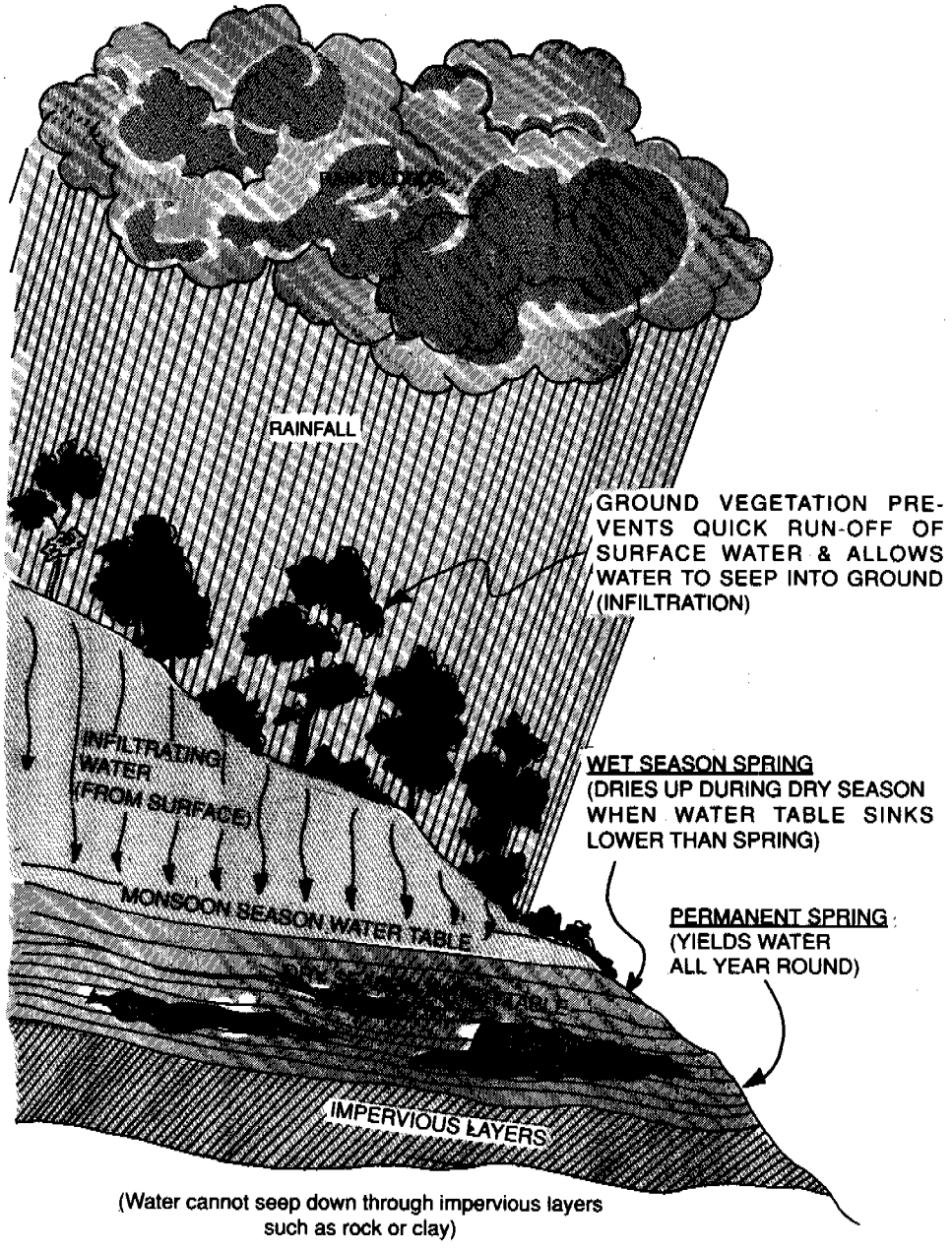



**Hydrologic Cycle**

In above drawing of the ***hydrologic cycle*** you can see the circulation of water in its liquid or vapour state. We will concentrate on the parts of the hydrologic cycle that are of importance to GWSS.

Some part of the rain falling to the earth evaporates. Some runs off in streams and rivers. Some infiltrates the ground and is used by vegetation or sinks below root level through porous soil until it reaches an impermeable layer. Under the force of gravity, the water finds its way downhill along the impermeable formation until it either emerges as ***springs*** or returns to the sea. It is this ***occurrence of springs*** that is of importance to the designer of a GWSS.

Below there is another drawing which illustrates the occurrence of springs:




Hydrologic Diagram of a Spring

It is important to realize that the water table can vary drastically during the year. It will be much higher during or just after the rainy season than during the dry season. ***It is, therefore, of utmost importance to observe a spring for at least one year before you decide on its use as the source of a GWSS.*** See more about springs in chapter *4.2 Springs*.

# 4 WATER SOURCES

## 4.1 GROUND WATER

The water which, under the force of gravity, flows downhill along an underground impermeable layer, is called ground water. As ***ground water*** flows through the aquifer (water bearing layer) there is a continuous filtering process going on. Most of the suspended particles will be removed and even bacterial pathogenes will be eliminated after a certain distance, generally less than 30 m.

Ground water can only be used for a GWSS when it appears in a spring. Otherwise it has to be extracted from the aquifer through a well.

## 4.2 SPRINGS

A place where ground water seeps to the surface without artificial help is called ***a spring.*** The flow of a spring is generally less than two litres per second but can be much bigger in rare cases. The flow of a spring depends on:

- Intake area (does not necessarily correspond with the topographical basin)
- Annual rainfall
- Percolation rate of water through the aquifer
- Storage capacity of aquifer
- Thickness of stratum which covers the aquifer

The flow of springs can vary quite substantially during the year. They tend to lag behind the seasonal rainfall patterns. Sometimes a spring is not a real spring but just water of a small stream that went underground for a short distance and is re-emerging. Obviously, such a "spring" should not be tapped for a GWSS. But usually, spring water, due to the filtration process in the aquifer, is free of pathogenes and is an ideal source of water for a GWSS.

## 4.3 STREAMS

Generally, streams are not safe sources for drinking water. It should be considered only when there is no other source available to meet the demand and the water is safe (treatment might be required).

## 4.4 QUALITY OF WATER

A GWSS will only benefit its users when the delivered water is safe for drinking. That means it must not contain any pathogenes which could be a risk to health. The World Health Organisation (WHO) has studied problems related to standards for drinking water and published various recommendations. Moreover, the National Water Supply and Drainage Board (NWSDB) of Sri Lanka has also published a standard for drinking water.

However, it is beyond the means of most rural villages to meet all demands regarding above mentioned standards for the quality of drinking water. We do not want to go too much into the details of these standards but we would like to make some basic remarks towards the quality of water used in GWSS. One has to distinguish between ***bacteriological and chemical standards.***

- ***Bacteriological Standard:*** Water should not contain any harmful organisms. The presence of ***coliforms*** in water is used as an indicator that the water is contaminated with faecal material.
- ***Chemical Standards***: These standards usually only apply for treated waters. However, attention has to be given to some toxic chemical substances contained in untreated water (e.g. remainder of agro-chemicals). Moreover, water that is safe for drinking can be very ***aggressive towards iron and cement*** (therefore our recommendation to use ***PVC instead of steel pipes***).

The local population in rural villages in Sri Lanka usually knows through experience whether the water of a particular source is drinkable or not. If there are any doubts about the quality of the water you want to use for a GWSS, have it tested in one of the existing laboratories in Sri Lanka. Remember that the test samples have to reach the laboratory within a few hours, that they have to be protected from sunlight and kept cool. It is not advisable to test the water on your own with a test-kit.

For further reading please refer to the references in the Appendix to this manual.

**Water Treatment**

For the time being, there is no practical water treatment system which could be broadly used in rural villages in Sri Lanka. Even slow sand filters, of which a few are installed in Sri Lanka, require regular maintenance, which is beyond the means of most rural communities. Thus emphasis must be put on locating the cleanliest possible source of drinking water and an adequate protection of such a source. For further reading about water treatment, please refer to the references.

# 5 HYDRAULICS

## 5.1 GENERAL REMARKS

On the following pages we will discuss the basic hydraulic principles of pipeline design. It will not be an in-depth analysis of hydraulics; fundamental theories, like the Equation on Continuity or Bernoulli's Equation will not be covered. Please refer to the references and bibliography in the Appendix to this manual for further reading if you want to study hydraulics in greater depth.

The basic principles of pipeline design have been presented in such a way as to be understood by a person who has never been taught hydraulics. Nevertheless, as a user of this manual, please do not go further before you really understand the following basic principles of hydraulics.

## 5.2 ENERGY

Whenever water is moved, uphill, downhill or horizontally, it requires ***energy***. This energy can be provided by a pump for example, or, in gravity-fed water supply schemes, by gravitational energy which is determined by the relative elevation of all points in a water system. ***For a given system, there is only a fixed, specific quantity of gravitational energy available.*** As water flows through pipes, fittings, tanks etc. some energy is lost to the system, dissipated by friction. A well designed GWSS preserves energy and allows to move the desired quantity of water through the pipelines.

## 5.3 MEASURE OF ENERGY IN A WATER SYSTEM

Pressure is defined as the force that a quantity of gas or liquid has on any surface it touches. It is measured by the amount of force that is exerted over a particular area. In our case we are interested in the pressure of a column of water. But first we have to clarify the measures and units used (according to the international metric system):

**A** = Area, measured in sq. millimetres [$mm^2$], sq. centimetres [$cm^2$] or sq. metres [$m^2$]

**F** = Force, is the effect of gravitation ($g = 9.81 \frac{m}{s^2}$) on mass (kg), therefore:

$$\text{Force} = m \times g = 1 \text{ kg} \times 9.81 \frac{m}{s^2} = 9.81 \frac{\text{kg} \times m}{s^2} = 9.81 \text{ N},$$

measured in Newtons [**N**] or kilo-Newtons [**kN**]. For practical use, 1 kg is considered to be equal to 10 N, or 1000 kg = 1 to is considered to be equal to 10 kN.

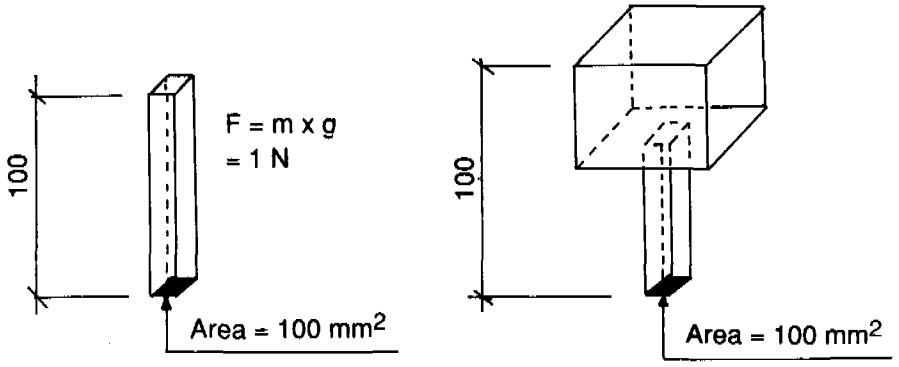
**P** = Pressure, measured in Newtons per sq. millimetre [**$N/mm^2$**], kilo-Newtons per sq. metre [**$kN/m^2$**] or ***Pascal [Pa]*** resp. kilo-Pascal [**kPa**].

1 $N/m^2$ = 1 Pa (≈ 0.1 $kg/m^2$ or 1 x $10^{-5}$ $kg/cm^2$)
1 $kN/m^2$ = 1 kPa (≈ 100 $kg/m^2$ or 1 x $10^{-2}$ $kg/cm^2$)

Pascals are also used to classify PVC pipes. The expression ISO Type 1000 means: pipes conferring to the ***International Standard Organisation*** and withstanding a pressure of 1000 kPa.

The pressure a column of water exerts over a particular area depends only on the height of the column but not on the geometric shape of the column.The general formula is:

$$P = \frac{F}{A}$$




$$p = \frac{F}{A} = \frac{1}{100} = 0.01\ N/mm^2 = \underline{\underline{10\ KPA}}$$

As it is rather laborious repeatedly to calculate the water pressures, in hydraulic work another, much easier, practice was introduced:
**The height of a water column is called *head* and represents the amount of gravitational energy contained in the water of the column**. It is measured in metres.
In the above example, instead of calculating a pressure of 0.01 $N/mm^2$ or
10 kPa, we can simply say, that there is one metre of head. Similarly a pressure of 1000kPa is reported to as 100m of head.

**Comparison of different measures for pressure:**

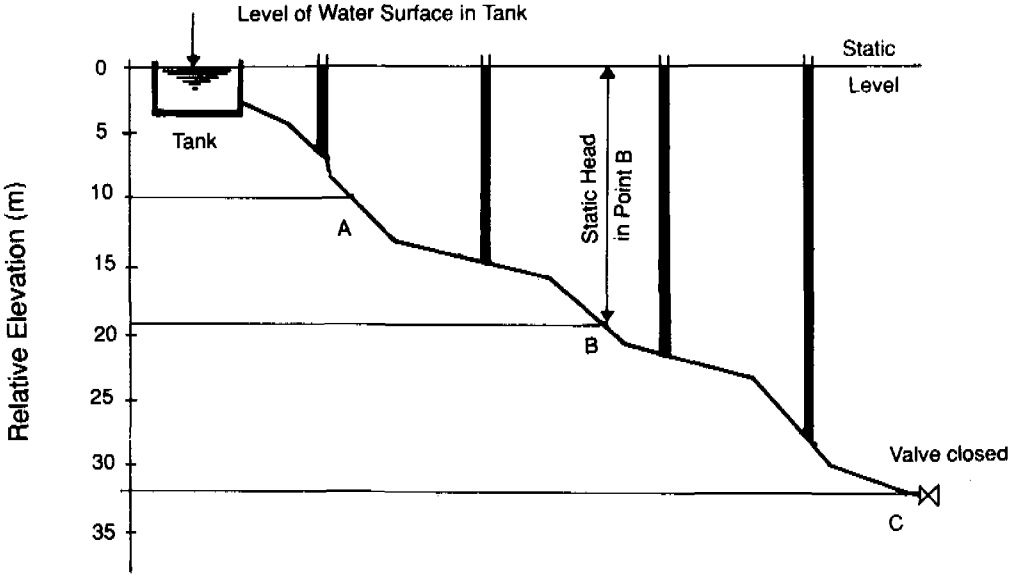
| | Pa | $N/mm^2$ | m of head | $kg/cm^2$ |
|---|---|---|---|---|
| 1 Pa | 1 | $1 \times 10^{-6}$ | $\approx 1 \times 10^{-4}$ | $\approx 1 \times 10^{-5}$ |
| 1 $N/mm^2$ | $1 \times 10^{6}$ | 1 | $\approx 100$ | $\approx 10$ |
| 1 m of head | $\approx 1 \times 10^{4}$ | $\approx 1 \times 10^{-2}$ | 1 | 0.1 |
| 1 $kg/cn^2$ | $\approx 1 \times 10^{5}$ | $\approx$ 0.1 | 10 | 1 |

The $\approx$ - symbol is used because the earth's gravity, expressed by the factor g, is not exactly 10 but 9.81 $m/s^2$.

## 5.4 FLUID STATICS

***The water pressure at a particular depth is directly related to the vertical distance from that depth to the level of the surface and is not affected by any horizontal distance.***

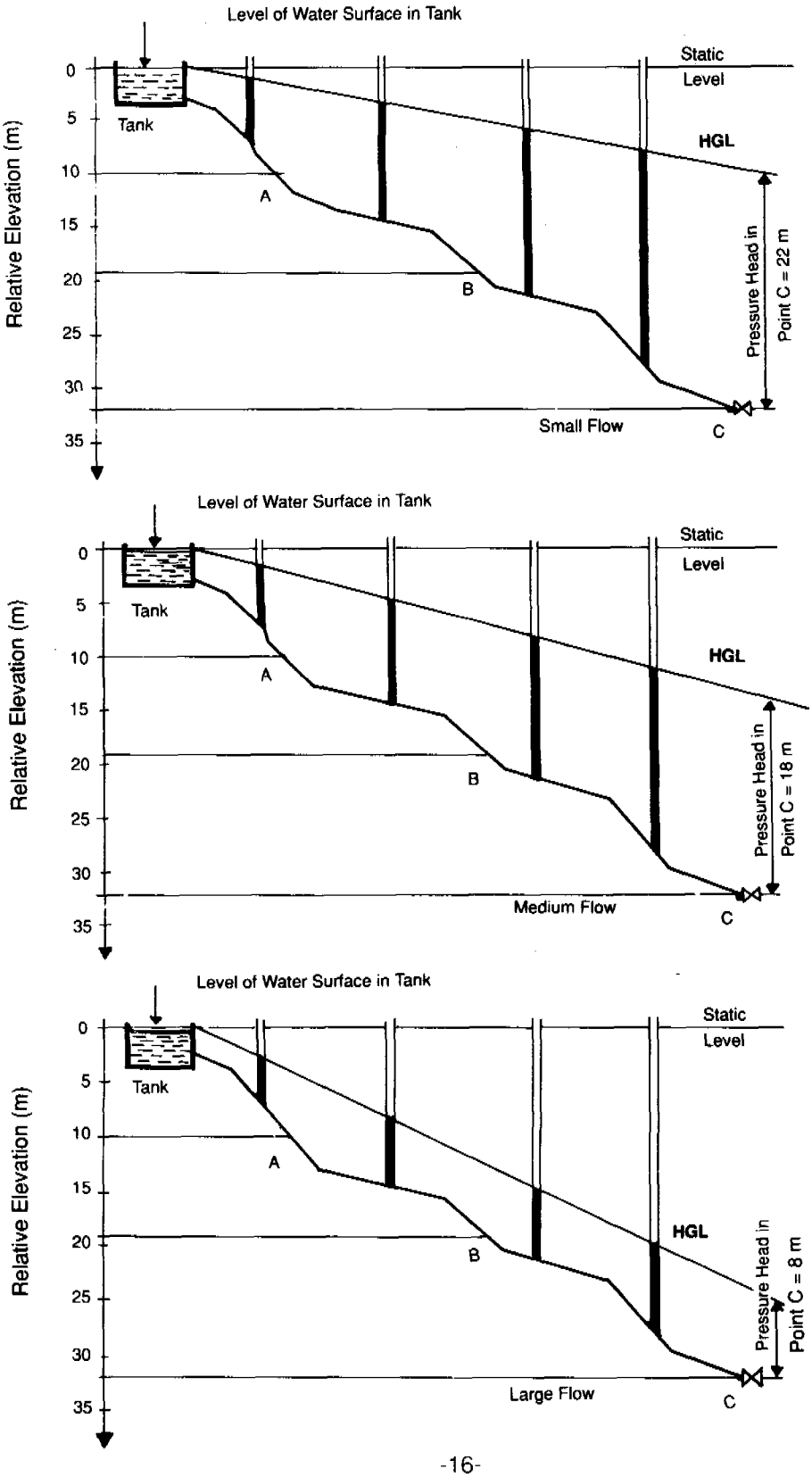
If small tubes were inserted into a pipeline, as shown in the drawing below, the water level in each tube would rise exactly to the level of the water surface in the tank or to the ***static level.*** The pressure at the bottom of this tube is called the ***static head.***




| Point | A | B | C |
|---|---|---|---|
| Static Head [m] | 10 | 19 | 32 |

## 5. 5 FLUID DYNAMICS

If the valve at point C is opened partially (and the tank refilled so that the static level remains constant) the water levels in the tubes will change according to the drawing below:




Dynamic Equilibriums

The water level in the tubes forms a new line for each flow. For a constant flow, the line formed will remain steady. The system is in a ***dynamic equilibrium***. The line formed by the water level in the tubes is called the ***hydraulic grade line or HGL***. The hydraulic grade line represents the energy levels at each point along the pipeline. For any constant flow there is a specific HGL. ***The vertical distance between the pipeline and the HGL is the measure of pressure head***, as given in the above drawings in point C.

## 5.6 FRICTION

As water flows through pipes, fittings, tanks, etc. some energy is lost to the system, dissipated by ***friction***. Any obstruction to the flow causes frictional loss of energy. The amount of energy lost depends on two major factors. There are many other, minor factors, but for our purpose it is enough to mention just the two major factors:

- Velocity of flow
- Roughness of pipes, fittings, etc.

Generally one can say that frictional losses are:

- Directly proportional to the length of the pipeline
- Directly proportional to the roughness of the pipe's interior surface
- Approx. proportional to the square of velocity or flow

While designing a water system, it is important to know how much energy (or head) will be lost to friction at any point of the system. The easiest method to calculate the frictional headloss is to make use of the ***frictional headloss tables***. These tables show the amount of frictional headloss per unit length of pipe, for a specific ***flow***.

***Flow: Quantity of water that moves through a pipeline within one second (l/s).***

The headloss tables express the loss as ***metres of headloss per 100 metres of pipe length*** or as ***m/100 m*** or ***%***. Such a headloss table is included in the Appendix to this manual (**Form K**). Remember that there are different headloss tables for different materials depending on the roughness of these materials (e.g. asbestos cement, PVC, GI, etc.)

The frictional headloss of flows through fittings such as elbows, reducers,tees, etc. are given as ***equivalent pipelengths***. That means the headlosses are calculated by taking into consideration an equivalent pipe length that creates the same amount of frictional headloss. For fittings this is commonly given as ***L/D Ratio*** (length/diameter ratio). Below a few examples of L/D ratio:

| Fitting | | L/D Ration |
|---|---|---|
| Tea | run - side | 68 |
| | run - run | 27 |
| Elbow | single | 33 |
| | double, same direction | 66 |
| | double, opposite direction | 132 |
| | double, three dimensional | 99 |
| Union | | 7 |
| Gate valve (fully open) | | 7 |
| Screened entrance | | 150 |
| Free entrance | | 29 |
| Reduction | | 15 |

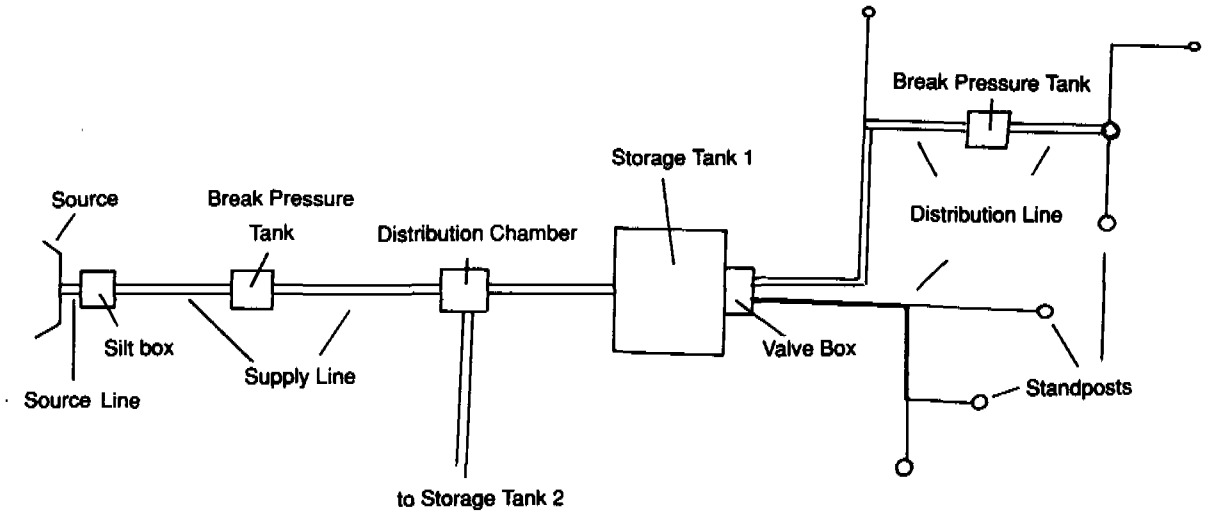
**Example**: What is the equivalent pipe length of a 32 mm elbow (single)?
L/D Ration = 33 : 33 x 32 = 1.056 mm = 1.06 m

Generally, the headloss of fittings is very small compared with the headloss in a long pipeline. Therefore, unless several fittings are installed close together, the headloss of fittings can be ***neglected*** when the pipe length is more than **1000** ***diameters***, e.g. more than 20 metres for a 20 mm pipe, etc.

# 6 COMPONENTS OF A GWSS

## 6.1 GENERAL REMARKS

On the following pages we will introduce you to the components of a gravity water supply scheme. Each component will be explained briefly and there will be references to the chapters where you can find more details about the particular component. Below you will first find a schematic drawing of a GWSS with all its components:




## 6.2 INTAKE

### 6.2.1 SPRING CATCHMENT

As explained in chapter *4.2 Springs*, a place where ground water seeps to the surface is called a spring. The flow of a spring has to be tapped and the structure of tapping is called spring catchment. ***A spring catchment*** is the heart of a GWSS and therefore utmost care has to be taken while designing and constructing the catchment. Due to the uniqueness of each source, there will never be a standard design for a catchment that can be built for every system. However, there are some standard design features which have to be considered before designing a particular catchment. Please refer to the second part of this manual, chapter *2 Spring Catchment* for more details.

It is obvious, that the catchment area has to be protected to prevent a spring from becoming polluted. The area just above and upstream of the catchment needs particular care. The size of the protection zone depends on the thickness and nature of the covering stratum. In any case, the radius of the protected area must not be smaller than ***10 m***. Within this area no farming, no domestic animal grazing, no rubbish pits, etc. are allowed. The area just above the catchment should be planted

with grass and outside of a radius of about 10 m the protection zone should be ***afforested***. It is advisable to insist that the protection zone is fenced and protected just after the completion of the catchment and before any other works are started.

There is one more important point to be kept in mind when talking about a spring as a source for a GWSS: **w a t e r r i g h t s**. Before any works are started, the water rights of those people dependent upon the water of the new GWSS spring have to be settled first.

### 6.2.2 STREAM INTAKE

As mentioned in chapter *4.3 Streams,* water from streams or rivulets is generally not safe for drinking. Nevertheless, sometimes there is no other source available and a ***stream intake*** has to be constructed. It is outside the immediate scope of this manual to deal in detail with stream intakes. In case you want to know more about this topic please refer to the references given in the Appendix to this manual.

## 6.3 SEDIMENTATION CHAMBER / SILT BOX

Water from large springs contains suspended particles. Such particles should be removed by allowing the water to sit quietly for a certain time in a sedimentation chamber or silt box. Such a silt box should be built as close to the catchment of the spring as possible. Very often the silt box can also serve as a collection chamber.If more than one source is tapped, each source should have its own pipeline to the silt box/collection chamber for inspection purposes. Small particles need some time to sink downwards under the influence of gravity. A settling period of ***20 minutes*** will allow fine silts and larger particles to settle in the silt box. We therefore recommend: ***detention time = 20 minutes***. The detention time is the period of time the water spends in the silt box.

For more details please refer to *7.9.1 Sedimentation Chamber / Silt Box.*

## 6.4 BREAK PRESSURE TANK (BPT)

If the differences in elevation cause too high a static pressure in a pipeline, ***Break Pressure Tanks*** have to be constructed. Please refer to *7.10.2 Pressure Head in Pipes* for permissible pressure heads. Break Pressure Tanks permit the water to discharge freely into the atmosphere thus reducing the static pressure head to zero. Any tank with an open water surface (e.g. storage tank, silt box, distribution chamber, etc.) acts as a BPT.

## 6.5 STORAGE TANK

In most GWSS the yield of the sources is smaller than the peak demand at the taps. Therefore a ***storage tank*** serves to store the surplus water during the night for use during the day. Please refer to *7.9.3 Storage Tank.* Before constructing a storage tank consider the following points:

- A storage tank should be located as close to the standposts as possible.
- It is more economical to have a long pipeline before the storage tank (without any taps) than to build a long distribution pipeline which is designed for the peak flow.

## 6.6 DISTRIBUTION CHAMBER

In medium and large GWSS it is necessary to divide the whole area of supply into easily manageable sub-systems of about 10 - 15 taps each. That means, that the water also has to be distributed accordingly. This can be arranged with the help of a distribution chamber. Please refer to *7.9.2 Distribution Chamber.*

## 6.7 VALVE BOX

The purpose of a valve box is to protect any kind of valves from undesirable tampering by outsiders. Valve boxes can be attached to a particular structure or they can be built separately along the pipeline.

## 6.8 PIPELINES

Pipes serve to distribute the water from the source to the individual users at a tap. The hydraulic calculations of a system determine the sizes(diameters) of pipes. We recommend the use of PVC pipes because in Sri Lanka the water is often very aggressive towards iron and GI pipes are therefore not recommended. It might be necessary to protect PVC pipes sometimes with GI pipes (e.g. in areas where pipes can not be buried, to cross small gullies, etc.). Please refer to *7.8 Velocity of Flow in Pipelines* and *7.10 Design of Pipeline.*

## 6.9 STANDPOSTS

The following is an abstract from the "Handbook of Gravity-Flow Water Systems" by T.D. Jordan Jr.: *The tapstands are the most frequently used component of the entire system. No other structure will face more abuse than these, and no other structure will have to fit in so closely with local, social and cultural needs.*

*A tapstand is more than just a physical structure. It will become a new and important gathering point of the village. Properly designed and built, the tapstand will be a clean, attractive and inviting place. Poorly completed, it will be a dirty, muddy, unhygienic eyesore.*

Please refer to *7.5.2 Situation Survey* and to *7.7 Flow at Standposts.*

## 6.10 INSTALLATIONS

### 6.10.1 AIR VALVES / AIR RELEASE

When a pipeline is filled/refilled air will be trapped in certain areas. As pressure builds up, these air pockets are compressed to smaller volumes. In the process, some of the hydrostatic pressure of the system is absorbed by compressing these air pockets. If too much energy is absorbed, the desired flow will not reach the discharge point. Therefore, at all ***high points*** an ***air release*** (e.g. air valve, standpipe, open pipe) has to be installed.

### 6.10.2 WASHOUTS

Suspended particles in the water tend to settle out at low points in the pipeline or where the flow velocity is too small. Therefore at all low points a ***washout*** (plug, valve, standpipe) has to be installed.

### 6.10.3 SECTIONAL VALVES

**Sectional valves** are installed for two different reasons:

- Parts of the supply system can be shut off for repair purposes
- Flow of water can be rationed in case of a severe drought or other problems which necessitate water rationing.

Sectional valves on long main lines should be located at a distance of 2 to 3 km and it is important to keep in mind that the shut off part of the pipeline can be ventilated (e.g. by air valves or standpost) to avoid the build up of a vacuum.

On distribution lines, sectional valves should be installed so that they control three to five standposts. Whenever possible a sectional valve has to be combined with an air release or washout (sectional valve upstream).The installation of sectional valves in distribution lines makes control valves at individual standposts superfluous. For branch lines, sectional valves should be located at the branch-off.

# 7 DESIGN GUIDELINES

## 7.1 GENERAL REMARKS

In this section you will find information on how to design a gravity water supply scheme. The flow diagram on the next page will give you an idea of the design process at a glance. References are given in the diagram to the particular chapters where you can find the issues explained in detail and to the forms to be filled in for certain activities. In exceptional cases,where the provisions of these guidelines will not be sufficient to solve a specific problem, please consult an experienced engineer or refer to the references and bibliography in the Appendix to this manual for further reading.

## 7.2 SUMMARY OF DESIGN CRITERIA

- Design Period : **20 years**

- Population Growth Rate : **1.24**

- Water Demand :
  - Rural Villages: **45 liters per person and day (30 liters in exceptional cases)**
  - Schools: **6 liters per student and day**

- Peak Demand Factor : **3.75**

- Number of People per Standpost : **max. 150** (future population)

- Flow of Standposts : **0.1 l/s if 0 - 80 users per tap**
  **0.2 l/s if 80 - 150 users per tap**

- Roughness of PVC Pipes : **k = 0.01 mm** (used to calculate the friction loss table)

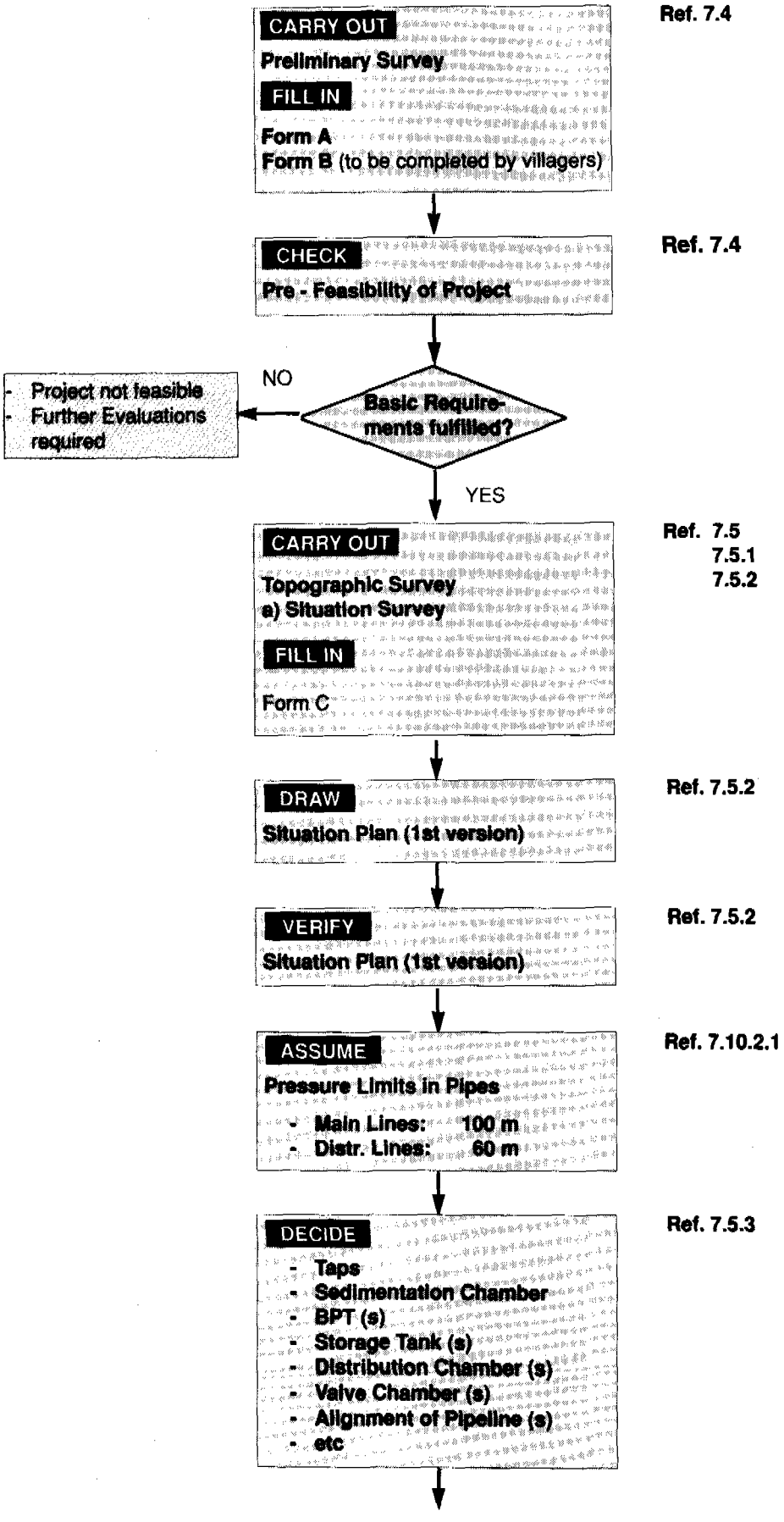
- Maximum Hydrostatic Pressure (PVC Pipes ISO 1000):

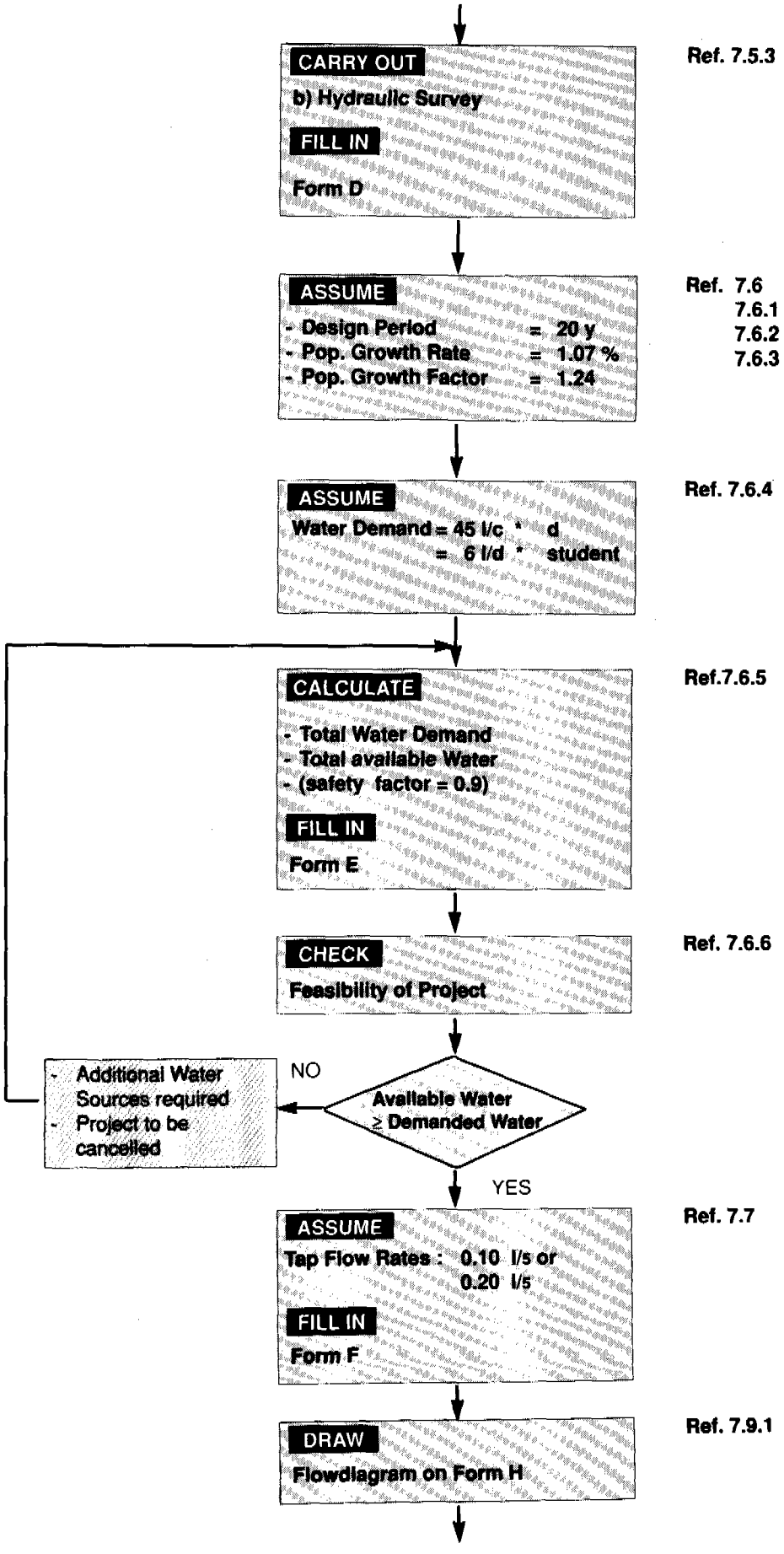
  **100 m in main lines (no taps)**
  **60 m in distribution lines**

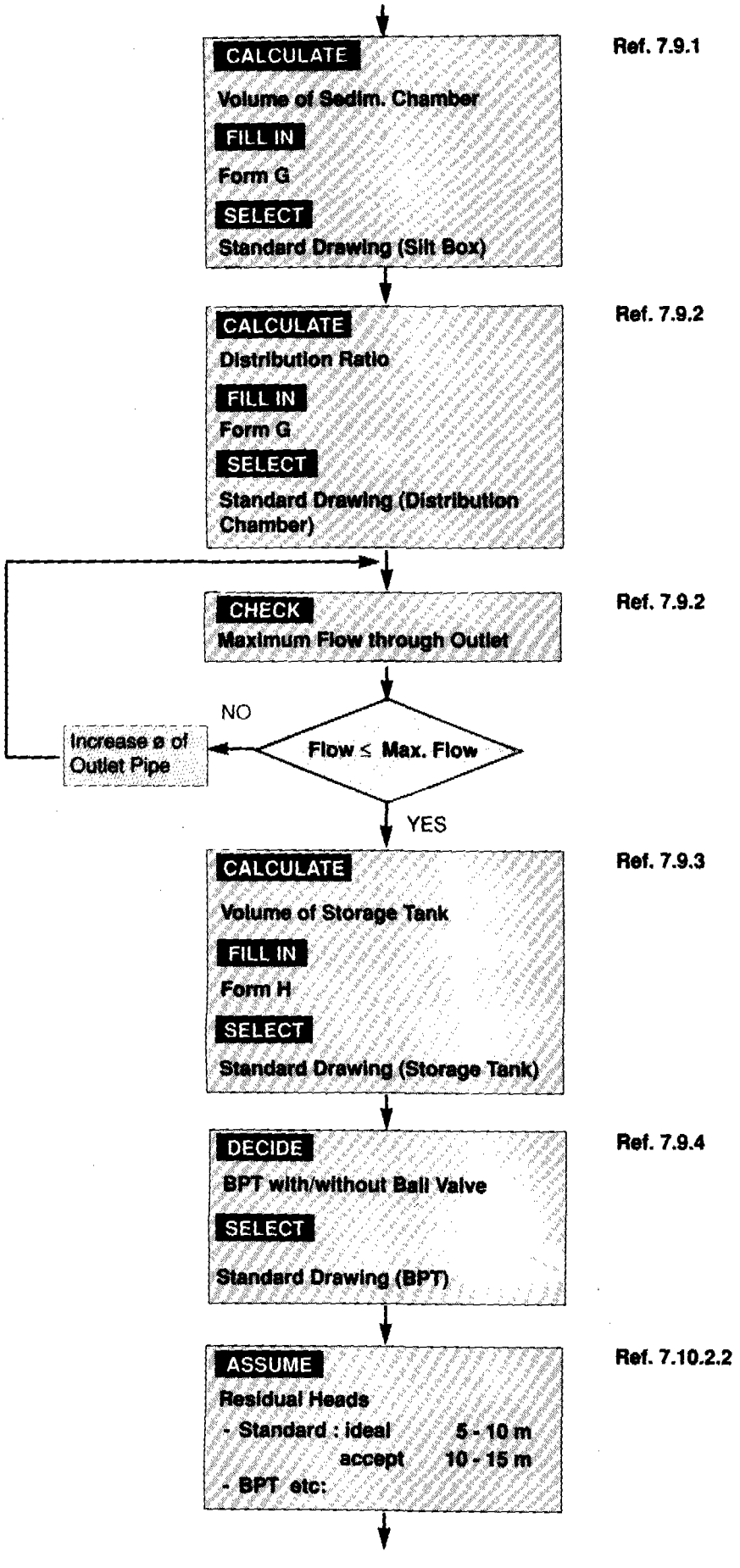
- Residual Head :
  - **at Standposts: ideal 5 - 10 m**
    **acceptable 10 - 15 m**
  - **BPT, Storage Tanks: 10 - 20 m**

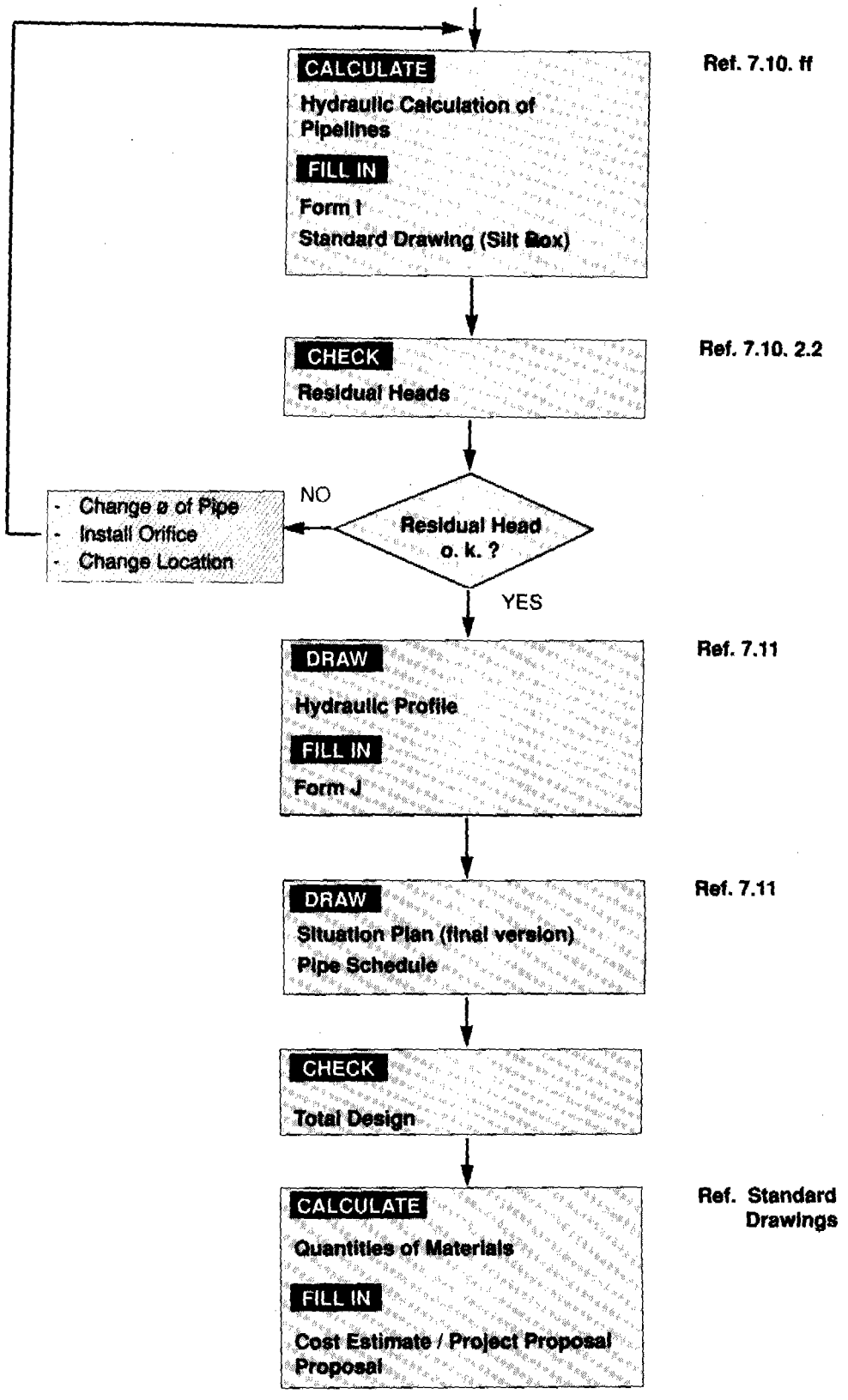
- Flow Velocities : **Maximum v = 3.0 m/s**
  **Minimum v = 0.5 m/s**

# 7.3 FLOW CHART OF DESIGN PROCEDURES




CARRY OUT
b) Hydraulic Survey
FILL IN
Form D
Ref. 7.5.3
ASSUME
- Design Period = 20 y
- Pop. Growth Rate = 1.07 %
- Pop. Growth Factor = 1.24
Ref. 7.6
7.6.1
7.6.2
7.6.3
ASSUME
Water Demand = 45 l/c * d
= 6 l/d * student
Ref. 7.6.4
CALCULATE
- Total Water Demand
- Total available Water
- (safety factor = 0.9)
FILL IN
Form E
Ref.7.6.5
CHECK
Feasibility of Project
Ref. 7.6.6
Available Water ≥ Demanded Water
NO
- Additional Water Sources required
- Project to be cancelled
YES
ASSUME
Tap Flow Rates : 0.10 l/s or
0.20 l/s
FILL IN
Form F
Ref. 7.7
DRAW
Flowdiagram on Form H
Ref. 7.9.1


CALCULATE
Volume of Sedim. Chamber
FILL IN
Form G
SELECT
Standard Drawing (Silt Box)
Ref. 7.9.1
CALCULATE
Distribution Ratio
FILL IN
Form G
SELECT
Standard Drawing (Distribution Chamber)
Ref. 7.9.2
CHECK
Maximum Flow through Outlet
Ref. 7.9.2
NO
Flow ≤ Max. Flow
Increase ø of Outlet Pipe
YES
CALCULATE
Volume of Storage Tank
FILL IN
Form H
SELECT
Standard Drawing (Storage Tank)
Ref. 7.9.3
DECIDE
BPT with/without Ball Valve
SELECT
Standard Drawing (BPT)
Ref. 7.9.4
ASSUME
Residual Heads
- Standard : ideal 5 - 10 m
accept 10 - 15 m
- BPT etc:
Ref. 7.10.2.2


CALCULATE
Hydraulic Calculation of Pipelines
FILL IN
Form I
Standard Drawing (Silt Box)
Ref. 7.10. ff
CHECK
Residual Heads
Ref. 7.10. 2.2
Residual Head o. k. ?
NO
- Change ø of Pipe
- Install Orifice
- Change Location
YES
DRAW
Hydraulic Profile
FILL IN
Form J
Ref. 7.11
DRAW
Situation Plan (final version)
Pipe Schedule
Ref. 7.11
CHECK
Total Design
CALCULATE
Quantities of Materials
FILL IN
Cost Estimate / Project Proposal
Proposal
Ref. Standard Drawings

## 7.4 PRELIMINARY SURVEY

Once a request for a GWSS is received from a village a first technical survey has to be done. Such a survey is called ***preliminary survey*** or ***feasibility study*** and should provide enough information to judge whether a GWSS is feasible for the concerned village. ***Form A*** (see Appendix) has to be filled in very carefully together with the villagers.
The altitudes of possible sources and of the consumers have to be measured (with a pocket altimeter). Do not forget to draw a sketch of the area.Together with the villagers all possible springs have to be measured. These spring measurements have to be entered into ***Form B***. Insist that a spring is measured at least ***once a week over a period of one year***. Most springs can be measured with spout, bucket and watch. Insist in using always the same bucket and enter its measurements into Form B.

## 7.5 TOPOGRAPHIC SURVEY

### 7.5.1 GENERAL REMARKS

The topographic survey can be divided into two parts. First a situation survey has to be done and then a hydraulic survey. The situation survey should allow you to draw a situation plan and the hydraulic survey enables you to calculate and design the whole water system. Instead of explaining all the necessary surveying instruments and the procedures of the surveys in detail we rather recommend an inexperienced surveyor to do one or two surveys together with an experienced surveyor. This ***on the job training*** will have a much greater impact and an experienced surveyor can give you many practical hints and prevent you from making annoying mistakes.
After completion of a survey, before you leave the village, be sure that you took all the necessary readings and that you got all the information you need. It is very frustrating to notice too late, that just a few readings are missing.

### 7.5.2 SITUATION SURVEY

To carry out a situation survey you need a bearing compass and a tape. The data of this survey will be used to draw up the ***situation plan*** which should contain the following information:

- Roads, railway tracks, foot paths
- Rivers, streams, lakes, tanks
- Paddy fields, tea land, forests, cliffs, etc.
- Houses and important buildings such as schools, temples, churches,ambalams, hospitals, post offices, community halls, etc.
- Water sources like springs, wells, etc.

Fill in ***Form C***. While surveying the village it is necessary to maintain a sketch which corresponds with the entries into Form C.
Always try to ***close a survey***. That means to tie the survey into two reference points of known elevations. In rural villages in Sri Lanka it will not be possible to find two points of known elevation. Therefore, each stretch of the survey has to be measured

twice not necessarily along the same route. Each elevation or location can then be calculated by using the average of two readings.
Once all necessary data are collected the situation plan can be drawn up in an appropriate scale:

- 1 : 2'500 for small villages
- 1 : 5'000 for medium villages
- 1 : 10'000 for large villages

To verify the situation plan, the surveyor should go to the village again and add all missing information. At the same time he can discuss the locations of the standposts with the villagers. It is important that the ***villagers themselves select the location of stand posts:***

- Nearest tap should be within ***150m*** of any dwelling
- Not more than ***150 people*** (future population) served by one tap
- Separate taps for public institutions (e.g. schools, temples, etc.
- The access to a tap has to be guaranteed to all users (in writing)

### 7.5.3 HYDRAULIC SURVEY

Once the situation plan is completed the surveyor has to decide upon the layout of the GWSS in close discussions with the villagers. That means they have to discuss the location of:

- Silt box
- Storage tanks
- Break pressure tanks
- Standposts
- Alignment of pipeline etc.

The hydraulic survey is carried out with the help of a clinometer (abney level), bearing compass and a tape. A box altimeter can be used to measure ***first*** the elevation of all important structures of a GWSS. These levels can then be cross checked with the clinometer readings. A levelling instrument is generally not required. But in cases where the differences in elevation are very small, it might be advisable to check the elevations with a levelling instrument to get more accurate readings.

***Take your time with a survey, never do it in a haste.***

Try to include as many ***cross checks*** as possible. Always reflect on your readings and check quickly whether they can be correct. Try to guess before you take a reading how much it could be. This prevents you from making mistakes with + or - signs. A surveyor should make use of as many ***reference points*** as possible. It helps you to re-survey a certain part later on.Reference points have to be permanent (e.g. rock outcrops). Mark them with colour (e.g. nail polish). Fill in ***Form D*** and make liberal use of the Remarks column.

## 7.6 FUTURE DESIGN DEMAND

### 7.6.1 DESIGN PERIOD

Experiences, also in other countries, show that a life span of 15 - 20 years for a GWSS can reasonably be expected. We, therefore, assume the design period as ***20 Years.***

### 7.6.2 POPULATION GROWTH RATE

According to official statistics the rate of population growth has been as follows:

| | |
|---|---|
| 1963 - 1978 | : 2.8 % |
| 1971 - 1981 | : 1.7 % |
| 1981 - 1990 | : 1.4 % |
| 1990 | : 1.1 % (estimated) |

The medium growth rate for time being can be assumed as ***1.07 %.*** This figure also coincides with the findings of Cowater international, Inc. in their District Development Plans, Volume 1, Summary, page 1.

### 7.6.3 POPULATION GROWTH FACTOR

To be able to calculate the future population we have to multiply the present population with the ***population growth*** factor for twenty years:

$$\textbf{\textit{Growth Factor}} = \left(1 + \frac{\text{Growth Rate}}{100}\right)^{20} = \left(1 + \frac{1.07}{100}\right)^{20} = \textbf{\textit{1.24}}$$

### 7.6.4 WATER DEMAND

Many different surveys of the consumption of water show that the average consumption is 25 - 70 litres per capita per day. According to the recommendations of WHO we decided upon the following figures:

Rural Village : ***45 l/c x d*** in exceptional cases: ***30 l/c x d***

Schools : ***6 l/day and student***

Included in above figures is a certain amount of water that is lost for various reasons (leakages, spillage, illegal use, etc.). Such losses depend on various factors (e.g. construction quality, operation and maintenance, pressure in pipes, etc.) and are estimated to be between 20 - 30 Percent.

### 7.6.5 AVAILABLE WATER

The yield of all the water sources during the ***dry season*** has to cover the future water demand of the population. There will always be some leakage or the spring catchment does not trap all the available water. Overall ***losses will be about 10 %.*** Therefore the yield in the dry season has to be multiplied with a safety factor of ***0.9*** to determine the ***safe yield.***

### 7.6.6 FEASIBILITY OF PROJECT

***Form E*** has to be filled in to see whether a GWSS is feasible or not. The amount of water available has to be bigger than the future design demand.In case it is smaller, the size of the project area has to be reduced or additional sources (even far away) have to be used.
In exceptional cases, it is possible to reduce the daily water demand from 45 l/c x d to 30 l/c x d. This decision has to be discussed with the villagers and they will have to take care that as little water as possible is wasted.

## 7.7 FLOW AT STANDPOSTS

If we want to get the design flow of each standpost we have to divide the future water demand by 86400 seconds (24 x 3600) and we will get the ***average flow***. This average flow does not represent the actual flow needed at a tap because there will be "peaks" in the consumption of water. The ***peak flow factor*** shows the relation between such peak demands and the average demand:

$$\text{Peak Flow Factor} = \frac{\text{Peak Flow}}{\text{Average Flow}}$$

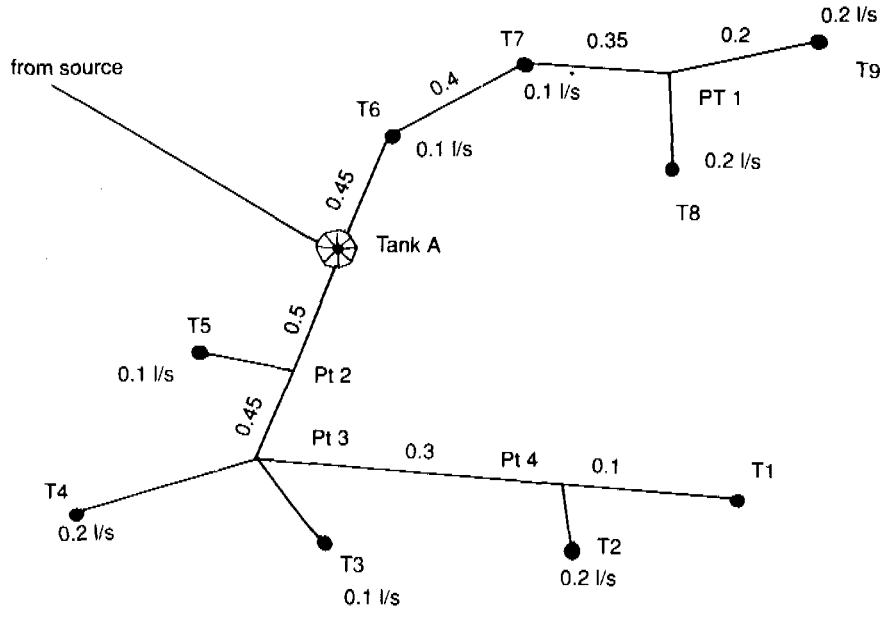
Basically the peak flow factor determines how quickly a water container can be filled. The higher the peak flow factor, the quicker a vessel will be filled. On the other hand, the higher the peak flow factor, the bigger the diameter of the pipes and the bigger the spillage of water. Therefore, a reasonable peak flow factor can be assumed as **3.75**. This peak flow factor has to be multiplied with the average flow and you will get the peak flow for each individual tap. This procedure proved to be laborious and the practical experience in the field showed that the accuracy of such a time consuming calculation procedure is not really justified. Therefore, ***tap flow rates*** were introduced.

| Users per Tap | Tap Flow Rate |
|---|---|
| 0 - 80 | **0.10 l/s** |
| 80 - 150 | **0.20 l/s** |

**Note:** Users per Tap means the future number of users of one tap.

It can be argued that not all taps along the same branch line will be open at the same time and therefore the flow rates for a system could be reduced. However, experiences in the field, not only in Sri Lanka, showed that it is necessary to add up all tap flow rates, without reduction, to get the total flow of a branch line or of a system. Fill in ***Form F*** to determine the flow rate at each tap. Additionally you also have to determine from which storage tank the different taps get their water and thus calculate the number of people and/or pupils to be served by a particular storage tank.

With the figures of Form F you can draw the ***Flowdiagram on Form H***. Such a flowdiagram is a simplified situation plan of the whole system. For very large systems it might be necessary to draw flowdiagrams for each branch line separately.
Below you find an example of a simple flowdiagram:




## 7.8 VELOCITY OF FLOW IN PIPELINES

The velocity of flow in a pipeline has to be considered as well. Too great a velocity can cause excessive erosion of the pipe or increase the risk of the occurrence of water hammers when a valve is closed suddenly. On the other hand, too small a velocity can cause settlements of suspended particles at low points in the pipeline. Therefore, the recommended velocity limits are:

| | |
|---|---|
| **Maximum :** | **v = 3.0 m/s** |
| **Minimum:** | **v = 0.5 m/s** |

The table below gives the corresponding minimum and maximum flows (l/s) for various PVC pipe sizes (nominal sizes in mm):

| | 20 | 25 | 32 | 40 | 50 | 63 | 75 | 90 |
|---|---|---|---|---|---|---|---|---|
| Max. Q = | .76 | 1.14 | 1.85 | 2.89 | 4.56 | 7.13 | 9.95 | 14.71 |
| Min. Q = | .13 | .19 | .31 | .48 | .76 | 1.19 | 1.66 | 2.45 |

## 7.9 CALCULATION OF THE SIZE OF STRUCTURES

### 7.9.1 SEDIMENTATION CHAMBER / SILT BOX

As mentioned in chapter *6.3 Sedimentation Chamber/Silt box* the ***detention time*** in a silt box is ***20 minutes***. During this time most of the suspended particles can sink down and settle on the bottom of the silt box.
The capacity of a silt box can be calculated with the following formula:

$$C \geq Q \times T$$

where: C = Capacity in litres
Q = Total maximum yield
T = Detention time in seconds
(20 minutes = 1200 seconds)

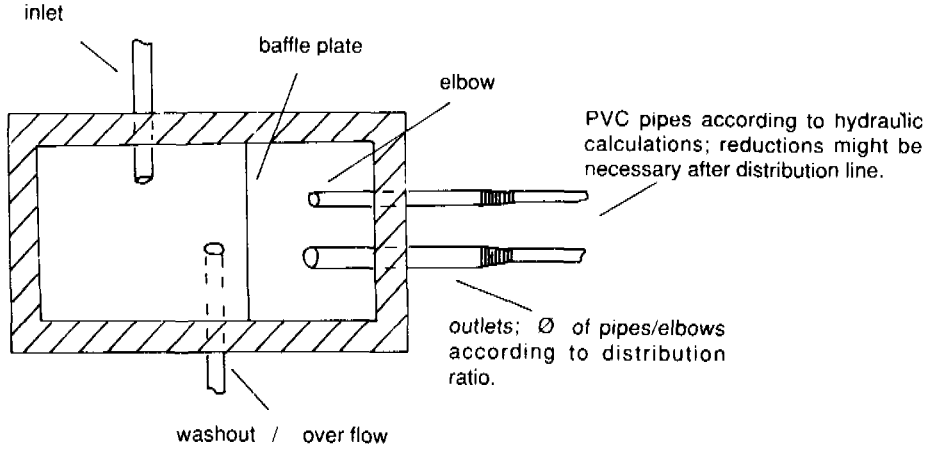
The flow used to calculate the capacity of the silt box is the ***total maximum yield of the spring(s).***

Please refer to the Appendix to this manual for the ***standard drawings of sedimentation chambers/siltboxes.***

### 7.9.2 DISTRIBUTION CHAMBER

In case a GWSS needs more than one storage tank it is necessary somehow to distribute the available water coming from the catchment(s) through the supply line in a distribution chamber located before the storage tanks.There are several designs of ***distribution chambers***. An easy and inexpensive way is the construction of a chamber with a ***baffle plate***. The plate is dividing the chamber into two sections, one for the inlet from the catchment(s) and one for the outlets to the storage tanks. The water in the first chamber is flowing under the baffle plate into the second chamber where it flows through the open ends of PVC elbows fixed to the outlet pipes. The PVC elbows should all be on the same level and in size direct proportional to the distribution ratio. If necessary, ***orifices*** can be used for fine adjustments.

After fixing the elbows and orifices, the actual flow of water into the storage tanks should be measured and fine adjustments be made at the orifices till the actual and the desired distribution ratios are equal.




Please refer to the ***standard drawing*** for distribution chambers in the Appendix to this manual for more details.

### 7.9.3 STORAGE TANK

As explained in chapter *6.5 Storage Tanks* the demand during peak times is very often bigger than the yield of the source. A storage tank serves to store water during periods of low demand for use during periods of high demand. Below you can see a typical demand pattern of a rural village in Sri Lanka:

| Time Period | Hours | % of Daily Demand |
|---|---|---|
| 05.30 - 08.30 | 3.0 | 30 % |
| 08.30 - 11.30 | 3.0 | 10 % |
| 11.30 - 13.30 | 2.0 | 15 % |
| 13.30 - 16.00 | 2.5 | 10 % |
| 16.00 - 19.00 | 3.0 | 30 % |
| 19.00 - 05.30 | 10.50 | 5% |

The location of a storage tank has to be considered very carefully. They should be located as far down the system as possible. A few small storage tanks are usually preferable to one large tank. To determine the size of a storage tank, the supply has to be compared with the daily demand. Such a comparison shows the deficit in supply during the day time. The storage capacity has to cover at least this deficit. Use ***Form H*** to calculate the minimum volume of a storage tank. Compare the calculated minimum volume with the volume of the ***standardized storage tanks*** in the Appendix to this manual and select the appropriate storage tank design!

### 7.9.4 BREAK PRESSURE TANK (BPT)

As explained in chapter *6.4 Break Pressure Tank* a BPT reduces the static pressure to zero and establishes a new static level. In chapter *7.10.2.1 Static Pressure Head* the maximum static pressure heads are given:

- ***Main Line :*** ***100 m*** Under the condition that PVC pipes ISO 1000 are used!
- ***Distribution Line :*** ***60 m***

Sometimes it is necessary to install a ball valve (float valve) at the inlet to the BPT (e.g. when there are standposts joined directly to the main line). However, it is always preferable not to have standposts on a main line. Please refer to the Appendix to this manual for the ***standard design drawings of BPTs.***

## 7.10 DESIGN OF PIPELINE

### 7.10.1 TYPES OF PIPELINE

We can distinguish between three types of pipelines:

- ***Source Line***: They deliver the water from the catchment to the silt box/ collection chamber. Each source should have its own pipeline. The minimum slope required is ***2 %***. The diameter depends on the ***maximum yield of the spring, but should not be smaller than 50mm*** (outside diameter). It is advisable to install a second source line a little bit higher than the first one, so that the caretaker can easily detect when the first line gets blocked.
- ***Main Line (without any taps)***: They link the different tanks, boxes and chambers with each other, but do not distribute water to the taps.Therefore, they can be designed for a continuous 24 hours ***average flow.***
- ***Distribution Lines***: They transport the water to the different standposts. They have to be designed for the ***peak flow.***

### 7.10.2 PRESSURE HEAD IN PIPES

#### 7.10.2.1 Static Pressure Head

As explained in chapter *5.4 Fluid Statics* the static pressure head is equal to the vertical distance between a particular point in the pipeline and the surface of the water at the open end of the pipeline, e.g. storage tank, BPT, etc. In distribution lines there is a continuous change of flow caused by the opening and closing of taps. These changes of flow rate can create pressure waves, and if there is an abrupt change of flow, e.g. a sudden closure of a tap or valve, a ***water hammer*** can develop. Therefore there are different max. pressure heads for main lines and distribution lines:

| | **Maximum Static Pressure Head** |
|---|---|
| Main Line | **100 m** |
| Distribution Line | **60 m** |

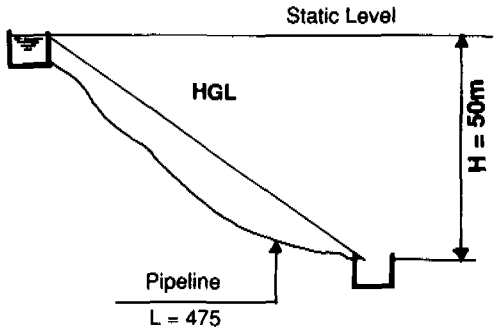
under the condition that ***PVC pipes ISO 1000*** are used.

#### 7.10.2.2 Residual Head (Dynamic Pressure Head)

**Residual Head** is the amount of energy remaining in a pipeline when the desired flow has reached the standpost. A designer of a GWSS has to fully understand the significance of residual head at standposts, storage tanks and break pressure tanks. The following examples should help to get this understanding.

**Natural Flow:** The natural flow of a pipeline is the ***absolute maximum flow*** that can be moved through a particular pipeline by gravity; the residual head will be zero.

**Example:**




What is the natural flow through the pipe-line shown in the sketch on the left when:

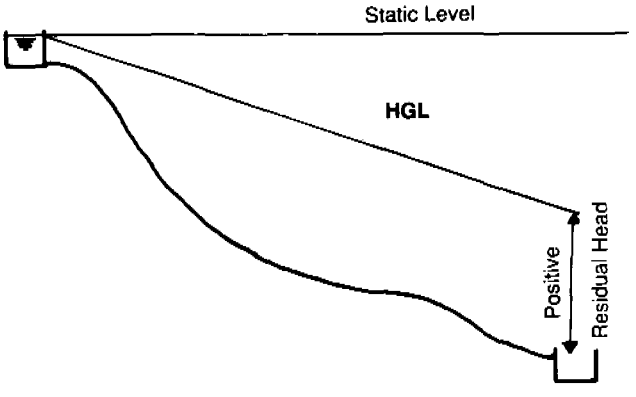
H = 50 m
L = 475 m

PVC pipe ø 32 mm

**Solution:** Friction loss factor = $\frac{50}{475}$ = 0.1053 = 10.53 %

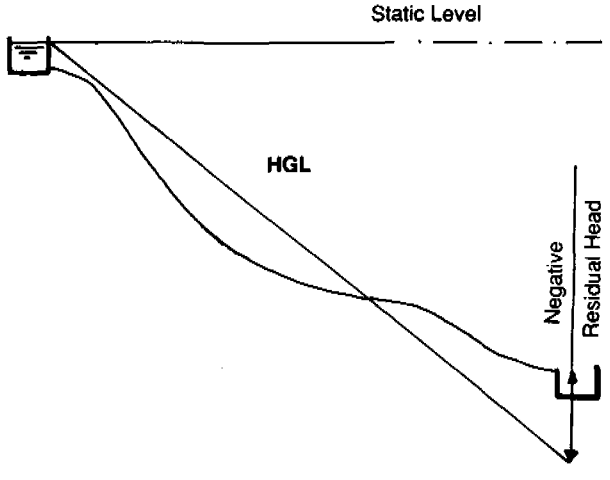
Friction loss table : for friction loss factor = 10.53 % and pipe diameter = 32 mm

→ Q = 0.96 l/s




**Positive Residual Head:**

There is an excess of gravitational energy; there is enough energy to move an even greater flow through the pipeline. If the flow is allowed to discharge freely, it will increase, thus increasing also the frictional head loss until there will be natural flow.

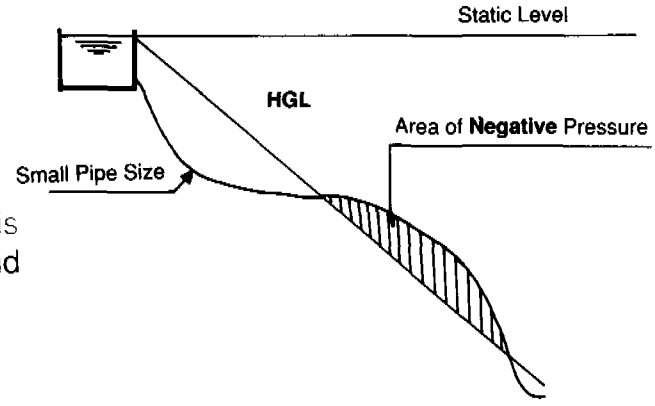



**Negative Residual Head:**

There is not enough gravitational energy to move the desired quantity of water. Therefore, the desired quantity will not flow.The HGL has to be re-plotted using a smaller flow and/or a larger pipe size.

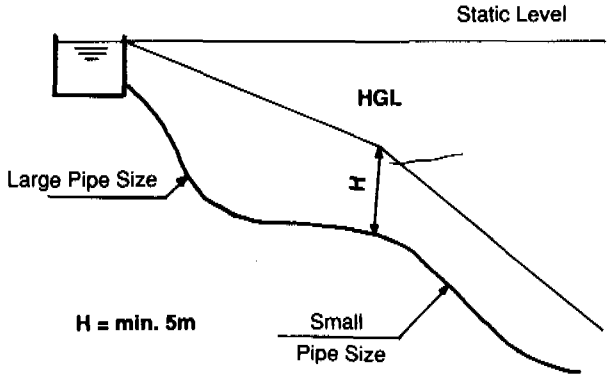
## Limits of Residual Head:

Sometimes, while plotting the HGL you discover that, due to the topography, the HGL will go "underground". See drawing. The pressure in the area where the HGL is "underground" is a ***negative pressure*** and there is a risk of sucking polluted liquids into the pipeline via leaky joints. Such a design is ***unacceptable!***




***The HGL should generally be not less than 10 m above ground level; but never fall less than 5 m above the ground!***

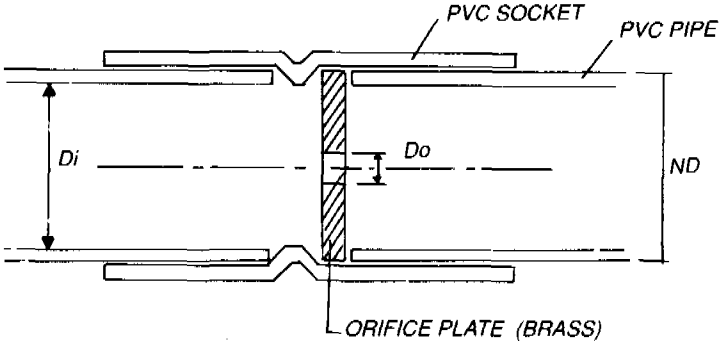
By changing the size of the pipe you can keep the HGL minimally 10 m above the ground.




On the other hand, too big a residual head at standposts increases wear and tear on valves and tends to increase water spillage. Therefore, the following residual heads are recommended.

| | | |
|---|---|---|
| - ***Standposts:*** | ***ideal*** | ***5 to 10 m*** |
| | ***acceptable*** | ***10 to 15 m*** |
| ***- BPT and storage tanks:*** | | ***10 to 20 m*** |

Above figures include a certain safety against inaccuracies of the topographic survey.
There may be standposts where the residual head is excessively high. In such a case it is necessary to install a device which causes a high frictional loss in a short length of pipeline. Such a device is called ***orifice*** and a possible design is shown in the drawing below:




Do = diameter of orifice

ND = nominal diameter of pipe

Di = inner diameter of pipe

The headloss through an orifice depends on the pipe diameter, the size of the orifice and the flow in the pipe. The general formula looks like this:

$Q = C \times A \times \sqrt{2 \times g \times H}$ where:

Q = Flow
C = Coefficient of orifice
A = cross-sectional area of orifice
g = Gravitational acceleration = 9.81 m/s2
H = Headloss through orifice

The coefficient of orifice for the above shown type is approximately ***0.6.***

$$H = \frac{Q^2}{C^2 \times A^2 \times 2 \times g} = \frac{Q^2}{A^2 \times 0.6^2 \times 2 \times 9.81} = \frac{Q^2}{A^2 \times 7.06}$$

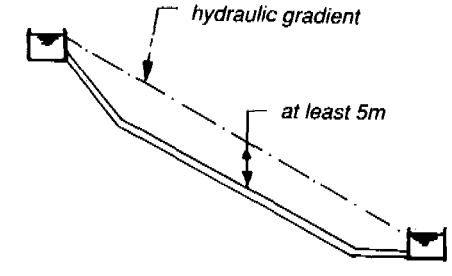
**Headloss through Orifice:**

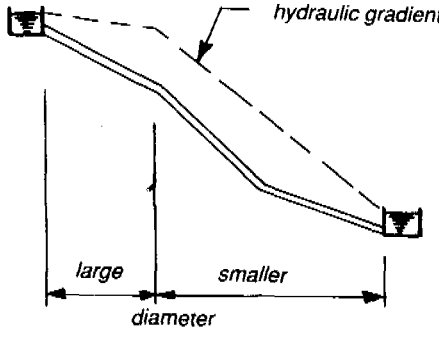
| Orifice diameter [mm] | Headloss [m] | |
|---|---|---|
| | Flow = 0.1 l/s | Flow = 0.2 l/s |
| 2.5 | 58.8 | 235.0 |
| 3.0 | 28.3 | 113.3 |
| 3.5 | 15.3 | 61.2 |
| 4.0 | 9.0 | 35.9 |
| 4.5 | 5.6 | 22.4 |
| 5.0 | 3.7 | 14.7 |
| 5.5 | 2.5 | 10.0 |
| 6.0 | 1.8 | 7.1 |

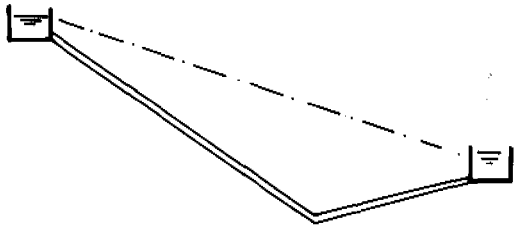
### 7.10.3 HINTS ON PIPELINE DESIGN

Below you find some drawings with correct/wrong pipeline designs:

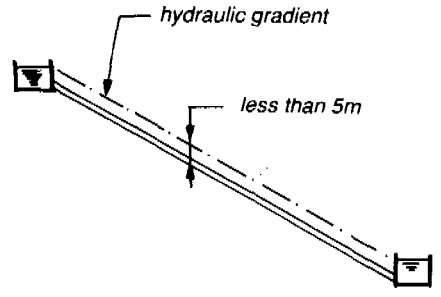
**correct:**

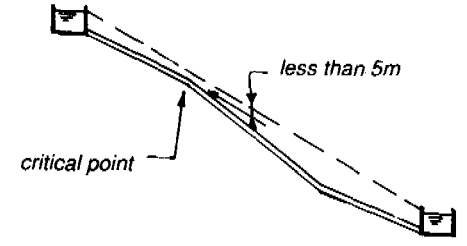




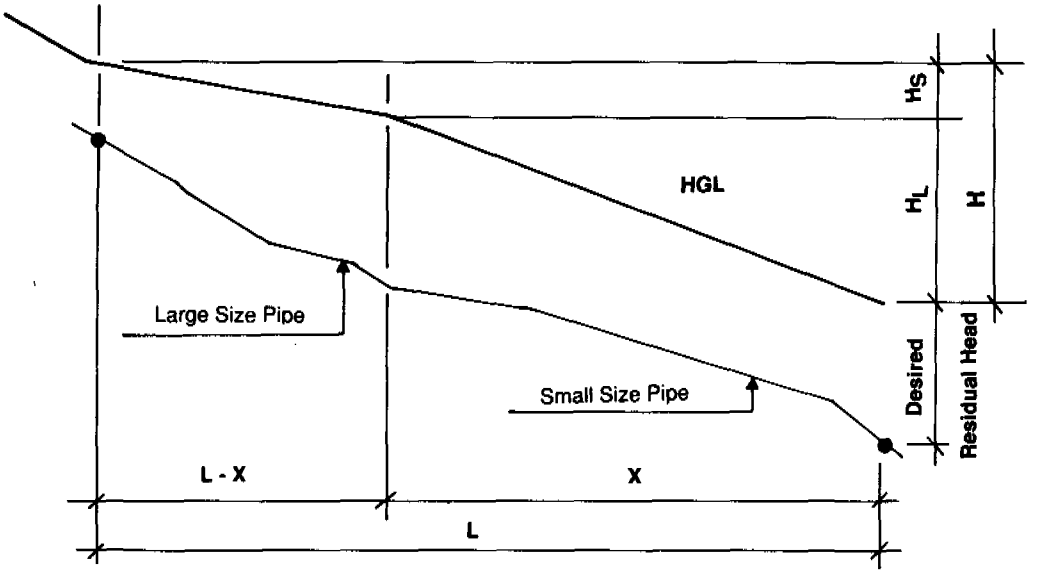
**wrong:**



### 7.10.4 PIPE COMBINATIONS

When designing a pipeline, it is sometimes impossible to select one pipe size which gives the desired frictional headloss. In such cases, a ***combination of pipe sizes*** is used.



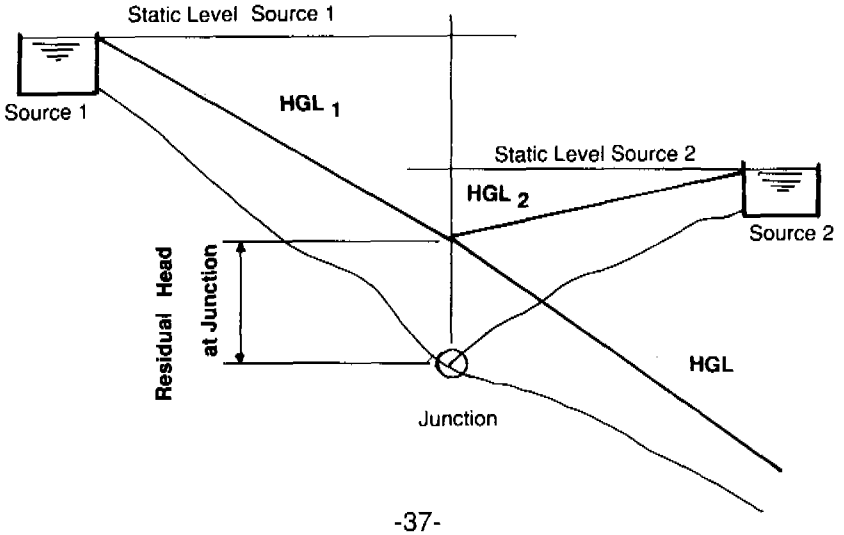

| | | | | | |
|---|---|---|---|---|---|
| L | = | total pipelength | FS | = | Friction factor of small pipe in % |
| X | = | small-size pipelength | FL | = | Friction factor of large pipe in % |
| L-X | = | large-size pipelength | HS | = | Headloss of small pipe |
| H | = | Total desired headloss | HL | = | Headloss of large pipe |

$$H = H_S + H_L \quad , \quad H_S = F_S \times \frac{X}{100} \qquad H_L = F_L \times \frac{L-X}{100}$$

$$H = F_S \times \frac{X}{100} + F_L \times \frac{L-X}{100} \quad \longrightarrow \quad X = \frac{100 \times H - (F_L \times L)}{F_S - F_L}$$

## 7.10.5 JOINING OF PIPELINES

In case two pipes have to be joined at a common point the residual heads of both pipes have to be ***equal***. Otherwise the pressure from one pipe will interfere with the flow from the second pipe.
It is easiest to design one pipeline to the junction. Then the sizes of the other pipe can be determined according to chapter *7.10.4 Pipe Combinations.* From the junction onwards you can continue with the total flow of both pipes.



## 7.11 DRAWINGS

As mentioned in the various preceding chapters some drawings are required to:

- Visualize the design of a GWSS.
- Enable an outsider to understand the design and to construct the GWSS accordingly.
- Help the designer in the designing process.
- Make checking of the design much easier.
- Show the design to any interested person.

Besides the various forms to be filled in, the following drawings should be compiled:

Situation Plan:
(completed)

- Roads, railway tracks, footpaths
- Rivers, streams, lakes, tanks
- Paddy fields, tealand, forests, cliffs, etc.
- Houses and buildings
- Water sources like springs, wells, etc.
- Pipe alignments (type, length and size can be shown in a separate pipe schedule)
- Structures like silt box, distribution chamber, storage tanks, BPTs, standposts, valve chambers,sectional valves, air releases, wash outs, etc.
- Volume and elevation of above structures

Use the symbols shown in ***Form L*** to draw the situation plan. An example of a header for a situation plan is given in ***Form M*** and an example of a pipe schedule is included in the same ***Form M.***
An example of a situation plan can be seen in chapter *8 Design Example.*

- Flow Diagram : has to be drawn on ***Form H***

- Hydraulic Profile : has to be drawn on ***Form J***

- Recommended Scales :
  - Horizontal: 1 : 2'000, 1 : 5'000, 1 : 10'000
  - Vertical: 1 : 200, 1 : 500, 1 : 1'000

All the above drawings should be kept together with all calculations and forms in one ***project file.***

# 8 DESIGN EXAMPLE

## 8.1 GENERAL REMARKS

On the following pages you will find a detailed example of a design of a GWSS. We assume that the preliminary and topographic surveys have been completed. This means that the location of the structures has been decided upon and we can now start with the calculation of the volumes of the structures and the pipeline design. Please refer to the enclosed situation plan of GWSS (see following page) to get an overview of the project.
The calculations in this example will follow the procedures given in the flow chart and the explanations given in chapter *7 Design Guidelines.*

## 8.2 FEASIBILITY OF PROJECT

***Form E*** has to be filled in. As the normal design period is 20 years, the growth factor is ***1.24***. The demand is 45 l/d per inhabitant and 6 l/d per student.

The project is ***feasible!***

**FORM E**

**FEASIBILITY OF PROJECT**

Name of Village: Atharagalla  Prepared by: A. Wilamuna
Division: Kundasale  Designation: A.T.A
District: kandy  Date: 19.06.1991

**Water Demand:**

| | Number (1) | Growth Factor (2) | Daily Consumption in l (3) | Demand (l/s) = (1)x(2)x(3) |
|---|---|---|---|---|
| Inhabitants | 576 | 1.24 | 45 | 32'141 |
| Students | 105 | 1.24 | 6 | 781 |
| | | Total Future Water Demand = | | 32'922 |

**Explanations:**
(1) : Present Population
(2) : 1.24 (for 20 years)
(3) : 45 l/c x d (30 l/c x d in exceptional cases)

**Available Water:**

| | Spring 1 | Spring 2 | Spring 3 | Spring 4 | Total Yield |
|---|---|---|---|---|---|
| Max. Yield (l/s)(1) | 0.49 | 0.40 | / | / | 0.89 |
| Min. Yield (l/s)(2) | 0.28 | 0.19 | / | / | 0.47 |

**Explanations:**
(1) : Highest yield measured (refer to spring measurements)
(2) : Lowest yield measured (refer to spring measurements)

Safety factor : 0.9
Total **safe yield**: 0.9 x Tot. Min. Yield = 09. x 0.47 = 0.423 l/s

Total **safe yield per day** : 0.9 x Tot. Min. Yield x 86'400
= 0.9 x 0.47 x 86'400 = 36'547 l/d

**Feasibility** : Check appropriate box :

[ ] **Project Feasible** : more water available than demanded

[ ] **Project Not Feasible** : less water available than demanded

# 8.3 FLOW RATE AT STANDPOSTS / TAPS

***Form F*** has to be filled in.
The taps have to be assigned to the storage tank from where they get their water and then the number of beneficiaries served by a particular tap can be added up.

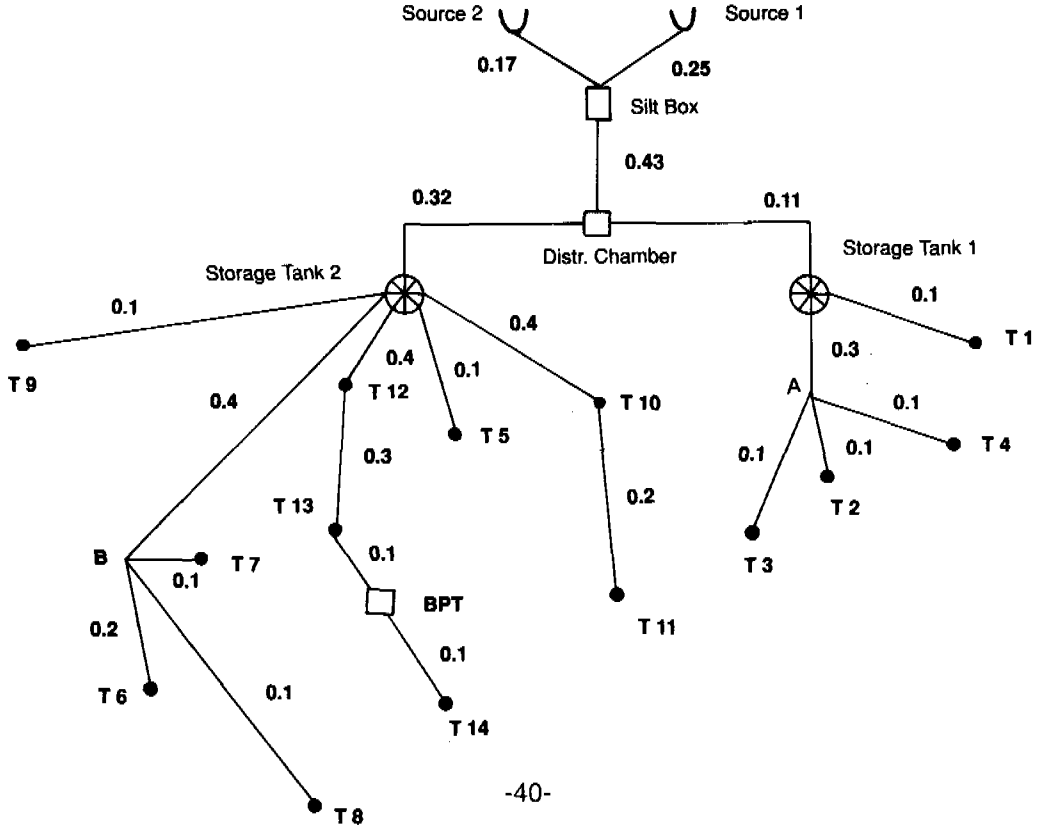
**Flow at Standposts / Taps:**

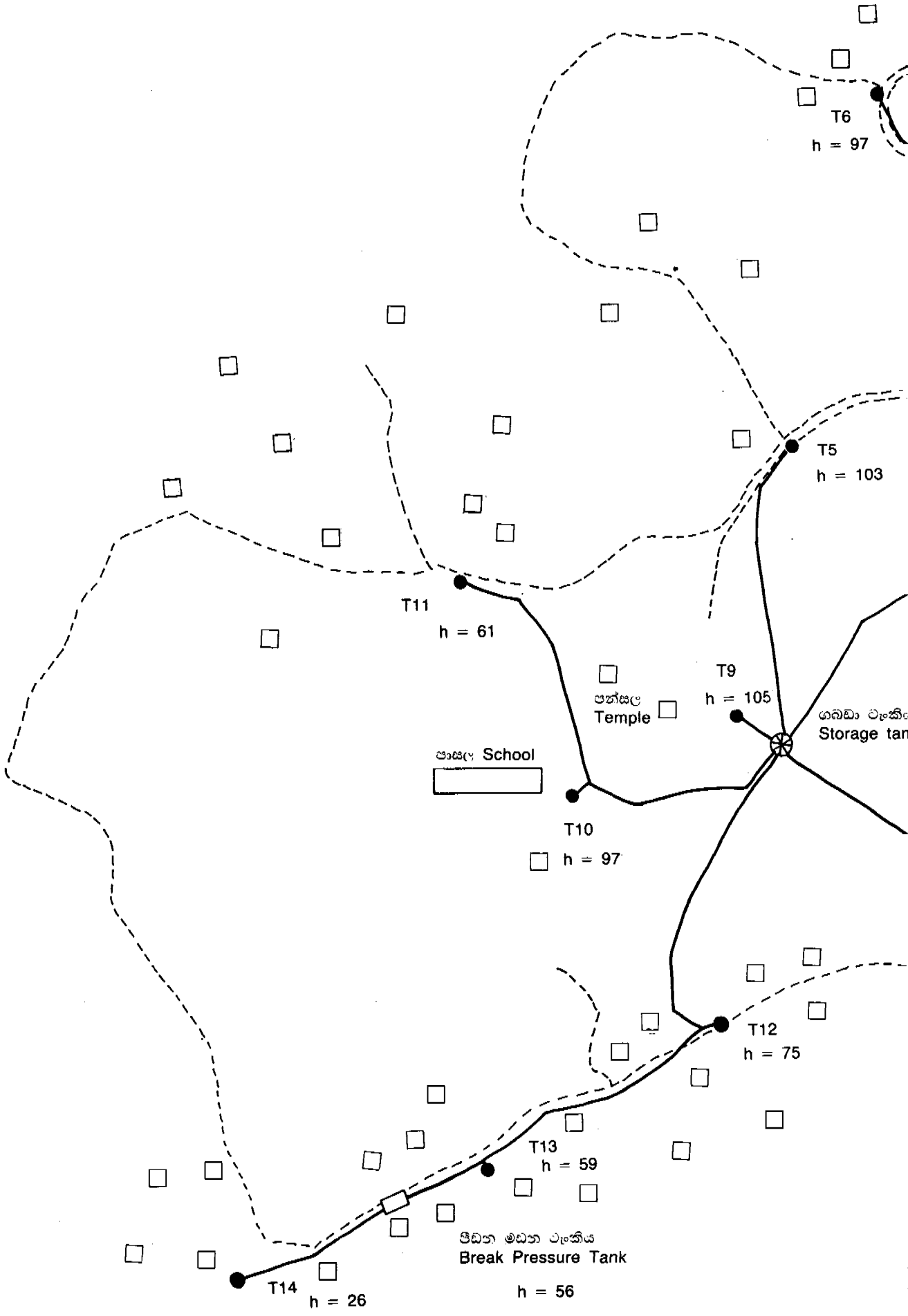
| Tap No. | Users People | (1) Pupils | Flow Rate l/s (3) | Storage Tank No. | Storage Tank People | (2) Pupils | Remarks (4) |
|---|---|---|---|---|---|---|---|
| 1 | 35 | | 0.1 | 1 | 35 | | |
| 2 | 44 | | 0.1 | 1 | 79 | | |
| 3 | 37 | | 0.1 | 1 | 116 | | |
| 4 | 67 | | 0.1 | 1 | 183 | | |
| 5 | 38 | | 0.1 | 2 | 38 | | |
| 6 | 99 | | 0.2 | 2 | 137 | | |
| 7 | 40 | | 0.1 | 2 | 177 | | |
| 8 | 35 | | 0.1 | 2 | 212 | | |
| 9 | 19 | | 0.1 | 2 | 231 | | temple |
| 10 | | 130 | 0.2 | 2 | | 130 | school |
| 11 | 198 | | 0.2 | 2 | 360 | | |
| 12 | 48 | | 0.1 | 2 | 408 | | |
| 13 | 93 | | 0.2 | 2 | 501 | | |
| 14 | 30 | | 0.1 | 2 | 531 | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| Total | 714 | 130 | | | | | |

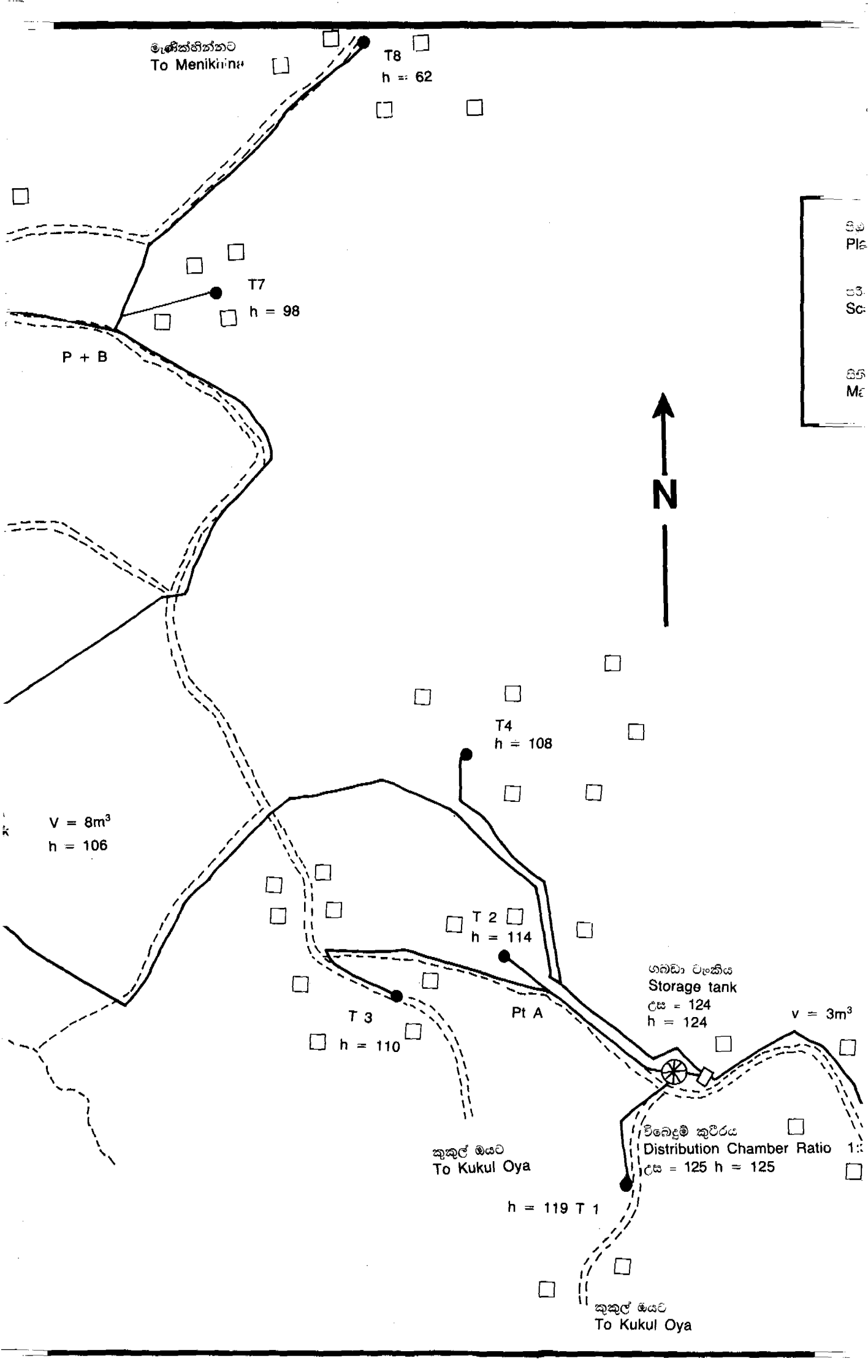
**Explanations:**

(1) : Future users (present population x growth factor)
(2) : Mark from which storage tank the tap gets water and add up the number of people or pupils per storage tank.
(3) : Flow rate according to the number of users (0.1 or 0.2 l/s)
(4) ; Give specific details e.g. tap for school, temple etc.

With above flow rates, the ***flowdiagram on Form H*** has to be drawn:

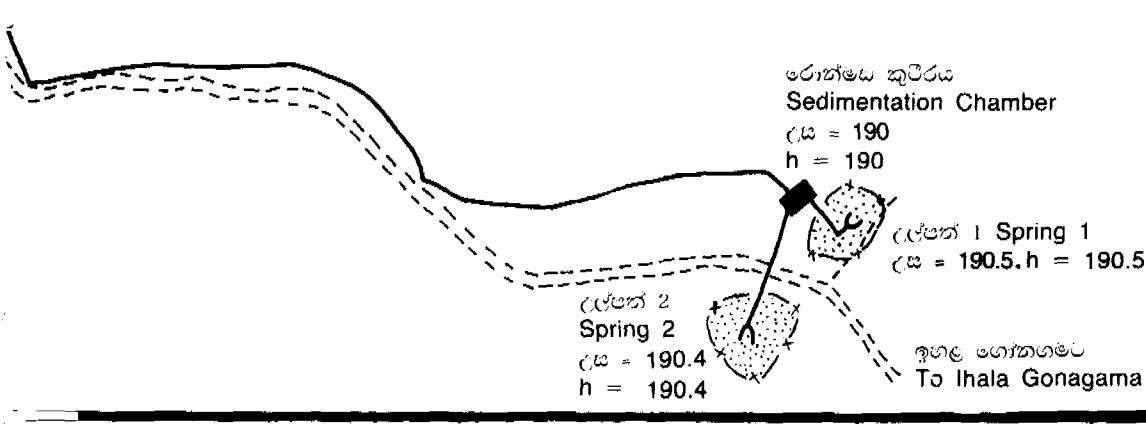



T6
h = 97
T5
h = 103
T11
h = 61
T9
h = 105
පන්සල
Temple
පාසල School
T10
h = 97
T12
h = 75
T13
h = 59
බිඳින මඩින ටැංකිය
Break Pressure Tank
h = 56
T14
h = 26


මැණික්හින්නට
To Menikhina
T8
h = 62
T7
h = 98
P + B
N
T4
h = 108
V = 8m³
h = 106
T 2
h = 114
T 3
h = 110
Pt A
ගබඩා ටැංකිය
Storage tank
උස = 124
h = 124
v = 3m³
විබෙදුම් කුටීරය
Distribution Chamber Ratio
උස = 125 h = 125
h = 119 T 1
කුකුල් ඔයට
To Kukul Oya
කුකුල් ඔයට
To Kukul Oya

# පිහිටීමේ සැලැස්ම SITUATION PLAN

| | | | | | | |
|---|---|---|---|---|---|---|
| ...ු අංකය<br>...n No. | **K - 1** | දිනය<br>Date: | ***19.06.91*** | | දිනය<br>Date: | විසින්<br>By: |
| ...ණය<br>...le: | **1:2000** | අඳින ලද්දේ<br>Drawn by: | ***Ashoka*** | සංශෝධන<br>Amendments | | |
| ...ට පත්‍රය<br>...n Sheet: | **Kandy** | මැනුම් කළේ<br>Surveved by: | ***Saman*** | | | |



## 8.4 SEDIMENTATION CHAMBER / DISTRIBUTION RATIO

***Form G*** has to be filled in.

**Volume of Sedimentation Chamber / Silt Box:**

Flow (total maximum yield, see Form E): Q = 0.89 l/s
Retention Time: T = 1'200 s
Capacity: C = Q x T = 0.89 x 1'200 = 1'068 l

Select the correct sedimentation chamber / silt box from the ***standard drawing*** in the manual *Construction and Standardisation of Gravity Water Supply Schemes in Rural Villages in Sri Lanka.*

Selected: ***Silt box with valve chamber (type A), volume = 1'000 l, standard drawing no. S - 03***

The available water has to be distributed between storage tank 1 and storage tank 2 in the ratio of ***one to three.***

**Water Demand per Storage Tank and Distribution Ratio:**

| Stor. Tank No. | No. of Beneficaries | | | | Demand per | | Distr. Factor (7) | Flow to Storage Tank (8) |
|---|---|---|---|---|---|---|---|---|
| | People (1) | l/d (2) | Pupils (3) | l/d (4) | Day (5) | Second (6) | | |
| 1 | 183 | 45 | / | 6 | 8'235 | 0.0953 | / | 0.1058 |
| 2 | 531 | 45 | 130 | 6 | 24'675 | 0.2856 | 3 | 0.3173 |
| 3 | / | / | / | 6 | / | / | / | / |

**Explanations:**

(1) : No. of people
(2) : 45 l/d (30 l/d)
(3) : No. of pupils
(4) : 6 l/d

(5) = (1) x (2) + (3) x (4)
(6) = (5) / 86'400
(7) : Distribution factor in comparison with the other storage tanks
(8) = Total safe yield distr. according to (7)

## 8.5 DISTRIBUTION CHAMBER

As there are two storage tanks, the available water has to be split between these two storage tanks. Therefore, a distribution chamber has to be constructed, preferably very close to storage tank 1.

Selected: ***Distribution chamber, ratio 1 : 3, standard drawing no. C - 04.***

## 8.6 STORAGE TANKS

***Form H*** has to be filled in.

Volume of storage tank 1:

$V \geq 2.7\ m^3$

Volume of storage tank 2:

$V \geq 8.0\ m^3$

**Volume of Storage Tank:**

**No. of Storage Tank:** 1

| Period | Inlet Q = ..... l/s Seconds | (1) lit. | Outlet D = ..... l/d % | (2) lit. | Difference + / - (3) | Water Level in litres (4) |
|---|---|---|---|---|---|---|
| 05.30 - 08.30 | 10'800 | 1'143 | 30 | 2'471 | - 1'328 | - 1'328 |
| 08.30 - 11.30 | 10'800 | 1'143 | 10 | 823 | + 320 | - 1'008 |
| 11.30 - 13.30 | 7'200 | 762 | 15 | 1'235 | - 473 | - 1'481 |
| 13.30 - 16.00 | 9'000 | 952 | 10 | 823 | + 129 | - 1'352 |
| 16.00 - 19.00 | 10'800 | 1'143 | 30 | 2'471 | - 1'328 | - 2'680 |
| 19.00 - 05.30 | 37'800 | 3'999 | 5 | 412 | + 3'587 | + 907 |
| Daily Inlet = 9'141 | | | 8235 = Daily Demand | | | Overflow |

Min. Storage Capacity = 2'680 l = 2.70 $m^3$ ; Tank chosen 3 $m^3$

Tank is filled within 10 hours (must be less than 10 hours)

**Explanations:**
(1) = Q x seconds
(2) = D x %
(3) = (1) - (2)
(4) = sum of (3)

Inlet Q: Flow of Inlet
Water Level: Indicate whether + or -
Min. Storage Capacity = smallest (4), (negative)
Tank chosen : Refer to Standard Drawings

**Flow Diagram (hand sketch):**

**Volume of Storage Tank:**

**No. of Storage Tank:** 2

| Period | Inlet Q = 0.3173 l/s Seconds | (1) lit. | Outlet D = 24.675 l/d % | (2) lit. | Difference + / - (3) | Water Level in litres (4) |
|---|---|---|---|---|---|---|
| 05.30 - 08.30 | 10'800 | 3'427 | 30 | 7'403 | - 3'976 | - 3'976 |
| 08.30 - 11.30 | 10'800 | 3'427 | 10 | 2'468 | + 959 | - 3'017 |
| 11.30 - 13.30 | 7'200 | 2'286 | 15 | 3'701 | - 1'416 | - 4'433 |
| 13.30 - 16.00 | 9'000 | 2'856 | 10 | 2'468 | + 388 | - 4'045 |
| 16.00 - 19.00 | 10'800 | 3'427 | 30 | 7'403 | - 3'976 | - 8'021 |
| 19.00 - 05.30 | 37'800 | 11'994 | 5 | 1'234 | 10'760 | + 2'739 |
| Daily Inlet = 27'475 | | | 24'675 = Daily Demand | | | Overflow |

Min. Storage Capacity = 8'021 l = 8.0 $m^3$ ; Tank chosen 8 $m^3$

Tank is filled within 7 hours (must be less than 10 hours)

**Explanations:**
(1) = Q x seconds
(2) = D x %
(3) = (1) - (2)
(4) = sum of (3)

Inlet Q: Flow of Inlet
Water Level: Indicate whether + or -
Min. Storage Capacity = smallest (4), (negative)
Tank chosen : Refer to Standard Drawings

**Flow Diagram (hand sketch):**

Selected: ***Storage tank 1 : V = 3 $m^3$, standard drawing no. T - 05/06***
***Storage tank 2 : V = 8 $m^3$, standard drawing no. T - O5/06***

## 8.7 BREAK PRESSURE TANK

When we compare the elevation of the structures with each other we see that the biggest difference is between storage tank 2 (h = 106 m) and tap 14 (h = 26 m). This difference in elevation is 80 m which is more than 60 m (max. static pressure head in distribution lines). Therefore a BPT has to be constructed between tap 13 and tap 14. As there are taps joined to the pipeline, it is necessary to install a BPT with a ***ball/float valve***. All other differences in elevation lie within the possible limit of 100 m static head on main lines and 60 m static head on distribution lines.

Selected: ***BPT type B with ball valve, standard drawing no. C - 03.***

## 8.8 HYDRAULIC CALCULATION OF PIPELINES

The following calculations can be done with the help of ***Form H.***

### 8.8.1 SOURCE LINES

**Source 1 - Sedimentation Chamber:**

**Given:** Max. yield = 0.49 l/s
Min. yield = 0.25 l/s
L = 11 m (Distance from spring to silt box)
h = 0.50 m (Difference in height between spring outlet and silt box inlet)
Q req. = 0.25 l/s (safe yield)

***Required: ø of source line and ø of overflow pipe***

***Solution:***

$$\text{Headloss} = \frac{0.50}{11.00} = 0.0455 = 4.6\ \%$$

Friction loss table: J = 4.6 %

→ ø 32 mm

Q = 0.49 l/s

Min. ø for source lines is 50 mm (*chapter 7.10.1. Types of Pipelines)*

***Selected: Source line : ø 50 mm, two pipes to be installed***
***Overflow : ø 50 mm***

**Source 2 - Sedimentation Chamber:**

**Given:** Max. yield = 0.40 l/s
Min. yield = 0.17 l/s
L = 19.00 m
h = 0.40 m
Q req. = 0.17 l/s

**Required:** ø of source line and overflow pipe
**Solution:**

$$\text{Headloss} = \frac{0.40}{19.00} = 0.021 = 2.1\ \%$$

Friction loss table: J = 2.1 %

→ ø ≥ 32 mm

Q = 0.4 l/s

**Selected:** ***Source line: ø 50 mm, two pipes to be installed***
***Overflow: ø 50 mm***

## 8.8.2 MAIN LINES

### Sedimentation Chamber - Distribution Chamber

**HYDRAULIC CALCULATION**

Name of Village : Atharagalla Division : Kundasale District : Kandy

Prepared by : A. Wilamuna Designation : A.T.A Date : 19.08.1991

| Station/ Tap | Elevation (m) | Static Head (m) | Distance (m) | Flow (l/s) | Desired Residual Head (m) | Desired Headloss (m)/Factor | Pipe ø (mm) | Actual Headloss Factor (%) | Friction Loss (m) | Friction Chainage (m) | Dynamic Head (m) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Silt box | 190.00 | 0.00 | 408 | 0.423 | 15.00 | 50.00/12.3% | no pipe available with a factor of 12.3% | | | | | |
| Distr. Ch. | 125.00 | 65.00 | | | | | ⇒ | | Combination of pipes / | | | |
| | | | 408 = Total length of both pipes | | | | | | | | | |
| Silt box | 190.00 | 0.00 | 153 / 255 | 0.423 | 15.00 | 50.00/12.3% | 20 / 25 | 20% / 7.67. | | | | |
| Distr. Ch. | 125.00 | 65.00 | | | | | | | 50.00 | 50.00 | 15.00 | Comb. of pipes |

**Selected**: pipe ø = 20 mm, length = 153 m
pipe ø = 25 mm, length = 255 m

### Distribution Chamber - Storage Tank 1

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distr. ch. | 125.00 | 0.00 | 10.00 | 0.11 | 1.00 | 0.00 | 50 | ~0 | | | | |
| Storage 1 | 124.00 | 1.00 | | | | | | | ~0' | ~0 | 1.00 | 0.4 |

**Selected:** pipe ø = 50 mm

### Distribution Chamber - Storage Tank 2

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distr. ch. | 125.00 | 0.00 | 497 | 0.32 | 15.00 | 400/0.8% | no Pipe available with a factor of | | 0.8% | | | |
| Storage 2 | 106.00 | 19.00 | | | | | ⇒ | | Combination of pipes / | | | |
| | | | 497 = Total length of both pipes | | | | | | | | | |
| Dist. ch. | 125.00 | 0.00 | 144 / 353 | 0.32 | 15.00 | 4.00/0.8% | 32 / 40 | 15% / 0.52% | | | | |
| Storage 2 | 106.00 | 19.00 | | | | | | | 4.00 | 4.00 | 15.00 | 0.4 |

**Selected:** pipe ø = 32 mm, length = 144 m
pipe ø = 40 mm, length = 353 m

## 8.8.3 DISTRIBUTION LINES

### Storage Tank 1 - Tap 1

| Station/ Tap | Elevation (m) | Static Head (m) | Distance (m) | Flow (l/s) | Desired Residual Head (m) | Desired Headloss (m)/Factor | Pipe ø (mm) | Actual Headloss Factor (%) | Friction Loss (m) | Friction Chainage (m) | Dynamic Head (m) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage 1 | 124.00 | 0.00 | 51 | 0.10 | 4.75 | 0.25/0.5% | 10 | 1.5 % | / | / | / | |
| Tap 1 | 119.00 | 5.00 | | | | | | | 0.77 | 0.77 | 4.24 | ok |

Selected: ***pipe ø 20 mm***

## Storage Tank 1 - Pt. A - Tap 2 - Tap 3 - Tap 4

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage | 124.00 | 0.00 | 60 | 0.30 | 8.50 | 0.50/6.85% | 40 | 0.46% | / | / | / | |
| Pt. A | 115.00 | 9.00 | 28 | 0.10 | 9.00 | 1.00/3.6% | 20 | 1.5% | 0.28 | 0.28 | 8.72 | ok. |
| Tap 2 | 114.00 | 10.00 | | | | | | | 0.42 | 0.70 | 9.30 | ok. |
| Pt. A | 115.00 | 9.00 | 105 | 0.10 | 10.00 | 4.00/3.8% | 20 | 1.5% | 0.28 | 0.28 | 8.72 | |
| Tap 3 | 110.00 | 14.00 | | | | | | | 1.58 | 1.86 | 12.14 | accept. |
| Pt. A | 115.00 | 9.00 | 126 | 0.10 | 10.00 | 6.00/4.0% | 20 | 1.5% | 0.28 | 0.28 | 8.72 | |
| Tap 4 | 108.00 | 16.00 | | | | | | | 1.89 | 2.17 | 13.85 | accept. |

**Selected**: Storage Tank 1 - Pt. A : **pipe ø 40 mm**
Pt. A - Tap 2 : **pipe ø 20 mm**
Pt. A - Tap 3 : **pipe ø 20 mm**
Pt. A - Tap 4 : **pipe ø 20 mm**

## Storage Tank 2 - Tap 5

| Station/ Tap | Elevation (m) | Static Head (m) | Distance (m) | Flow (l/s) | Desired Residual Head (m) | Desired Headloss (m)/Factor | Pipe ø (mm) | Actual Headloss Factor (%) | Friction Loss (m) | Friction Chainage (m) | Dynamic Head (m) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage2 | 106.00 | 0.00 | 60 | 0.10 | 3.00 | 0.00/0.6% | 25 | 0.6% | / | / | / | |
| Tap 5 | 103.00 | 3.00 | | | | | | | 0.36 | 0.36 | 2.64 | accept |

**Selected**: pipe ø 25 mm

## Storage Tank 2 - Pt. B - Tap 6 - Tap 7 - Tap 8

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage2 | 106.00 | 0.00 | 174 | 0.40 | 5.00 | 2.00/1.1% | 40 | 0.76% | 1.32 | 1.32 | 5.68 | ok. |
| Pt. B | 99.00 | 7.00 | 47 | 0.20 | 5.00 | 2.68/5.7% | 20 | 5.20% | 2.44 | 3.76 | 5.24 | ok. |
| Tap 6 | 97.00 | 9.00 | | | | | | | | | | |
| Pt. B | 99.00 | 7.00 | 46 | 0.10 | 6.00 | 0.68/1.5% | 20 | 1.5% | 1.32 | 1.32 | 5.68 | |
| Tap 7 | 98.00 | 8.00 | | | | | | | 0.69 | 2.01 | 5.99 | ok. |
| Pt. B | 99.00 | 7.00 | 330 | 0.10 | 10 | 33/10% | 20 | 1.50% | 1.32 | 1.32 | 5.68 | |
| Tap 8 | 62.00 | 44.00 | an orifice has to be installed before 8 | | | | | | 4.95 | 6.27 | 37.75 | too big! |
| | | | | | | | orifice ø 3.0 mm | | 28.3 | 34.57 | 9.43 | ok |

**Selected**: Storage Tank 2 - Pt. B : **pipe ø 40 mm**
Pt. B - Tap 6 : **pipe ø 20 mm**
Pt. B - Tap 7 : **pipe ø 20 mm**
Pt. B - Tap 8 : **pipe ø 20 mm, with orifice!**
**orifice ø 3.00 mm**

## Storage Tank 2 - Tap 9

| Station/ Tap | Elevation (m) | Static Head (m) | Distance (m) | Flow (l/s) | Desired Residual Head (m) | Desired Headloss (m)/Factor | Pipe ø (mm) | Actual Headloss Factor (%) | Friction Loss (m) | Friction Chainage (m) | Dynamic Head (m) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage2 | 106.00 | 0.00 | | | | | | | | | | |
| Tap 9 | 105.00 | 1.00 | 20 | 0.10 | 1 | ~0 | 25 | 0.6% | 0.12 | 0.12 | 0.88 | accept |

**Selected**: pipe ø 25 mm

## Storage Tank 2 - Tap 10 - Tap 11

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage2 | 106.00 | 0.00 | | | | | | | | | | |
| Tap 10 | 97.00 | 9.00 | 107 | 0.40 | 5.00 | 4.00/3.7% | 32 | 2.3% | 2.46 | 2.46 | 6.54 | ok |
| Tap 11 | 61.00 | 45.00 | 131 | 0.20 | 10 | 32/25% | 20 | 5.3% | 6.94 | 9.40 | 35.60 | too big |
| | | | an orifice has to be installed before tap 11 | | | | | | 22.40 | 31.80 | 13.20 | accept |
| | | | | | | | orifice ø = 4.5 mm | | | | | |

**Selected**: Storage Tank 2 - Tap 10 : **pipe ø 32 mm**
Tap 10 - Tap 11 : **pipe ø 20 mm, with orifice!**
**orifice ø 4.5 mm**

## Storage Tank 2 - Tap 12 - BPT - Tap 13 - Tap 14

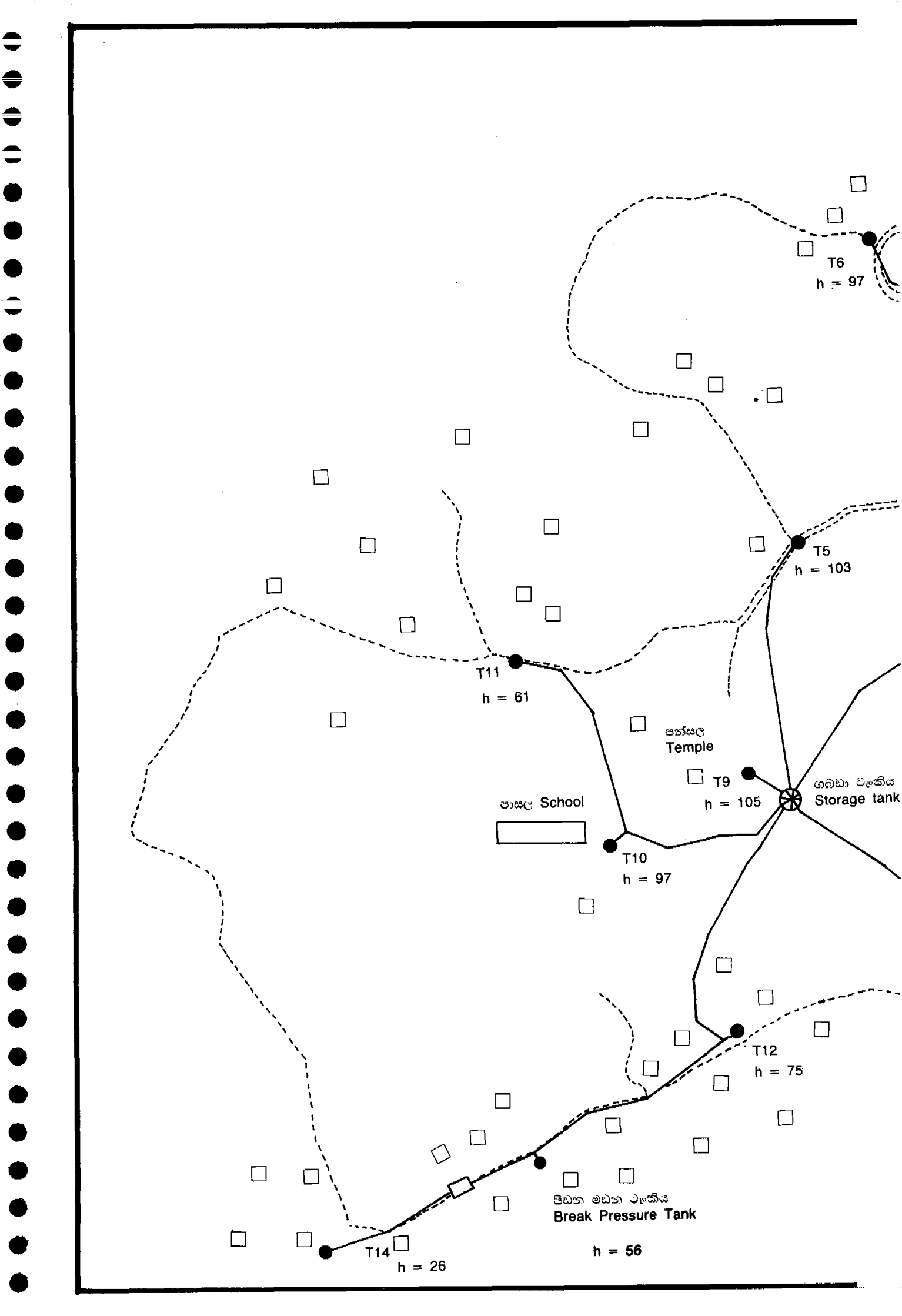
| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Storage2 | 106.00 | 0.00 | | | | | | | | | | |
| Tap 12 | 75.00 | 31.00 | 127 | 0.40 | 10 | 20/16% | 20 | 1850% | 23.50 | 23.50 | 7.50 | ok |
| Tap 13 | 59.00 | 47.00 | 86 | 0.30 | 10 | 10/12% | 20 | 11% | 9.46 | 32.96 | 14.04 | accept |
| BPT | 56.00 | 50.00 | 10 | 0.10 | 15 | 2/20% | 20 | 1.5% | 0.15 | 33.11 | 16.89 | ok |
| Tap 14 | 26.00 | 50.00 | 94 | 0.10 | 10 | 29/30% | 20 | 1.5% | 1.41 | 1.41 | 28.59 | too big! |
| | | | an orifice has to be installed before tap 14 | | | | | | 15.30 | 16.21 | 13.29 | ok |
| | | | | | | | orifice ø = 3.5 mm | | | | | |

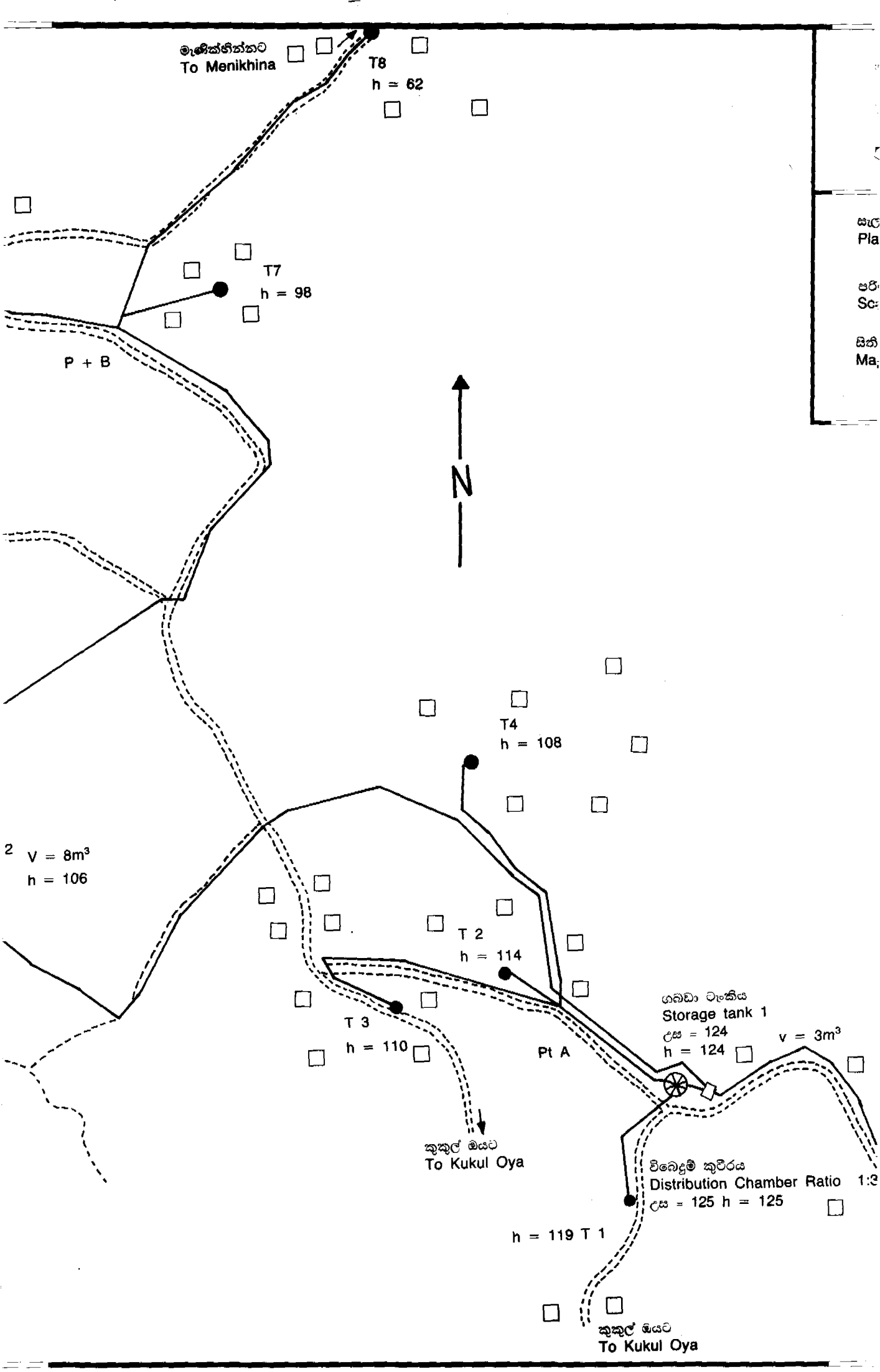
Selected: Storage Tank 2 Tap 12 : **pipe ø 20 mm**
Tap 12 Tap 13 : **pipe ø 20 mm**
Tap 13 BPT : **pipe ø 20 mm**
BPT Tap 14 : **pipe ø 20 mm, with orifice!**
**orifice ø 3.5 mm**

# 8.9 DRAWINGS

Below you will find the two drawings which have to be prepared for each GWSS:

- Situation Plan
- Hydraulic Profile


T6
h = 97
T5
h = 103
T11
h = 61
පන්සල
Temple
T9
h = 105
ගබඩා ටැංකිය
Storage tank
පාසල School
T10
h = 97
T12
h = 75
බිඳින අඩන ටැංකිය
Break Pressure Tank
h = 56
T14
h = 26


මැණික්හින්නට
To Menikhina
T8
h = 62
T7
h = 98
P + B
N
T4
h = 108
V = 8m³
h = 106
T 2
h = 114
T 3
h = 110
Pt A
ගබඩා ටැංකිය
Storage tank 1
උස = 124
h = 124
v = 3m³
කුකුල් ඔයට
To Kukul Oya
විබෙදුම් කුටීරය
Distribution Chamber Ratio
උස = 125 h = 125
h = 119 T 1
කුකුල් ඔයට
To Kukul Oya

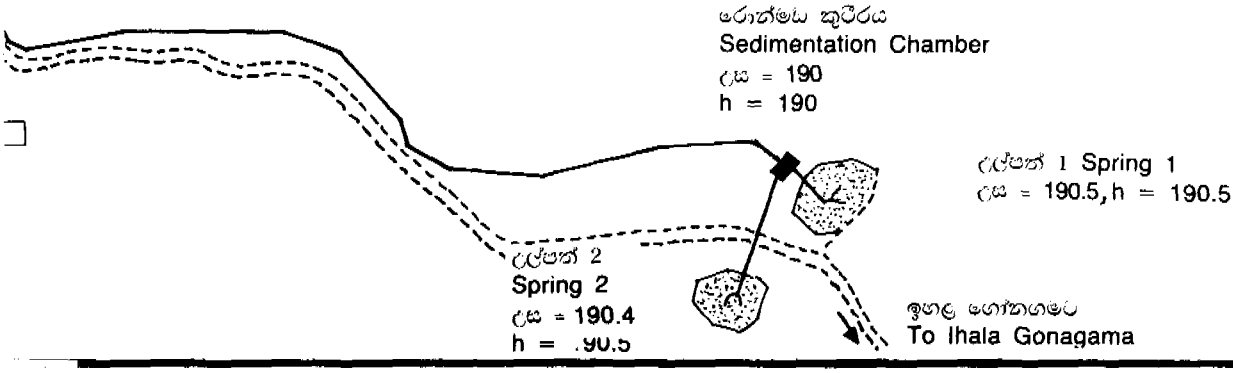
# සිහිටීමේ සැලැස්ම SITUATION PLAN

**60 × 45 cm**

| | | | | | | |
|---|---|---|---|---|---|---|
| සුම් අංකය: i No. | **K-1** | දිනය: Date: | ***19.06.91*** | | දිනය Date: | විසින් By: |
| ඛාණය: le: | **1:2000** | අඳින ලැබුවේ: Drawn by: | ***Ashoka*** | සංශෝධන Amendments | | |
| ඝම් පත්‍රය: ı Sheet: | **Kandy** | මැනුම් කළේ Surveved by: | ***Saman*** | | | |

## ජී. වී. සී. නල අයි. එස්. ඕ. වර්ගය 1000 P.V.C. PIPES I.S.O. TYPE 1000

| සිට FROM | | දක්වා TO | දුර DISTANCE | විෂ්කම්භය DIAMETER | සිට FROM | | දක්වා TO | දුර DISTANCE | විෂ්කම්භය DIAMETER |
|---|---|---|---|---|---|---|---|---|---|
| S.B. | — | D.C. | 153/255 | 20/25 | PTB | — | T 7 | 46 | 20 |
| D.C. | — | ST 1 | 10 | | PTB | — | T 8 | 330 | 20 |
| D.C. | — | ST 2 | 144/353 | 32/40 | ST 2 | — | T 5 | 60 | 25 |
| ST 1 | — | T 1 | 51 | 20 | ST 2 | — | T 9 | 20 | 25 |
| ST 1 | — | PTA | 60 | 40 | ST 2 | — | T 10 | 107 | 32 |
| PT A | — | T 2 | 28 | 20 | T 10 | — | T 11 | 131 | 20 |
| PT A | — | T 3 | 105 | 20 | ST 2 | — | T 12 | 127 | 20 |
| PT A | — | T 4 | 126 | 20 | T 12 | — | T 13 | 86 | 20 |
| ST 2 | — | PT B | 174 | 40 | T 13 | — | BPT | 10 | 20 |
| PT B | — | T 6 | 47 | 20 | BPT | — | T 14 | 94 | 20 |
| PT B | — | T 7 | 46 | 20 | ST 2 | — | T 10 | 107 | 32 |



# HYDRAULIC PROFILE

Name of Village: Atharagalla
Division: Kundasale
District: Kandy

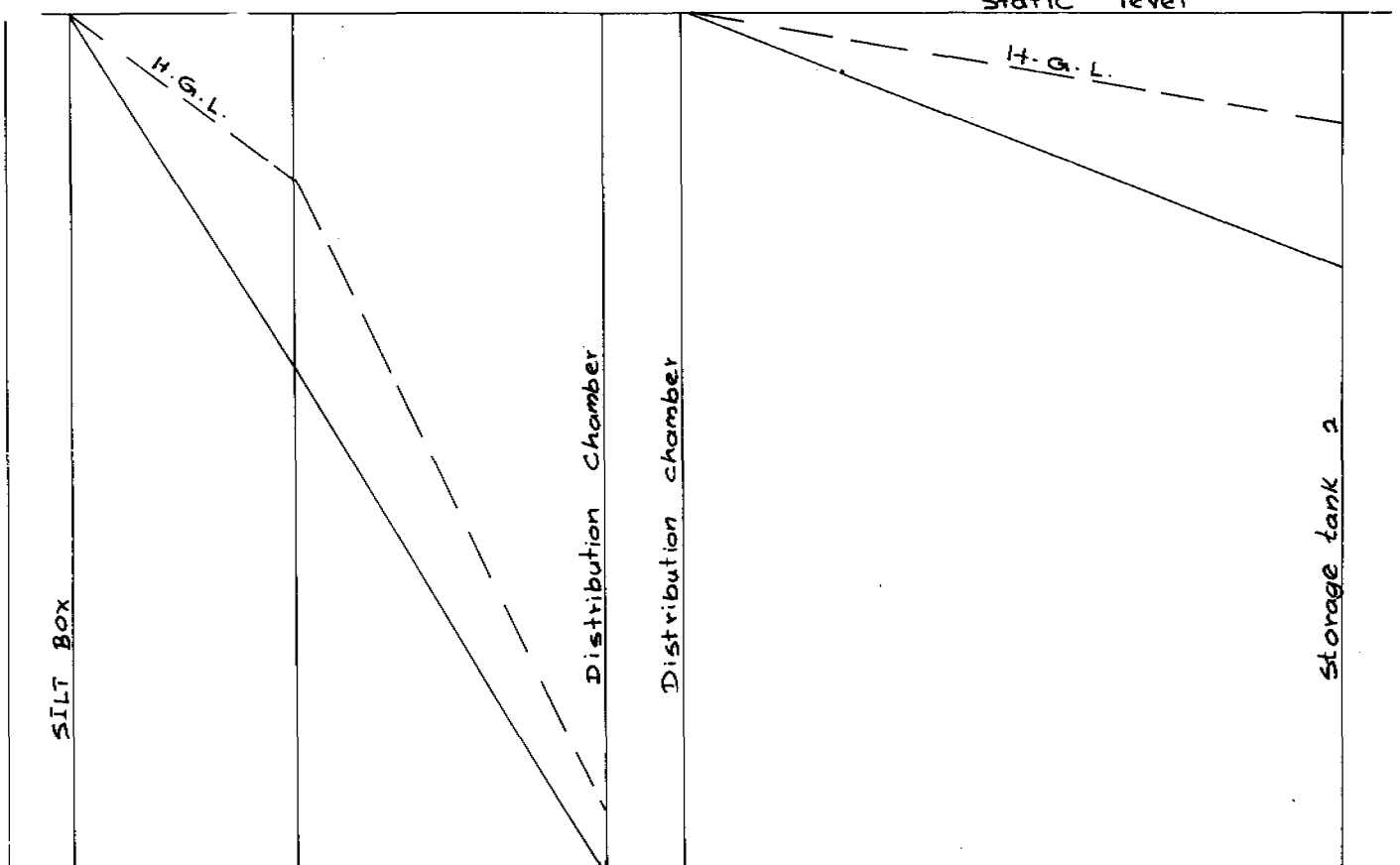
Prepared by: Ashoka
Designation: A.T.A
Date:

**Scales:**
Horizontal: 1 : 500
Vertical: 1 : 5000

**Remarks:**

Silt box - Dist' Chamber

Dist' chamber - storage tank 2




| | | | | | | |
|---|---|---|---|---|---|---|
| Point No. | | S.B | | D.C. | D.C. | ST2 |
| Distance | (m) | 173 | 225 | | 499 | |
| Elevation | (m) | 190 | 27 | 125 | 125 | 106 |
| Static Head | (m) | 0 | | 65 | 0 | 19 |
| Design Flow | (l/s) | 0.423 | 0.423 | | 0.32 | |
| **Pipe Size (ISO 1'000)** | | 25 | 20 | | 32 | |
| Friction Factor | (%) | 7.5 | 20 | | 1.5 | |
| Friction Loss | (m) | 13 | 47 | | 7.49 | |
| Friction Chainage | (m) | 13 | | 60 | | 7.49 |
| Dynamic Head | (m) | 14 | | 5 | | 11.51 |

FORM J

# HYDRAULIC PROFILE

Name of Village: Atharagalla
Division: Kundasale
District: Kandy

Prepared by: Ashoka
Designation: A.T.A
Date:

**Scales:**
Horizontal: 1 : 500
Vertical: 1 : 5000

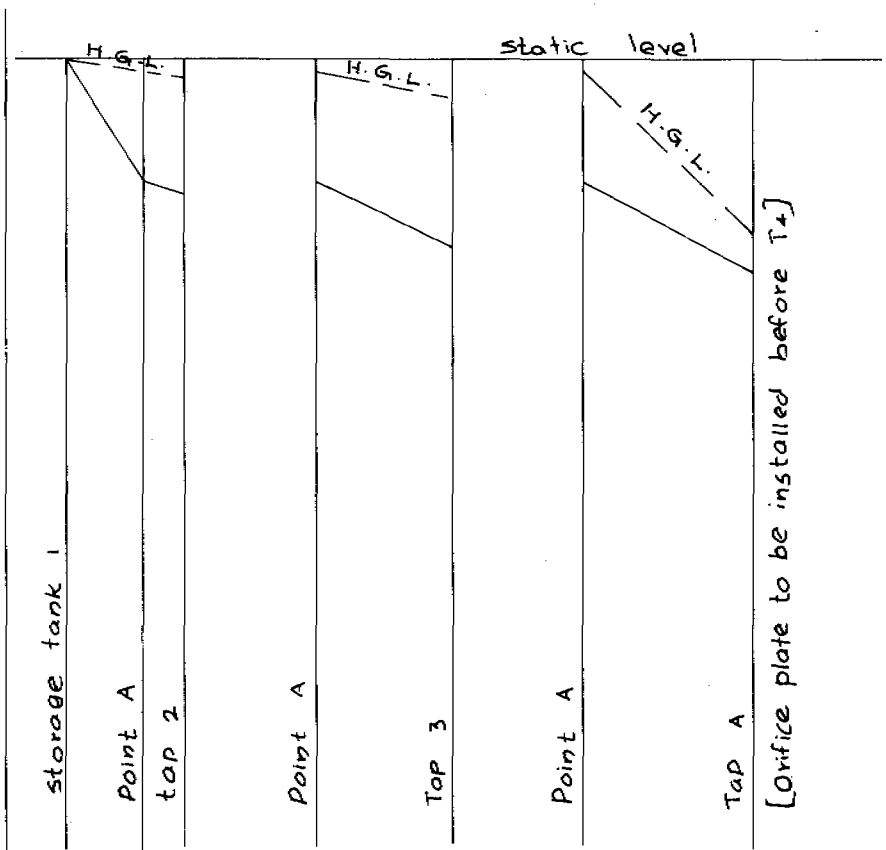
**Remarks:**

$ST_1$ - Pt' A

Pt' A - $T_2$

Pt' A - $T_3$

Pt' A - $T_4$




| Point No. | | ST2 | Pt A | T2 | Pt A | T3 | Pt A | T4 |
|---|---|---|---|---|---|---|---|---|
| Distance | (m) | | 60 | 28 | | 105 | | 126 |
| Elevation | (m) | 124 | 115 | 114 | 115 | 110 | 115 | 108 |
| Static Head | (m) | 0 | 9 | 10 | 9 | 14 | 9 | 16 |
| Design Flow | (1/s) | | 0·3 | 0·1 | | 0·1 | | 0·1 |
| **Pipe Size (ISO 1'000)** | | | 32 | 20 | | 20 | | 20 |
| Friction Factor | (%) | | 1·3 | 1·5 | | 1·5 | | 1·5 |
| Friction Loss | (m) | | 0·78 | 0·42 | | 1·58 | | 1·89 |
| Friction Chainage | (m) | | 0·78 | 1·2 | | 2·78 | 0·78 | 2·67 |
| Dynamic Head | (m) | | 8·22 | 8·8 | | 11·22 | 8·22 | 13·33 |

FORM J

# HYDRAULIC PROFILE

Name of Village: Atharagalla
Division: Kundasale
District: Kandy

Prepared by: AShoka
Designation: A.T.A.
Date:

**Scales:**
Horizontal: 1 : 500
Vertical: 1 : 5000

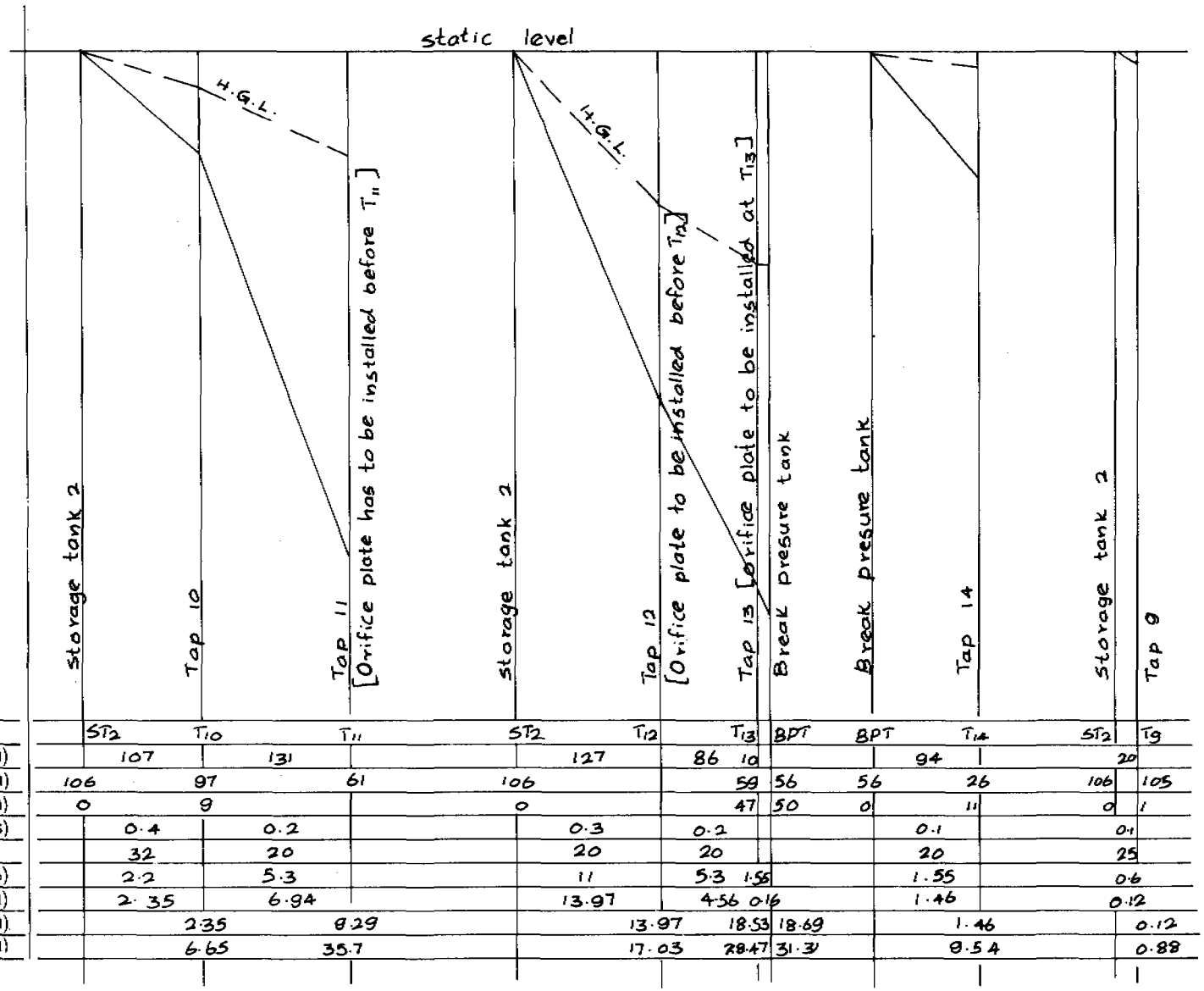
**Remarks:**

$ST_2$ - $T_{10}$, $T_{11}$

$ST_2$ - $T_{12}$, $T_{13}$ PBT

PBT - $T_{14}$

$ST_2$ - $T_9$




| Point No. | | $ST_2$ | $T_{10}$ | $T_{11}$ | $ST_2$ | $T_{12}$ | $T_{13}$ | BPT | BPT | $T_{14}$ | $ST_2$ | $T_9$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distance | (m) | 107 | 131 | | 127 | | 86 10 | | | 94 | 20 | |
| Elevation | (m) | 106 | 97 | 61 | 106 | | 59 | 56 | 56 | 26 | 106 | 105 |
| Static Head | (m) | 0 | 9 | | 0 | | 47 | 50 | 0 | 11 | 0 | 1 |
| Design Flow | (l/s) | 0.4 | 0.2 | | 0.3 | 0.2 | | | | 0.1 | 0.1 | |
| **Pipe Size (ISO 1'000)** | | 32 | 20 | | 20 | 20 | | | | 20 | 25 | |
| Friction Factor | (%) | 2.2 | 5.3 | | 11 | 5.3 | 1.55 | | | 1.55 | 0.6 | |
| Friction Loss | (m) | 2.35 | 6.94 | | 13.97 | 4.56 | 0.16 | | | 1.46 | 0.12 | |
| Friction Chainage | (m) | 2.35 | 9.29 | | 13.97 | 18.53 | 18.69 | | | 1.46 | 0.12 | |
| Dynamic Head | (m) | 6.65 | 35.7 | | 17.03 | 28.47 | 31.31 | | | 9.54 | 0.88 | |

FORM J

# HYDRAULIC PROFILE

Name of Village: Atharagalla
Division: Kundasale
District: Kandy

Prepared by: Ashoka
Designation: A.T.A
Date:

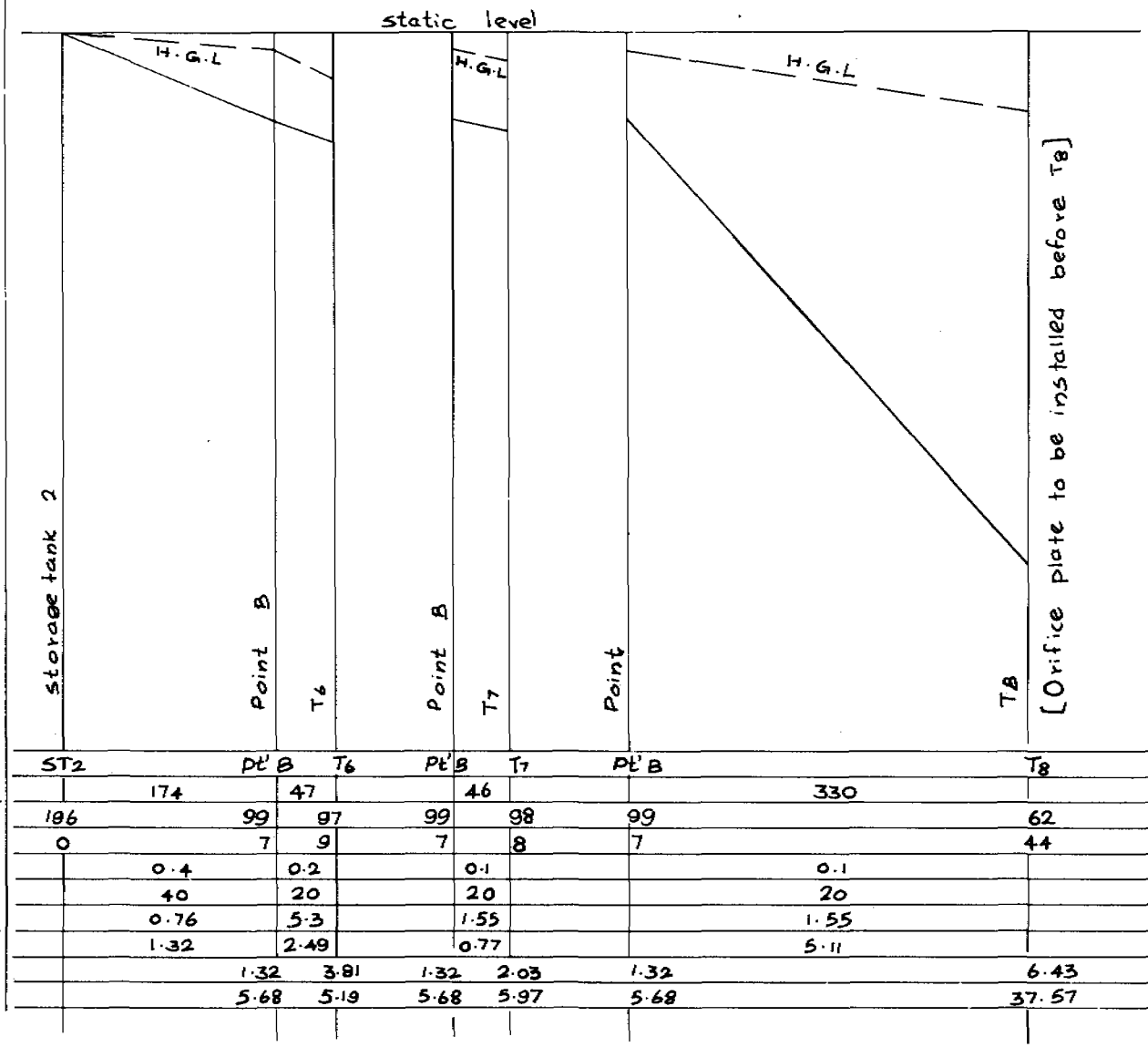
**Scales**:
Horizontal: 1 : 5000
Vertical: 1 : 50000

**Remarks:**

$ST_2$ - Pt. B . $T_6$

Pt. B - $T_9$

Pt. B - $T_8$




| Point No. | | ST2 | Pt' B | T6 | Pt' B | T7 | Pt' B | T8 |
|---|---|---|---|---|---|---|---|---|
| Distance | (m) | 174 | 47 | | 46 | | 330 | |
| Elevation | (m) | 106 | 99 | 97 | 99 | 98 | 99 | 62 |
| Static Head | (m) | 0 | 7 | 9 | 7 | 8 | 7 | 44 |
| Design Flow | (l/s) | 0.4 | 0.2 | | 0.1 | | 0.1 | |
| **Pipe Size (ISO 1'000)** | | 40 | 20 | | 20 | | 20 | |
| Friction Factor | (%) | 0.76 | 5.3 | | 1.55 | | 1.55 | |
| Friction Loss | (m) | 1.32 | 2.49 | | 0.77 | | 5.11 | |
| Friction Chainage | (m) | | 1.32 | 3.81 | 1.32 | 2.03 | 1.32 | 6.43 |
| Dynamic Head | (m) | | 5.68 | 5.19 | 5.68 | 5.97 | 5.68 | 37.57 |

FORM J

# PART II

# CONSTRUCTION AND STANDARDISATION

# 1 INTRODUCTION

This second part of the manual *Design, Construction and Standardisation of Gravity Water Supply Systems in Rural Villages in Sri Lanka* is closely related to Part I which covers most aspects concerned with the design of a GWSS, whereas this part gives some practical hints and information about the construction of a GWSS. Additionally, ***forms and standard drawings*** of all relevant structures are included in the Appendix to this manual.
It is beyond the scope of this manual to give a detailed introduction into the topics of building construction, concrete and masonry technology, site supervision, etc., nor is it intended to be a handbook for masons. As mentioned above, we concentrate on practical hints for the construction of a GWSS. Therefore, a site supervisor of a gravity water supply system should have some experience in construction works. All basic knowledge of how to prepare concrete, how to build masonry walls, etc. should be available with the site supervisor.

# 2 SPRING CATCHMENT

## 2.1 GENERAL REMARKS

The ***spring catchment is the heart of a water supply system*** and not accessible any more after its construction. Therefore, the design and construction of a catchment have to be done very carefully. Due to the uniqueness of each source, there cannot be a standard design of a catchment that is applicable for every system. However, there are some standard design features which can be applied to all catchments.
The ***natural flow of a spring must never be changed!*** In the immediate vicinity of a catchment there should be no trees whose roots could damage the catchment.

## 2.2 TYPES OF SPRINGS

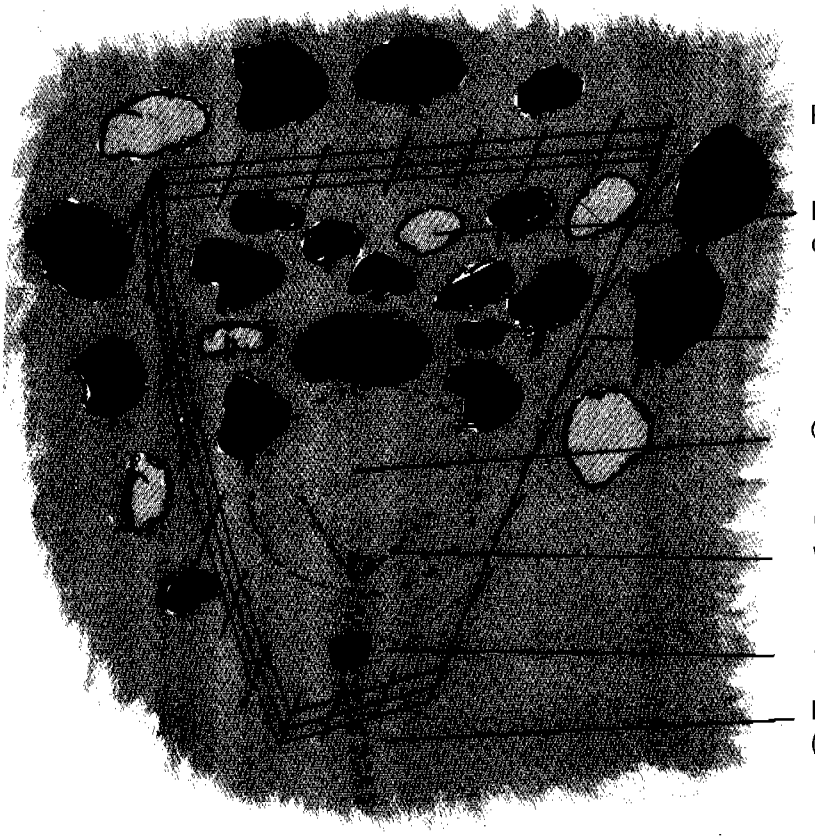
There are several types of springs and they can be classified with the help of different methods (e.g. geological, hydrological, etc.). For the construction of a catchment it is important to distinguish between two types of springs:

- **Gravity springs**: The spring water is moved by the force of gravity along an impermeable layer and emerges more or less horizontally from the ground.
- **Artesian spring**: The spring water is trapped between impervious layers and is forced to the surface by hydrostatic pressure. The water emerges more or less vertically from the ground.

We will concentrate in this manual on the common type of gravity springs and only briefly touch artesian springs in chapter *2.5. Artesian Springs*.

## 2.3 PROTECTION ZONE

It is obvious, that the catchment area has to be protected to prevent a spring from becoming polluted. Especially the area just above and upstream of the catchment needs extreme care. The size of the protection zone depends on the thickness and nature of the covering stratum. In any case, the radius of the protected area must not be smaller than ***10 m***. Within this area no farming, no domestic animal grazing, no rubbish pits, etc. are allowed. The area just above the catchment should be planted with grass and outside of a radius of about 10 m the protection zone should be ***afforested***. It is advisable to insist that the protection zone is fenced and protected just after the completion of the catchment and before any other works are started.



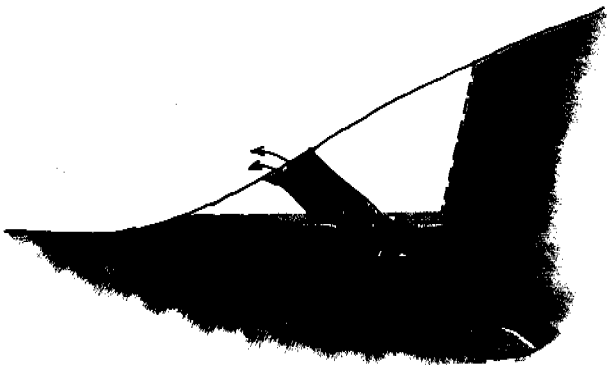

## 2.4 CONSTRUCTION OF CATCHMENT FOR A GRAVITY SPRING

The construction of a spring catchment can be divided into the following phases:

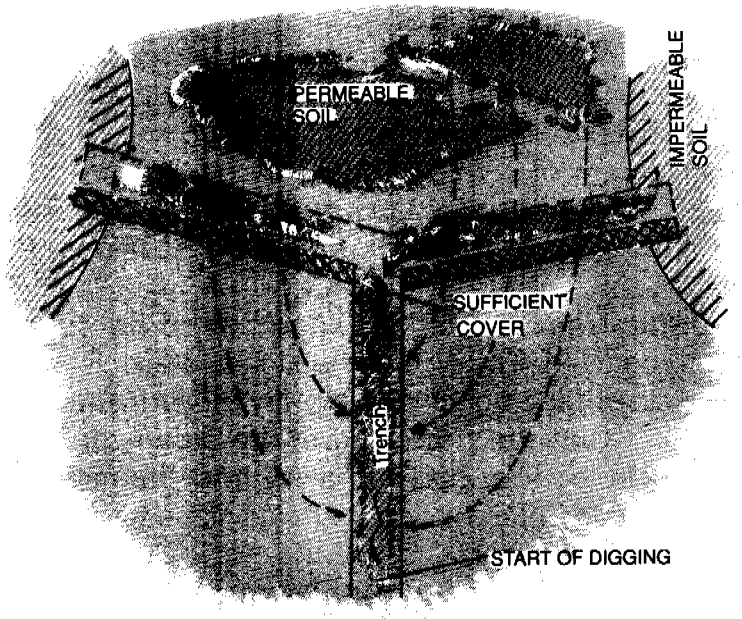
- Excavation
- Construction of catchment
- Construction of collection / sedimentation chamber
- Laying of source lines
- Backfilling of catchment with filter package
- Refilling of earth cover and completion of protection zone

## 2.4.1 EXCAVATION

The excavation of a catchment should be done during the dry season when the yield of a spring is lowest. However, the catchment has to be designed to trap the peak flow during the rainy season.
The digging is started at the point where the water emerges from the ground. From here, the excavation has to follow the flow of water back into the ground/hill until the earth cover of the source is at least ***3 m***. Be sure to allow a free flow of the water at all times so that the source does not get blocked. Excavate along the impermeable layer but take care not to cut through this layer. In case it is not possible to dig as deep as the impermeable layer (see sketch below) You have to consider the spring as an artesian one and the catchment has to be built accordingly. Please refer to chapter *2.5. Artesian Springs*.



The trench walls have to be sloped to ensure their stability. In rare cases it might even be necessary to use shuttering to guarantee that the trench walls do not collapse.
In many cases the flow of spring water appearing at the head of the excavation of a trench decreases with the advancing excavation. This means that water is flowing into the trench not only at the head of the excavation but also from the sides of the trench. In such a case the trench has to be split to form a T or V as soon as the earth cover is big enough(3 m). See sketch below:



## 2.4.2 DESIGN AND CONSTRUCTION OF CATCHMENT

Once the excavation is completed the nature of the spring is much more visible than before and the design of the catchment can be made accordingly.
A catchment consists of the following main parts:

- ***Barrage / Dam:*** Directs the water into the supply system.
- ***Permeable Structure / Drain***: Acts as a shuttering for the water bearing layer and prevents it from being washed out. It also drains the water into the supply system.
- ***Cover of Catchment:*** Prevents the infiltration of surface water into the catchment.

### 2.4.2.1 Barrage (Dam)

The barrage (dam) is built on the opposite side of the place where the spring water enters into the catchment. The barrage directs the water into the source line which delivers the water to the collection chamber/siltbox.
First, a temporary dam (made out of clay and a temporary pipe) has to be built to divert the water from the place where you want to build the barrage. The foundation of the barrage should be located 20 - 30 cm inside the impermeable layer and should extend into the side walls to prevent the water from flowing around the barrage. The concrete for the foundation is cast directly against the ground. The barrage is built on top of the foundation either in concrete or in stone masonry. A mortar layer on the exposed, inside wall makes the barrage watertight. The top of the dam should not be higher than the top of the water bearing layer. The pipe for the source line is placed at the lowest possible location with a minimum ***slope of 2 %*** and a minimum ***ø of 50 mm.*** It is advisable to install a second source line (or at least an overflow pipe) a little (= 5 cm) higher than the first pipeline, so that the caretaker can easily detect when the first line gets blocked. It is important to install the second pipe to prevent the spring from getting blocked in case the first pipe gets clogged. If the spring is blocked, the spring might disappear completely because the water could find another way.

### 2.4.2.2 Permeable Structure / Drain

The permeable structure/drain collects the spring water and guides it into the supply system. Moreover, the filter package around the drain acts as a shuttering for the water bearing layer and it prevents it from being washed out.
The drain can be made out of dry stone masonry or a perforated pipe. The cross-section has to be big enough to allow the drainage of the maximum yield of the spring. Again, ***the natural spring flow must not be obstructed!*** The slope of the drain should be ***1 - 2 %.***
Above and behind the drain, a filter package has to be constructed. Washed stones/gravel have to be used. The size of the stones/gravel immediately around the drain depend on the size of the opening in the dry stone masonry or the size of the perforation of the pipe. Obviously the size of the stones/gravel can be reduced continuously as you build the filter package away from the drain. The filter package should be built as high as the barrage and it should slope towards the barrage with a gradient of ***min. 5%.***

The top of the filter package will serve as formwork for the concrete cover of the catchment. ***Never walk on the filter package to prevent any contamination of the catchment.***

### 2.4.2.3 Cover of Catchment / Inspection Chamber

Surface water which seeps through the refilled earth cover on top of the catchment has to be prevented from entering into the catchment. This can be achieved by constructing a ***concrete cover*** with a thickness of ***min. 5cm***. The cover is constructed on top of the filter package and together with the barrage it should cover the whole catchment and even extend (for about 20cm) into the side walls. It should slope (***min. 5 %***) towards the barrage to ensure proper drainage. There should also be a cross-fall in the cover, so that the surface water can be guided into the seepage water drain pipe. Use rather dry concrete (earth dry), at least for the first layer, so that the cover prevents the pores in the filter package from getting clogged by concrete slurry. The concrete has to be compacted well and its surface has to be floated to make it smooth enough to drain the percolated surface water.

An ***inspection chamber*** can be constructed above the outlet of the catchment.This would allow later access for inspection of the catchment (e.g. if outlet is blocked) without breaking the cover. ***Important: If such an inspection chamber is constructed, the opening must be sealed watertight to avoid any seepage of surface water through the cover into the catchment!***

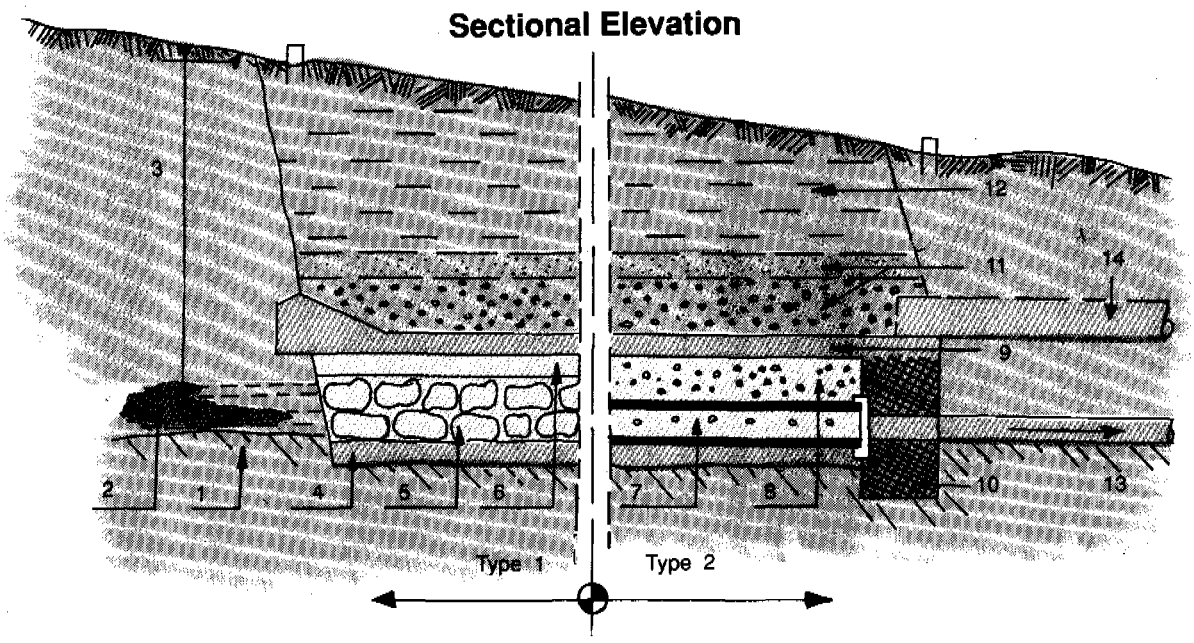
### 2.4.2.4 Earth Cover of Catchment

Once the concrete cover is completed and has set, the whole catchment has to be covered with earth again so that it looks as it did before the excavation was started. Use the excavated material for refilling and backfill in ***layers of 20 - 30cm*** and compact each layer very well. Once the backfilling is completed the surface has to be planted with grass to protect it from erosion. Do not plant trees within a radius of 10 m of the catchment as the roots of such trees could damage the catchment structure. About 20 m above the catchment a trench has to be built to divert the surface water. The length of such a trench depends on the width of the catchment but should extend a few metres on both sides of the catchment. Besure to divert the surface water to a place where it does not cause any erosion.

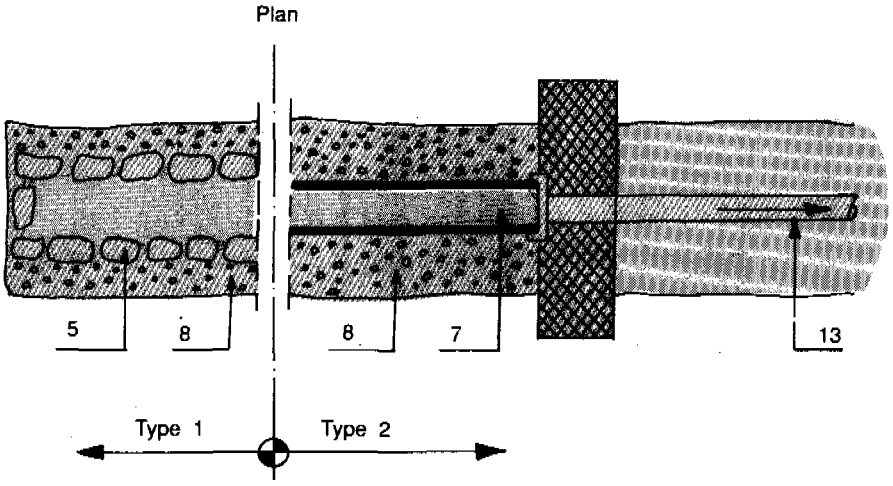
Finally, mark the location of the catchment with bench marks (pegs, or permanent stones) and complete the protection zone according to chapter *2.2 Protection Zone.*

## 2.4.3 DRAWINGS OF TYPICAL GRAVITY SPRING CATCHMENTS

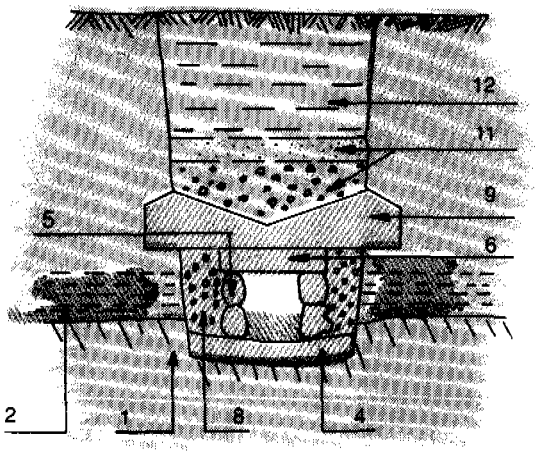
### 2.4.3.1 Spring Catchment in Line



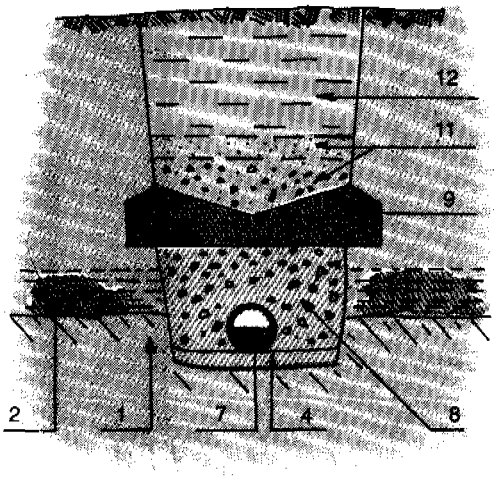

1. Impervious strata
2. Water bearing soil
3. Cover of water bearing soil
4. Bed plate
5. Dry wall
6. Cover slab
7. Perforated pipe
8. Gravel
9. Watertight cover
10. Dam
11. Permeable material
12. Impermeable backfilling
13. Supply pipe
14. Seepage water drain pipe




Cross section type 1

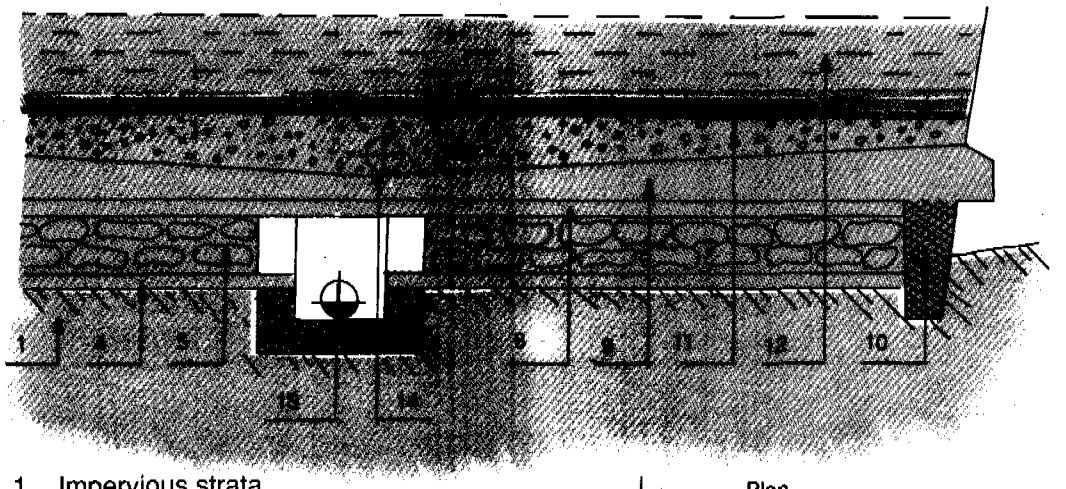


Cross Section type 2

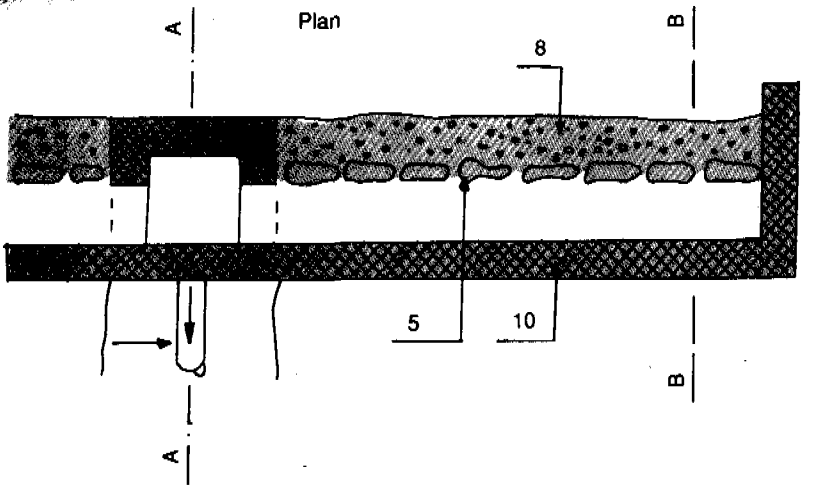


## 2.4.3.2 Spring Catchment in V - or T - Form

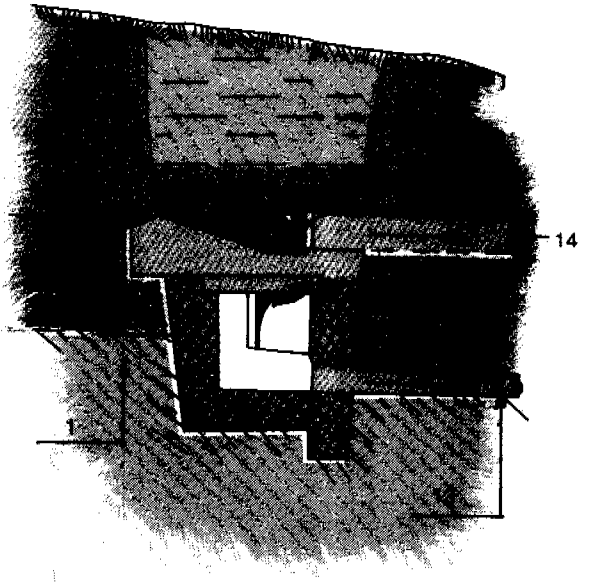
### Sectional Elevation



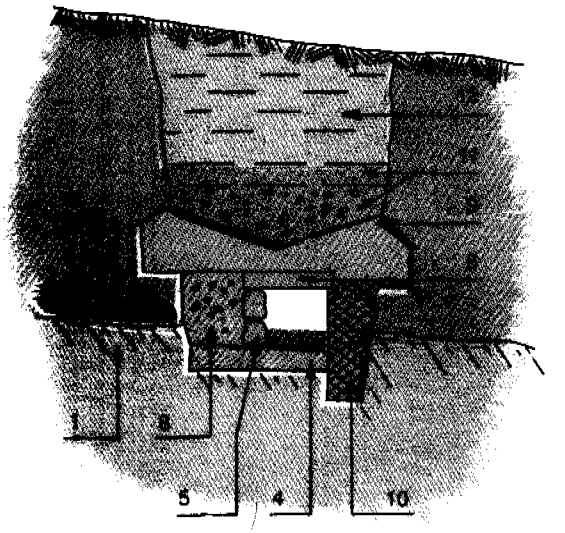

1. Impervious strata
2. Water bearing soil
3. Cover over water bearing soil
4. Bed plate
5. Dry masonry wall
6. Cover slab
7. Perforated pipe (not shown)
8. Gravel
9. Watertight cover
10. Dam
11. Permeable material
12. Impermeable backfilling material
13. Supply pipe
14. Seepage water drain pipe




### Section A-A

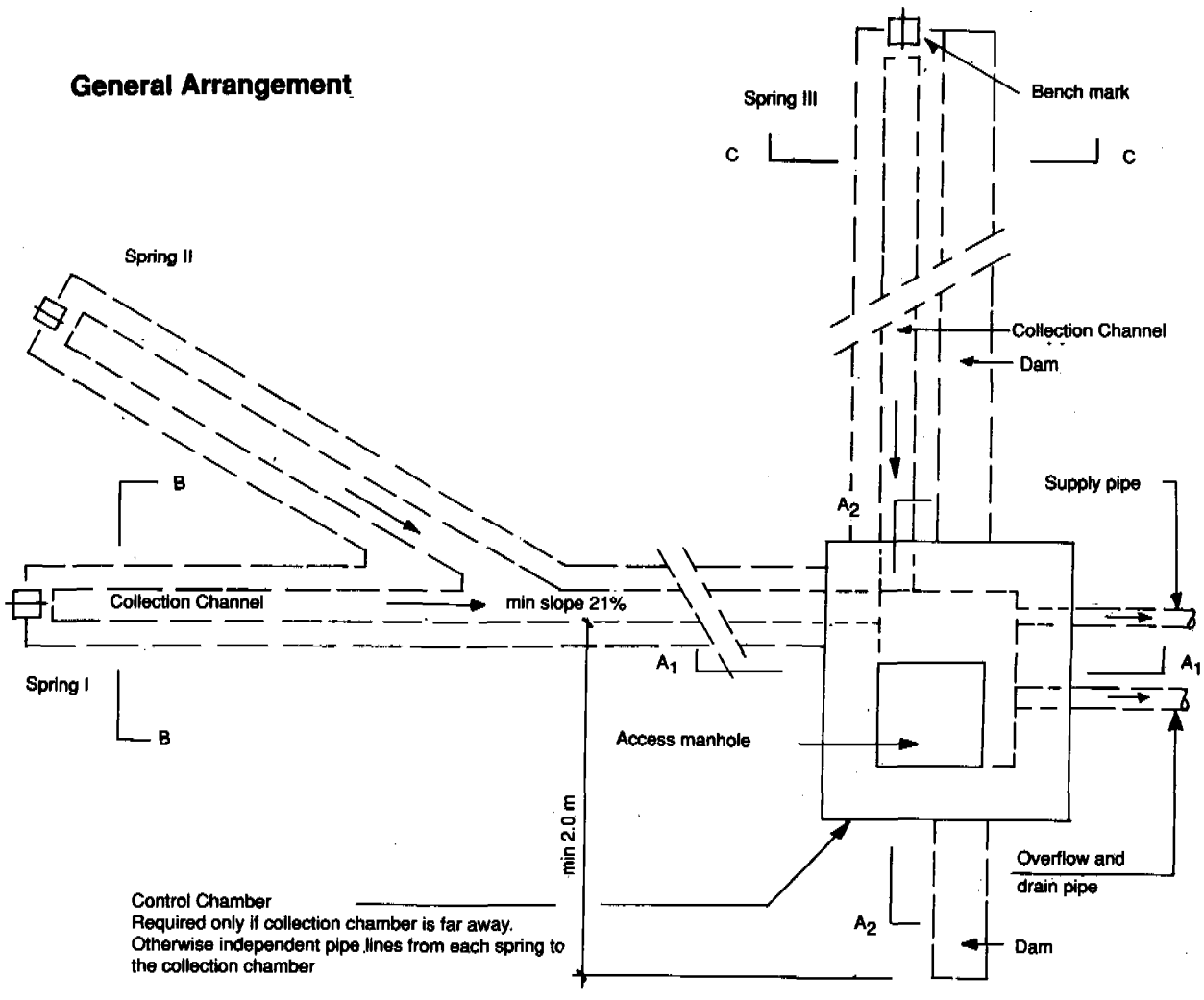



### Section B-B

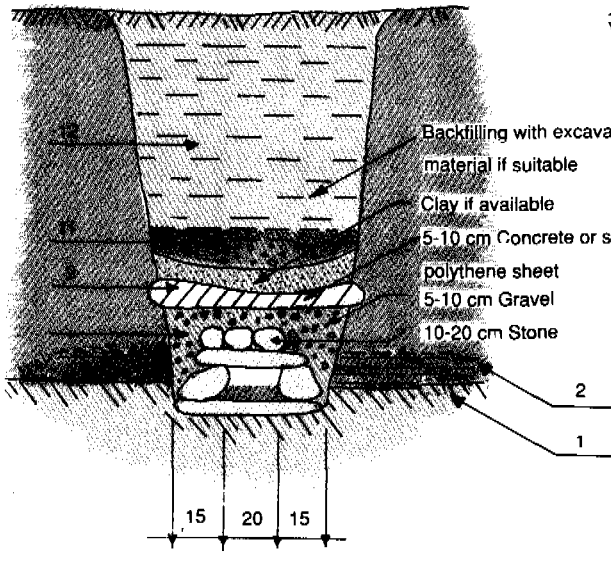


## 2.4.3.3 Catchment of various Small Springs

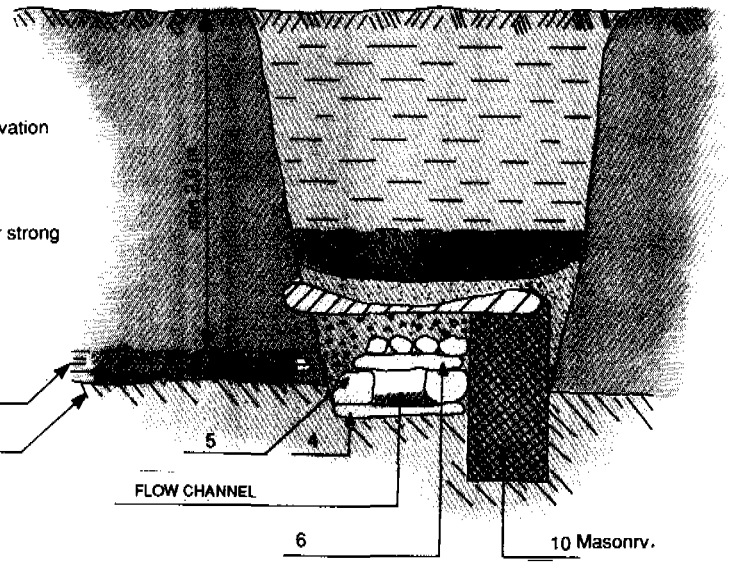
### General Arrangement



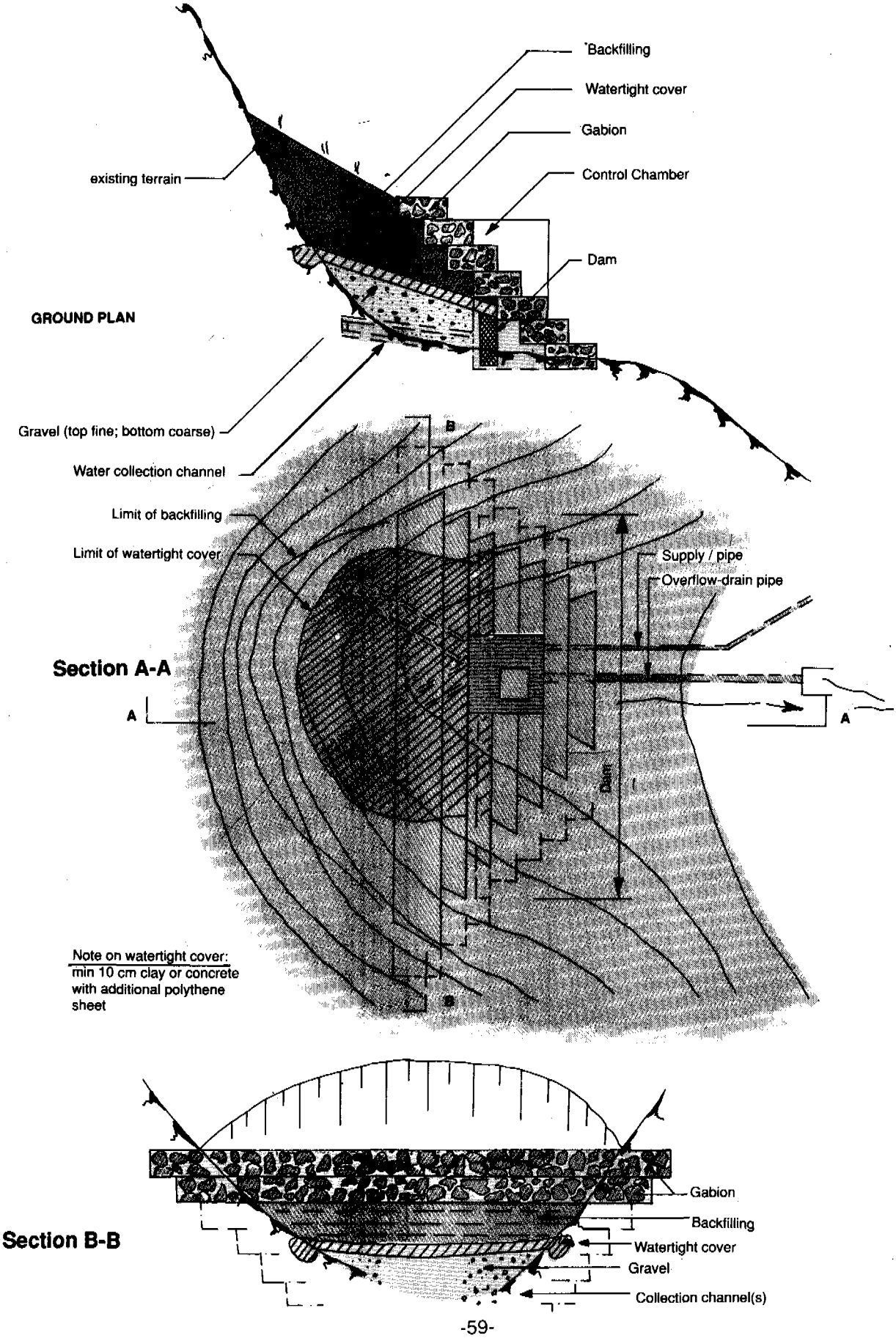

### SECTION B-B




### SECTİON C-C



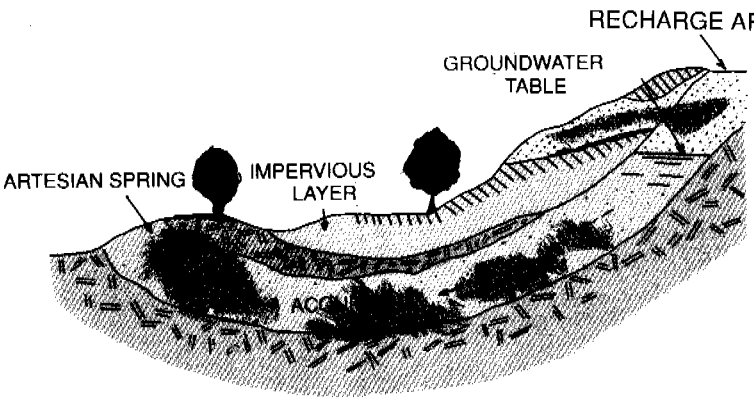
## 2.4.3.4 Catchment of Springs in Rocky Areas or Steep Hills



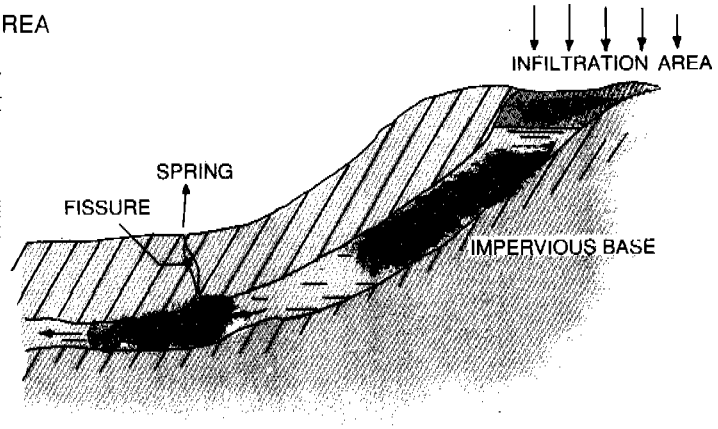
## 2.5 ARTESIAN SPRINGS

### 2.5.1 GENERAL REMARKS

In an artesian spring the water seeps more or less vertically out of the ground, forced upwards by hydrostatic pressure (see pictures below).




Artesian Overflow Spring

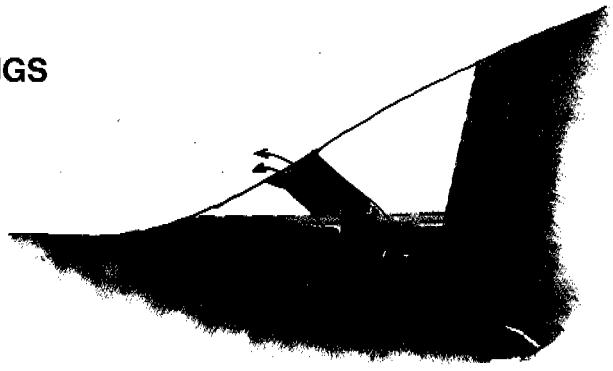



Artesian Fissure Spring

This type of a spring is less common than a gravity spring, therefore on the following pages we will only briefly discuss artesian springs.

### 2.5.2 CATCHMENT OF ARTESIAN SPRINGS

The water of an artesian spring enters the catchment through the bottom. Therefore, the catchment looks like a well with the difference that the water flows out of the catchment under the force of gravity and it is not necessary to extract it mechanically.



Catchment of an Artesian Spring

### 2.5.3 ARTESIAN SPRINGS IN HARD, STABLE SOIL

#### 2.5.3.1 Excavation

The excavation starts at the point where the water emerges from the ground and proceeds downward against the flow of water to a depth of 1.5 to 2metres. The following points have to be considered:

- Excavation done by hand.

- No blasting possible (it could cause underground cracks through which the spring could disappear).
- Pores and cracks through which water is emerging must not be blocked.
- Deposit the excavated material away from the excavation area.
- Ensure a free flow of the spring water away from the excavation area.
- Ensure that the side walls of the excavation do not collapse.

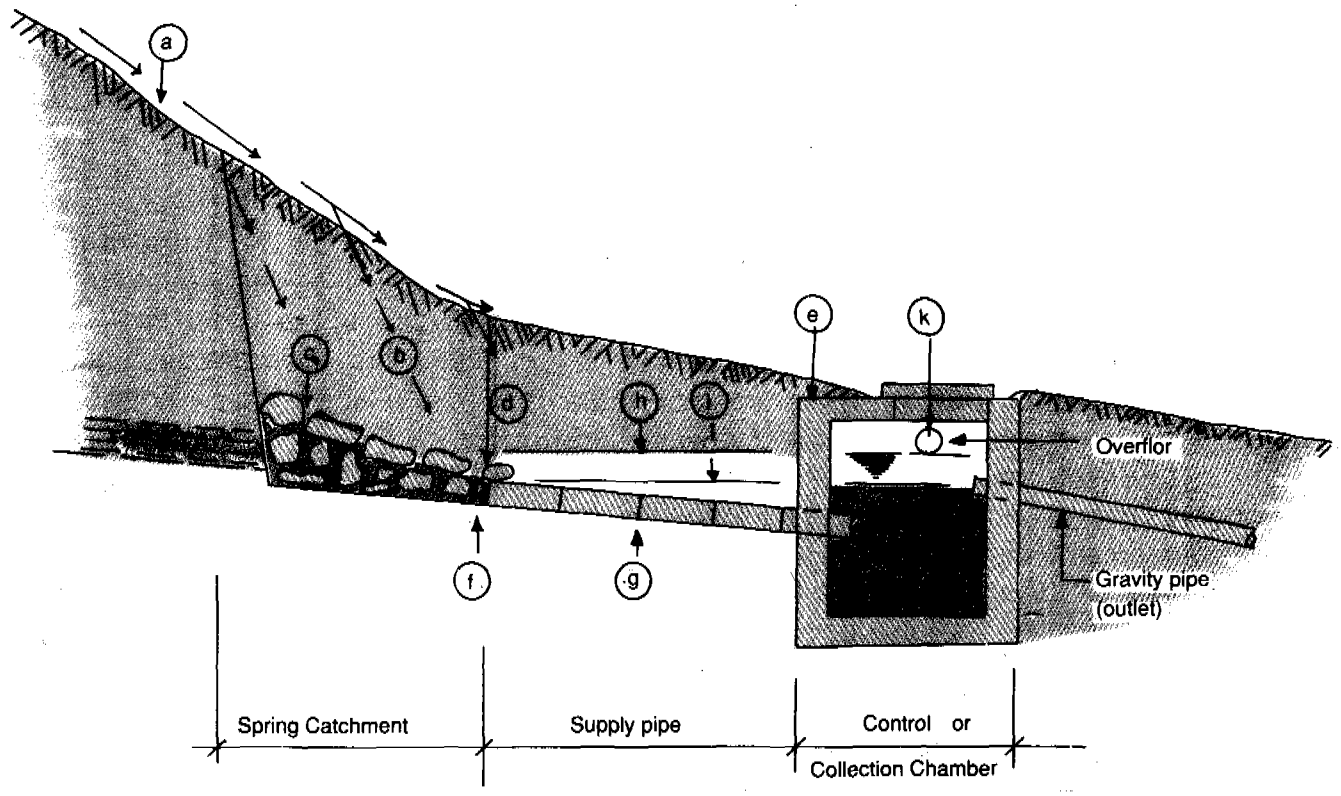
### 2.5.3.2 Catchment of Artesian Springs

Once the excavation is completed the catchment has to be designed and constructed. It looks very much like a hand-dug well; a circular or rectangular wall collects the water entering through the bottom of it and directs the water into the supply system. The walls have to be built 30 - 50cm higher than the water table (be sure that the max. yield can be drained from the catchment). At the lowest possible point, the source line is placed into the wall of the catchment.
In most cases the spring water does not emerge at one particular spot only,but appears over a certain area. It is up to the supervisor of the project to decide whether one large catchment or several smaller ones have to be built.
The walls of the catchment can be built with concrete or stone masonry(must be watertight) and on top of a concrete foundation of a depth of ***min.20 cm***, which is cast directly against the ground.
In hard, stable soil no filter package is needed to prevent the water bearing layer from getting washed out.
The catchment has to be covered with a precast concrete slab. Before designing the size of the catchment, remember that it will be covered after completion and that the covering-slab for a large catchment will be very heavy and difficult to move on to the catchment walls. Be sure that the cover seals the catchment completely to prevent it from becoming contaminated.
The area around and on top of the catchment(s) has to be backfilled with excavated material. Backfill in layers of 20 - 30 cm and compact each layer well.

### 2.5.4 ARTESIAN SPRINGS IN LOOSE SOIL

The excavation of an artesian spring in loose soil has to be done in the same way as a well is dug in loose or sandy soil: ***by caissoning***. The excavation is done inside a precast concrete ring to prevent the side walls from collapsing. The precast concrete rings will sink under their own weight while the excavation is going on. Please refer to the manual *Construction of Hand-Dug Wells in Rural Villages in Sri Lanka*. In that manual you will find detailed instructions on how to proceed with the above mentioned method of caissoning.

# 2.6 COMMON MISTAKES OCCURRING IN SPRING CATCHMENTS




**LEGEND**

(a) *no surface run off water interception drain*
(b) unsuitable backfilling material (permeable)
(c) no watertight cover
(d) cover of water bearing soil inadequate
(e) top of control / collection chamber below ground level
(f) no dam or dam with too short wing-walls and/or insufficient depth of dam foundation

→ surface water is able to pollute spring water

(g) leakages from pipe joints

→ loss of spring water

(h) position (elevation) of overflow to high [1)]
(i) position (elecation) of outlet to high [1)]
(k) insufficient overflow capacity

→ obstruction to spring flow and impounding of spring[2)]

Note: 1) in relation to spring horizon
2) spring may find an other outlet to overcome the obstruction

# 3 COLLECTION CHAMBER AND / OR SEDIMENTATION CHAMBER / SILT BOX

Very often a silt box can serve both as sedimentation chamber and as a collection chamber. It has to be built as close to the catchment as possible. The floor and the walls have to be watertight and the corners and edges (inside) have to be bevelled. Be sure that the outlet pipe is aerated so that it can be shut down without the outflowing water creating a vacuum in the pipe.

**Standard Drawings:**

- **S-01, Silt Box (type A), Volume = 300 - 800 l**
- **S-02, Silt Box (type B), Volume = 300 - 800 l**
- **S-03, Silt Box with Valve Chamber (type A), Volume = 1000 - 2000 l**
- **S-04, Silt Box, (type B), Volume = 1000 - 2000 l**
- **S-05, Silt Box with Valve Chamber (type A), Volume = 300 - 800 l**
- **C-03, Pressure Break or Collection Chamber (type A + B)**

# 4 STORAGE TANK

## 4.1 GENERAL REMARKS

The construction of a storage tank requires the coordinated tasks of a lot of people. The supervisor has to plan the construction procedure well inadvance and he has to make sure that all materials are available at the time they are needed. There are two different types of storage tanks:

- **Stone Masonry**: The walls and the (arched) roof are made of stone masonry.The design of this type of tank was developed by HELVETAS in Cameroon and was later introduced in other countries (e.g. Sri Lanka). Its advantages are sturdiness and low maintenance. But it also has some serious drawbacks. Considerable quantities of stone, cement and sand are required. It proved to be difficult to produce watertight constructions mainly because of the quality of the stones and the fact that local craftsmen are not always familiar with stone masonry technology.

- **Ferrocement**: These tanks require less cement, stones and gravel, and are cheaper and quicker to build. They consist of sand-cement mortar heavily reinforced with rods and chicken wire. The reinforcement, with a layer of chicken wire on both sides (inside + outside), is embedded in mortar made of one part cement and two parts sand (1:2). Ferrocement is particularly suitable for curved structures, such as circular tanks. The main advantages of this type of material are low cost, simplicity of construction and durability. According to studies done in Nepal, ferrocement tanks are 25 % - 50 % cheaper than stone masonry tanks.

**Standard Drawings:**

- **T-01, Storage Tank (type A), Volume = 2 - 5 $m^3$**
- **T-02, Storage Tank (type B), Volume = 2 - 5 $m^3$**
- **T-03, Storage Tank (type A), Volume = 6.5 - 12 $m^3$**
- **T-04, Storage Tank (type B), Volume = 6.5 - 12 $m^3$**
- **T-05, Storage Tank (Ferrocement), Volume = 2 - 15 $m^3$, (Drawing No. 1)**
- **T-06, Storage Tank (Ferrocement), Volume = 2 - 15 $m^3$, (Drawing No. 2)**

## 4.2 CONSTRUCTION SCHEDULE FOR FERROCEMENT STORAGE TANKS

This construction schedule for ferrocement storage tanks is intended as a guide to enable you to construct ferrocement tanks within the shortest possible period of time. It also helps to plan the required community participation for each day. This time schedule will not differ much for the construction of 8 $m^3$, 10 $m^3$ or 15 $m^3$ tanks, provided that good supervision and sufficient community participation is ensured.

### Preparation of Work Site:

The following preparations must be completed in advance to keep to the time schedule:

- All required building materials (according to the material list on the standard drawing) have to be collected and stored at the construction site.
- All necessary equipment, like formwork for walls and roof, planks for shuttering and bracing, etc., have to be made available.
- All installations, like washout, overflow, inlet, outlet, etc., have to be prepared and made ready for use.
- All reinforcement bars have to be purchased and cut and bent according to the table on the standard drawing.
- The stone soling (20 cm, sloping 10 cm towards washout) has to be constructed and the support pipe (PVC ø 50 mm, filled with cement mortar)has to be set up.
- Please refer to ***standard drawing no. T-05 and T-06!***

### CONSTRUCTION SCHEDULE:

| | | |
|---|---|---|
| 1st day: | Installations: | Washout, overflow, inlet, supply<br>Reinforcement: Foundation slab steel bars<br>Foundation: Concrete 1:2.5:4, topping 1:3 wet in wet |
| 2nd day: | Preparation: | Cover fresh topping of foundation to avoid damage<br>Reinforcement: Wall steel bars<br>Wall formwork: P.E. pipe ø 32 mm |
| 3rd day: | Wall formwork: | P.E. pipe ø 32 mm<br>Reinforcement: Chicken wire, plain wire ø 3.5 mm, spacing 2.5 cm |
| 4th day: | Plastering: | 1st coat 1:3 for wall (outside), thickness 2 - 3 cm, surface rough<br>2nd coat 1:3 for wall (outside), thickness 1 - 2 cm, surface floated.<br>The 2nd coat is only applied once the 1st coat has set. The water/cement ratio should be 0.45 - 0.50. |
| 5th day: | Curing: | 1st and 2nd coat on wall (outside) can harden |
| 6th day: | Curing: | Cover the wall with suitable material and keep it wet |
| 7th day: | Curing: | Keep the wall and the covering material wet |

| | | |
|---|---|---|
| 8th day: | Preparation: | Remove the wall formwork |
| | Plastering: | 1st coat 1:4 for wall (inside), thickness 2 - 3 cm, surface floated |
| | | 2nd coat cement paste, thickness 1 - 2 mm. Apply the cement paste up to 5 - 10 cm above max. water level. |
| 9th day: | Reinforcement: | Roof steel bars |
| | Formwork: | Formwork for manhole (45 x 60 cm) |
| | Reinforcement: | Plain wire ø 3.5 mm / chicken wire |
| | Roof formwork: | Hardboard |
| 10th day: | Plastering: | 1st coat 1:3 for roof (outside), thickness 3 - 4 cm, surface floated. |
| 17th day - 24th day: | Formwork: | Remove roof formwork |
| | Plastering: | 2nd coat 1:3 for roof (inside), thickness 2 - 3 cm |

# 5 BREAK PRESSURE TANK (BPT)

There is no minimum required capacity for a BPT as long as the water is able to drain from the BPT as fast as it is discharged into it. The dimensions are more influenced by the size of the installations / fittings.

There are two standardized types: Type A and type B. Type B needs less materials and is cheaper to build. Both types can be fitted with or without a ball (float) valve. A ball valve has to be installed in case the flow of the inlet pipeline has to be controlled.

**Standard Drawing: C-03, Break Pressure Tank or Collection Chamber (Type A and B)**

# 6 DISTRIBUTION CHAMBER

Although there is only one type of distribution chamber standardized, various distribution ratios are possible. The size of the distribution chamber depends upon the installations / fittings installed.
It is important that the tops of the outlet elbows are on the same elevation/level to guarantee an equal distribution according to the distribution ratio.

**Standard Drawing: C-04, Distribution Chamber**

# 7 VALVE CHAMBER

There are two types of valve chambers standardized. The choice of either of them depends upon the number of supply pipes. Remember that each valve has to be protected by a valve chamber. There should not be any valves freely accessible to outsiders.

**Standard Drawing: - C-01, Valve Chamber 60 x 45 cm**
**- C-02, Valve Chamber 60 x 90 cm**

# 8 PIPELINE CONSTRUCTION

## 8.1 GENERAL REMARKS

The construction of the pipeline is a very laborious task. Often, due to bad management and/or supervision, the pipeline works are excessively prolonged which drains away the enthusiasm of the community. It is important, therefore, that the pipeline work is done properly the first time. It is very frustrating to locate an internal blockage as a result of carelessness, or to have to re-dig the trenchline because the depth is incorrect.
It is very important that the site supervisor keeps the following points in mind:

- The supervisor should be a technical consultant, assisting the local community and he should make use of village individuals who emerge as natural foremen.
- The most difficult part of the trenchline should be tackled first when enthusiasm is still high.
- The pipe should be laid as continuously as possible to avoid the trench from becoming filled in. As soon as the pipeline is laid, the trench can be backfilled.
- The total work has to be divided into different parts on which the villagers can work simultaneously.
- It is necessary to be firm on standards and procedures which cannot be altered (e.g. depth of trench). The supervisor has to insist on these from the beginning. This will create fewer problems later on.

## 8.2 TRENCH WORKS

### 8.2.1 GENERAL REMARKS

The pipeline should be laid along the straightest possible route; along the same route as the hydraulic survey. Whenever one has to deviate from the survey route, the supervisor has to re-survey the new section to determine how it will effect the HGL of the system. The slope of the pipeline should be ***min. 1 %***. One stretch of a pipeline should be laid with either a continuous rise or a continuous fall. Where the slope changes from rise to fall ***an air release*** has to be installed. Where the slope changes from fall to rise ***a washout*** has to be installed (see chapter *10 Installations*).

### 8.2.2 SIZE OF TRENCHES

The width of the trench depends on:

- Diameter of pipe
- Type of soil and soil condition
- Practical working condition etc.

***A practical width will be 40 cm.***
The depth of the trench depends on:

- Climate (Temperature)
- Type of soil and soil condition
- Location of pipeline (paddy fields, roads, etc.) etc.

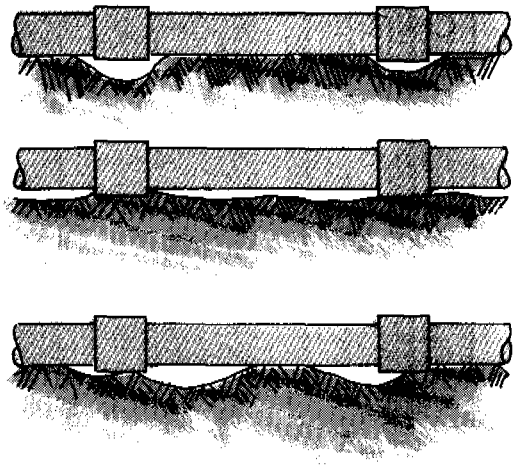
From our experience we recommend the following depths for trenches:

| | |
|---|---|
| - Generally: | **0.60 m** |
| - Crossing minor roads: | **1.00 m** |
| - Crossing main roads: | **1.50 m** |

With above depths, a pipeline is well protected against weight (and sharp hooves) of animals walking over it; it is well below the depth of plough;it is insulated against great variations of temperature; it is protected against tampering by children, etc. ***The depths given are minimum depths and they must not be reduced!*** The supervisor of a GWSS has to explain to the local community the reason for burying the pipeline and he has to insist on the min. depths of the trenches.

### 8.2.3 LAYING OF PIPES

The pipes should be laid on ***firm ground*** and rocks or stones should be removed from the bottom of the trenches to prevent the pipe from getting damaged by them. The pipe should be supported over its entire length and not only under its couplings.



correct, pipe is supported over its entire length

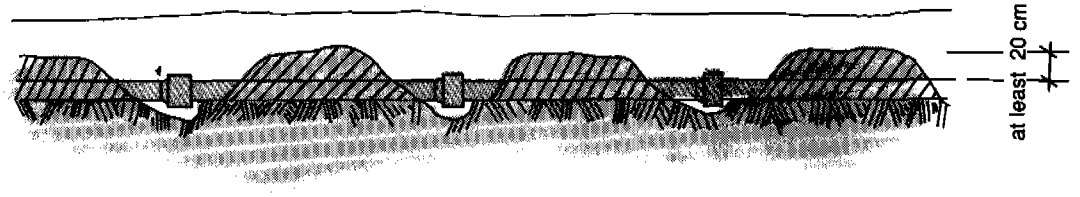
wrong, pipe is supported under couplings only

wrong, pipe is not supported over its entire length

Immediately before any pipe is going to be laid into the trench, the pipe should be checked for: Cracks, blemishes, holes, etc. Do not forget to check the interior of the pipes as well!

## 8.2.4 BACKFILLING OF TRENCHES

As soon as the pipe has been laid, the trench should be backfilled, at least partially. The backfilling has to be done in layers of 20 - 30 cm.The first layer must not contain any sharp materials like stones, rocks,branches, etc. Once the pipe is covered with a ***soft soil layer of about 20cm*** the excavated material can be used for backfilling. Do not backfill the full trench before each pipeline section is tested against leakages.

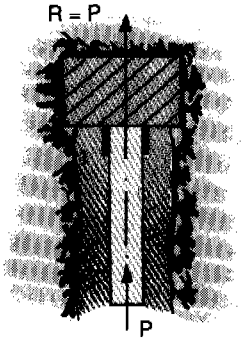



Backfilling of Trench before Leakage-Test

## 8.2.5 THRUST-BLOCKS

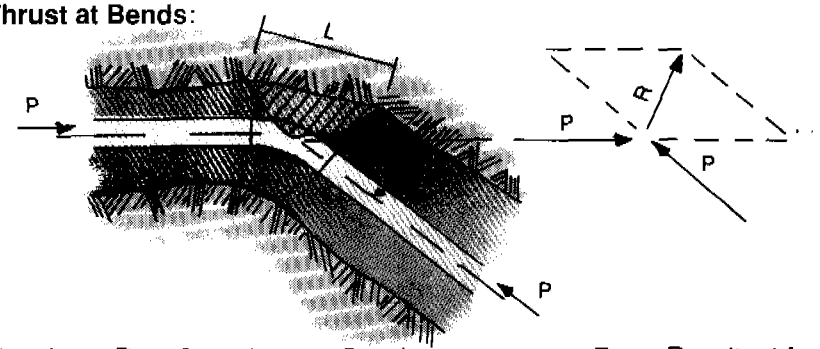
Whenever the pipeline changes its direction the water pressure in the pipe exerts a certain force on the pipeline. These ***thrusts*** can be surprisingly high and it is necessary to absorb them with ***thrust-blocks***. Without such thrust-blocks, the pipeline can easily become damaged.

**Thrust at End of Pipe:**




$$P = p \times \frac{d^2 \times \pi}{4}$$ where: P = Force in N
p = Water pressure in N/mm$^2$
d = Outer diameter of pipe in mm

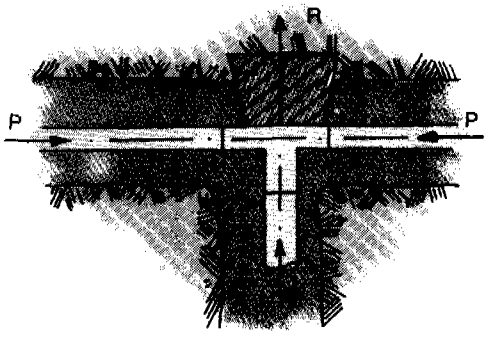
**Thrust at Bends:**




Resultant $R = 2 \times \sin \sigma \times P$ where: R = Resultant force in N
$\sigma$ = Angle of bend
P = Force in N

Below, you find a table with the thrusts for different pipe diameters and various bends. The calculations were done for a water pressure of 0.5 N/mm$^2$ ≈ 50 m of head ≈ 500 kPa. If you want to calculate the thrust for another pressure just divide the thrust given in the table by 0.5 and multiply it with the pressure you want.

Example: What is the thrust on a bend , σ = 45 °, pipe ø = 75 mm,
p = 0.8 N/mm$^2$ ( ≈ 80 m of head)?
Solution: table below: σ = 45°
ø = 75 mm —> thrust $R_1$ = 1.69 kN
p = 0.5 N/mm$^2$




$$p = 0.8 \text{ N/mm}^2 \quad \rightarrow R = \frac{R1}{0.5} \times 0.8 = 2.70 \text{ kN} \ (\approx 270 \text{ kg})$$

Also included in the table below are the thrusts on a T (branch) for the different pipe diameters for a pressure of 0.5N/mm$^2$. The calculations for other pressures are the same as above. The thrust on a T-branch is about 70 % of P.

**Thrust on Bends and T - branches for a Pressure of 0.5 N/mm$^2$ (= 50 m of head) in kN (= 100 kg)**

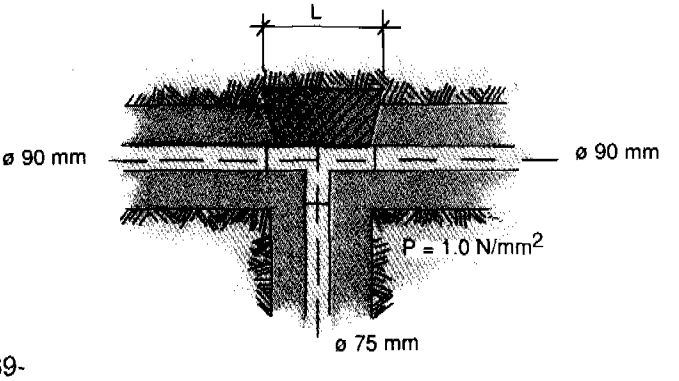
| ø of Pipe | at Pipe Plug | at Bends with an Angle of | | | | | at T - Branch |
|---|---|---|---|---|---|---|---|
| | | 15° | 30° | 45° | 60° | 90° | |
| 50 | 0.98 | 0.26 | 0.51 | 0.75 | 0.98 | 1.39 | 0.69 |
| 63 | 1.56 | 0.41 | 0.81 | 1.19 | 1.56 | 2.20 | 1.10 |
| 75 | 2.21 | 0.56 | 1.14 | 1.69 | 2.21 | 3.12 | 1.55 |
| 90 | 3.18 | 0.83 | 1.65 | 2.44 | 3.18 | 4.50 | 2.23 |

For small pipe diameters (20 - 40 mm) the thrust is little and therefore not included in the above table.

If the thrust is absorbed by a thrust-block you have to make sure that the surrounding ground can support the concrete thrust-block (the permissible soil bearing capacity must be bigger than the pressure exerted by the thrust block).

**Examples:**

A) What is the size of the thrust-block in the sketch on the right?
Permissible soil-bearing capacity
$\sigma_{perm.}$ = 0.075 N/mm$^2$

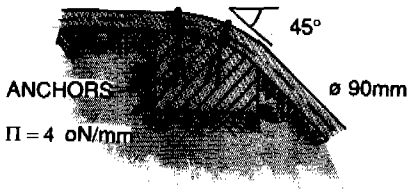


**Solution:**

Table - > T-branch: $P = \frac{1.55}{0.5} \times 1.0 = 3.1$ kN

Required thrust-block area: $A_{req.} = \frac{P}{\sigma_{perm.}} = \frac{3100}{0.075} \times 10^{-2} = 413$ cm$^2$

chosen: Thrust-block 20 x 30 cm = 600 cm$^2$




B) What is the required volume of the thrust-block in the sketch on the right ?

Weight of concrete: 24 kN/m$^3$

Solution:

$\sigma = 45°$

$ø = 90$ mm - > table —> $P = \frac{2.44}{0.50} \times 1.0 = 4.88$ kN

$p = 1.0$ N/mm$^2$

Volume of block: $V = \frac{4.88}{24} = 0.20$ m$^3$

chosen: 0.6 x 0.6 x 0.6 m = 0.22 m$^3$

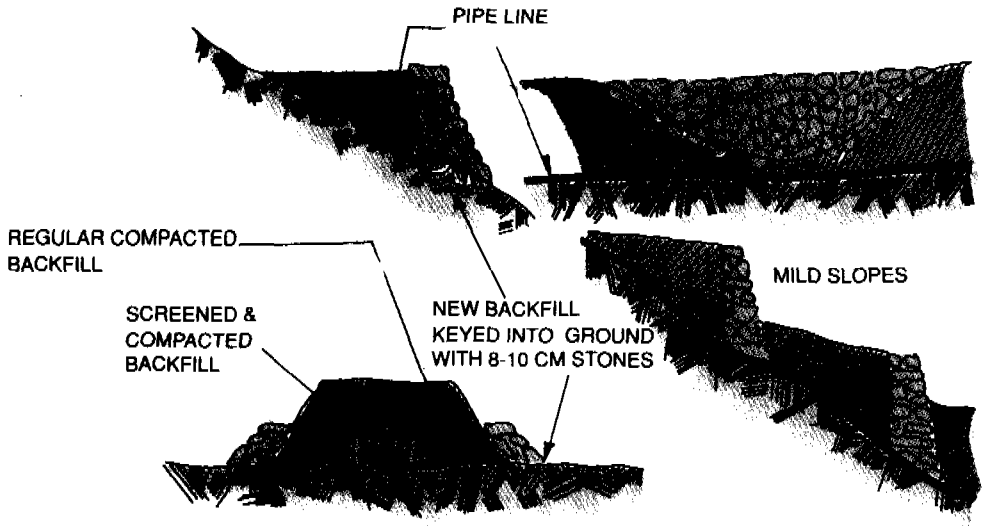
## 8.2.6 MARKING OF PIPELINE

The route of the pipeline has to be marked to enable the users of the system to locate it after several years of use in case some repair works are necessary. Immediately after the trench has been backfilled the route of the pipeline has to be marked with ***permanent pegs***. It is easiest to use concrete pegs on which the following information can be mentioned:

- Material of pipe and ø of pipe
- Direction of route of pipeline
- Continuous numbering of pegs

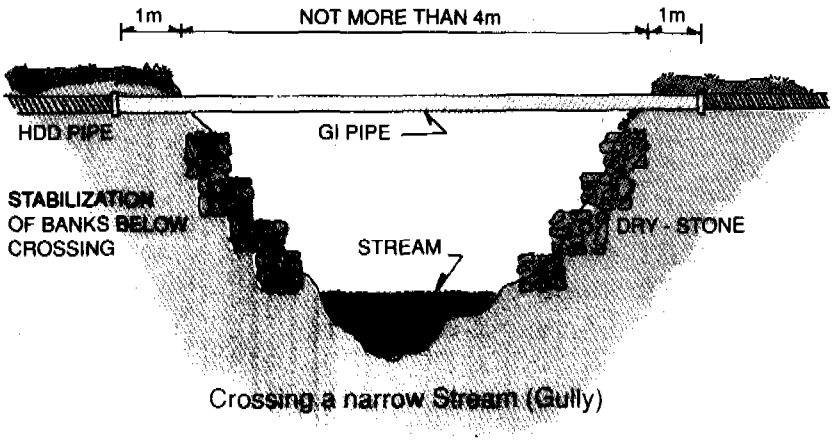
## 8.2.7 DIFFICULTIES IN TRENCH WORK

### 8.2.7.1 Trench Work in Hard or Rocky Ground



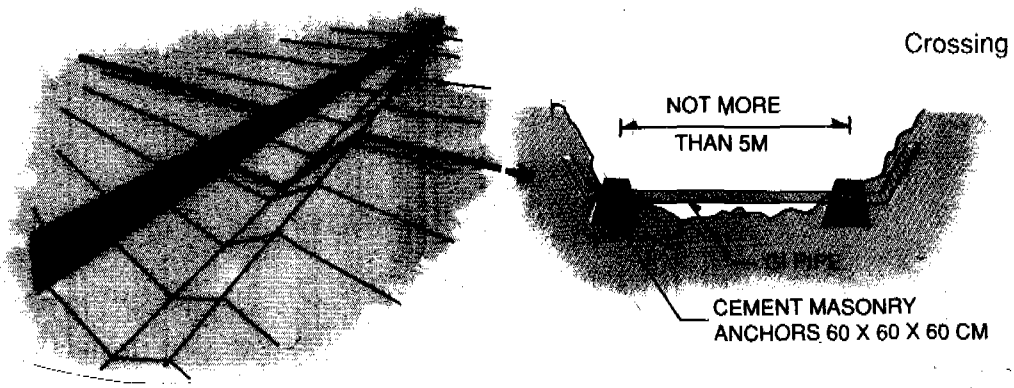

### 8.2.7.2 Stream or Gully Crossings

Narrow, deep gullies or streams can be crossed by a span of GI pipe above the bottom of the gully, clear of the maximum flood level.




Crossing a narrow Stream (Gully)

In broader gullies, the pipeline has to be buried as well as possible. Importance has to be given to a good anchorage.




Crossing a broad Gully

# 9 TAPSTANDS

The following is an abstract from the "Handbook of Gravity-Flow Water Systems" by T.D. Jordan Jr.: "*The tapstands are the most frequently used component of the entire system. No other structure will face more abuse than these, and no other structure will have to fit in so closely with local, social and cultural needs.*
*A tapstand is more than just a physical structure. It will become a new and important gathering point of the village. Properly designed and built, the tapstand will be a clean, attractive and inviting place. Poorly completed, it will be a dirty, muddy, unhygienic eyesore.*"

We standardized three different tapstands. The first one is attached to a storage tank. The second one was standardized in 1986 and revised in 1988.In comparison with the third one, the second requires more materials for its construction and is, therefore, more expensive. Otherwise it is just a matter of preference.

**Standard Drawings:**

**V-01, Tap Attached to Storage Tank Type A + B**
**V-02, Standpost "86"**
**V-03, Standpost "88"**

# 10 INSTALLATIONS

## 10.1 AIR RELEASE / ANTI VACUUM VALVE

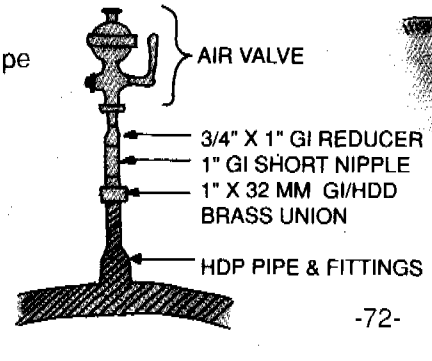
As mentioned in the first part of this manual, *6.10.1 Air valves/Air Releases,* and in chapter *8.2.1 General Remarks* of the second part, ***at each high point an air release has to be installed.*** An air release can be:

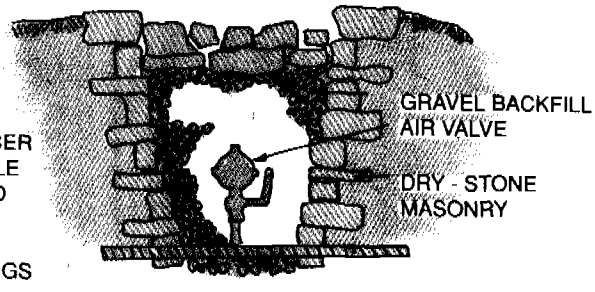
- Air Valve
- Standpost / Standpipe
- Open Pipe

Besides these high points, there are other locations along a pipeline where an air release or, better, an anti-vacuum valve has to be installed. ***There should be a device to ventilate a pipeline after each main valve.*** This prevents the building up of a vacuum when the main valve is closed and the water drains from the pipe.

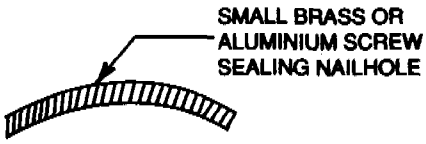
Below you will find a few examples of air releases/anti-vacuum valves:

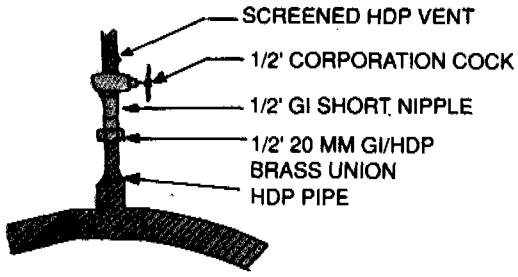
Automatic air valve installed on HDP pipe



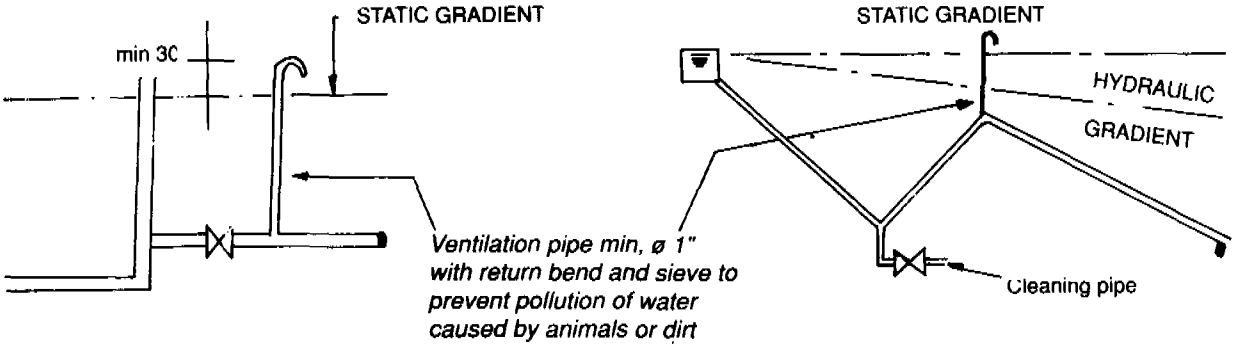



**Alternative methods**

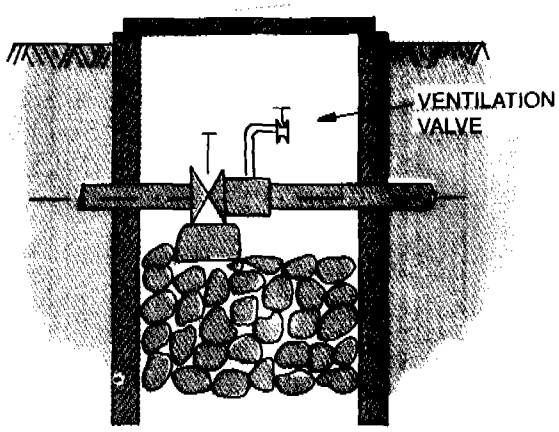


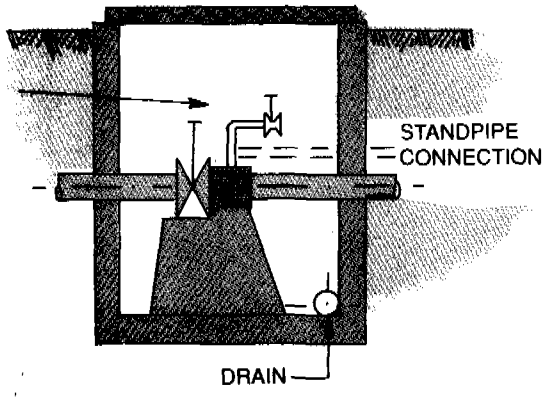




## Anti-Vacuum Valves




After closing the main valve the ventilation valve must be opened (prevention of vacuum)




***Be sure to install air valves well above the highest possible ground water level.*** Otherwise, polluted ground water could enter into the pipeline. Similarly, be sure to drain the valve box appropriately!

## 10.2 WASHOUTS

As mentioned in the first part of this manual, *6.10.2 Washouts* and in chapter *8.2.1 General Remarks* of the second part of this manual, ***at each low point a washout has to be installed.*** Wash outs can be:

- Plug
- Valve
- Standpipe

A washout pipe should be of the same size as the pipeline at that point. Plugs require that the pipeline will be completely drained, which is not the case if a valve (gate valve) is installed.
Remove the handles of such valves and store them in a safe place. Additionally, the valves should be well protected inside a valve chamber to prevent them from being tampered with. If a plug is used, ensure that it cannot be removed by hand.

## 10.3 SECTIONAL VALVES

As mentioned in the first part of this manual, in chapter *6.10.3 Sectional Valves*, such ***sectional valves*** have to be installed for two reasons:

- Parts of the supply system can be shut off for repair works
- Flow can be rationed in case of a severe drought

Sectional valves on long main lines should be located at a distance of 2 - 3 km and it is important to keep in mind that the shut off part of the pipeline can be ventilated (see *chapter 10.1 Air release/Anti-Vacuum Valve*).
On distribution lines, sectional valves should be installed so that they control three to five standposts. Whenever possible, a sectional valve should be combined with an air release or wash out. For branch lines, the sectional valve should be located at the branch-off.

# APPENDIX

## APPENDIX 1

### REFERENCES AND BIBLIOGRAPHY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# APPENDIX 2

## FORMS A - M


Form A: PRELIMINARY SURVEY ..... A2/1
Form B: SPRING MEASUREMENTS ..... A2/2
Form C: SITUATION SURVEY ..... A2/3
Form D: HYDRAULIC SURVEY ..... A2/4
Form E: FEASIBILITY OF PROJECT ..... A2/5
Form F: FLOW RATE AT STANDPOSTS ..... A2/6
Form G: VOLUME OF SEDIMENTATION CHAMBER / DISTRIBUTION RATIO ..... A2/7
Form H: STORAGE TANK AND FLOW DIAGRAM ..... A2/8
Form I: HYDRAULIC CALCULATION ..... A2/9
Form J: HYDRAULIC PROFILE ..... A2/10
Form K: FRICTION LOSSES IN PVC PIPES ..... A2/11
Form L: SYMBOLS FOR DRAWINGS ..... A2/12
Form M: EXAMPLE OF HEADER FOR SITUATION PLAN AND PIPE SCHEDULE ..... A2/13


# APPENDIX 3

## STANDARD DRAWINGS

| *Number* | *Title* |
|---|---|
| C - 01 | VALVE CHAMBER 60 x 45 cm |
| C - 02 | VALVE CHAMBER 60 X 90 cm |
| C - 03 | BREAK PRESSURE TANK OR COLLECTION CHAMBER (TYPE A & B) |
| C - 04 | DISTRIBUTION CHAMBER |
| S - 01 | SILT BOX (TYPE A), VOLUME = 300 - 800 l |
| S - 02 | SILT BOX (TYPE B), VOLUME = 300 - 800 l |
| S - 03 | SILT BOX WITH VALVE CHAMBER (TYPE A) VOLUME = 1000 - 2000 l |
| S - 04 | SILT BOX (TYPE B), VOLUME = 1000 - 2000 l |
| S - 05 | SILT BOX WITH VALVE CHAMBER (TYPE A), VOLUME 300 - 800 l |
| T - 01 | STORAGE TANK (TYPE A), VOLUME = 2 - 5 $m^3$ |
| T - 02 | STORAGE TANK (TYPE B), VOLUME = 2 - 5 $m^3$ |
| T - 03 | STORAGE TANK (TYPE A), VOLUME = 6.5 - 12 $m^3$ |
| T - 04 | STORAGE TANK (TYPE B), 6.5 - 12 $m^3$ |
| T - 05 | STORAGE TANK (FERROCEMENT), VOLUME = 2 - 15 $m^3$ (DRAWING NO.1) |
| T - 06 | STORAGE TANK (FERROCEMENT), VOLUME = 2 - 15 $m^3$ (DRAWING NO. 2) |
| V - 01 | TAP ATTACHED TO STORAGE TANK TYPE A & B |
| V - 02 | STANDPOST "86" |
| V - 03 | STANDPOST "88" |

**FORM A**

# PRELIMINARY SURVEY

Name of Village: ..... Name of Surveyor: .....
Division: ..... Designation: .....
District: ..... Date: .....
Map sheet: .....

---

Population: No. of Families: ..... No. of Inhabitants: .....
Existing Infrastructure: .....
.....
.....
.....
.....

Dry Season (s): From ..... To .....
From ..... To .....

Wet Season (s): From ..... To .....
From ..... To .....

---

Water Sources: - Present: .....
.....
.....
.....
.....

| | | Source 1 | Source 2 | Source 3 | Source 4 |
|---|---|---|---|---|---|
| - Future: | Elevation of Source | ..... | ..... | ..... | ..... |
| | Approx. Yield: | ..... | ..... | ..... | ..... |
| | Elevation of Consumers | ..... | ..... | ..... | ..... |

---

Name and Address of Contact Person: .....
.....
.....
.....
.....

Remarks: .....
.....
.....
.....

Encl. : hand sketch

# SPRING MEASUREMENTS

**FORM B**

Name of Village: .....

Division: .....

District: .....

| Date of Measurement | Spring 1 | | Spring 2 | | Spring 3 | | Spring 4 | |
|---|---|---|---|---|---|---|---|---|
| | Time | Yield | Time | Yield | Time | Yield | Time | Yield |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
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| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
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| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
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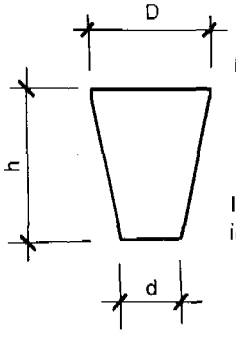
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

Remarks: Use always the same bucket and measure the yield at least once a week at the same spot. Measure the time in ***seconds*** (s) and calculate the yield in ***litres per second*** (l/s)




D = ..... dm

d = ..... dm

h = ..... dm

Inside Dimensions in decimetres

$$V = \frac{\pi}{12} \times h \times (D^2 + D \times d + d^2)$$

# SITUATION SURVEY

**FORM C**

Name of Village: ..... Name of Surveyor: .....

Division: ..... Designation: .....

District: ..... Date: .....

| Station (from - to) | Compass Reading in grades | Distance m | Remarks and Sketches |
|---|---|---|---|
| ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... |

# HYDRAULIC SURVEY

Name of Village: ..... Division: ..... District: .....

Name of Surveyor: ..... Designation: ..... Date: .....

| Station (from - to) | Compass Reading in **grades** | Distance m | Vertical Angle in **grades** | Remarks | Distance D Vert | Station | Elevation |
|---|---|---|---|---|---|---|---|
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
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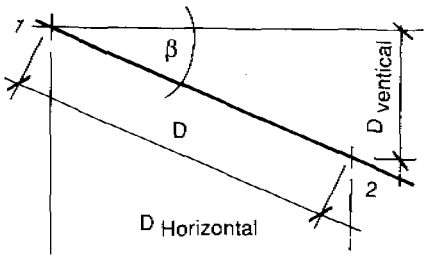
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |

**Explanations:**




D Horiz. = Distance x cos β

D Vert. = Distance x sin β

A2/4

FORM D

# FEASIBILITY OF PROJECT

**FORM E**

Name of Village: ..... Prepared by: .....

Division: ..... Designation: .....

District: ..... Date: .....

**Water Demand:**

| | Number (1) | Growth Factor (2) | Daily Consumption in l (3) | Demand (l/s) = (1)x(2)x(3) |
|---|---|---|---|---|
| Inhabitants | | | | |
| Students | | | | |
| | | | **Total Future Water Demand =** | |

**Explanations:**
(1) : Present Population
(2) : 1.24 (for 20 years)
(3) : 45 l/c x d (30 1/c x d in exceptional cases)

**Available Water:**

| | Spring 1 | Spring 2 | Spring 3 | Spring 4 | Total Yield |
|---|---|---|---|---|---|
| Max. Yield (l/s)(1) | | | | | |
| Min. Yield (l/s)(2) | | | | | |

**Explanations:**
(1) : Highest yield measured (refer to spring measurements)
(2) : Lowest yield measured (refer to spring measurements)

Safety factor : **0.9**
Total **safe yield**: 0.9 x Tot. Min. Yield = 09. x ..... = ..... **l/s**

Total **safe yield per day** : 0.9 x Tot. Min. Yield x 86'400

= 0.9 x ..... x 86'400 = ..... **l/d**

**Feasibility** : Check appropriate box :

[ ] **Project Feasible** ; more water available than demanded

[ ] **Project Not Feasible** : less water available than demanded

# FLOW RATE AT STANDPOSTS

**FORM F**

Name of Village : ..... Prepared by: .....

Division: ..... Designation: .....

District: ..... Date: .....

**Flow at Standposts / Taps:**

| Tap No. | Users People | (1) Pupils | Flow Rate l/s (3) | Storage Tank No. | Storage Tank People | (2) Pupils | Remarks (4) |
|---|---|---|---|---|---|---|---|
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
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| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... |
| Total | | | | | | | |

**Explanations:**

(1) : Future users (present population x growth factor)
(2) : Mark from which storage tank the tap gets water and add up the number of people or pupils per storage tank.
(3) : Flow rate according to the number of users (0.1 or 0.2 l/s)
(4) ; Give specific details e.g. tap for school, temple etc.

# FORM G

# VOLUME OF SEDIMENTATION CHAMBER DISTRIBUTION RATIO

Name of Village : ..... Prepared by: .....

Division: ..... Designation: .....

District: ..... Date: .....

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**Volume of Sedimentation Chamber / Silt Box:**

Flow (total maximum yield, see Form E): Q = ..... l/s
Retention Time: T = 1'200 s
Capacity: C = Q x T = ..... x 1'200 = ..... l

Select the correct sedimentation chamber / silt box from the ***standard drawing*** in the manual *Construction and Standardisation of Gravity Water Supply Schemes in Rural Villages in Sri Lanka.*

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**Water Demand per Storage Tank and Distribution Ratio:**

| Stor. Tank No. | No. of Beneficaries | | | | Demand per | | Distr. Factor (7) | Flow to Storage Tank (8) |
|---|---|---|---|---|---|---|---|---|
| | People (1) | l/d (2) | Pupils (3) | l/d (4) | Day (5) | Second (6) | | |
| 1 | | | | 6 | | | | |
| 2 | | | | 6 | | | | |
| 3 | | | | 6 | | | | |

**Explanations:**

(1) : No. of people
(2) : 45 l/d (30 l/d)
(3) : No. of pupils
(4) : 6 l/d

(5) = (1) x (2) + (3) x (4)
(6) = (5) / 86'400
(7) : Distribution factor in comparison with the other storage tanks
(8) = Total safe yield distr. according to (7)

# STORAGE TANK AND FLOW DIAGRAM

**FORM H**

Name of Village: ..... Prepared by: .....

Division: ..... Designation: .....

District: ..... Date: .....

**Volume of Storage Tank:**

**No. of Storage Tank:.....**

| Period | Inlet Q = ..... l/s | | Outlet D = ..... l/d | | Difference + / - | Water Level in litres |
|---|---|---|---|---|---|---|
| | Seconds | (1) lit. | % | (2) lit. | (3) | (4) |
| 05.30 - 08.30 | 10'800 | ..... | 30 | ..... | ..... | ..... |
| 08.30 - 11.30 | 10'800 | ..... | 10 | ..... | ..... | ..... |
| 11.30 - 13.30 | 7'200 | ..... | 15 | ..... | ..... | ..... |
| 13.30 - 16.00 | 9'000 | ..... | 10 | ..... | ..... | ..... |
| 16.00 - 19.00 | 10'800 | ..... | 30 | ..... | ..... | ..... |
| 19.00 - 05.30 | 37'800 | ..... | 5 | ..... | ..... | ..... |
| Daily Inlet = ..... | | | ..... = Daily Demand | | | Overflow |

Min. Storage Capacity = ..... l = .....$m^3$ ; Tank chosen .....$m^3$

Tank is filled within .....hours (must be less than 10 hours)

**Explanations:**

(1) = Q x seconds
(2) = D x %
(3) = (1) - (2)
(4) = sum of (3)

Inlet Q: Flow of Inlet
Water Level: Indicate whether + or -
Min. Storage Capacity = smallest (4), (negative)
Tank chosen : Refer to Standard Drawings

**Flow Diagram (hand sketch):**

# HYDRAULIC CALCULATION

Name of Village : ..... Division : ..... District : .....

Prepared by : ..... Designation : ..... Date : .....

| Station/ Tap | Elevation (m) | Static Head (m) | Distance (m) | Flow (l/s) | Desired Residual Head (m) | Desired Headloss (m)/Factor | Pipe ø (mm) | Actual Headloss Factor (%) | Friction Loss (m) | Friction Chainage (m) | Dynamic Head (m) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

# HYDRAULIC PROFILE

Name of Village:
Division:
District:

Prepared by:
Designation:
Date:

**Scales**:
Horizontal:
Vertical:

**Remarks:**

| | |
|---|---|
| Point No. | |
| Distance | (m) |
| Elevation | (m) |
| Static Head | (m) |
| Design | (1/s) |
| **Pipe Size (ISO 1'000)** | |
| Friction Factor | (%) |
| Friction Loss | (m) |
| Friction Chainage | (m) |
| Dynamic Head | (m) |

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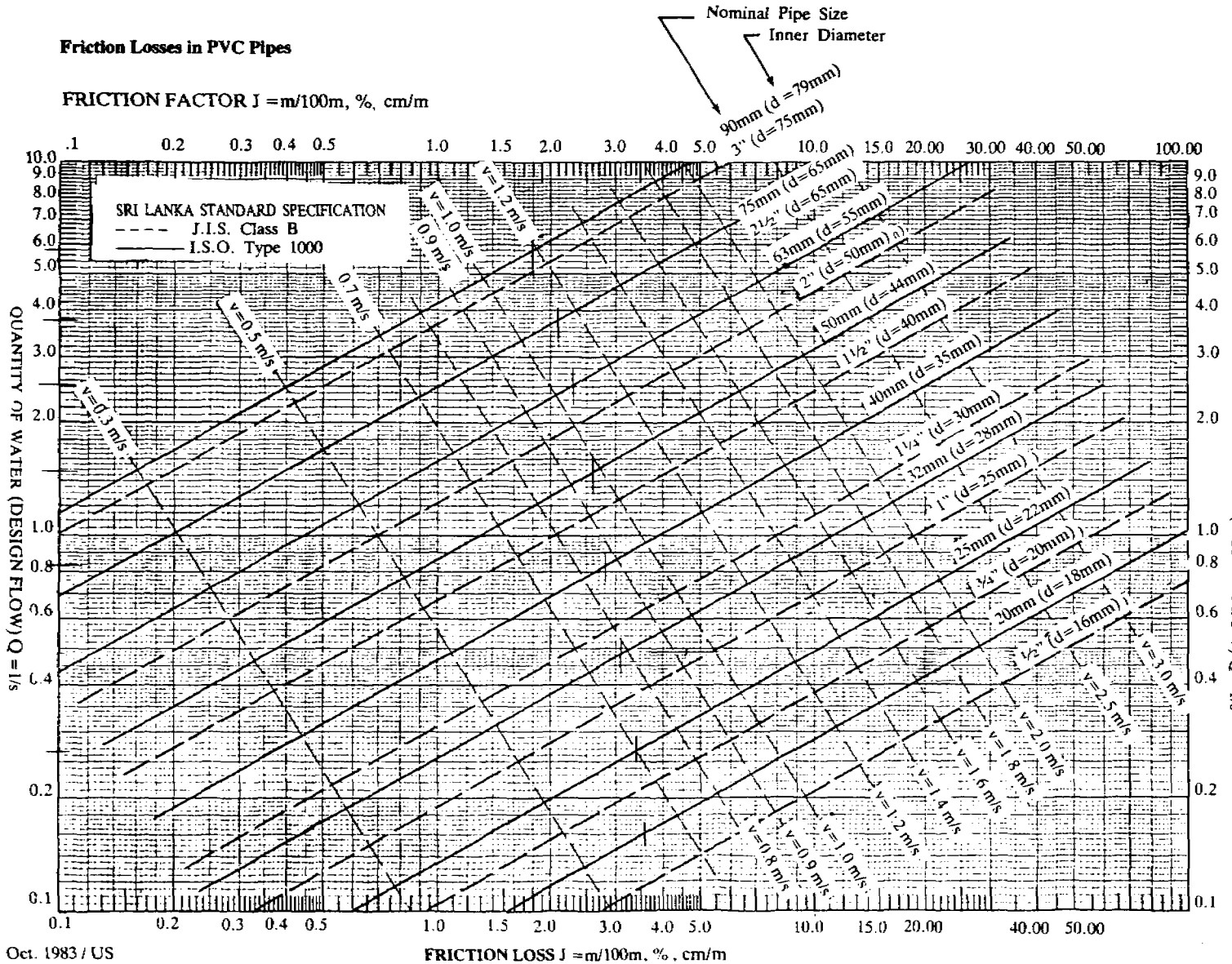
FORM J

**Friction Losses in PVC Pipes**

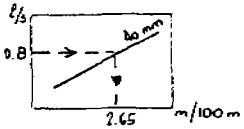



How to Read the Drawing :

Example:
Design Flow = 0.8 L
Pipe Length = 120m
Selected Pipe
=40mm (ISO)

Friction Loss =?

From Drawing:




Result:

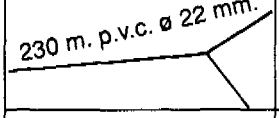
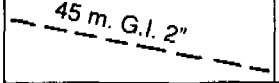
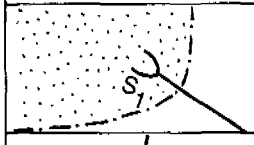
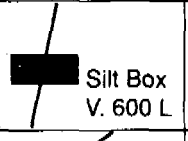
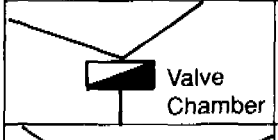
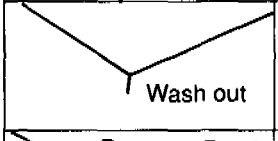
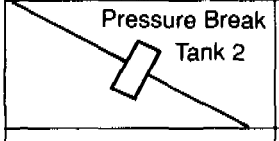
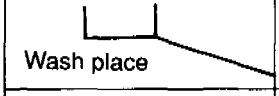
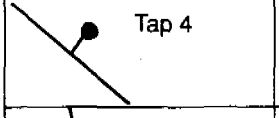
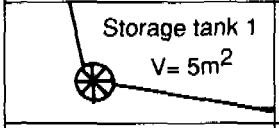
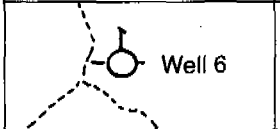
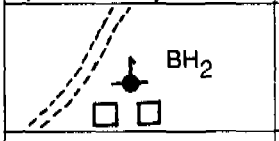
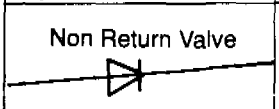
Friction Factor
2.65m/100m
Total Loss:
120m x 2.65m/100m =3.1m

Pipe Roughness K =0.01 mm
Water at 10°C(50F°)

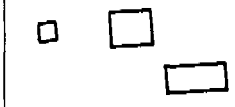
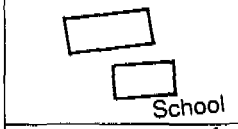
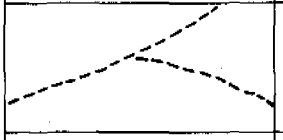
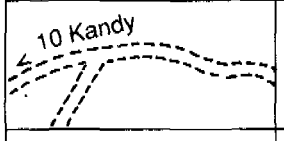
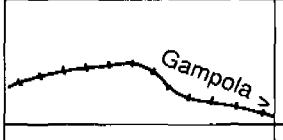
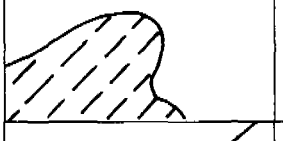
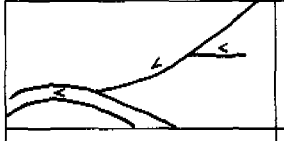
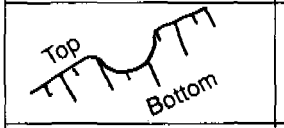
Oct. 1983 / US

**FORM K**

# SYMBOLS FOR DRAWINGS

| SYMBOL | USED FOR |
|---|---|
|   | Pipe Line (Supply, Distribution) |
|   | Existing Pipe Line |
|   | Spring with Protection Zone |
|   | Silt Box |
|   | Valve Chamber |
|   | Wash out with Plug |
|   | Pressure Break Tank |
|   | Wash Place |
|   | Stand Pipe |
|   | Storage Tank |
| | Well |
|   | Well with hand Pump |
|   | Bore Hole with Hand Pump |
|   | Non Return Valve |

For all Installations of the Water Supply use Pen 0.4 or 0.5, Lettering 3-4 mm.

| SYMBOL | USED FOR |
|---|---|
|  | Houses |
|   | Important Buildings |
|  | Foot Path |
|   | Road |
|   | Railway Line |
|  | Paddy Field |
|  | Rivers |
| | Forest |
| | Temple |
|   | Cliff, Steep Slope |
| | Bridge, Culvert |
| | Tea Land |
| | |
| | |

For all Natural and Man made Features use Pen 0.1 or 0.2 mm, Lettering 2 - 3 mm.

# EXAMPLE OF HEADER FOR SITUATION PLAN AND PIPE SCHEDULE

**Header:**

Name and Address of Organisation

## SITUATION PLAN OF

Name of Project

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Plan No. : | ..... | Date : | ..... | Amend-ments | Date | by: |
| Scale: | ..... | Drawn by: | ..... | | ..... | ..... |
| Map Sheet: | ..... | Surveyed by: | ..... | | ..... | ..... |
| | | | | | ..... | ..... |

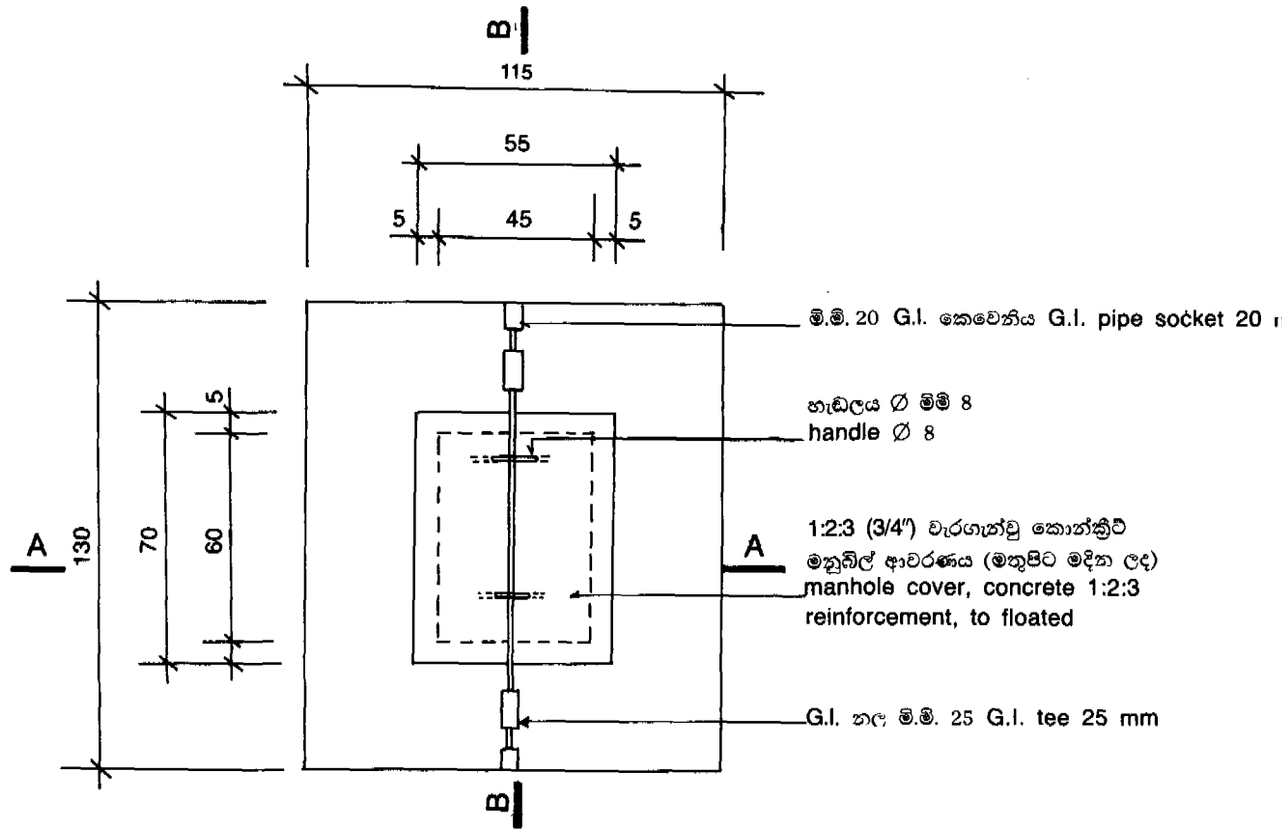
**Pipe Schedule:**

PVC - Pipes, I.S.O. 1'000

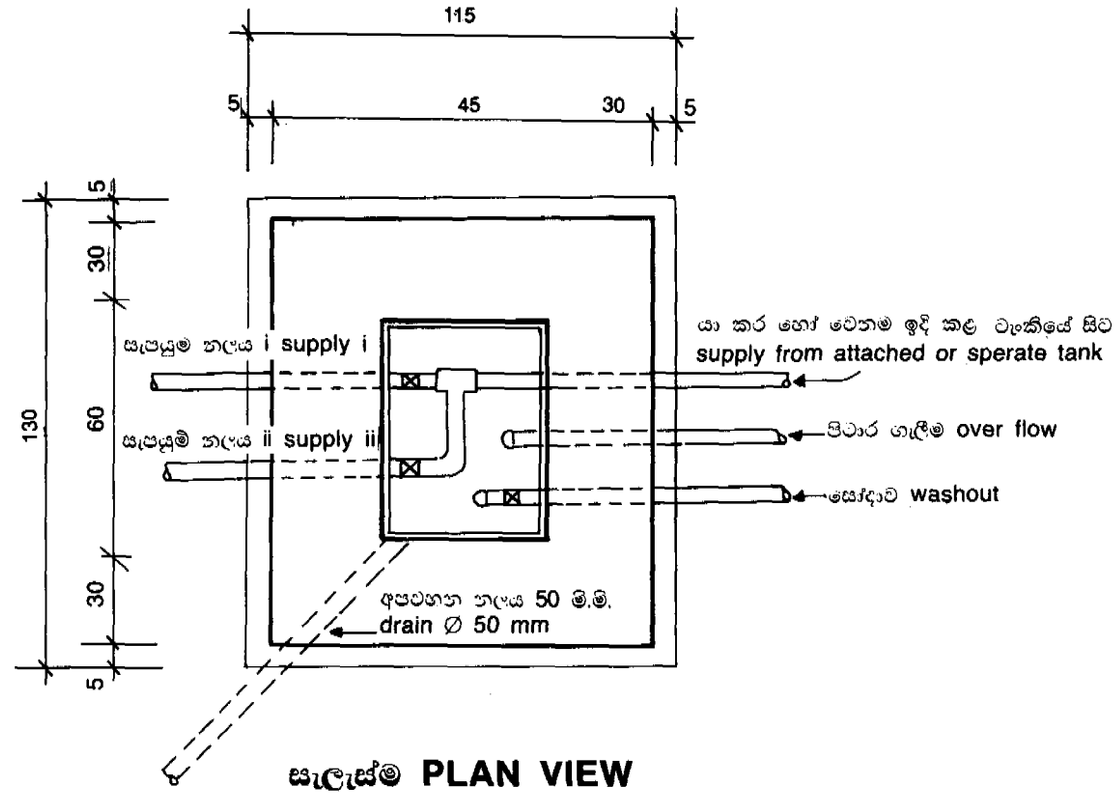
| From - To | Distance | Diameter | From - to | Distance | Diameter |
|---|---|---|---|---|---|
| | | | | | |

A2/13

FORM M

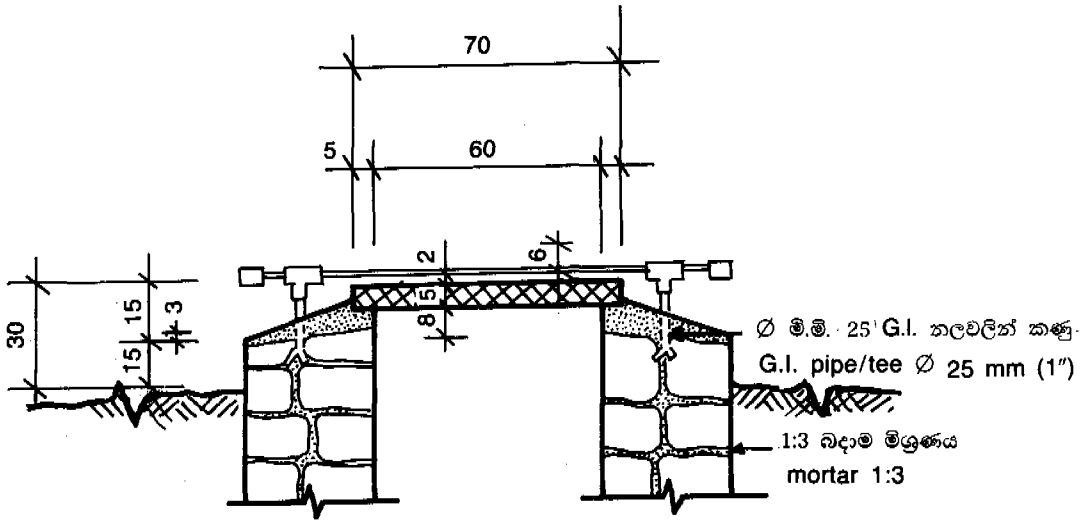



## මතුපිට පෙනුම TOP VIEW

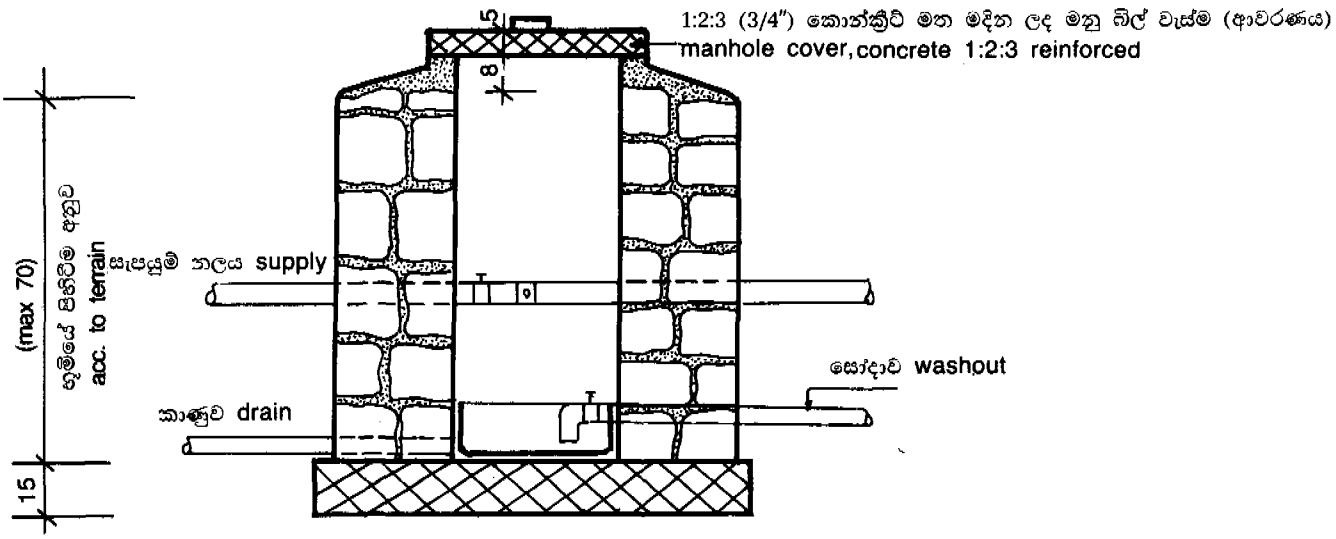



## සැලැස්ම PLAN VIEW

සටහන්:
සවිකිරීම් ද්‍රාව විද්‍යාත්මක ගණනය කිරීම්වලට අනුවය.
**Remarks:**
Installations according to hydraulic calculations




**B – B හරහා ඡේදීය පෙනුම SECTION B – B**




**A – A හරහා ඡේදීය පෙනුම SECTION A – A**

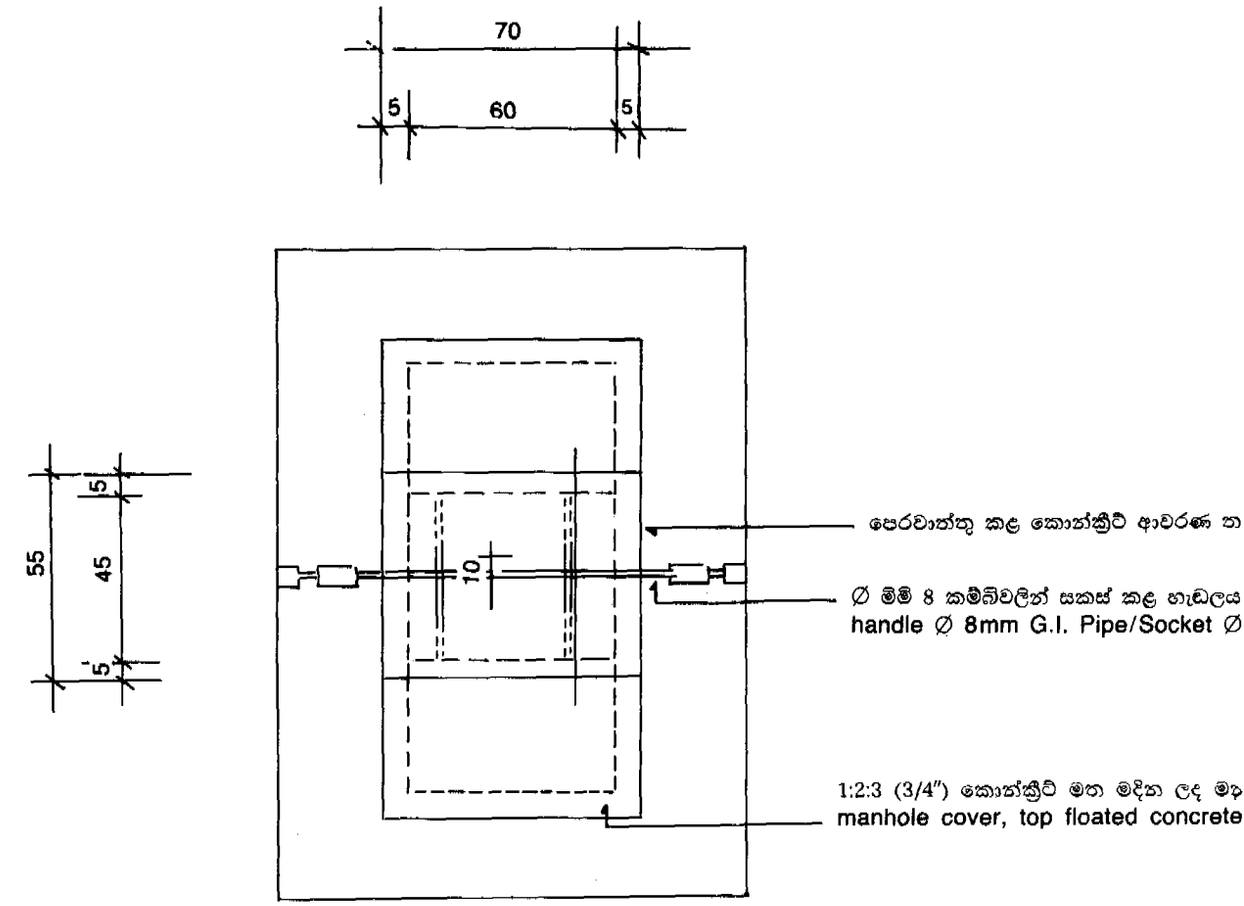
# කපාට කුටීරය VALVE CHAMBER

**60 × 45 cm**

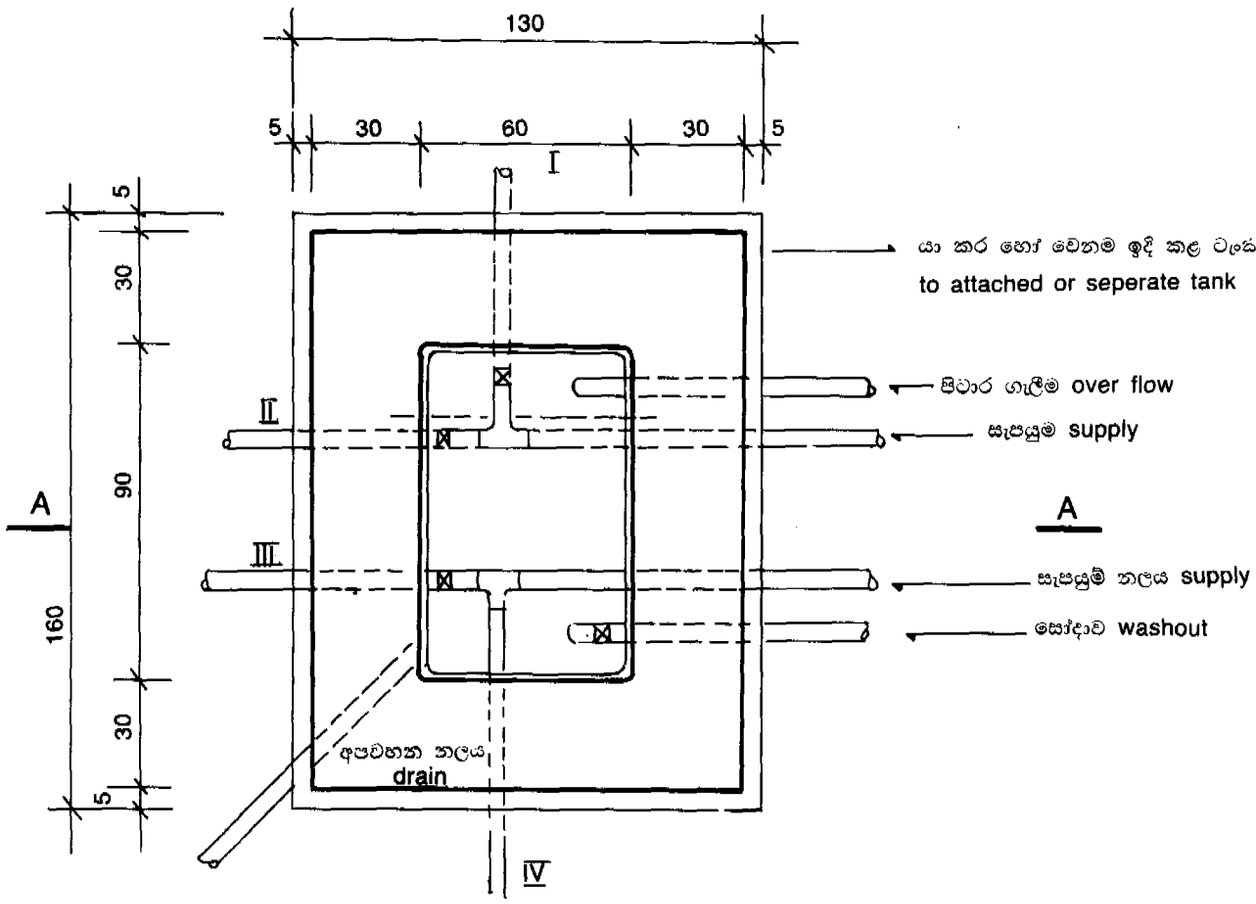
| | | | | | | |
|---|---|---|---|---|---|---|
| සුම් අංකය: ı No. | C-1 | දිනය: Date: | *April 1992* | | දිනය Date: | විසින් By: |
| ාණය: le: | 1:20 | අඳින ලැබුවේ: Drawn by: | *Kumuduni* | සංශෝධන Amendments | | |
| යම් පත්‍රය: Sheet: | — | සැලසුම් කළේ Designed by: | *H. Pf* | | | |

## ද්‍රව්‍ය ලැයිස්තුව List of materials

| | | | |
|---|---|---|---|
| සිමෙන්ති | cement | කොට්ට bags | 4.5 |
| වැලි | sand | $m^3$ | 0.7 |
| මැටල් ගල් | metal | $m^3$ | 0.6 |
| සක්ක ගල් | stones | $m^3$ | 0.8 |
| වැරගැන්වුම් | rebar ø 6 mm | kg | 4 |
| G.I. නල සවිකුරු | G.I. pipe/fittings | | yes |




## මතුපිට පෙනුම TOP VIEW



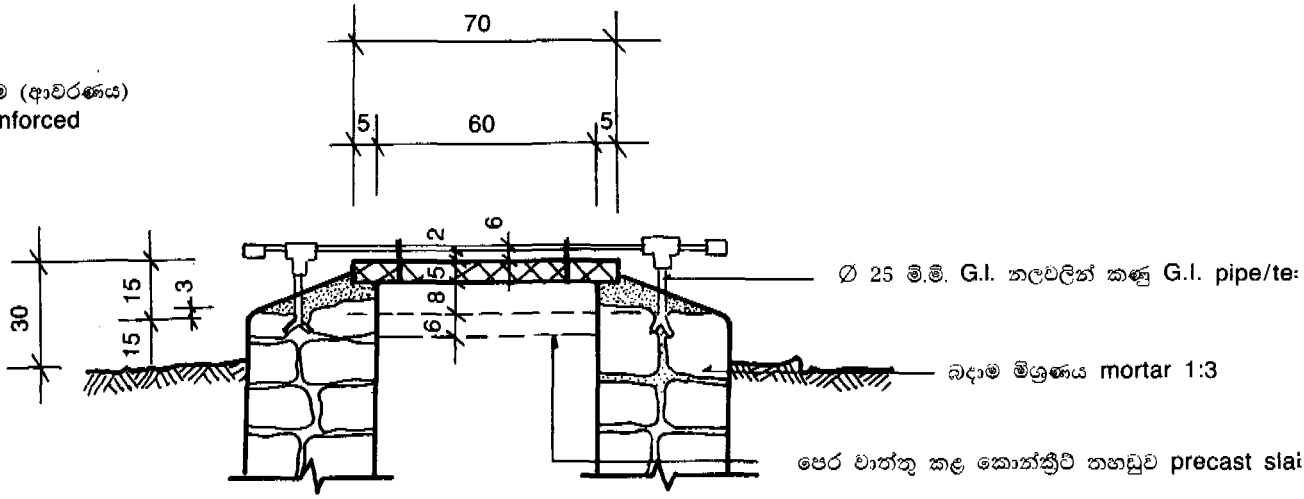

## සැලැස්ම PLAN VIEW

**සටහන්:**
සවිකිරීම් ද්‍රාව විද්‍යාත්මක ගණනය කිරීම්වලට අනුවය.
**Remarks:**
Installations according to hydraulic calculations

ඝඩුව precast cover slab

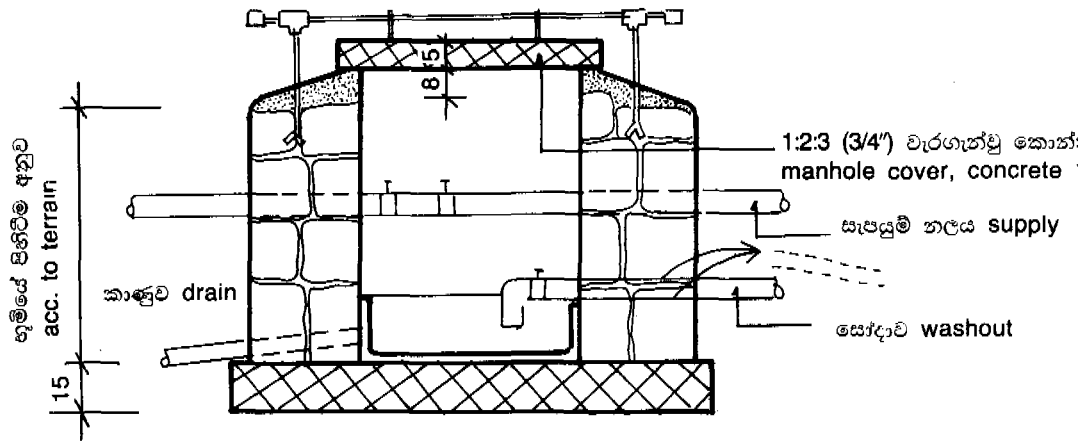
/ Ø මිමී 20 ගැල්වනයිස් කළ සහ කෙවනිය
20mm

බිල් වැස්ම (ආවරණය)
1:2:3 reinforced




## A – A හරහා ඡේදීය පෙනුම SECTION A – A

### (මනුබිල වැස්ම පිළිබඳ විස්තර Details of Manhole Cover)




## A – A හරහා ඡේදීය පෙනුම SECTION A – A

# කපාට කුටිරය VALVE CHAMBER

**60 × 90 cm**

| | | | | | | |
|---|---|---|---|---|---|---|
| ලසුම් අංකය: :n No. | **C - 02** | දිනය: Date: | ***April 1992*** | | දිනය Date: | විසින් By: |
| මාණය: ale: | **1:20** | අඳිනු ලැබුවේ: Drawn by: | ***Kumuduni*** | සංශෝධන Amendments | | |
| යම් පත්‍රය: p Sheet: | **—** | සැලසුම් කළේ Designed by: | ***H. Pf*** | | | |

## ද්‍රව්‍ය ලැයිස්තුව List of materials

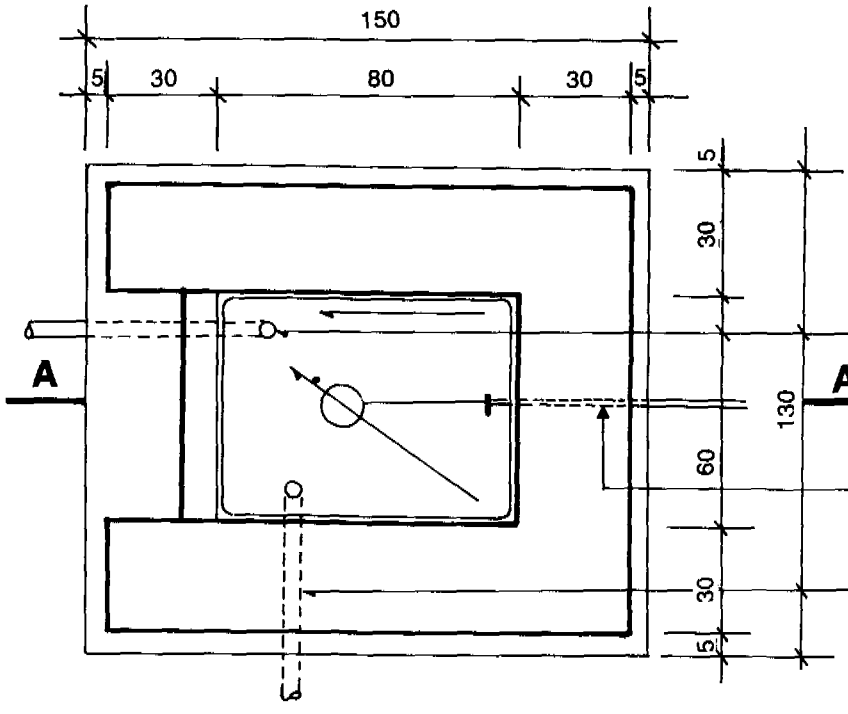
| | | | |
|---|---|---|---|
| සිමෙන්ති | cement | bags | 6 |
| වැලි | sand | $M^3$ | 0.9 |
| 3/4 මැටල් ගල් | metal 20 mm | $M^3$ | 0.8 |
| ගක්කගල් | stones | $M^3$ | 1 |
| වැරගැන්වුම් | rebar ø 6 mm | kg | 6 |
| G.I. නල | G.I. pipe fittings | | yes |

Ø 25 mm

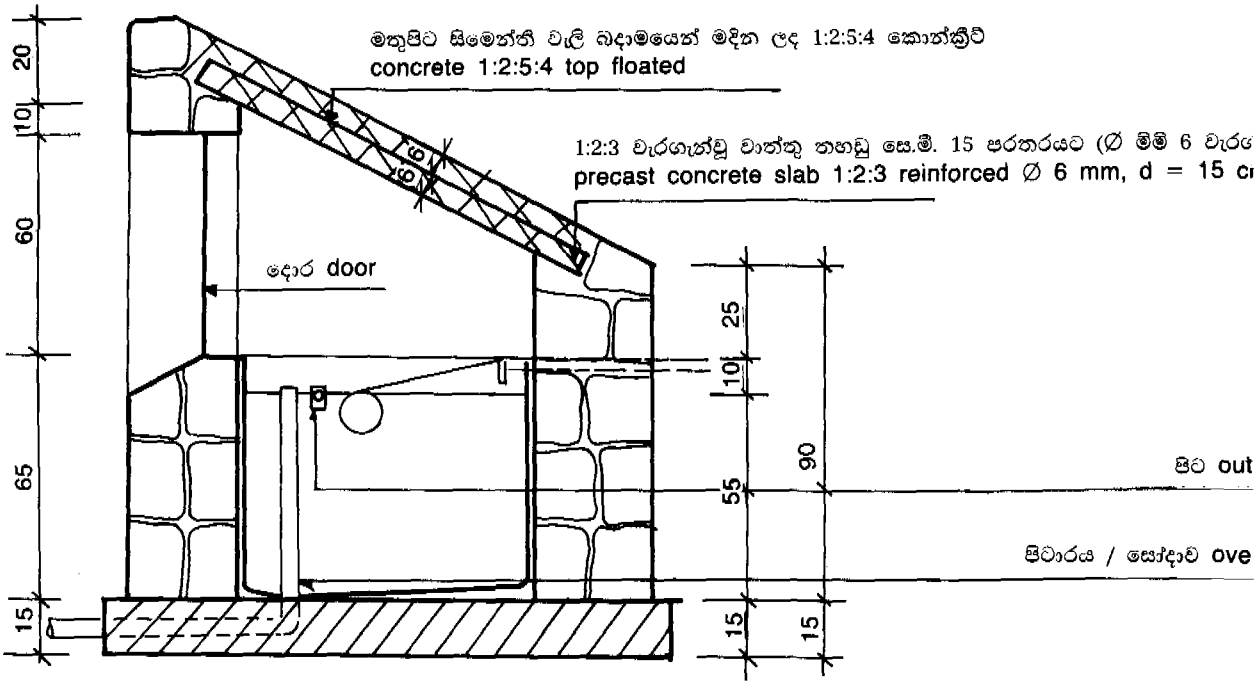
s

floated

## A වර්ගය TYPE A (බෝල කපාටය සහිත හෝ ර



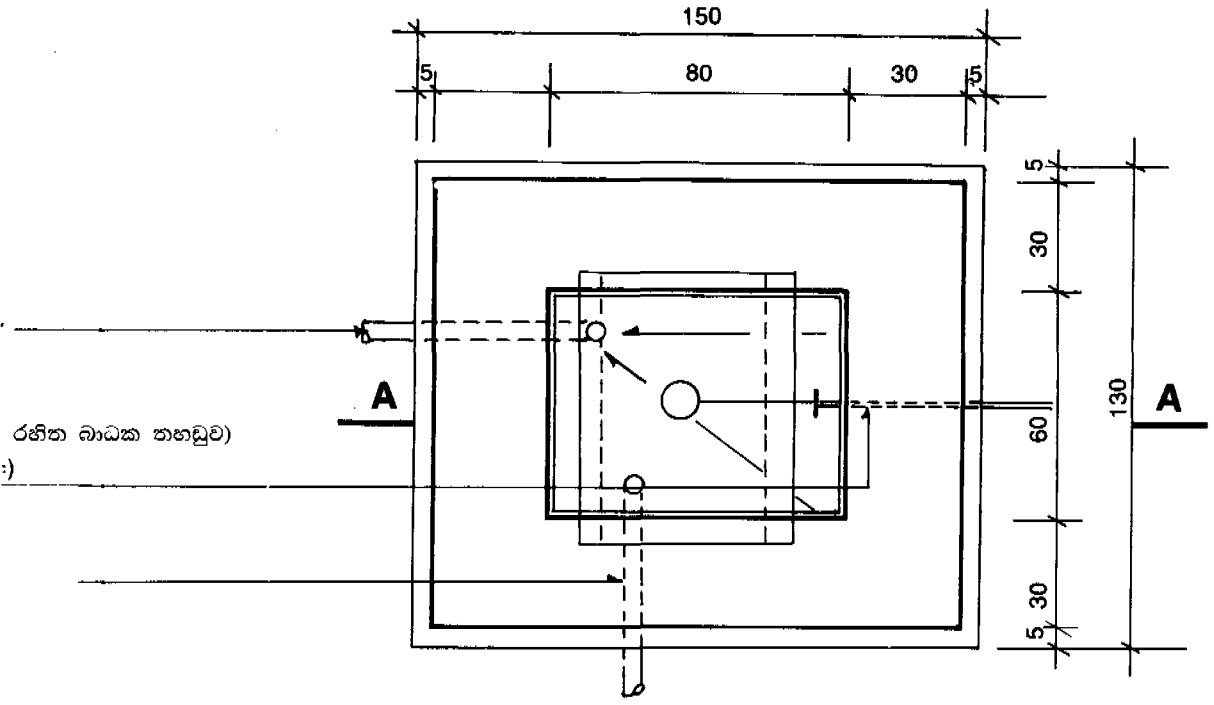

## සැලැස්ම PLAN VIEW



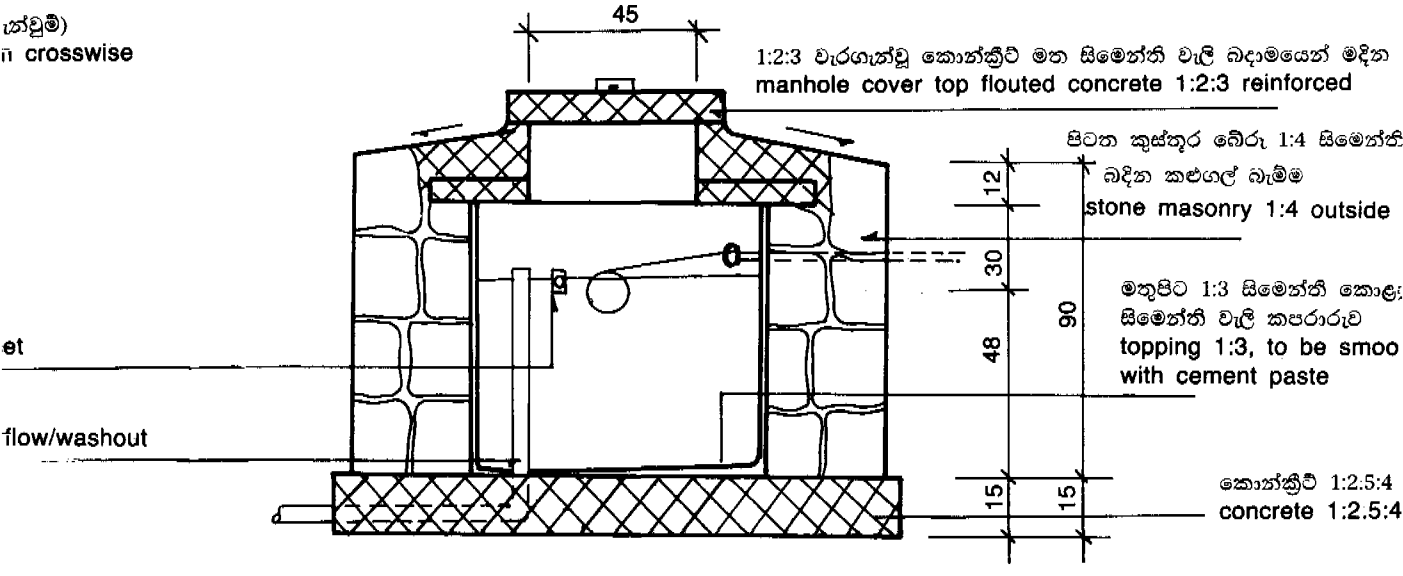

## A - A හරහා ඡේදීය පෙනුම SECTON A - A

ශිත) (WITH OR WITHOUT BALL VALVE)

## B වර්ගය TYPE B




## සැලැස්ම PLAN VIEW




## A - A හරහා ඡේදීය පෙනුම SECTON A - A

# ...ය මඩින ටැංකිය (BPT) හෝ රැස්කිරීමේ කුටිරය (වර්ගය A + B)

# BREAK PRESSURE TANK (BPT) OR COLLECTION CHAMBER (TYPE A + B)

| | | | | | | |
|---|---|---|---|---|---|---|
| ...සුම් අංකය: ...n No. | C - 03 | දිනය: Date: | April 1992 | | දිනය Date: | විසින් By: |
| ...මාණය: ...ale: | 1:20 | අඳින ලැබුවේ: Drawn by: | Kumuduni | සංශෝධන Amendments | | |
| ...යම් පත්‍රය: ...ip Sheet: | — | සැලසුම් කළේ Designed by: | R. St. & H. Pf | | | |

## ද්‍රව්‍ය ලැයිස්තුව List of materials

| | A වර්ගය Type A | B වර්ගය Type B |
|---|---|---|
| සිමෙන්ති කොට්ට cement bags | 9 | 7 |
| වැලි sand $m^3$ | 1.2 | 0.9 |
| මැටල් ගල් metal $m^3$ | 1 | 0.8 |
| සක්ක ගල් stones $m^3$ | 1.2 | 1 |
| වැරගැන්වුම් ⌀ 6 මි.මී rebar ø 6mm kg | 10 | 6 |
| වානේ දොර steel door pc | 1 | ... |
| ජී. අයි. නල සවිකුරු G.I. pipe fittings | no | yes |

...ද මනු බිල් ආවරණය

වැලි බදාමයෙන්

...key-pointing

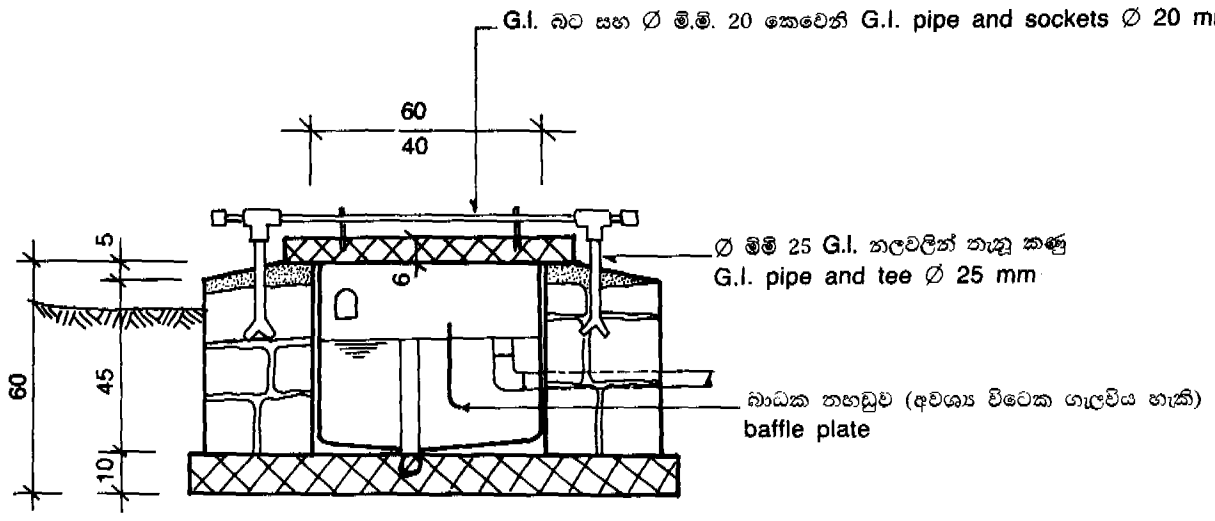
...ව

...hed

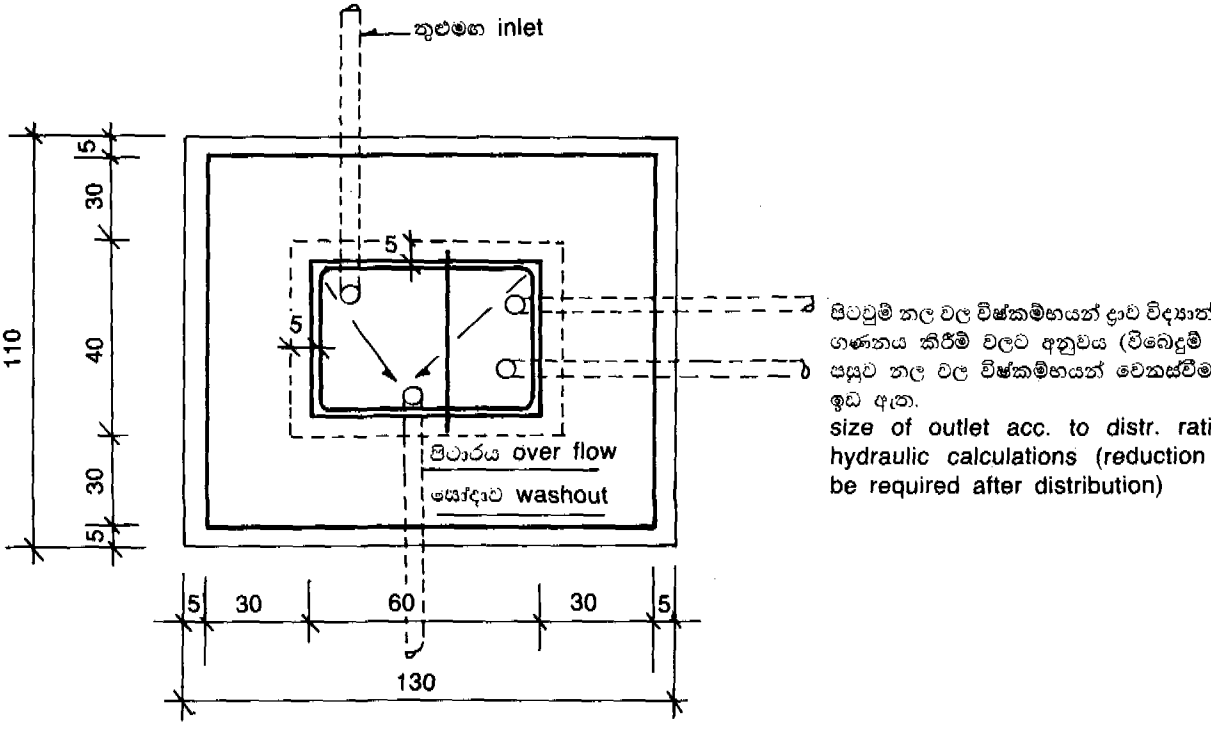
...3/4")
(3/4")

සැ.යු.
B වර්ගයේ කුටිරයේ මාන සෙ.මී 80 × 60 සිට සෙ.මී. 45 × 60 දක්වා වෙනස් කිරීමෙන් රැස්කිරීමේ කුටිරයක් ලෙස යොදා ගැනීමට සුදුසු වේ.
ගුලා කපාටයක් හෝ ඉසිල්ලක් අවශ්‍ය නොවන අවස්ථාවල දී 45 × 60 සෙ.මී. මාන සහිත කුටිරය පීඩන මඩින ටැංකියක් සඳහා සුදුසු වෙයි.

**Note:**
Type B is recommended for collection chambers by altering the measurements from 80 × 60 cm to 45 × 60 cm
The same size 45 × 60 can be used for pressure break chambers if no float or ball valve is needed.




## A – A හරහා ඡේදිය පෙනුම SECTION A – A




## සැලැස්ම PLAN VIEW

| විබෙදුම් අනුපාතය Distribution ratio | පිටමුව නලවල විෂ්කම්භය මි.මී. වලින් Diametre of outlets in mm | | | | |
|---|---|---|---|---|---|
| 1 : 2 | 25 / 32 | 50 / 63 | | | |
| 1 : 3 | 20 / 25 | | 63 / 75 | | |
| 1 : 4 | 25 | | 2 x 50 | | |
| 1 : 2 : 3 | 25 / 20 | 50 / 40 | 75 / 63 | | |
| 2 : 3 | | 32 / 25 | 50 / 32 | | |
| 2 : 5 | | 25 / 20 | | | 63 / 50 |
| 2 : 3 : 4 | | 25 | 32 | 50 | |
| 2 : 3 : 4 : 5 | | 20 | 32 | 40 | 50 |

## විබෙදුම් උදාහරණය Example of distribution

විබෙදුම් අනුපාතය (ද්‍රව විද්‍යාත්මක ගණනය කිරීම් වලට අනුකූලව) = 2:5
Distribution ratio (according to hydraulic calculations = 2:5)

පිටමුව වල විශ්කම්භය මිමී 25 සහ මිමී 63 හෝ මිමී 20 සහ මිමී 50
Diameter of outlets: either 25 mm and 63 mm or 20 mm and 50 mm

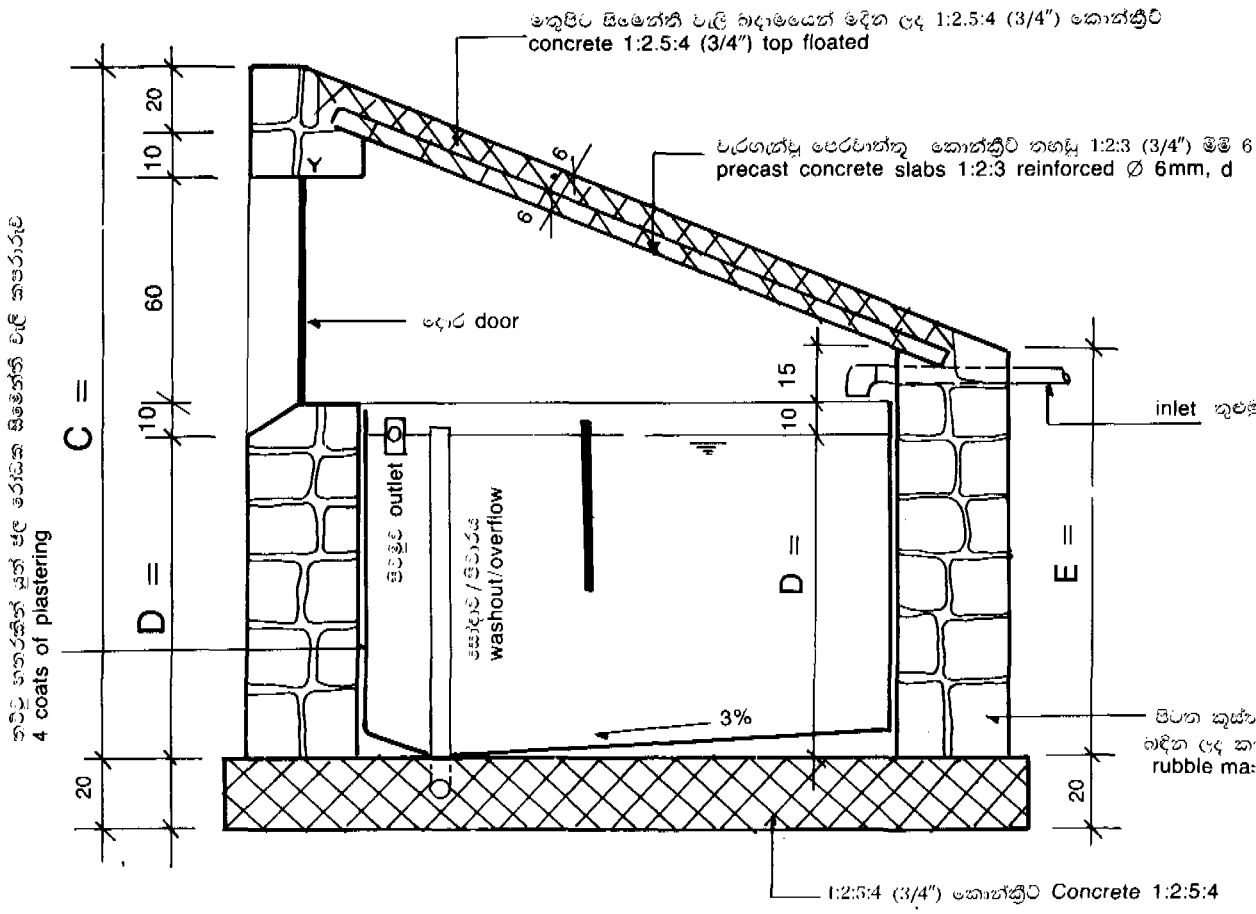
**වැදගත්:**
පිටමුව එල්බෝ නලවල ඉහළ කෙළවරවල් එක මට්ටමේ තිබිය යුතුය.
**Important:**
The tops of the outlet elbows have to be on the same elevation / level.

# විබෙදුම් කුටීරය DISTRIBUTION CHAMBER

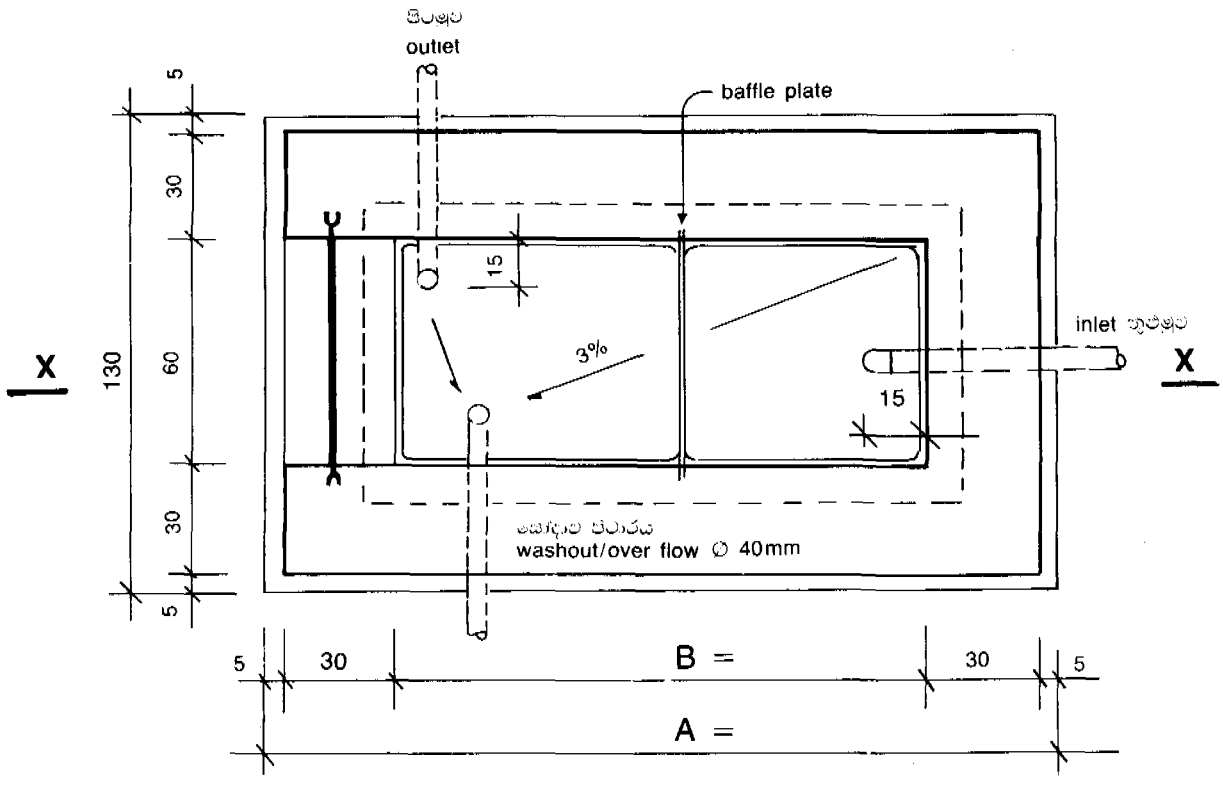
| | | | | | | |
|---|---|---|---|---|---|---|
| සැලසුම් අංකය: n No. | C - 04 | දිනය: Date: | April 1992 | | දිනය Date: | විසින් By: |
| මාණය: ale: | 1:20 | අඳිනු ලැබුවේ: Drawn by: | Kumuduni | සංශෝධන Amendments | | |
| යම් පත්‍රය: p Sheet: | — | සැලසුම් කළේ Designed by: | H. Pf | | | |

## ද්‍රව්‍ය ලැයිස්තුව List of materials

| | | | |
|---|---|---|---|
| සිමෙන්ති | cement | කොට්ට bags | 5 |
| වැලි | sand | $M^3$ | 0.5 |
| 3/4 මැටල් ගල් | metal | $M^3$ | 0.3 |
| පැතිගල් (හැඩකළ) | stones (shaped) | pcs | 250 |
| වැරගැන්වුම් ⌀ මි මී 6 කිග්‍රෑ | reinforcements 6 mm | kg | 1 |
| බාධක තහඩු | baffle plate | | 1 |
| G.I. නල | G.I. pipe | | yes |




## X – X හරහා ඡේදීය පෙනුම




## සැලැස්ම PLAN VIEW

Ø d = සෙ.මී. 15 පරතරයට
15cm 15 crosswise

ව

ර බේරු 1:4 සිමෙන්ති වැලි බදාමයෙන්
ගල් බැම්ම
:onry 1:4, out side key pointing

## මිමි / මාන සෙ.මී. වලිනි MEASUREMENTS / DIMENSIONS IN CM

| | රොන්මඩ කුටීරයේ පරිමාව Volume of silt box | | | | | |
|---|---|---|---|---|---|---|
| | 300 L | 400 L | 500 L | 600 L | 700 L | 800 L |
| A | 170 | 170 | 190 | 205 | 210 | 225 |
| B | 100 | 100 | 120 | 135 | 140 | 155 |
| C | 150 | 160 | 170 | 175 | 185 | 185 |
| D | 50 | 60 | 70 | 75 | 85 | 85 |
| E | 75 | 85 | 95 | 100 | 110 | 110 |

**සටහන:**
තුළුමුව සහ පිටමුවෙහි නලවල විෂ්කම්භයන් දුව විද්‍යාත්මක ගණනය කිරීම්වලට අනුවය.
**Note:**
Sizes of inlet and outlet according to hydraulic calculations.

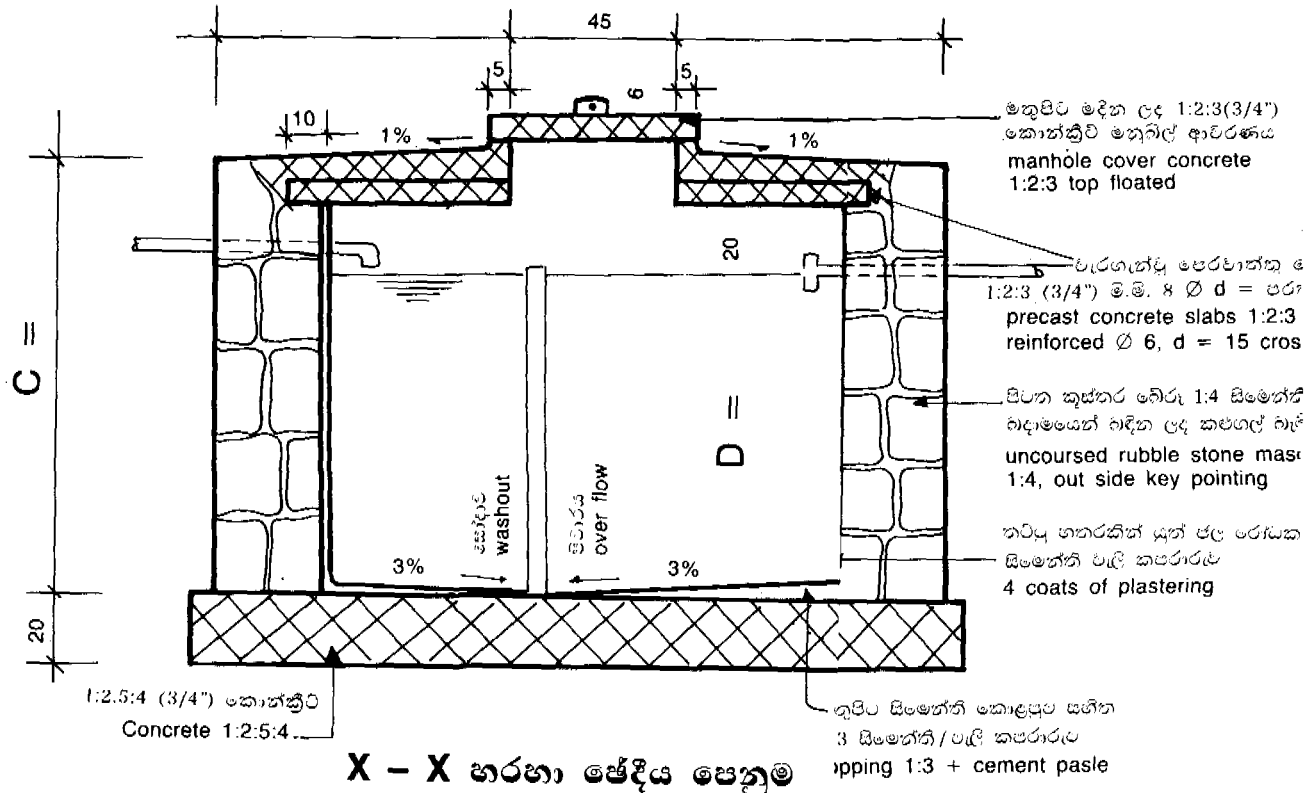
# රොන්මඩ කුටීරය (A වර්ගය)
# SILT BOX (TYPE A)

පරිමාව 300 ලී. වී 800 ලී. **Volume 300 L – 800 L**

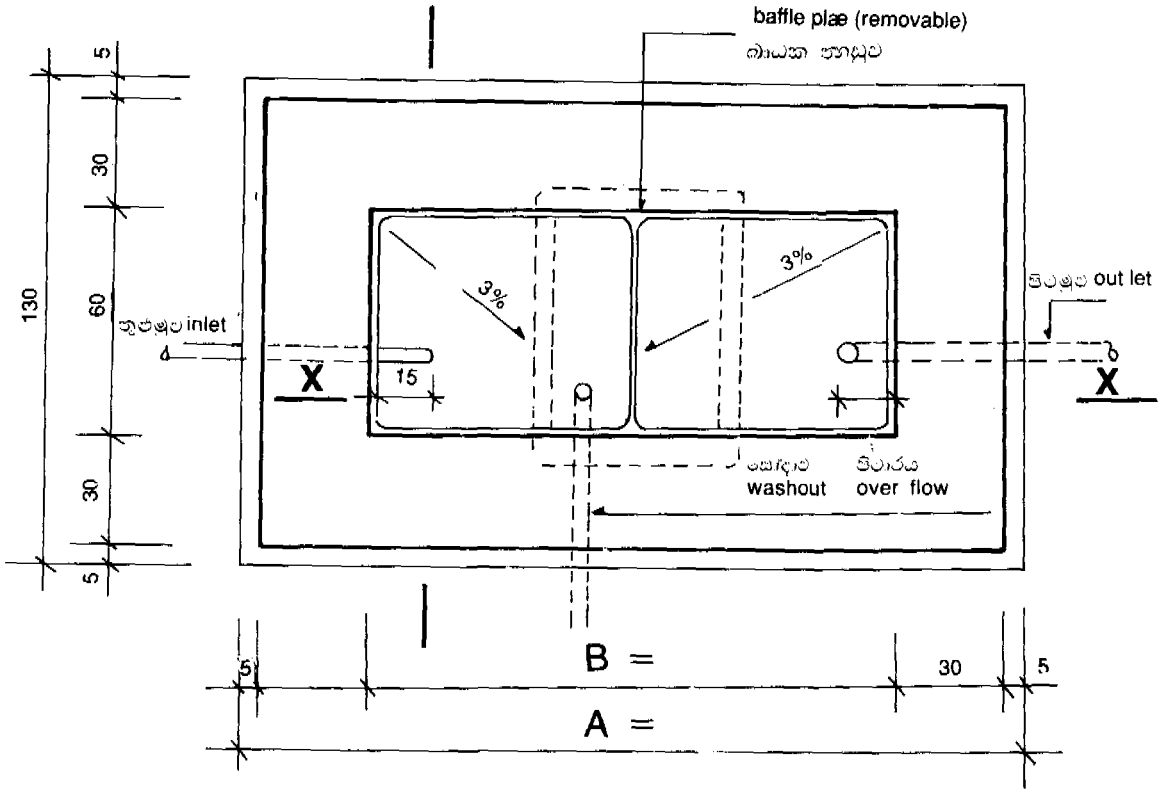
| | | | | | |
|---|---|---|---|---|---|
| ලසුම් අංකය: in No. **S-01** | දිනය: Date: ***April 1992*** | | දිනය Date: | වසින් By: |
| ාමාණය: ale: **1:20** | අඳින ලද්දේ: Drawn by: ***Kumuduni*** | සංශෝධන Amendments | | |
| ීයම් පත්‍රය: ip Sheet: | සැලසුම් කළේ Designed by: ***R. St. & H. Pf*** | | | |

## ලැයිස්තුව List of materials

| | | රොන්මඩ කුටීරයේ පරිමාව Volume of silt box | | | | | |
|---|---|---|---|---|---|---|---|
| | | 300 L | 400 L | 500 L | 600 L | 700 L | 800 L |
| සිමෙන්ති cement මෙකොටස bags | | 11 | 13 | 15 | 16 | 19 | 20 |
| ් තාවිටි sand | $m^3$ | 1.2 | 1.9 | 1.8 | 2.1 | 2.4 | 2.8 |
| ුල් ගල් metal | $m^3$ | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 |
| ගල් කැලි line stones | pcs | 240 | 260 | 310 | 350 | 390 | 420 |
| ගල් කැලි corner stones | pcs | 45 | 55 | 65 | 70 | 75 | 85 |
| හැල්ලුම් rebar ø 6mm | kg | 5 | 6 | 7 | 8 | 9 | 10 |
| ක තහඩු baffle plate | pc | 1 | 1 | 1 | 1 | 1 | 1 |
| entrance door 60 x 60 cm | pc | 1 | 1 | 1 | 1 | 1 | 1 |

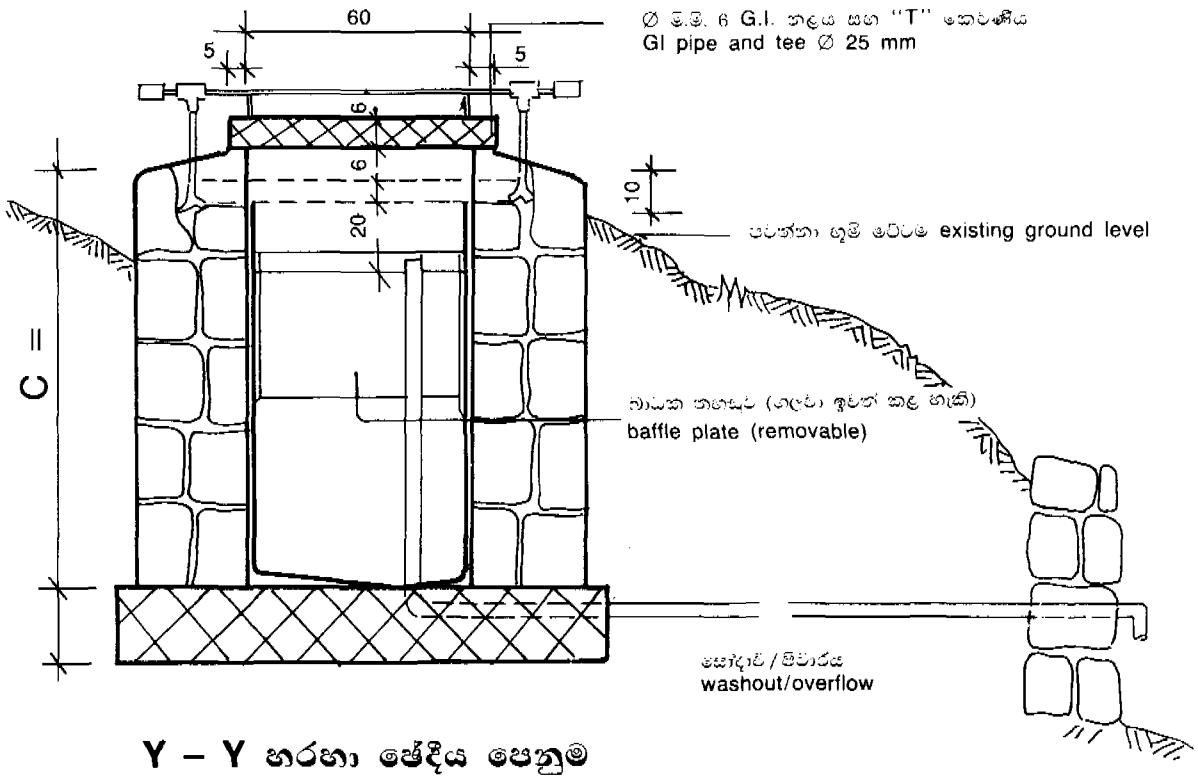



## X – X හරහා ඡේදීය පෙනුම
## SECTION X – X




## සැලැස්ම PLAN VIEW

| | රොන්මඩ කුටීරයේ පරිමාව<br>Volume of silt box | | | | | |
|---|---|---|---|---|---|---|
| | 300 L | 400 L | 500 L | 600 L | 700 L | 800 L |
| A | 170 | 170 | 190 | 205 | 210 | 225 |
| B | 100 | 100 | 120 | 135 | 140 | 155 |
| C | 82 | 92 | 102 | 107 | 117 | 117 |
| D | 50 | 60 | 70 | 75 | 85 | 85 |
| E | 57.5 | 57.5 | 67.5 | 75 | 77.5 | 85 |




## Y – Y හරහා ඡේදීය පෙනුම
## SECTION Y – Y

**සටහන:**
නුඹමුව සහ පිටමුවෙහි නලවල විෂ්කම්භයන් දැව විද්‍යාත්මක ගණනය කිරීම්වලට අනුවය.
**Note:**
Sizes of inlet and outlet according to hydraulic calculations.

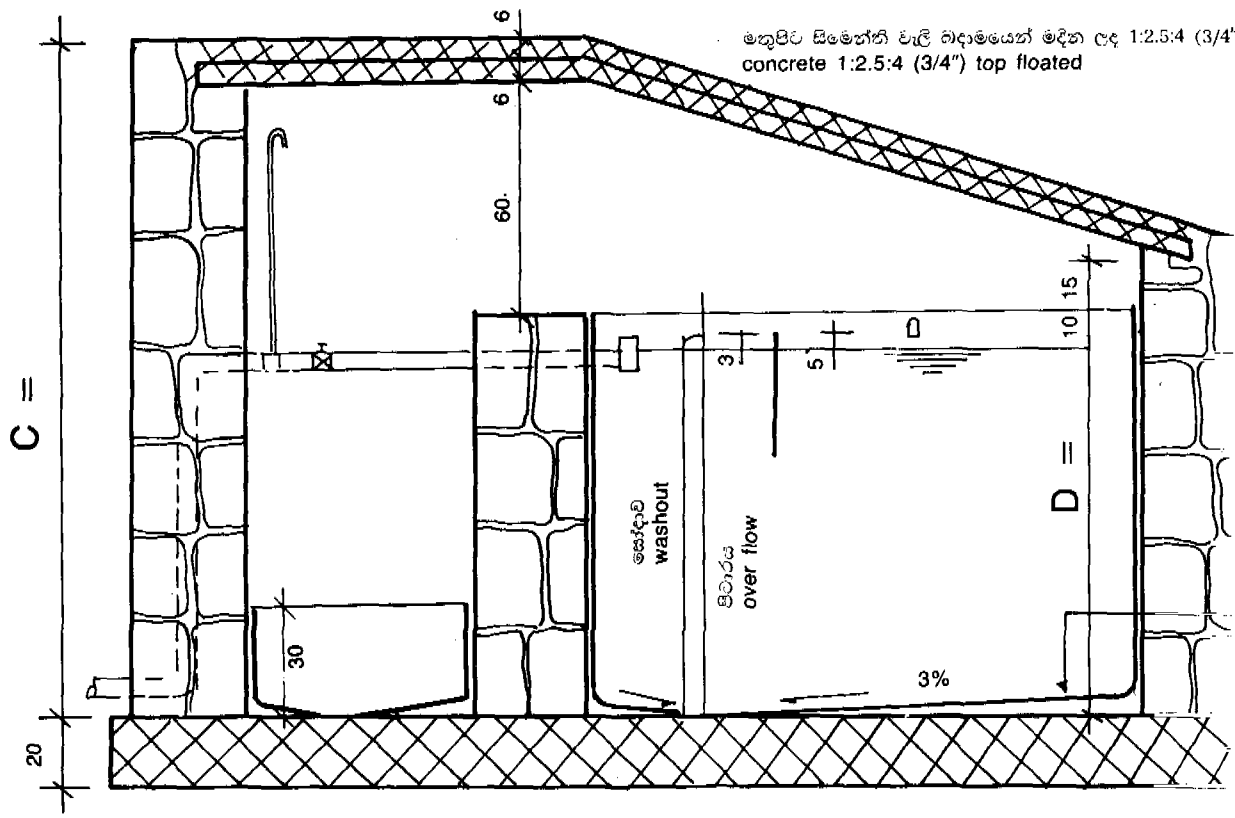
# රොන්මඩ කුට්ටිය (B වර්ගය)
# SILT BOX (TYPE B)

පරිමාව 300 ලී. සී 800 ලී. **Volume 300 L – 800 L**

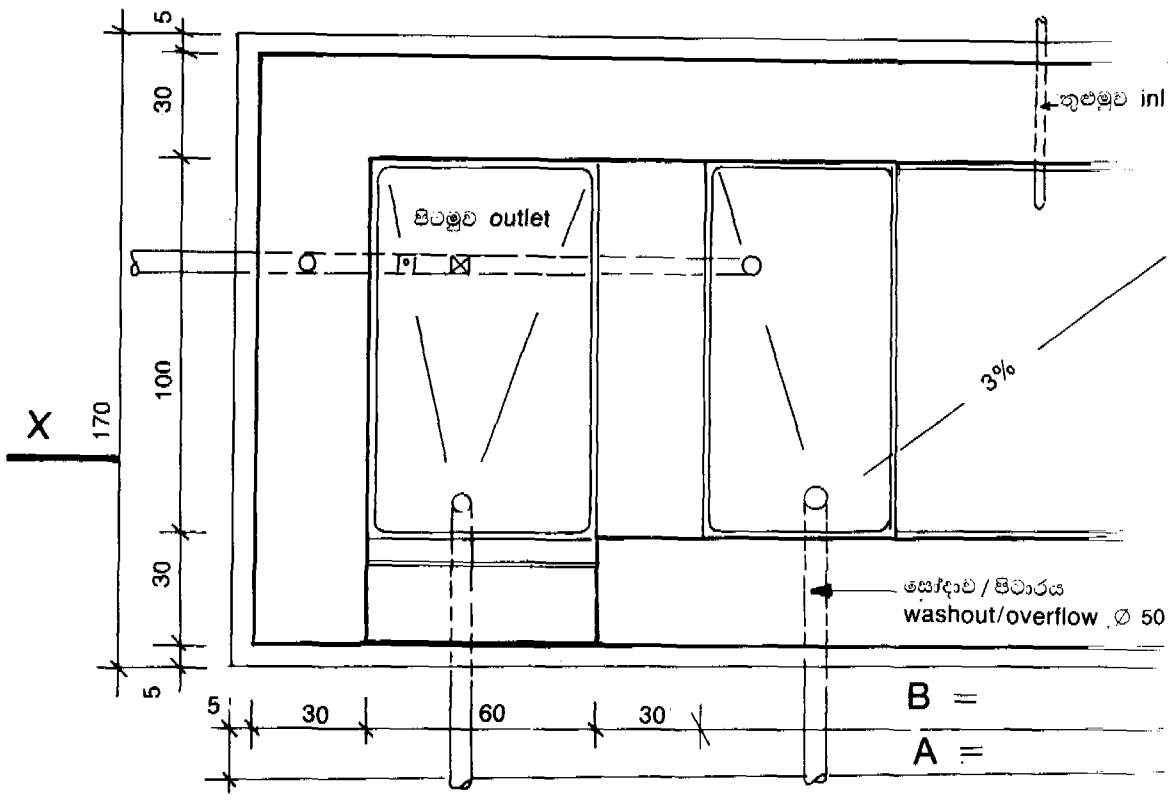
| | | | | | | |
|---|---|---|---|---|---|---|
| සැලසුම් අංකය: Plan No. | **S - 02** | දිනය: Date: | ***April 1992*** | | දිනය Date: | විසින් By: |
| පරිමාණය: Scale: | **1:20** | අඳින ලද්දේ: Drawn by: | ***Kumuduni*** | සංශෝධන Amendments | | |
| සිතියම් පත්‍රය: Map Sheet: | | සැලසුම් කළේ Designed by: | ***R. St. & H. Pf*** | | | |

## ද්‍රව්‍ය ලැයිස්තුව List of materials

| | | | රොන්මඩ කුට්ටියේ පරිමාව Volume of silt box | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 300 | 400 | 500 | 600 | 700 | 800 |
| සිමෙන්ති | cement බොටිල bags | | 10 | 11 | 13 | 14 | 16 | 17 |
| වැලි | sand | $m^3$ | 1 | 1.3 | 1.5 | 1.8 | 2 | 2.3 |
| ගරල් | metal | $m^3$ | 0.5 | 0.6 | 0.7 | 0.8 | 0.9 | 1 |
| සෑහි ගල් | line stones | pcs | 200 | 220 | 260 | 290 | 320 | 350 |
| මුල් ගල් | corner stones | pcs | 30 | 40 | 50 | 55 | 60 | 70 |
| යකගැන්වුම | rebar ø 6mm | kg | 4 | 5 | 6 | 7 | 8 | 9 |
| බාධක තහඩුව | baffle plate | | 1 | 1 | 1 | 1 | 1 | 1 |
| ගල සවිකුරු | G.I. pipe/fittings | | yes | yes | yes | yes | yes | yes |

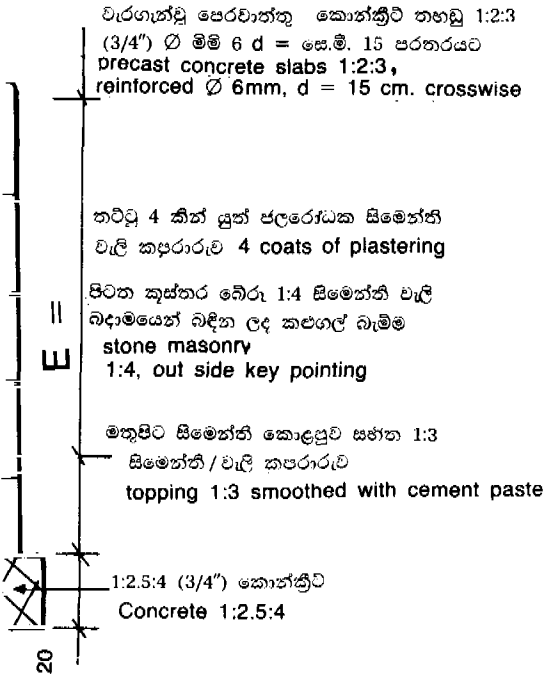



## X – X හරහා ඡේදීය පෙනුම SECTION X – X

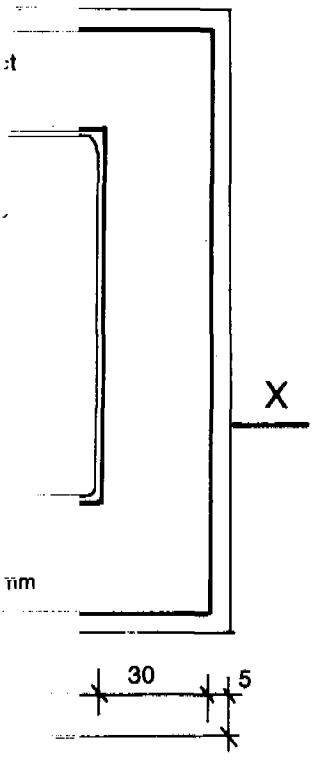



## සැලැස්ම PLAN VIEW

) කොන්ක්‍රීට්




## මිමි / මාන සෙ.මී. වලින්
## MEASUREMENTS / DIMENSIONS IN CM




| | රොන්මඩ කුටීරයේ පරිමාව Volume of silt box | | | |
|---|---|---|---|---|
| | 1000 L | 1200 L | 1500 L | 2000 L |
| A | 277 | 293 | 310 | 341 |
| B | 117 | 133 | 150 | 181 |
| C | 167 | 172 | 182 | 192 |
| D | 85 | 90 | 100 | 110 |
| E | 110 | 115 | 125 | 135 |

**සටහන:**
තුළුමුව සහ පිටමුවෙහි නලවල විෂ්කම්භයන් දාව විද්‍යාත්මක ගණනය කිරීම්වලට අනුවය.
**Note:**
Sizes of inlet and outlet according to hydraulic calculations.

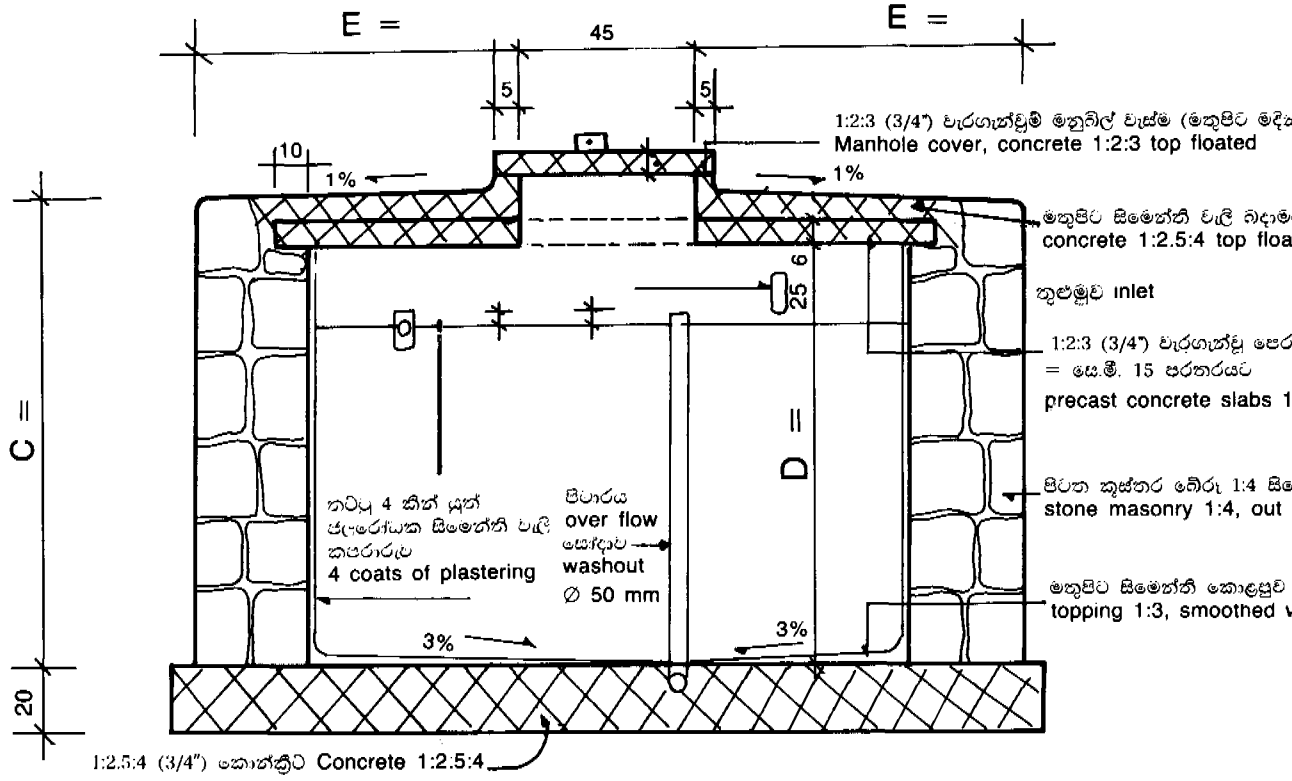
# කපාට කුටීරය සහිත රොන්මඩ කුටීරය (A වර්ගය)
# SILT BOX WITH VALVE CHAMBER (TYPE A)

පරිමාව 1000 - 2000 ලී. **Volume 1000 L – 2000 L**

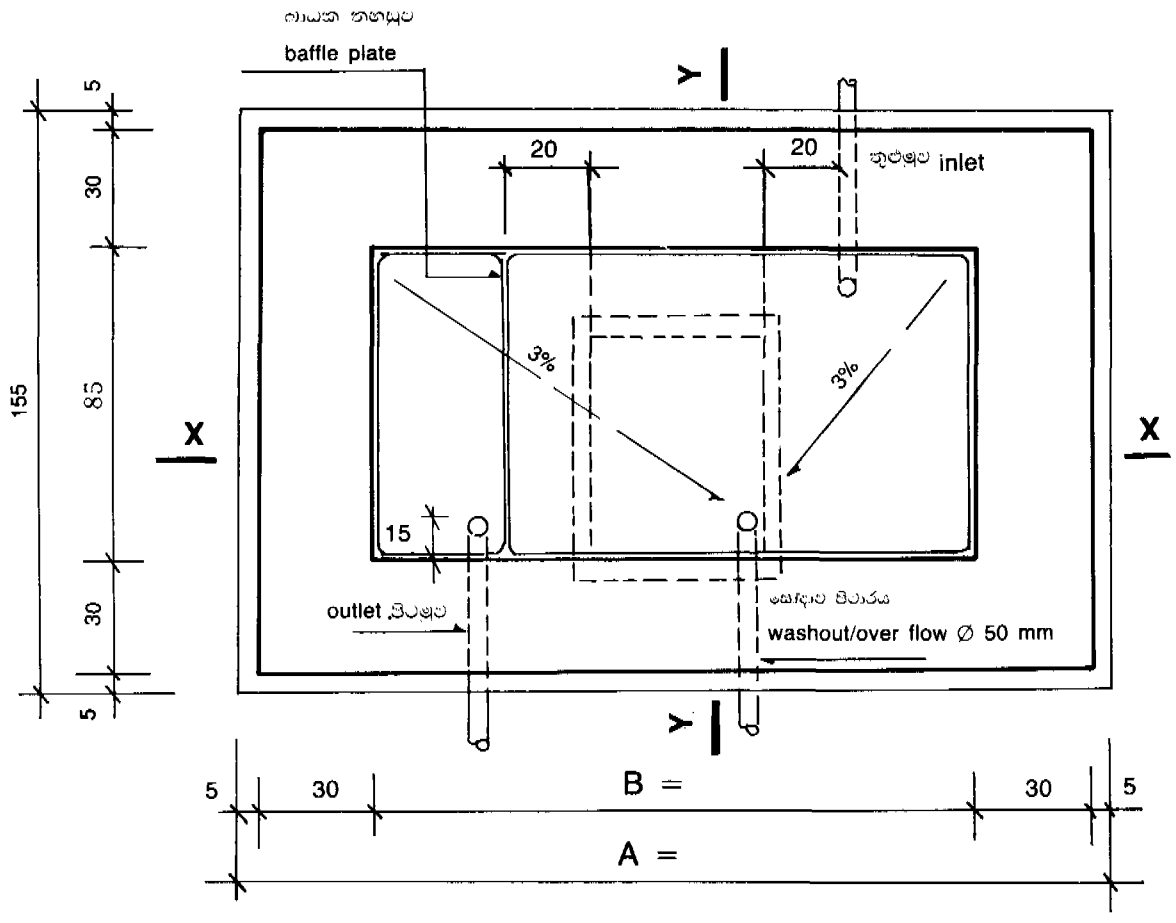
| | | | | | | |
|---|---|---|---|---|---|---|
| සැලසුම් අංකය: Plan No. | **S-03** | දිනය: Date: | ***April 1992*** | | දිනය Date: | විසින By: |
| පරිමාණය: Scale: | **1:20** | අඳින ලදුව් Drawn by: | ***Kumuduni*** | සංශෝධන Amendments | | |
| පිටපත් පත්‍රය: Map Sheet: | **–** | නිර්මාණය Designed by: | ***R. St. & H. Pf*** | | | |

## ද්‍රව්‍ය ලැයිස්තුව List of materials

| | | | රොන්මඩ කුටීරය Volume of silt box | | | |
|---|---|---|---|---|---|---|
| | | | 1000 L | 1200 L | 1500 L | 2000 L |
| සිමෙන්ති | cement | කොට්ට bags | 22 | 24 | 26 | 30 |
| වැලි නාවිටි | sand | $M^3$ | 2.9 | 3.1 | 3.5 | 4 |
| 3/4 මැටල් ගල් | metal | $M^3$ | 1.3 | 1.4 | 1.5 | 1.7 |
| පැති ගල් කැලි ම්ම කිහුෑ | line stones | pcs | 450 | 530 | 600 | 870 |
| මුල් ගල් කැලි | corner stones | pcs | 90 | 105 | 120 | 150 |
| වැරගැන්වුම් | rebar ø 6mm | kg | 12 | 14 | 16 | 19 |
| තහඩු | baffle plate | pc | 1 | 1 | 1 | 1 |
| පිවිසීමේ දොර | entrance door 60 x 100 | pc | 1 | 1 | 1 | 1 |




## X – X හරහා ඡේදීය පෙනුම SECTION X – X




## සැලැස්ම PLAN VIEW

ලද)

යන් මදින ලද 1:2.5:4 කොන්ක්‍රීට්
ed

ාත්තු කොන්ක්‍රීට් තහඩු Ø මිමි 6 d

2:3 re-rods Ø 6, d = 15 mm crosswise

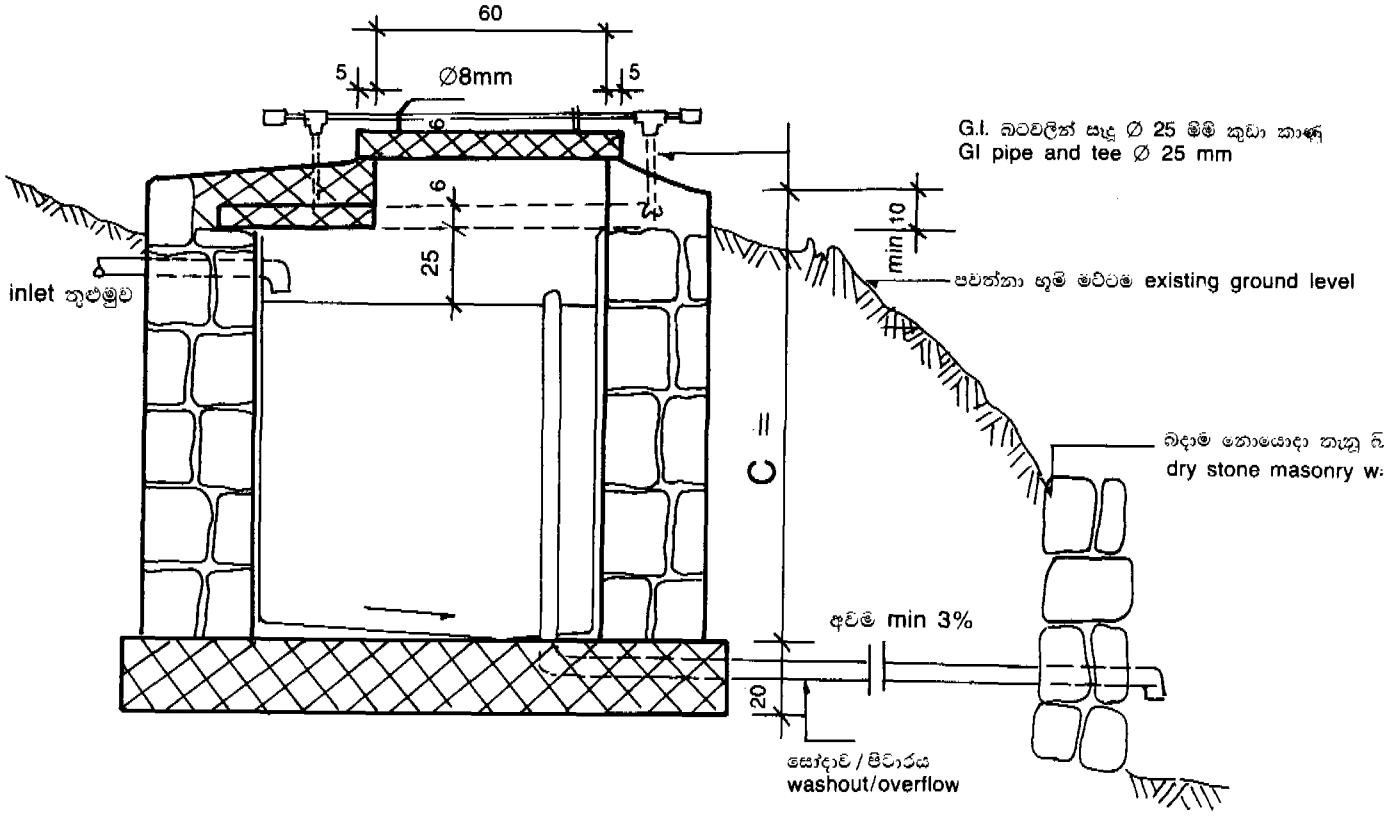
ඕන්නි වැලි බදාමයෙන් බඳින ලද කළඟල් බැම්ම
ide key pointing

සහිත 1:3 සිමෙන්ති / වැලි කපරාරුව
ith cement paste

## මිමි / මාන සෙ.මී. වලින්
## MEASUREMENTS / DIMENSIONS IN CM

| | රොන්මඩ කුටීරයේ පරිමාව Volume of silt box | | | |
|---|---|---|---|---|
| | 1000 L | 1200 L | 1500 L | 2000 L |
| A | 220 | 230 | 250 | 285 |
| B | 150 | 160 | 180 | 215 |
| C | 122 | 127 | 137 | 147 |
| D | 85 | 90 | 100 | 110 |
| E | 82.5 | 87.5 | 97.5 | 115 |

**සටහන:**
තුළුම්මුව සහ පිටමුවෙහි නලවල විෂ්කම්භයන් ද්‍රව විද්‍යාත්මක ගණනය කිරීම්වලට අනුවය.
**Note:**
Sizes of inlet and outlet according to hydraulic calculations.




## Y – Y හරහා ඡේදීය පෙනුම SECTION Y – Y

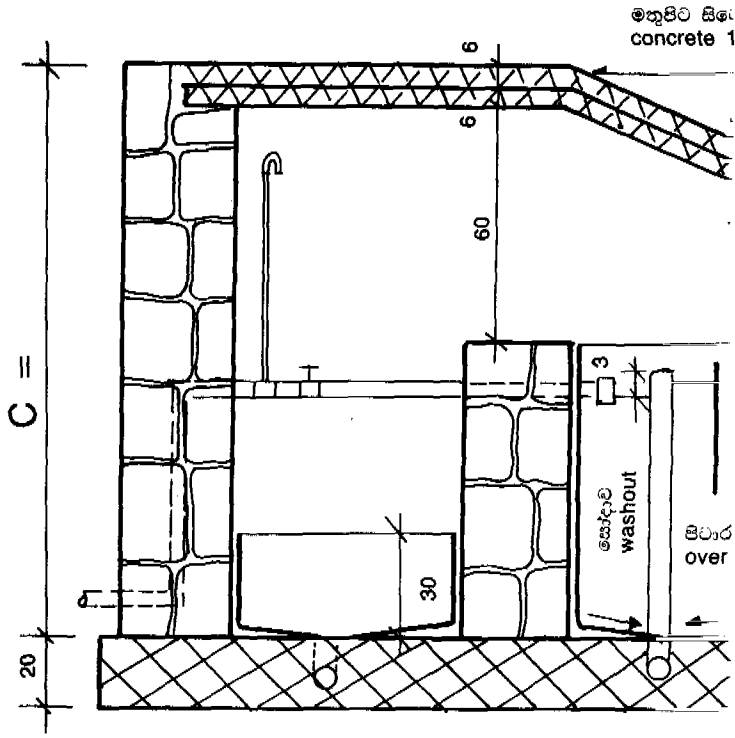
# රොන්මඩ කුට්ටිය (B වර්ගය)
# SILT BOX (TYPE B)

## පරිමාව 1000 ලී. වි 2000 ලී. Volume 1000 L – 2000 L

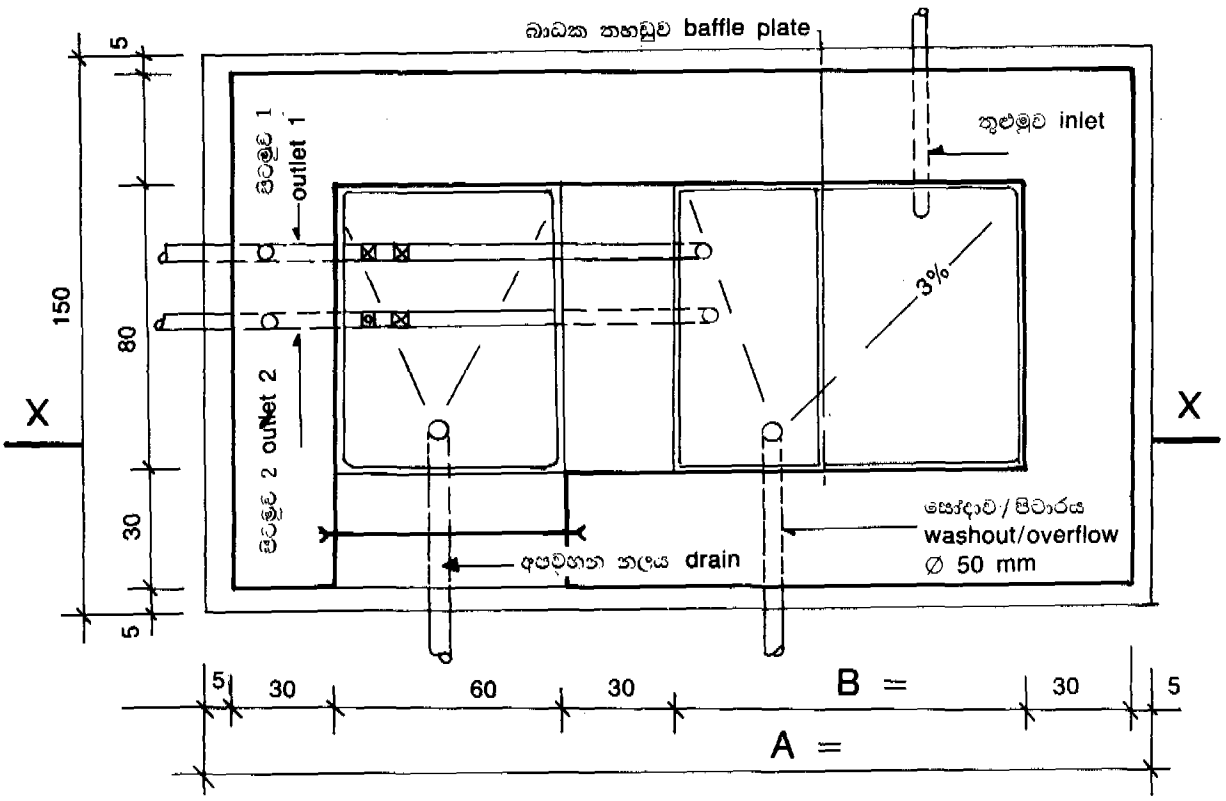
| | | | | | | |
|---|---|---|---|---|---|---|
| සැලසුම් අංකය: Plan No. | **S - 04** | දිනය: Date: | ***April 1992*** | | දිනය Date: | විසින් By: |
| පරිමාණය: Scale: | **1:20** | අඳින ලැබුවේ: Drawn by: | ***Kumuduni*** | සංශෝධන Amendments | | |
| ද්විතියම පත්‍රය: Map Sheet: | **—** | සැලසුම් කළේ Designed by: | ***R. St. & H. Pf*** | | | |

## ද්‍රව්‍ය ලැයිස්තුව List of materials

| | | | රොන්මඩ කුට්ටියේ පරිමාව Volume of silt box | | | |
|---|---|---|---|---|---|---|
| | | | 1000 L | 1200 L | 1500 L | 2000 L |
| සිමෙන්ති | cement කොට්ට bags | | 19 | 21 | 23 | 25 |
| වැලි | sand | $M^3$ | 2.5 | 2.7 | 2.8 | 3 |
| 3/4 මැටල් ගල් | metal | $M^3$ | 1.2 | 1.3 | 1.4 | 1.6 |
| පැති ගල් | line stones | pcs | 380 | 410 | 480 | 570 |
| මුල් ගල් | corner stones | pcs | 75 | 80 | 85 | 90 |
| වැරගැන්වුම් | rebar ø 6 mm | kg | 11 | 13 | 15 | 17 |
| බාධක තහඩු | baffle plate | pcs | 1 | 1 | 1 | 1 |
| නල සවිකුරු | G.I. pipes fittings | | yes | yes | yes | yes |



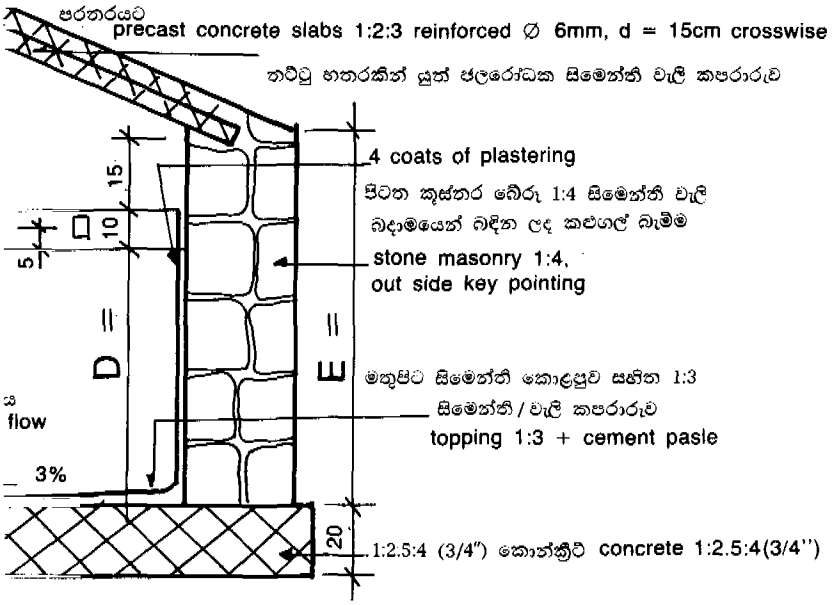

**X – X හරහා ඡේදීය පෙ**




**සැලැස්ම PLAN VIEW**

ෙන්නී වැලි බදාමයෙන් මදින ලද 1:2.5:4 (3/4") කොන්ක්‍රීට්
:2:5:4 top floated

වැරගැන්වූ පෙරවාත්තු කොන්ක්‍රීට් තහඩු 1:2:3 (3/4") Ø මිමී 6 d = සෙ.මී. 15




සැලසුම්
Plan N

පරිමාණ
Scale:

සිතියම්
Map Si

ද්‍රව්‍ය ලැ

## හරස්කඩ SECTION X – X

### මිමී / මාන සෙ.මී. වලින් MEASUREMENTS / DIMENSIONS IN CM

| | Volume of silt box | | | | | |
|---|---|---|---|---|---|---|
| | 300 L | 400 L | 500 L | 600 L | 700 L | 800 L |
| A | 235 | 245 | 250 | 265 | 265 | 275 |
| B | 75 | 85 | 90 | 105 | 105 | 115 |
| C | 132 | 142 | 152 | 157 | 167 | 167 |
| D | 50 | 60 | 70 | 75 | 85 | 85 |
| E | 75 | 85 | 95 | 100 | 110 | 110 |

සිමෙන්
වැලි
3/4" මැටල්
20
පැති ගල්
මුල් ගල්
වැරගැන්වූ
Ø මිමී 6
බාධක තහ
පීවීසීමේ

**සටහන:**
තුළුමුව සහ පිටමුවෙහි තලවල විෂ්කම්භයන් ද්‍රව විද්‍යාත්මක ගණනය කිරීම්වලට අනුවය.
**Note:**
*Sizes of inlet and outlet according to hydraulic calculations.*

# කපාට කුටීරය සහිත රොන්මඩ කුටීරය (A වර්ගය)
# SILT BOX WITH VALVE CHAMBER (TYPE A)

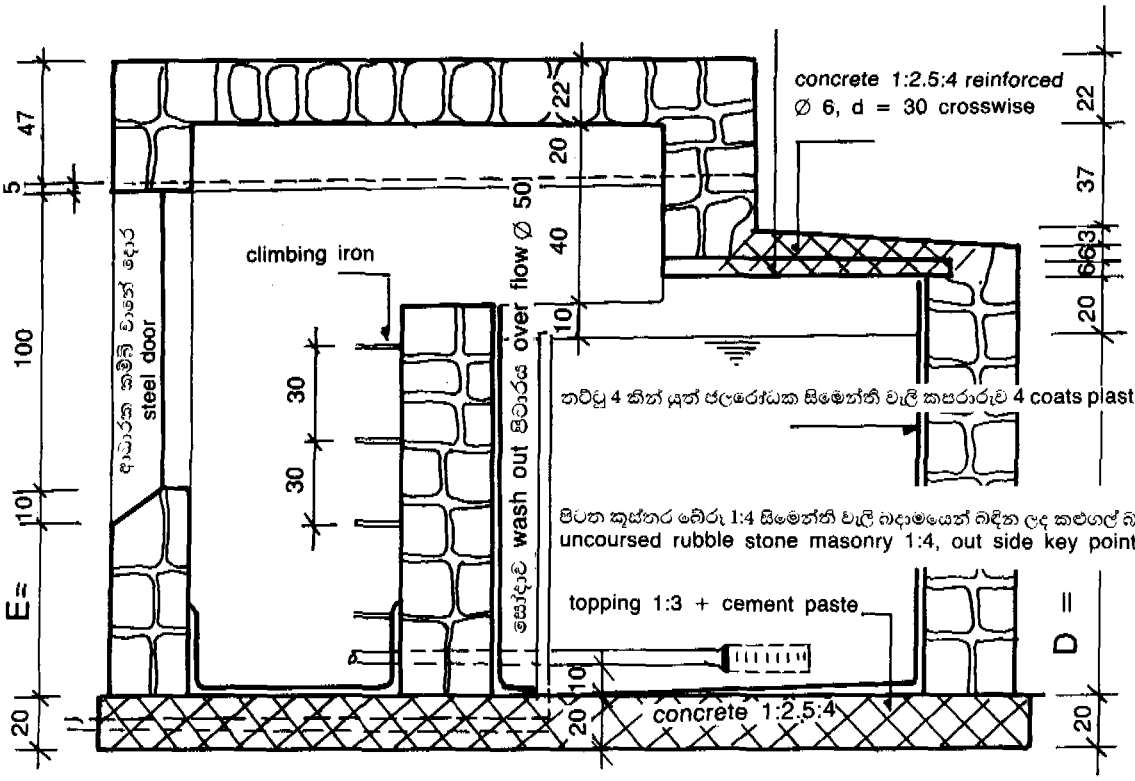
පරිමාව 300 ලී. වී 800 ලී. **Volume 300 L – 800 L**

| | | | | | | |
|---|---|---|---|---|---|---|
| අංකය: . | **S-05** | දිනය: Date: | ***April 1992*** | | දිනය Date: | විසින් By: |
| ය: | **1:20** | අඳින ලැබුවේ: Drawn by: | ***Kumuduni*** | සංශෝධන Amendments | | |
| පත්‍රය: eet: | **—** | සැලසුම් කළේ Designed by: | ***R. St. & H. Pf*** | | | |

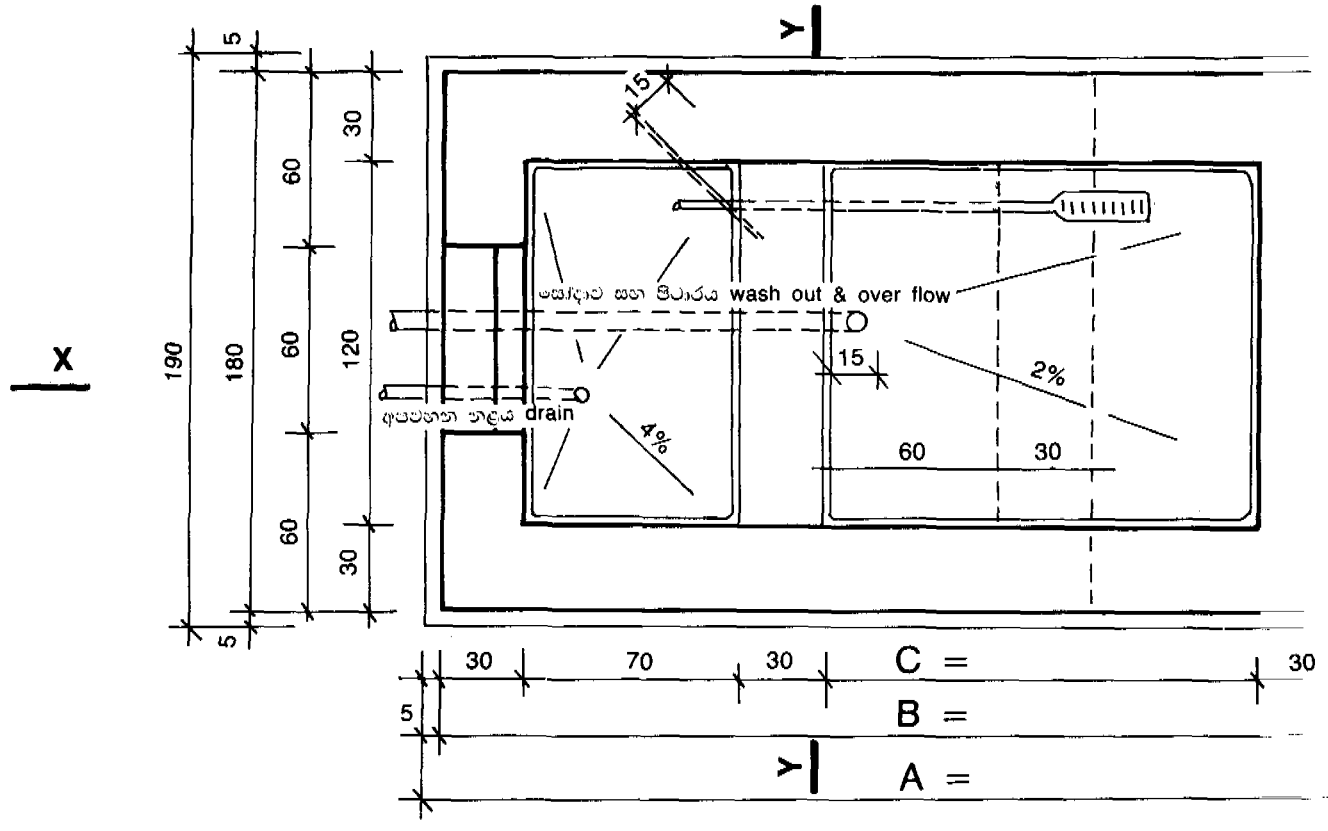
## ද්‍රව්‍ය ලේඛනය List of materials

| | රොන්මඩ කුටීරය Volume of silt box | | | | | |
|---|---|---|---|---|---|---|
| | 300 L | 400 L | 500 L | 600 L | 700 L | 800 L |
| cement කොට්ට bags | 14 | 16 | 17 | 19 | 20 | 22 |
| sand තාවිටි $M^3$ | 1.5 | 2.0 | 2.3 | 2.5 | 2.7 | 3.0 |
| metal 20 mm | 0.6 | 0.7 | 0.8 | 0.9 | 1.0 | 1.1 |
| line stones pcs | 300 | 340 | 400 | 430 | 510 | 550 |
| corner stones pcs | 60 | 75 | 85 | 95 | 105 | 120 |
| rebar ø 6 mm kg | 7 | 8 | 9 | 10 | 11 | 12 |
| baffle plate pcs | 1 | 1 | 1 | 1 | 1 | 1 |
| entrance door pcs 60 x 60 cm | 1 | 1 | 1 | 1 | 1 | 1 |

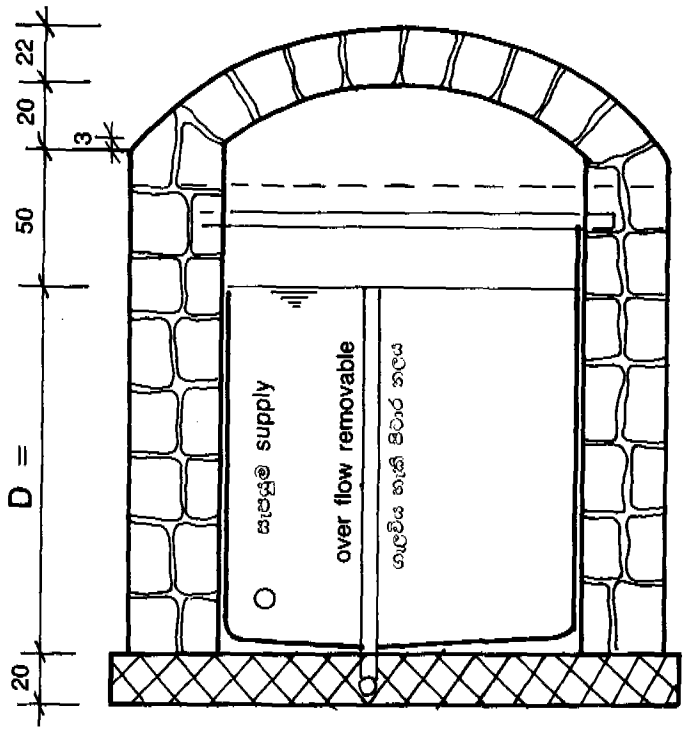
වැරගැන්වූ පෙරවාත්තු කොන්ක්‍රීට් තහඩු 1:2:3 Ø මිමි 6 වෙර ගැන්වුම් සෙ.මී. 15 පරතරයට
precast concrete slabs 1:2:3 reinforced Ø 6, d = 15 crosswise




## X – X හරහා ඡේදීය පෙනුම SECTION X – X




## සැලැස්ම PLAN VIEW




## Y – Y හරහා ඡේදීය පෙනුම
## SECTION Y – Y

### මිමි / මාන සෙ.මී. වලිනි
### MEASUREMENTS / DIMENSIONS IN CM

| | ටැංකියේ පරිමාව Volume of tank | | | |
|---|---|---|---|---|
| | 2 $M^3$ | 3 $M^3$ | 4 $M^3$ | 5 $M^3$ |
| A | 310 | 380 | 400 | 455 |
| B | 300 | 370 | 390 | 445 |
| C | 140 | 210 | 230 | 285 |
| D | 120 | 120 | 145 | 145 |
| E | 55 | 55 | 80 | 80 |

**සටහන:**
නුඳුම්වූ සහ පිටමුවෙහි නලවල විෂ්කම්භයන් ද්‍රව විද්‍යාත්මක ගණනය කිරීම්වලට අනුවය.
**Note:**
Sizes of inlet and outlet according to hydraulic calculations.

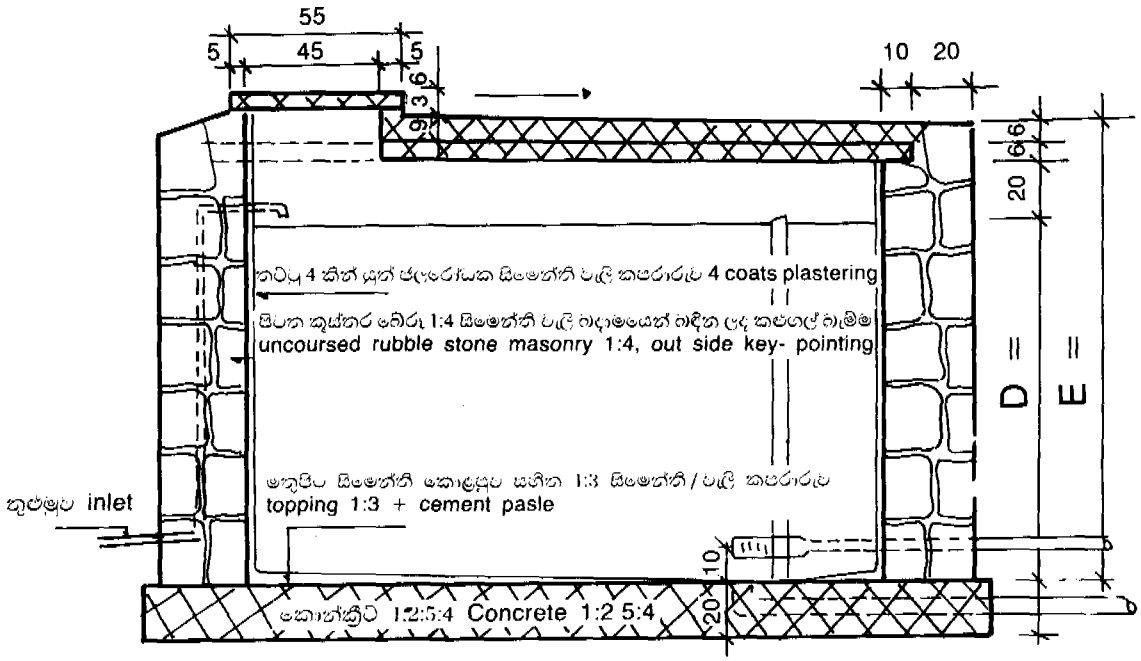
# ගබඩා ටැංකිය (A වර්ගය)
# STORAGE TANK (TYPE A)

## පරිමාව 2 – 5මී $^3$ Volume 2 – 5 m$^3$

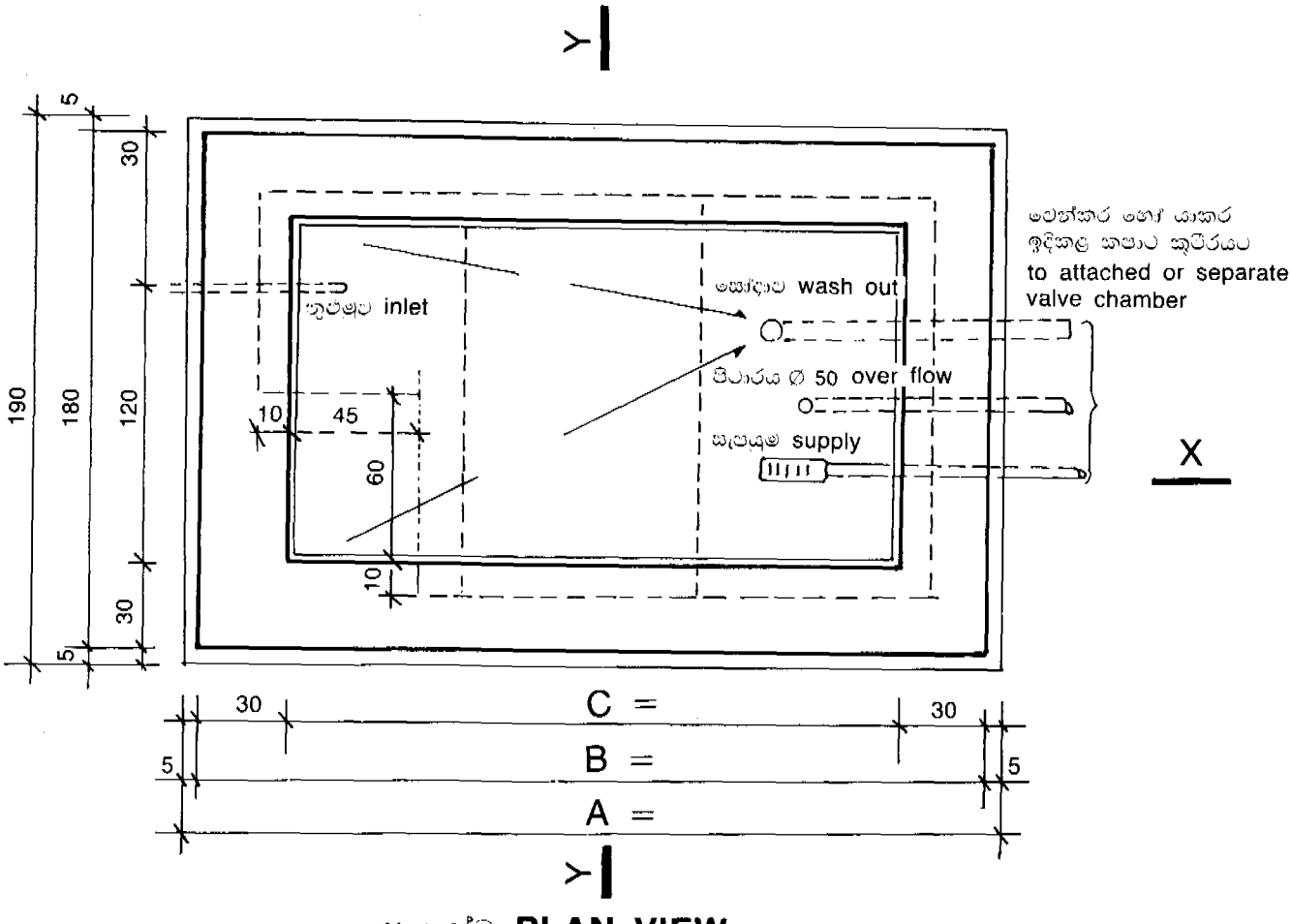
| | | | | | |
|---|---|---|---|---|---|
| සුම් අංකය: / No. | T - 01 | දිනය: / Date: | *April 1992* | | දිනය Date: / විසින් By: |
| ාණය: / le: | 1:25 | අඳිනු ලැබුවේ: / Drawn by: | *Kumuduni* | සංශෝධන Amendments | |
| යම් පත්‍රය: / Sheet: | – | සැලසුම් කළේ / Designed by: | *R. St. & H. Pf* | | |

## ද්‍රව්‍ය ලැයිස්තුව List of materials

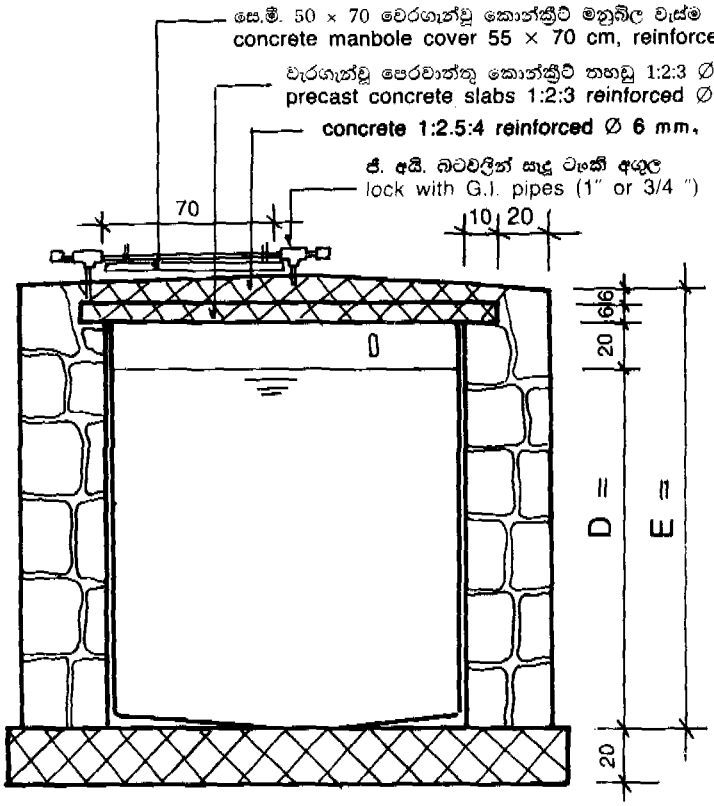
| | | | ටැංකියේ පරිමාව Volume of tank | | | |
|---|---|---|---|---|---|---|
| | | | 2m$^3$ | 3m$^3$ | 4m$^3$ | 5m$^3$ |
| සිමෙන්ති | cement කොට්ට | bags | 30 | 36 | 40 | 45 |
| වැලි | sand | M$^3$ | 4.2 | 4.8 | 5.6 | 6.1 |
| පැති ගල් | lime stones | pcs | 1950 | 2150 | 2450 | 2650 |
| මුල් ගල් | corner stones | pcs | 150 | 150 | 180 | 180 |
| සක්ක ගල් | unshaped stones | M$^3$ | 1.5 | 1.7 | 2.0 | 2.3 |
| 3/4" මැටල් ගල් | metal 20 mm | M$^3$ | 1.5 | 1.9 | 2.1 | 2.4 |
| වැරගැන්වුම් | rebar ø 6 mm | kg | 17 | 24 | 31 | 38 |
| පිවිසීමේ දොර | enter door 60 x 100 | pcs | 1 | 1 | 1 | 1 |
| ජී. අයි. නල | G.I. pipes 1/2" | M | 2.4 | 2.4 | 3.0 | 3.0 |



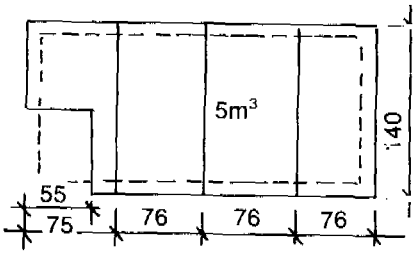

## X – X හරහා ඡේදීය පෙනුම SECTION X – X

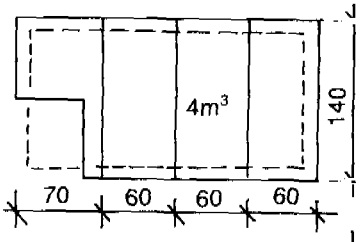


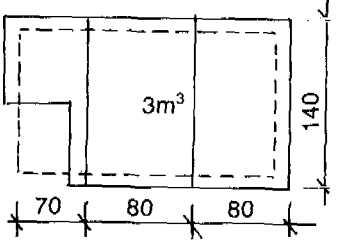

## සැලැස්ම PLAN VIEW

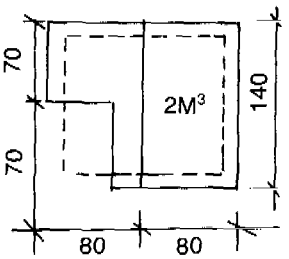



## Y – Y හරහා ඡේදිය පෙනුම SECTION Y – Y




## මිමි/මාන සෙ.මී. වලින්
## MEASUREMENTS/DIMENSIONS IN CM

| | Volume of tank | | | |
|---|---|---|---|---|
| | 2 $M^3$ | 3 $M^3$ | 4 $M^3$ | 5 $M^3$ |
| A | 210 | 280 | 300 | 355 |
| B | 200 | 270 | 290 | 345 |
| C | 140 | 210 | 230 | 285 |
| D | 120 | 120 | 145 | 145 |
| E | 153 | 153 | 177 | 177 |

සටහන:
නුපුම්ට සහ පිටමුවෙහි නලවල විෂ්කම්භයන් දැව විද්‍යාත්මක ගණනය කිරීම්වලට අනුවය.

**Note:**
Sizes of inlet and outlet according to hydraulic calculations.

## පෙරවාත්තු කොන්ක්‍රීට් තහ
## PRECAST CONCRETE SL

# ගබඩා ටැංකිය (B වර්ගය)
# STORAGE TANK (TYPE B)

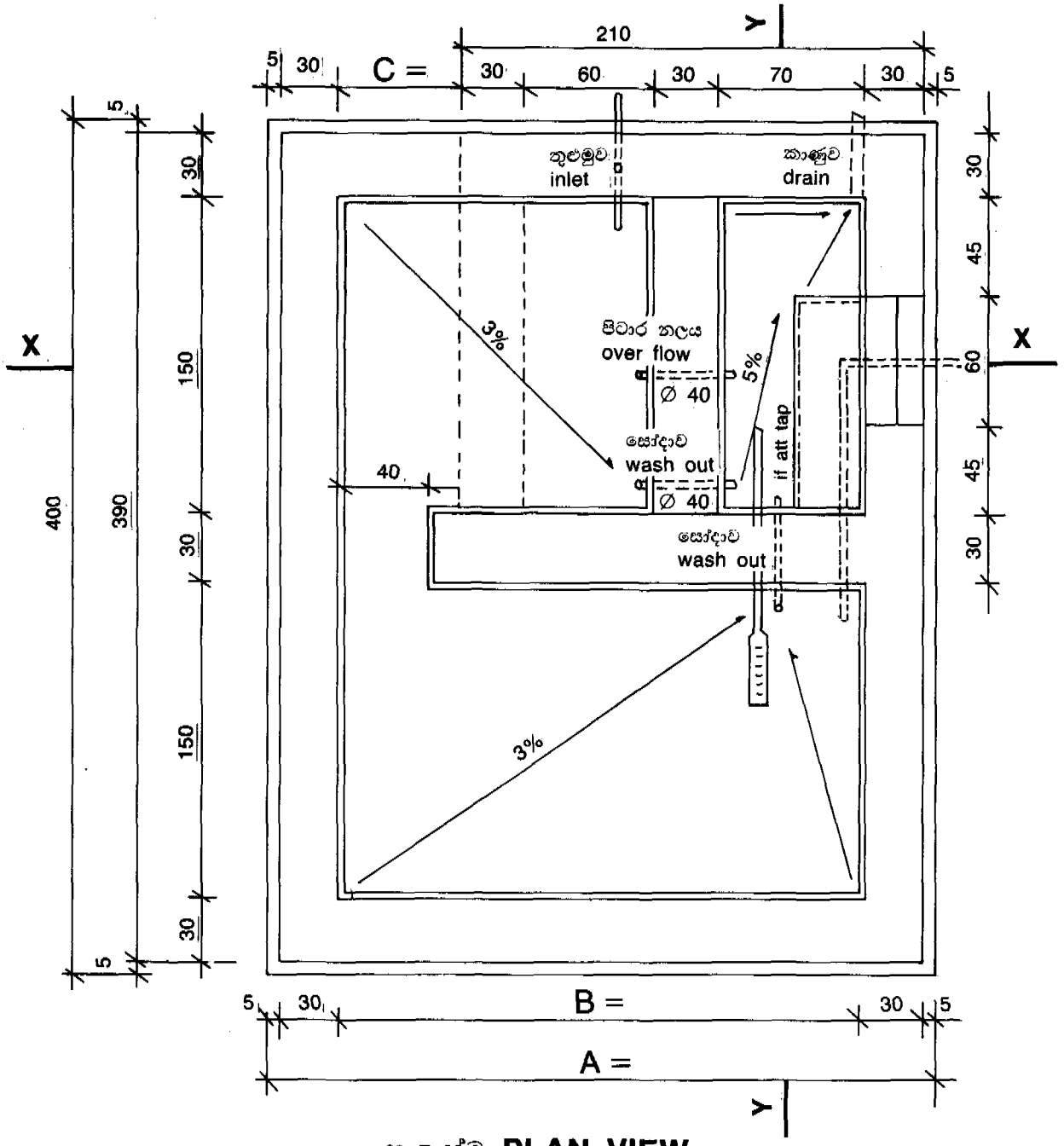
**පරිමාව 2 – 5මී $^3$ Volume 2 – 5 m$^3$**

| | | | | | | |
|---|---|---|---|---|---|---|
| ...ම් අංකය: No. | **T-02** | දිනය: Date: | ***April 1992*** | | දිනය Date: | විසින් By: |
| ...ණය: e: | **1:25** | අඳිනු ලැබුවේ: Drawn by: | ***Kumuduni*** | සංශෝධන Amendments | | |
| ...ම් පත්‍රය. Sheet: | — | සැලසුම් කළේ Designed by: | ***R. St. & H. Pf*** | | | |

## ද්‍රව්‍ය ලැයිස්තුව List of materials

| | | | ටැංකියේ පරිමාව Volume of tank | | | |
|---|---|---|---|---|---|---|
| | | | 2 M$^3$ | 3 M$^3$ | 4 M$^3$ | 5M$^3$ |
| සිමෙන්ති | cement | කොට්ට bags | 21 | 25 | 28 | 35 |
| පෙති ගල් | line stones | pcs | 600 | 700 | 850 | 900 |
| මූල් ගල් | corner stones | pcs | 100 | 100 | 120 | 120 |
| සක්ක ගල් | unshaped stones | M$^3$ | 1.3 | 2.0 | 2.4 | 2.8 |
| වැලි | sand | M$^3$ | 3 | 3.5 | 3.8 | 4.5 |
| 3/4" මැටල් ගල් | metal 20 mm | M$^3$ | 1.5 | 1.7 | 2.0 | 2.5 |
| වැරගැන්වුම් | rebar ø 6 mm | kg | 19 | 26 | 33 | 40 |

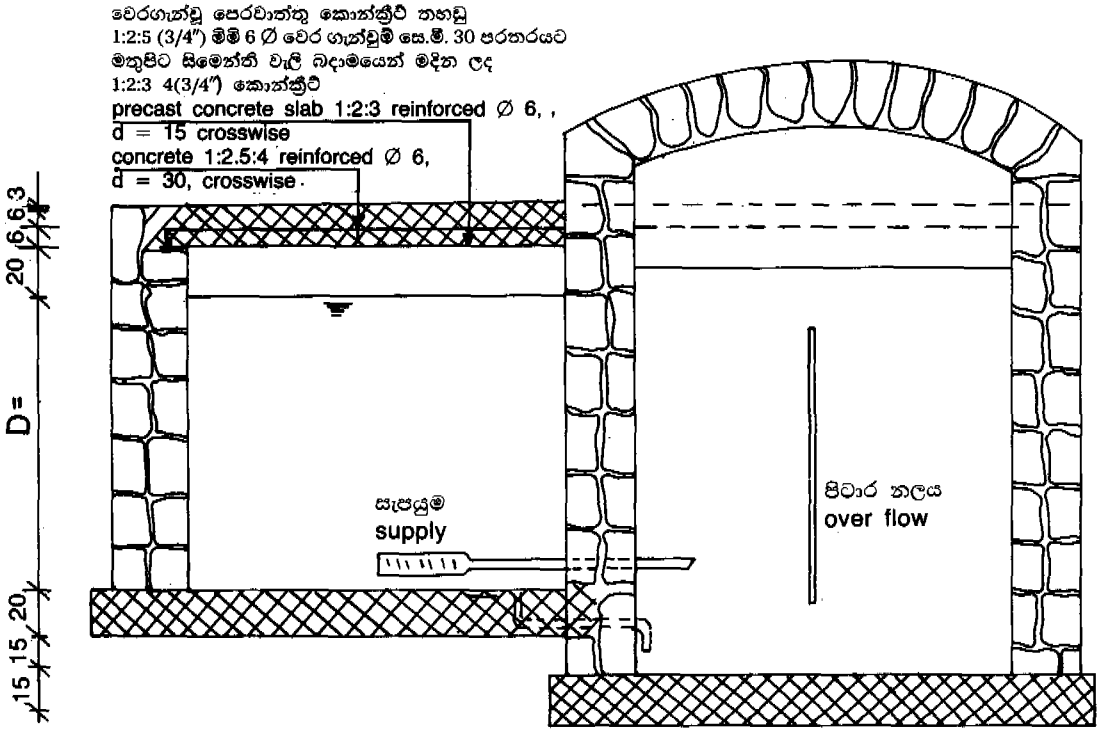
...ඩු
BS




## සැලැස්ම PLAN VIEW

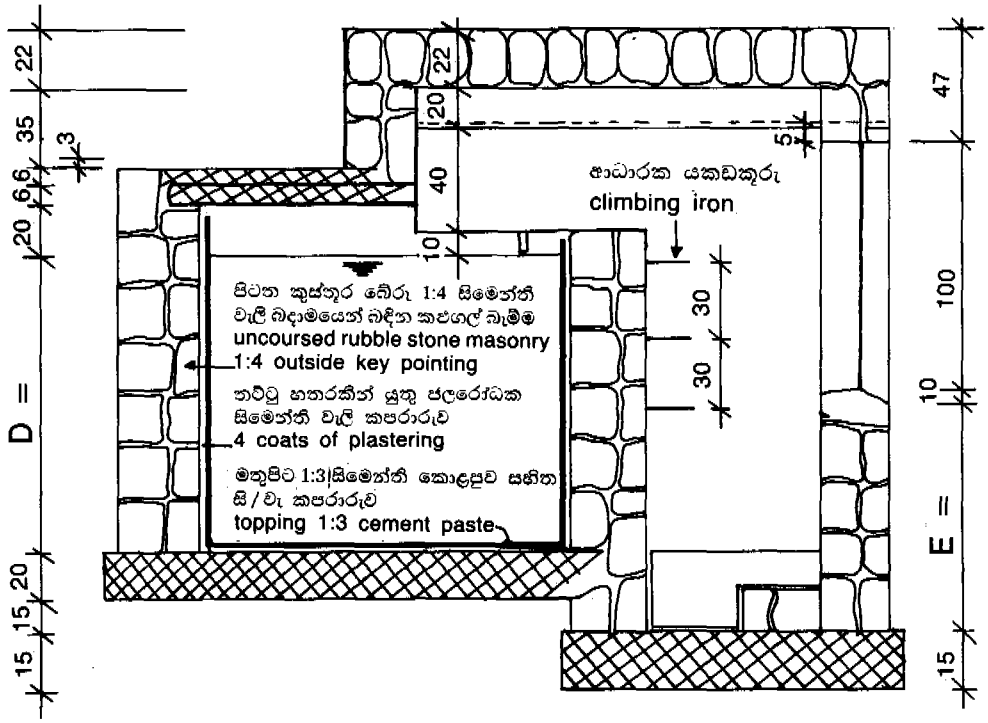
## මිමි / මාන සෙ.මී. වලින් MEASUREMENTS / DIMENSIONS IN CM

| | ටැංකියේ පරිමාව Volume of tank | | | |
|---|---|---|---|---|
| | 6.5 $M^3$ | 8 $M^3$ | 10 $M^3$ | 12 $M^3$ |
| A | 300 | 340 | 380 | 400 |
| B | 230 | 270 | 310 | 330 |
| C | 40 | 80 | 120 | 140 |
| D | 120 | 120 | 130 | 140 |
| E | 90 | 90 | 100 | 110 |




## Y – Y හරහා ඡේදීය පෙනුම SECTION Y – Y

සැ.යු.
තුළුම්වූව සහ පිටමුවෙහි නලවල විෂ්කම්භයන් ද්‍රව විද්‍යාත්මක ගණනය කිරීම්වලට අනුවය.
**Note:**
Sizes of inlet and outlet according to hydraulic calculations.




## X – X හරහා ඡේදීය පෙනුම SECTION X – X

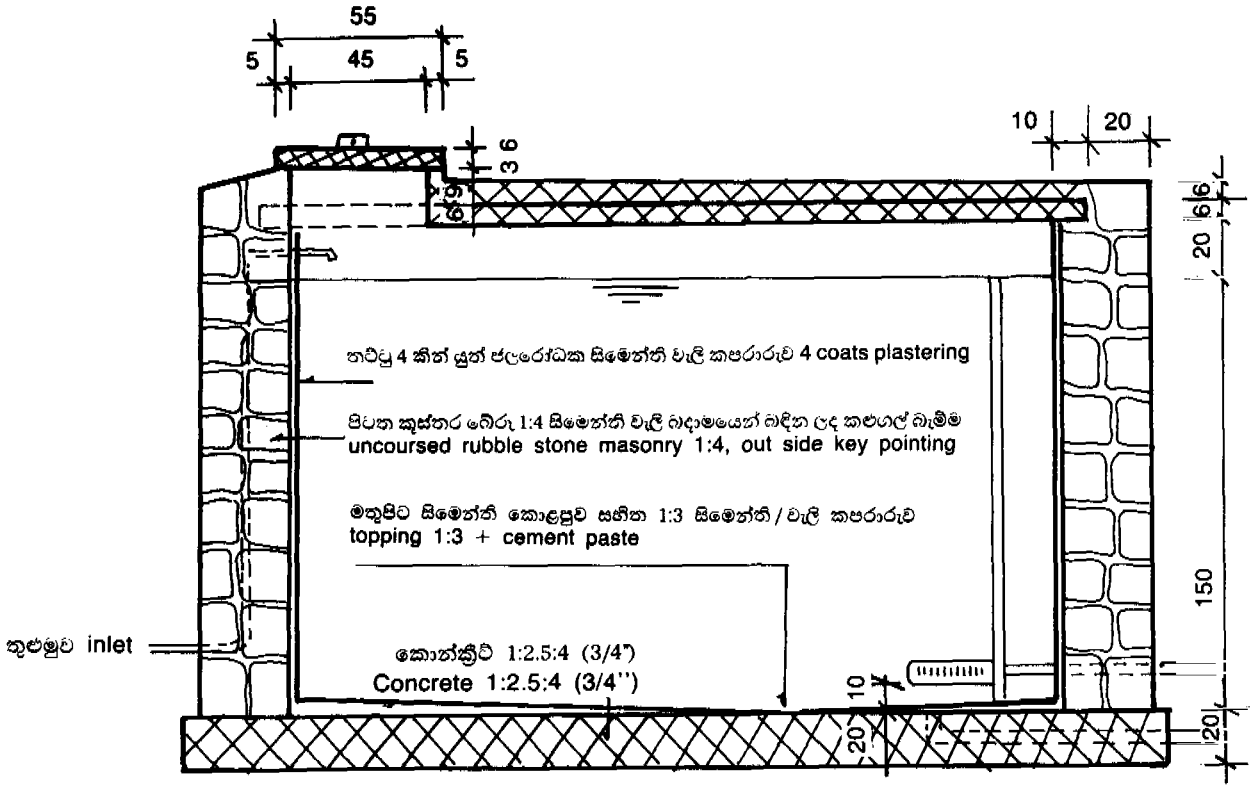
# ගබඩා ටැංකිය (A වර්ගය)
# STORAGE TANK (TYPE A)

**පරිමාව 6.5 – 12මී $^3$ Volume 6.5 – 12m$^3$**

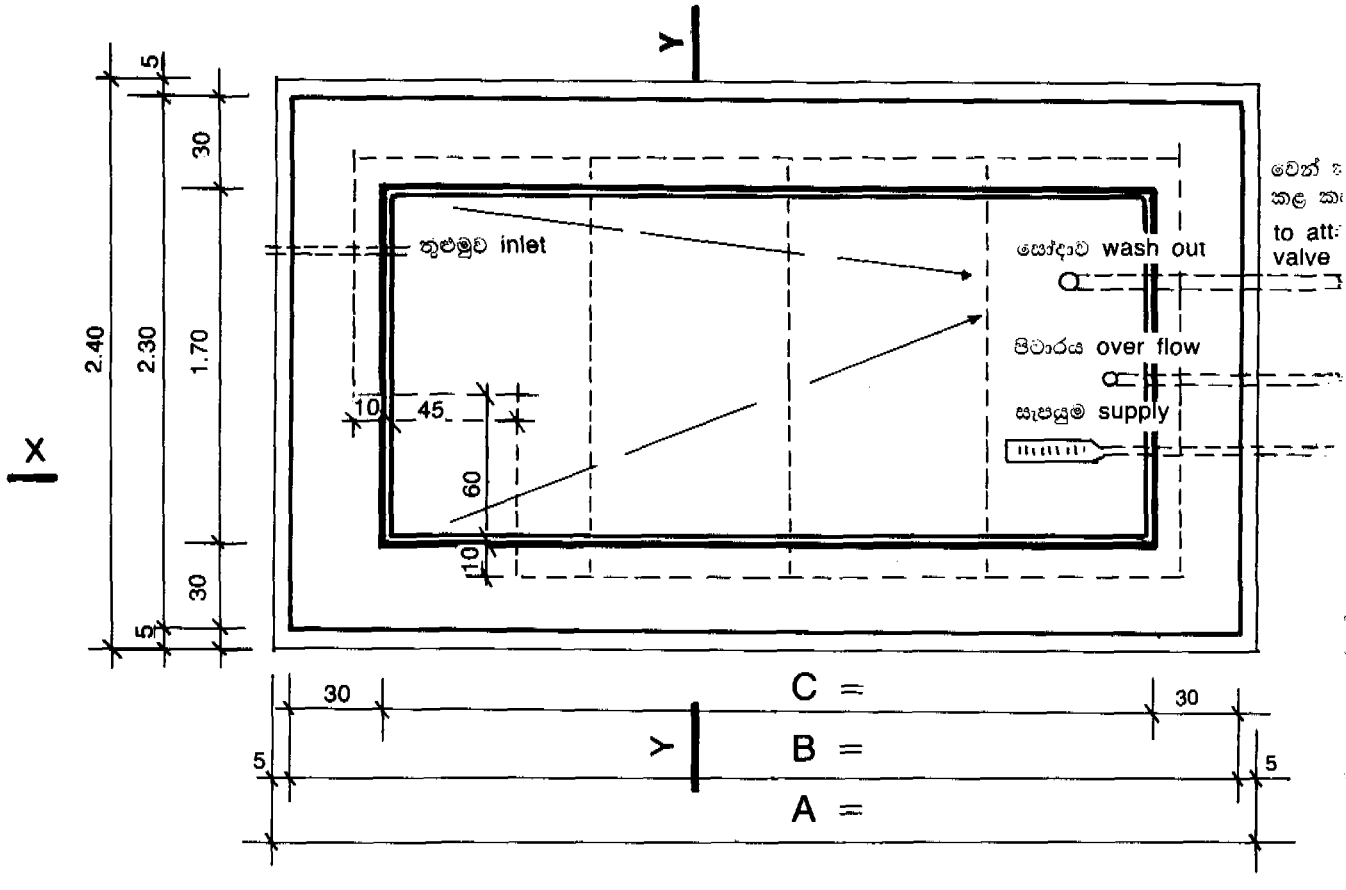
| | | | | | | |
|---|---|---|---|---|---|---|
| අංකය: o. | T - 03 | දිනය: Date: | *April 1992* | | දිනය Date: | විසින් By: |
| ය: | 1:30 | අඳින ලැබුවේ: Drawn by: | *Kumuduni* | සංශෝධන Amendments | | |
| පත්‍රය: eet: | – | සැලසුම් කළේ Designed by: | *R. St. & H. Pf* | | | |

## ද්‍රව්‍ය ලැයිස්තුව List of materials

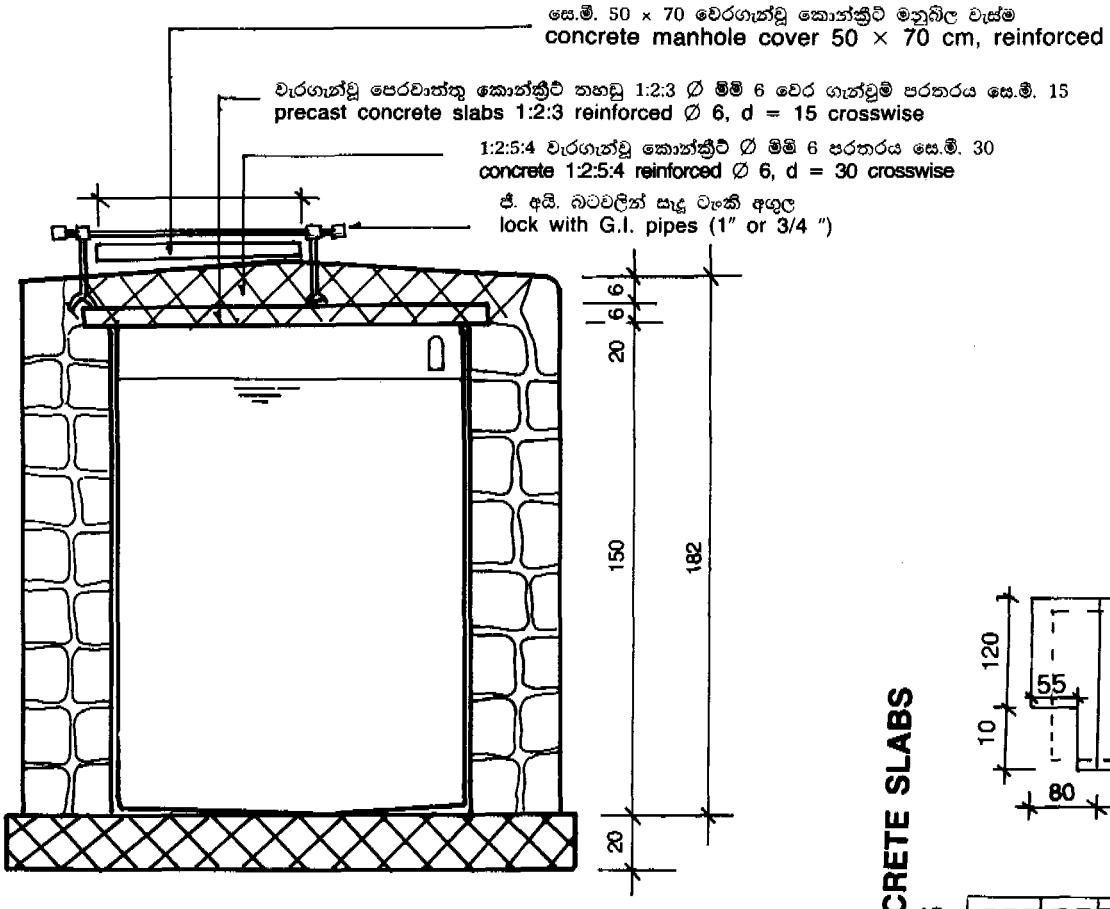
| | | | ටැංකියේ පරිමාව Volume at tank | | | |
|---|---|---|---|---|---|---|
| | | | 6.5m$^3$ | 8m$^3$ | 10m$^3$ | 12m$^3$ |
| සිමෙන්ති | cement | කොට්ට bags | 68 | 73 | 81 | 89 |
| වැලි | sand | m$^3$ | 82 | 9 | 10 | 11 |
| පැති ගල් | line stones | pcs | 3500 | 3700 | 3900 | 4100 |
| මුල් ගල් | corner stones | pcs | 220 | 230 | 240 | 250 |
| සක්ක ගල් | unshaped stones | m$^3$ | 3.2 | 3.6 | 4.0 | 4.5 |
| මැටල් ගල් | metal 20 m.m. | m$^3$ | 4.1 | 4.8 | 5.6 | 6.3 |
| වැරගැන්වුම් 6 මි මී | rebar ø 6 mm | kg | 48 | 53 | 61 | 65 |
| පිවිසීමේ දොර | enter door 60 x 100 | pcs | 1 | 1 | 1 | 1 |
| ජී. අයි. නල 1/2" | G.I. pipes 1/2" | m | 3 | 3 | 3.5 | 3.5 |




## X – X හරහා ඡේදීය පෙනුම SECTION X – X




## සැලැස්ම PLAN VIEW



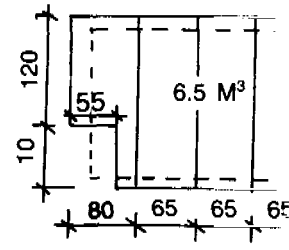

## Y – Y හරහා ඡේදීය පෙනුම
## SECTION Y – Y

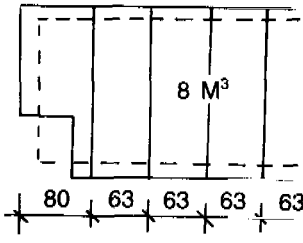
ාළ හෝ යා
ාට කුටීරයට
ched or separate
chamber

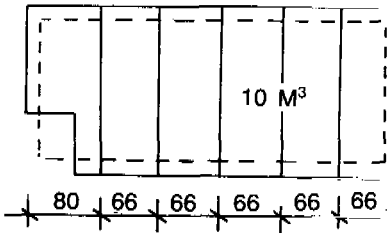
X

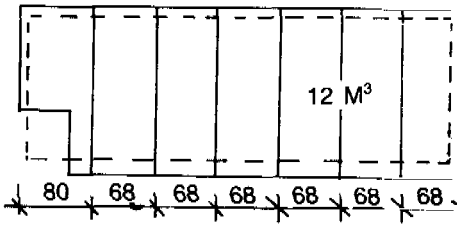
| | ටැංකියේ පරිමාව Volume of tank | | | |
|---|---|---|---|---|
| | 6.5 $M^3$ | 8 $M^3$ | 10 $M^3$ | 12 $M^3$ |
| A | 325 | 385 | 460 | 540 |
| B | 315 | 375 | 450 | 530 |
| C | 255 | 315 | 390 | 470 |

**PRECAST CONCRETE SLABS**
**1:75**



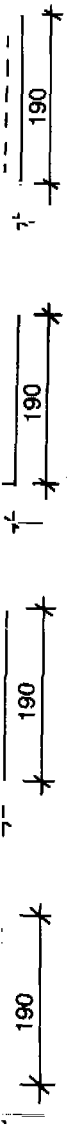

**සටහන:**
තුළුමුව සහ පිටමුවෙහි තලවල විෂ්කම්භයන් ද්‍රව විද්‍යාත්මක ගණනය කිරීම්වලට අනුවය.

**Note:**
Sizes of inlet and outlet according to hydraulic calculations.

# ගබඩා ටැංකිය (B වර්ගය)
# STORAGE TANK (TYPE B)

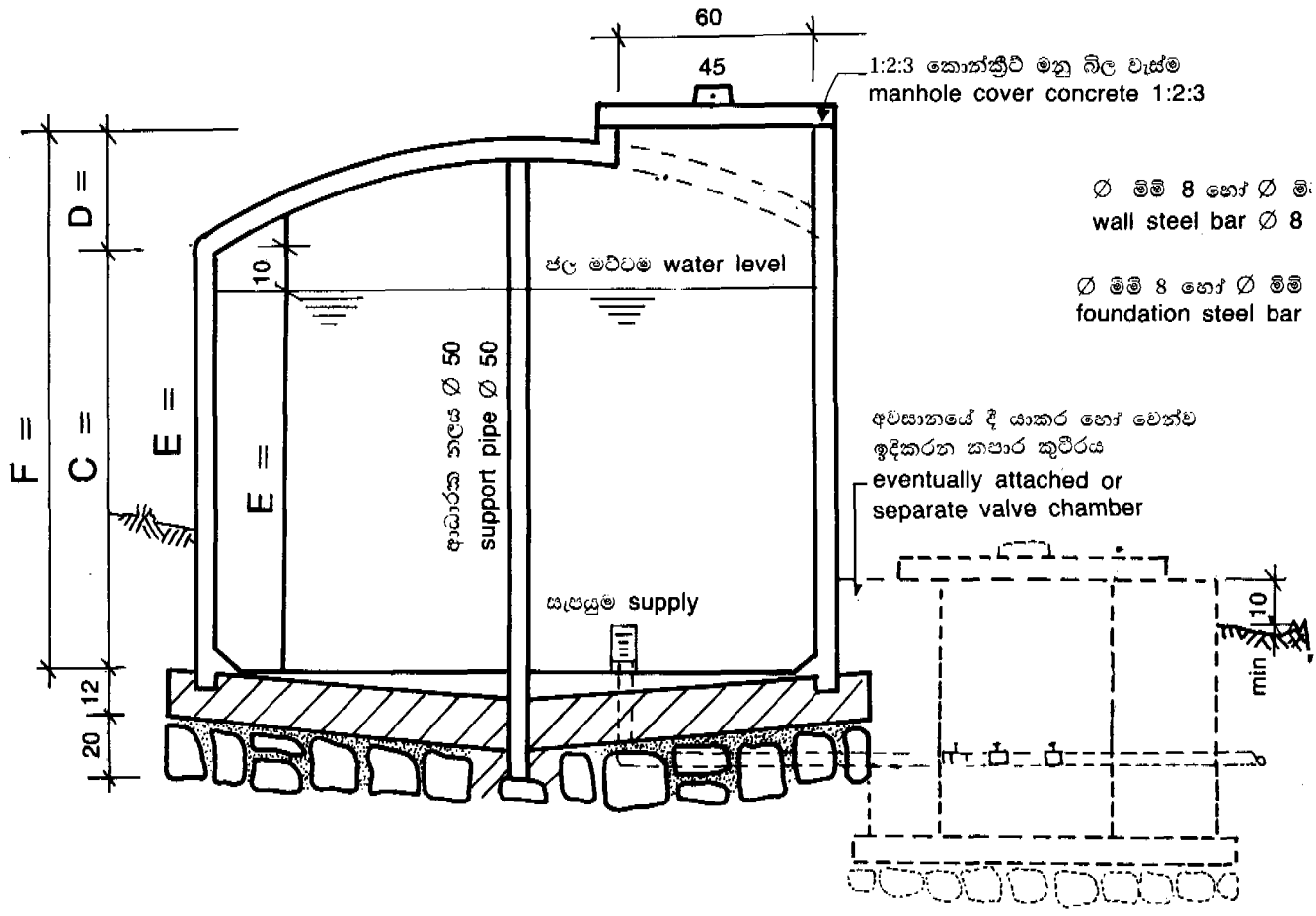
**පරිමාව 6.5 – 12මී $^3$**
**Volume 6.5 – 12 m$^3$**

| | | | | | | |
|---|---|---|---|---|---|---|
| සැලසුම් අංකය: n No. | T - 04 | දිනය: Date: | *April 1992* | | දිනය Date: | විසින් By: |
| මාණය: le: | 1:25 | අඳින ලැබුවේ: Drawn by: | *Kumuduni* | සංශෝධන Amendments | | |
| යම් පත්‍රය: Sheet: | – | සැලසුම් කළේ Designed by: | *R. St. & H. Pf* | | | |

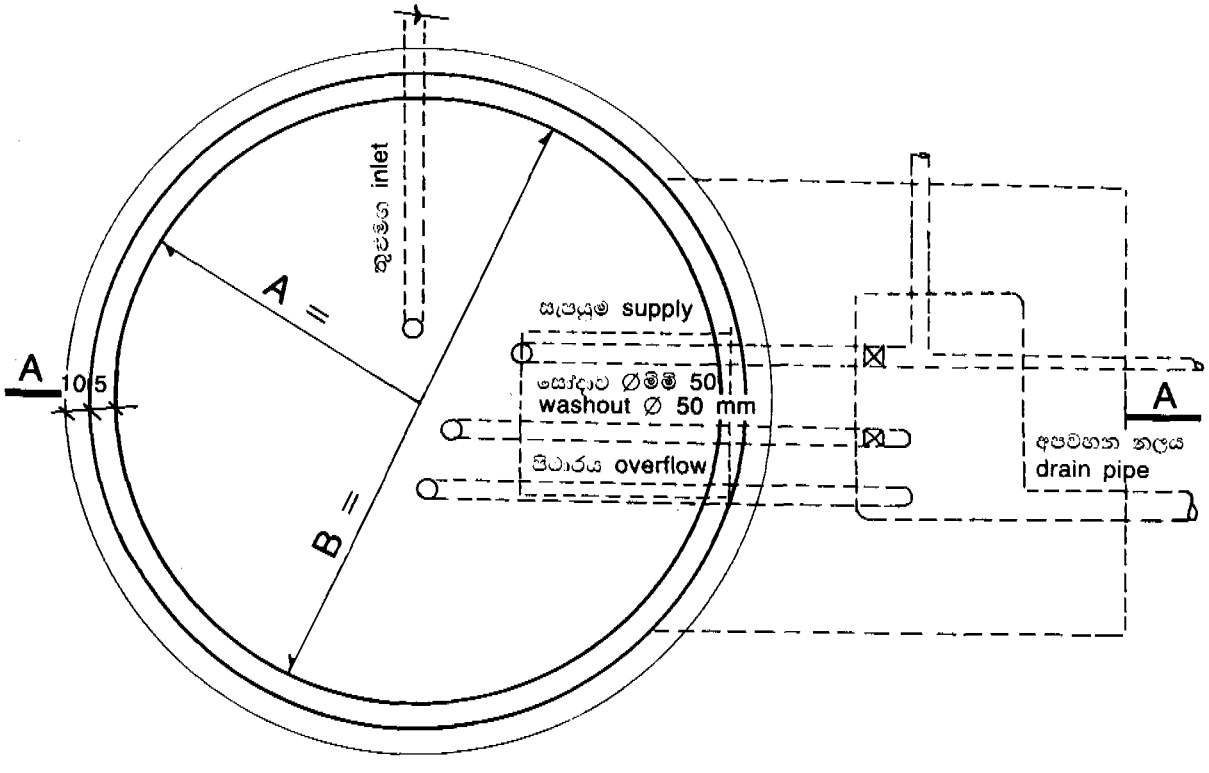



## ද්‍රව්‍ය ලැයිස්තුව List of materials

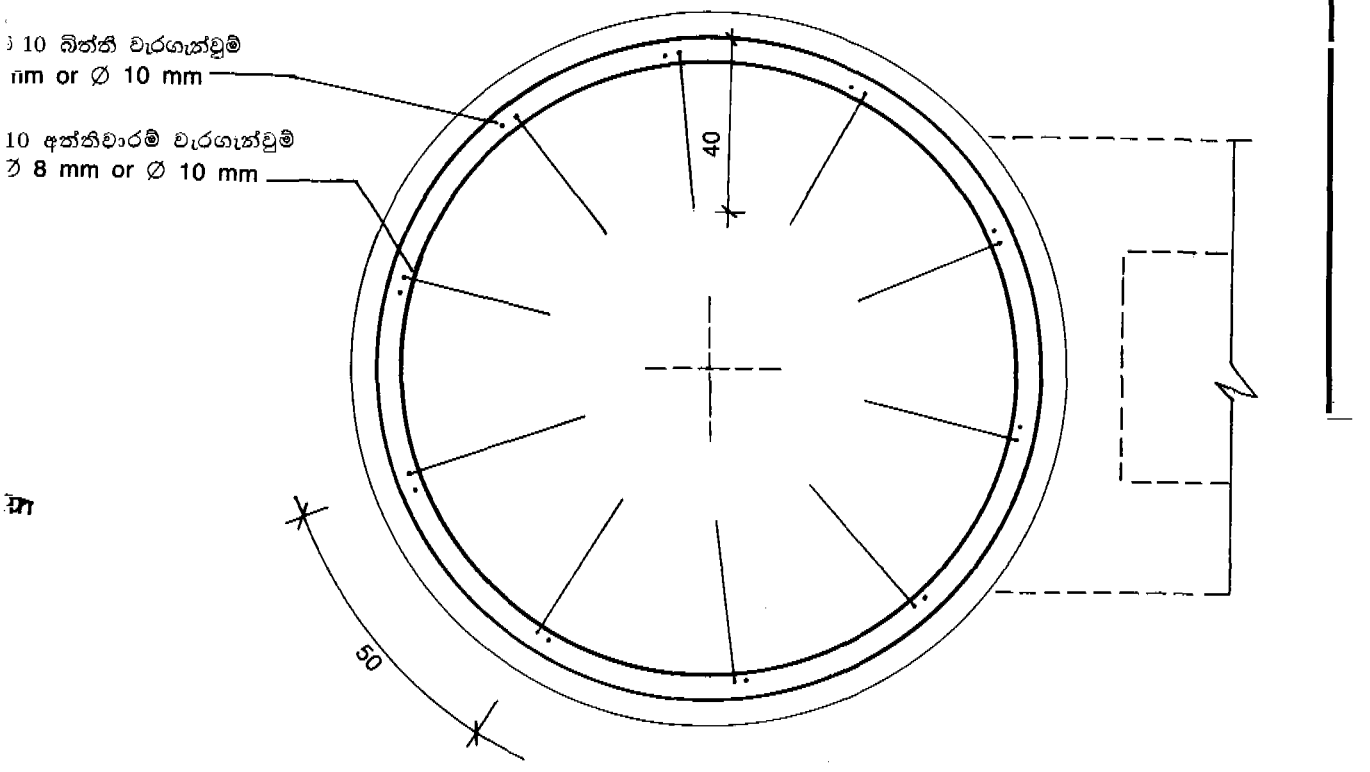
| | | | ටැංකියේ පරිමාව Volume of tank | | | |
|---|---|---|---|---|---|---|
| | | | 6.5 M$^3$ | 8 M$^3$ | 10 M$^3$ | 12 M$^3$ |
| සිමෙන්ති | cement කොට්ට bags | | 42 | 48 | 55 | 63 |
| වැලි | sand | m$^3$ | 55 | 6 | 7 | 8 |
| පැති ගල් | line stones | pcs | 1050 | 1200 | 1400 | 1600 |
| සක්ක ගල් | unshaped stones | m$^3$ | 3 | 3.2 | 3.5 | 3.8 |
| මුල් ගල් | corner stones | pcs | 150 | 160 | 170 | 180 |
| 3/4 මැටල් ගල් | metal 20 mm | m$^3$ | 3 | 3.5 | 4.0 | 4.5 |
| වැඩගැන්වුම Ø 6 මි මී | rebar Ø 6mm කිලෝ | kg | 45 | 50 | 55 | 60 |
| ජී. අයි. නළ සහ උපාංග | G.I. pipes/fittings | lock | yes | yes | yes | yes |




## A - A හරහා ඡේදීය පෙනුම SECTION A - A




## සැලැස්ම PLAN




## වැරගැන්වුම් සැලැස්ම PLAN REINFORCEMENT

| | 2 $M^3$ | 4 $M^3$ | 6 $M^3$ | 8 $M^3$ | 10 $M^3$ | 15 $M^3$ |
|---|---|---|---|---|---|---|
| (අරය) A (radius) | 80 | 110 | 130 | 140 | 150 | 175 |
| (විෂ්කම්භය) B (diameter) | 160 | 220 | 260 | 280 | 300 | 350 |
| (බිත්ති උස) C (wall height) | 110 | 120 | 125 | 140 | 155 | 170 |
| (ගෝලාධ උස) D (dome height) | 30 | 40 | 40 | 40 | 50 | 50 |
| (ජල මට්ටමේ උස) E (water level h.) | 100 | 110 | 115 | 130 | 145 | 160 |
| (සම්පූර්ණ උස) F (total height) | 140 | 160 | 165 | 180 | 205 | 220 |

මිමි / මාන සෙ.මී. වලින් MEASUREMENTS / DIMENSIONS IN CM

# ගබඩා ටැංකිය ෆෙරෝ සිමෙන්ට්

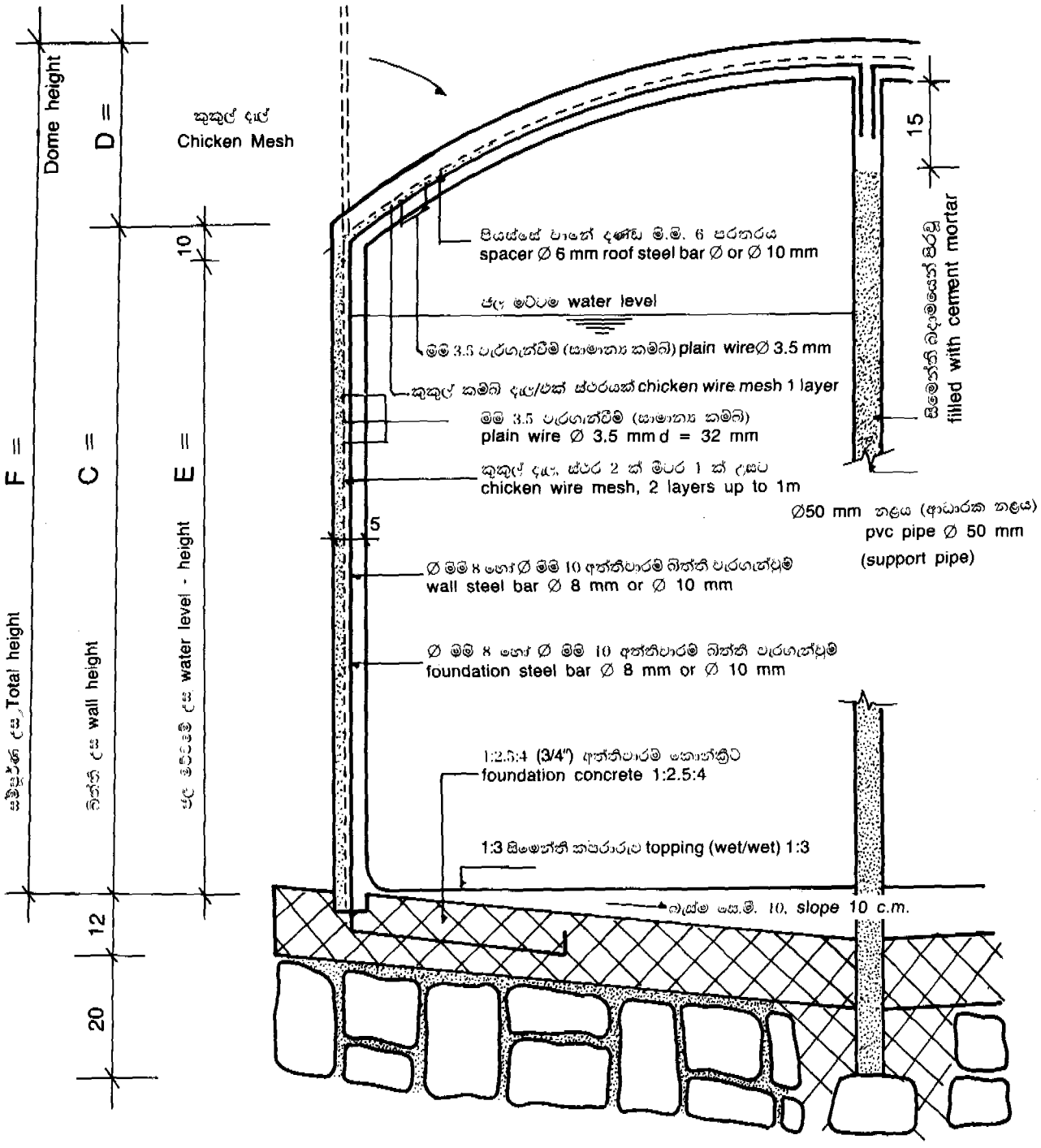
# STORAGE TANK FERROCEMENT

## පරිමාව 2 – 15මී$^3$ (සැලසුම් අංක 1) Volume 2 – 15m$^3$ (Drawing 1)

| | | | | | |
|---|---|---|---|---|---|
| සැලසුම් අංකය: Plan No. **T - 05** | දිනය: Date: ***April 1992*** | | දිනය Date: | විසින් By: |
| පරිමාණය: Scale: **not to scale** | අඳිනු ලැබුවේ: Drawn by: ***Kumuduni*** | සංශෝධන Amendments | | |
| සිතියම් පත්‍රය: Map Sheet: **–** | සැලසුම් කළේ Designed by: ***H. Pf*** | | | |

ද්‍රව්‍ය ලැයිස්තුව සඳහා, සැලසුම් පත් අංක 06 බලන්න.
**MATERIALS SEE DRAWING NO. T-06**

# අත්තිවාරම / බිත්තිය / සියළුම විස්තර FOUNDATION/WALL/ROOF/DETAILS

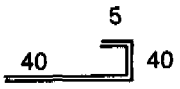
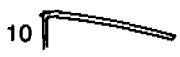



**කපරාරුව බිත්තියේ පිට පැත්ත**
1 වන තට්ටුව 1:3 (2-3 සෙ.මී.) වැරගැන්වුම් වලසන සේ මතුපිට රළුවට
2 වන තට්ටුව (අංශෝධය) 1:3 (2-3 සෙ.මී.) 1 වන තට්ටුව වියැලුනු පසු එදිනම මතුපිට මදින්න
**බිත්තියේ අතුල් පැත්ත (දින 3කට පසුව)**
1 වන තට්ටුව 1:4 (සෙ.මී. 2-3) වැරගැන්වුම් වලසන සේ මතුපිට මදින්න
2 වන තට්ටුව - එදිනම සිමෙන්ති පොළුවුව යොදන්න.
**සියළුම**
1 වන තට්ටුව 1:3 (සෙ.මී. 3-4) වැරගැන්වුම් වලසන සේ මතුපිට මදින්න
2 වන තට්ටුව 1:3 (සෙ.මී. 2-3) වැරගැන්වුම් වලසන සේ මතුපිට මදින්න.

**Plastering: Outside wall:**
1 coat 1:3 (2-3 c.m.) cover reinforcement / surface rough
2. coat 1:3 (1-2 c.m.) apply same day after 1. coat has sef/surface floated
**Inside wall (after 3 days)**
1 coat 1:4 (2-3 c.m.) cover reinforcement / surface floated
2. coat cement paste (same day)
**Roof**
1. coat 1:3 (3-4 c.m.) cover reinforcement / surface floated
2. coat 1:3 (2-3 c.m.) apply inside after 7-14 days/cover reinforcement

# වැරගැන්වුම් සටහන REINFORCEMENT TABLE

## මිමි/මාන සෙ.මී. වලිනි MEASUREMENTS IN CM

| | | 2 $M^3$ | 4 $M^3$ | 6 $M^3$ | 8 $M^3$ | 10 $M^3$ | 15 $M^3$ |
|---|---|---|---|---|---|---|---|
| foundation<br>අත්තිවාරම<br>  | කැබැල්ලක දිග length/pc | 85 | 85 | 85 | 85 | 85 | 85 |
| | වැරගැන්වුම් Ø steel bar ø | 8 mm | 8 mm | 8 mm | 10 mm | 10 mm | 10 mm |
| | කැබලි ගණන total no | 11 | 14 | 17 | 18 | 19 | 23 |
| wall<br>බිත්ති<br> | කැබැල්ලක දිග length/pc | 165 | 175 | 180 | 195 | 210 | 225 |
| | වැරගැන්වුම් Ø steel bar ø | 8 mm | 8 mm | 8 mm | 10 mm | 10 mm | 10 mm |
| | කැබලි ගණන total no | 11 | 14 | 17 | 18 | 19 | 23 |
| roof<br>පියස්ස<br>  | කැබැල්ලක දිග length/pc | 90 | 120 | 140 | 150 | 160 | 185 |
| | වැරගැන්වුම් Ø steel bar ø | 8 mm | 8 mm | 8 mm | 10 mm | 10 mm | 10 mm |
| | කැබලි ගණන total no | 9 | 12 | 15 | 16 | 17 | 21 |
|  | කැබැල්ලක දිග length/pc | 160 | 220 | 260 | 280 | 300 | 350 |
| | වැරගැන්වුම් Ø steel bar ø | 8 mm | 8 mm | 8 mm | 10 mm | 10 mm | 10 mm |
| | කැබැලි ගණන total no | 2 | 2 | 2 | 2 | 2 | 2 |
| spacers<br>පරතරය | වැරගැන්වුම් Ø steel bar 6 mm | 10 ml | 15 ml | 20 ml | 25 ml | 28 ml | 35 ml |

# ගබඩා ටැංකිය ෆෙරෝ සිමෙන්ට්

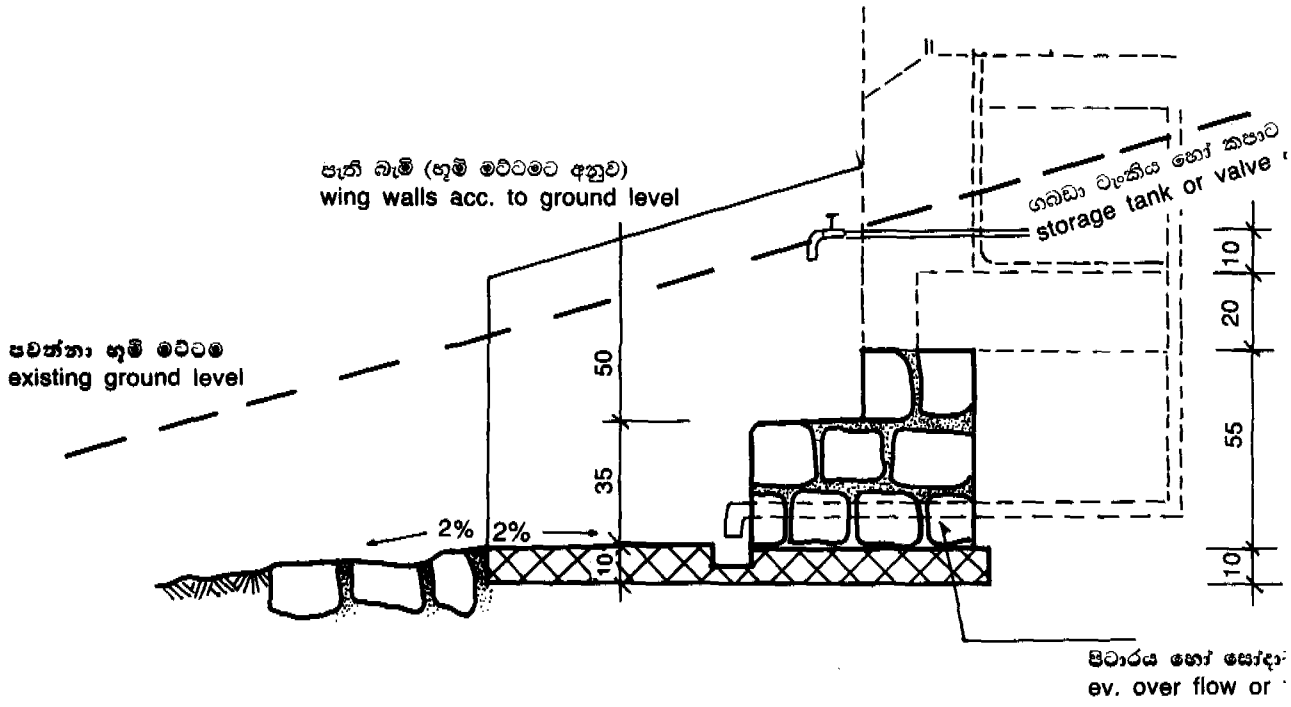
# STORAGE TANK FERROCEMENT

## පරිමාව 2 – 15$m^3$ (සැලසුම් අංක 2) Volume 2 – 15$m^3$ (Drawing 2)

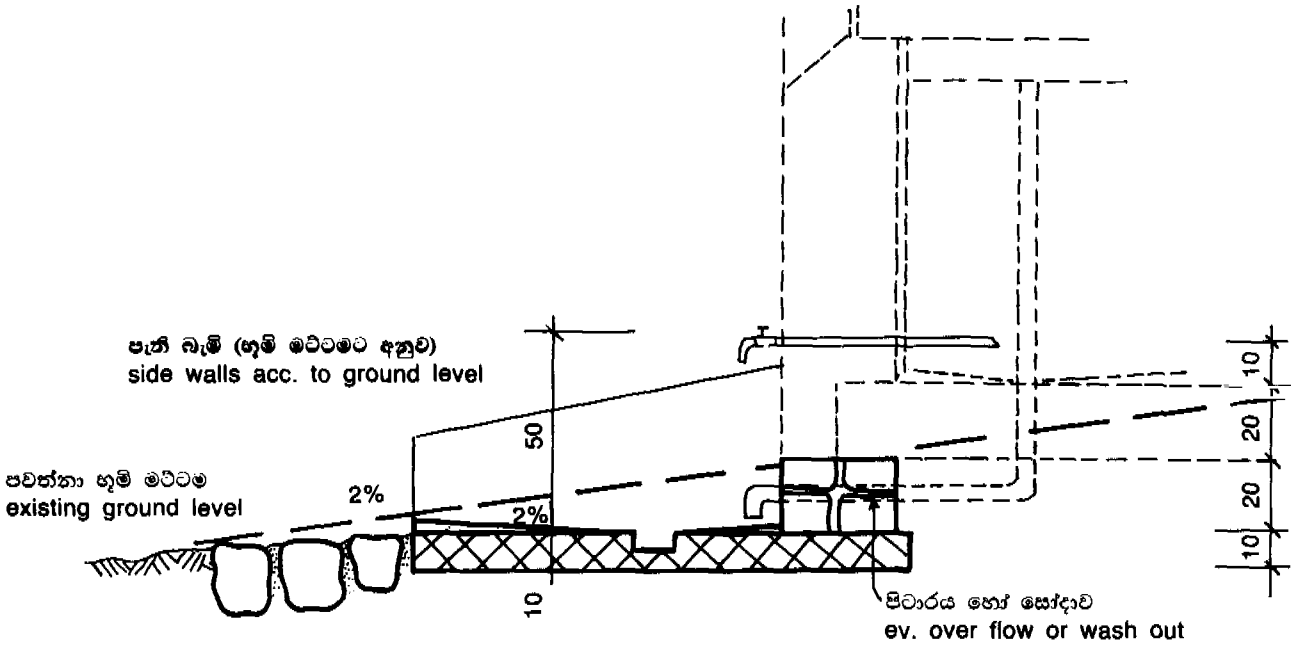
| | | | | | | |
|---|---|---|---|---|---|---|
| සුම් අංකය: / No. | T - 06 | දිනය: / Date: | April 1992 | | දිනය Date: | විසින් By: |
| ාණය: / le: | not to scale | අඳින ලැබුවේ: / Drawn by: | Kumuduni | සංශෝධන Amendments | | |
| යම් පත්‍රය: / Sheet: | — | සැලසුම් කළේ / Designed by: | H. Pf | | | |

## ාය ලැයිස්තුව List of materials

| | | 2 $M^3$ | 4 $M^3$ | 6 $M^3$ | 8 $M^3$ | 10 $M^3$ | 15 $M^3$ |
|---|---|---|---|---|---|---|---|
| සිමෙන්ති / cement | කොට්ට (bags) | 7 | 12 | 16 | 18 | 22 | 28 |
| වැලි / sand | ($m^3$) | 0.8 | 1.3 | 1.7 | 2.0 | 2.3 | 3.1 |
| 3/4" මැටල් ගල් / metal | ($m^3$) | 0.3 | 0.5 | 0.7 | 0.9 | 1.0 | 1.3 |
| සක්ක ගල් / stones unshaped | ($m^3$) | 0.4 | 0.7 | 1.0 | 1.2 | 1.4 | 1.9 |
| මිමි 3.5 සාමාන්‍ය කම්බි / plain wire 3.5 mm | (kg) | 15 | 20 | 25 | 30 | 35 | 40 |
| බැඳුම්කම්බි / binding wire 0.8 mm | (kg) | 4 | 4.5 | 5 | 5.5 | 6 | 6.5 |
| කුකුල් දැල් / chicken wire mesh, ø = 90 cn | ($m^2$) | 17 | 25 | 28 | 35 | 40 | 50 |
| ඇතිරගැන්වීම් / reinforcement Ø 6 mm | (kg) | 3 | 4 | 5 | 6 | 7 | 8 |
| ඇතිරගැන්වීම් / reinforcement Ø 8 mm | (kg) | 16 | 22 | 30 | - | - | - |
| ඇතිරගැන්වීම් / reinforcement Ø 10 mm | (kg) | - | - | - | 50 | 56 | 73 |




## A - A හරහා ඡේදීය පෙනුම (A වර්ගය)
## SECTION A - A (VAR. A)



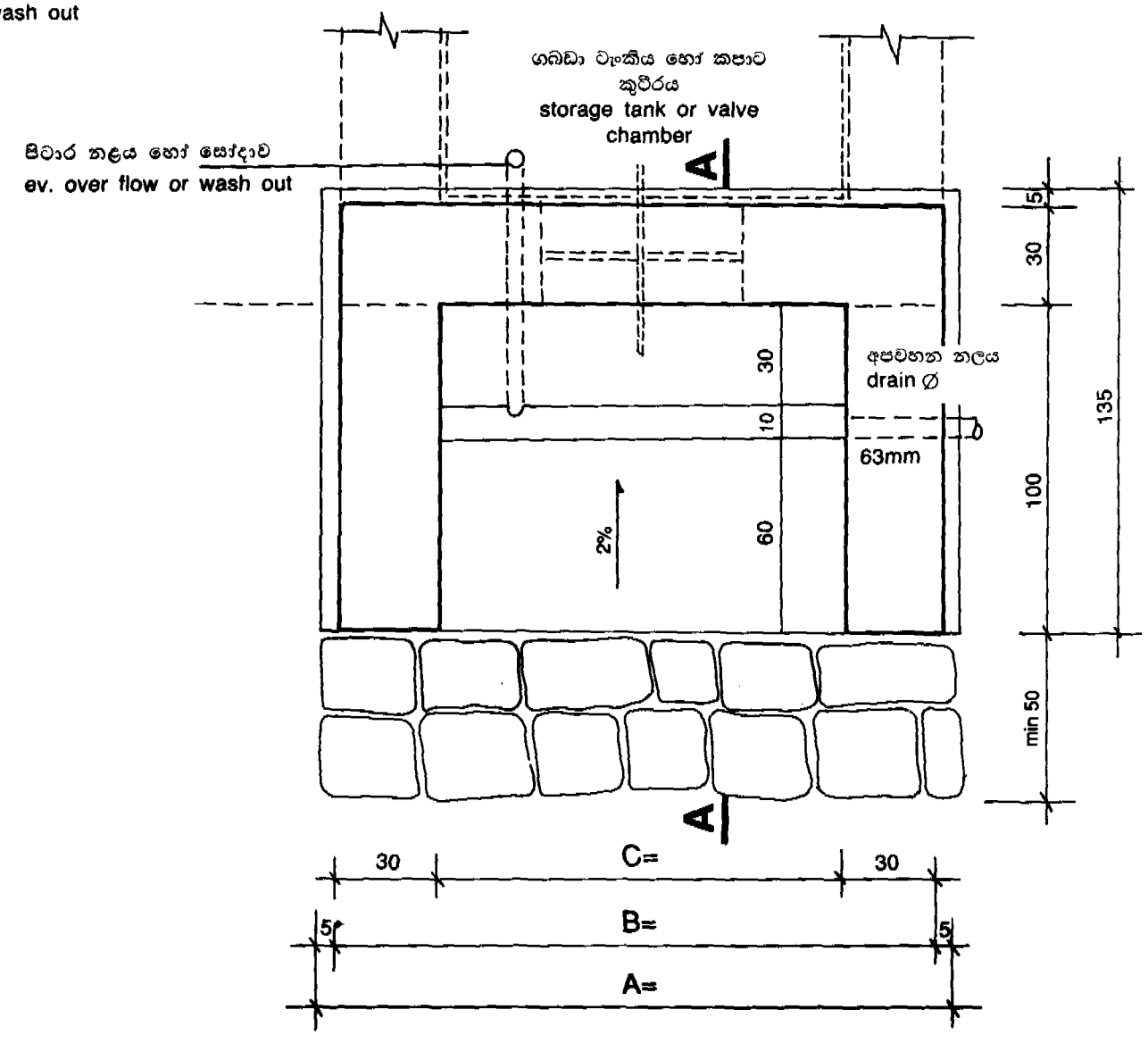

## A - A හරහා ඡේදීය පෙනුම (VAR Bවර්ගය)
## SECTION A - A (VAR B)

කුටීරය
.hamber

| | 2-5 මී² ගබඩා ටැංකියට සවිකළ කරාමය Tap att. to st. tank 2-5m² | 6-5 මී² ගබඩා ටැංකියට සවිකළ කරාමය Tap att. to st. tank 6.5-12m² |
|---|---|---|
| A | 190 | 220 |
| B | 180 | 210 |
| C | 120 | 150 |

**මිමි / මාන සෙ.මී. වලින්**
**MEASUREMENTS / DIMENSIONS IN CM**

vash out




**සැලැස්ම PLAN VIEW**

# ගඛඩා ටැංකියට සවිකල කරාමය

# TAP ATTACHED TO STORAGE TANK

## A හා B වර්ගය TYPE A AND B

| | | | | | | |
|---|---|---|---|---|---|---|
| ලසුම් අංකය: gn No. | V - 01 | දිනය: Date: | *April 1992* | | දිනය Date: | විසින් By: |
| මාණය: ale: | 1 : 20 | අඳින ලැබුවේ: Drawn by: | *Kumuduni* | සංශෝධන Amendments | | |
| යම් පත්‍රය: ap Sheet: | — | සැලසුම් කළේ Designed by: | *R. St. & H. Pf* | | | |

### ද්‍රව්‍ය ලැයිස්තුව List of Materials

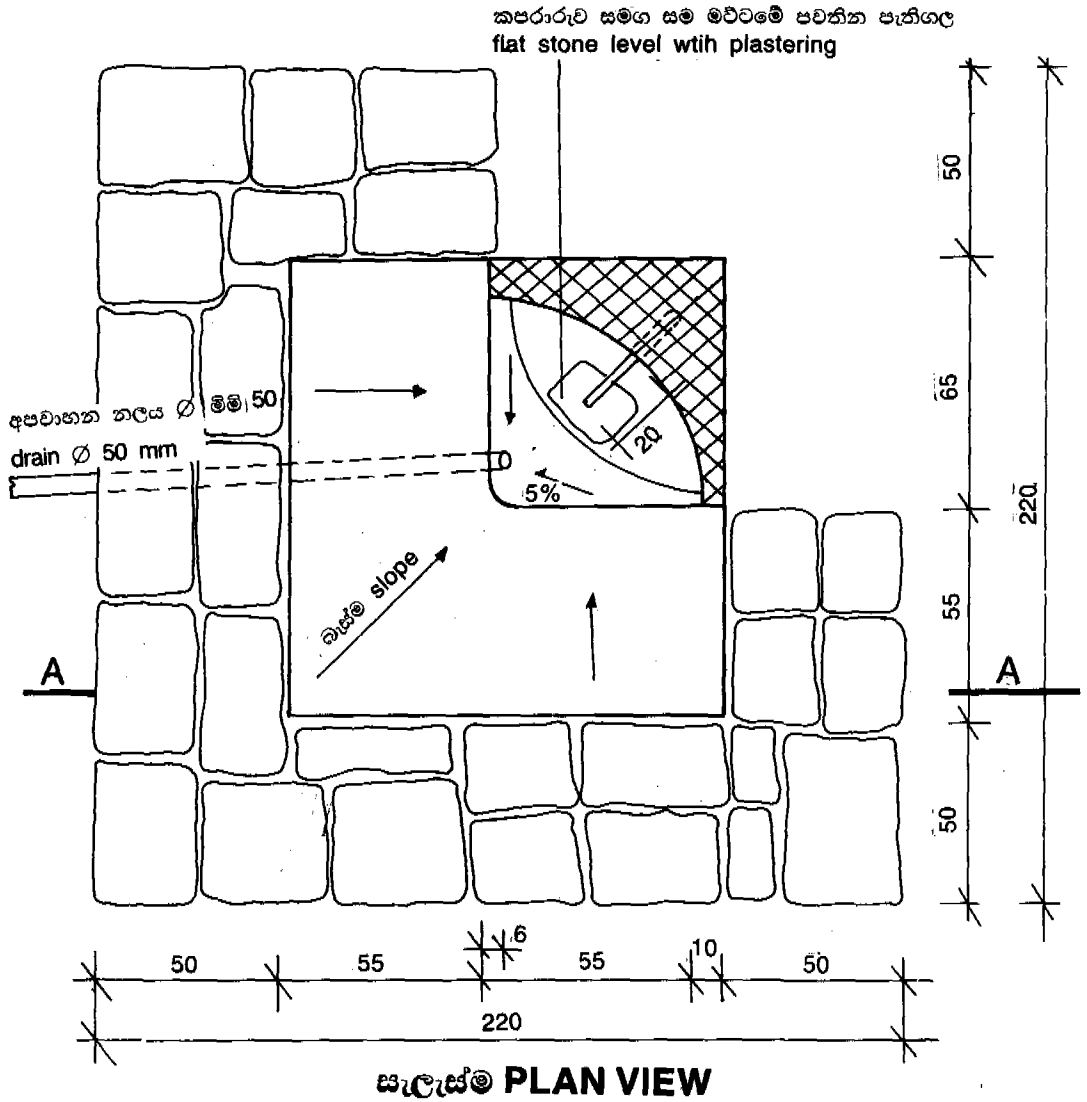
| | | | සවිකල කරාමය Top attached to | | | |
|---|---|---|---|---|---|---|
| | | | st. t. 2-5 $m^3$ | | st. t. 6.5-12 $m^3$ | |
| | | | var. A | var. B | var. A | var. B |
| සිමෙන්ති කොට්ට | cement | bags | 5 | 4 | 6 | 5 |
| වැලි | sand | $M^3$ | 0.5 | 0.4 | 0.7 | 0.6 |
| 3/4" මැටල් ගල් | metal | $M^3$ | 0.9 | 0.9 | 1 | 1 |
| පැති ගල් | shaped sto. | pcs | 350 | 150 | 400 | 200 |
| සක්ක ගල් | rubble | pcs | 900 | 900 | 900 | 900 |

# කරාම කුළුණ 86"
# STAND POST 86"

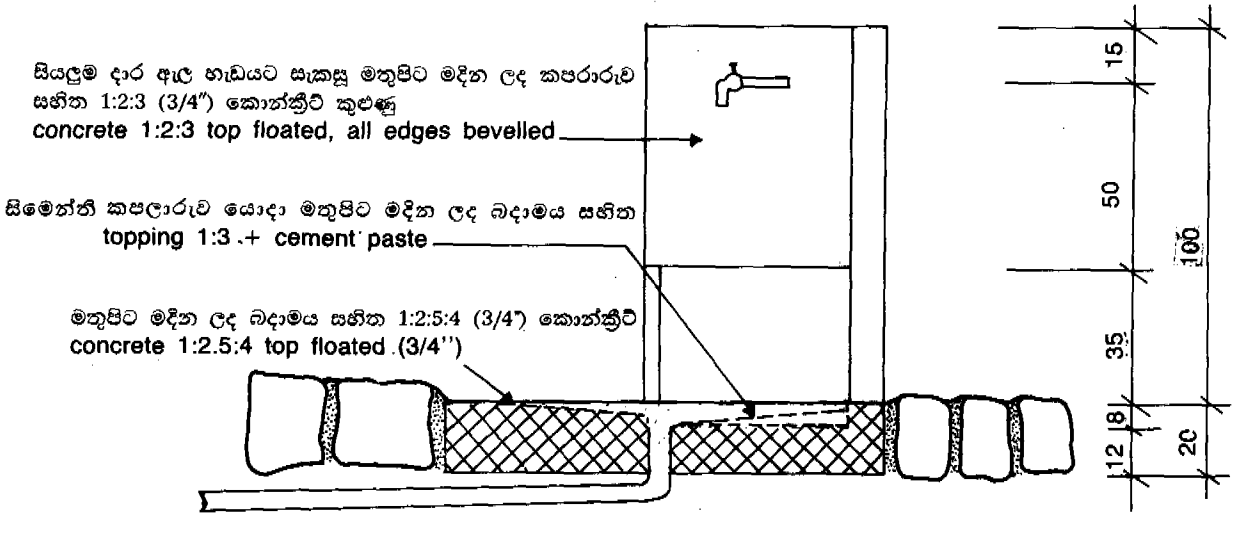
| | | | | | |
|---|---|---|---|---|---|
| සැලසුම් අංකය: Plan No. | **V - 02** | දිනය: Date: | ***April 1992*** | | දිනය Date: |
| පරිමාණය: Scale: | **1:20** | අඳින ලැබුවේ: Drawn by: | ***Kumuduni*** | සංශෝධන Amendments | |
| සිතියම් පත්‍රය: Map Sheet: | **–** | සැලසුම් කළේ Designed by: | ***R. St. & H. Pf*** | | |

## ද්‍රව්‍ය ලැයිස්තුව List of materials

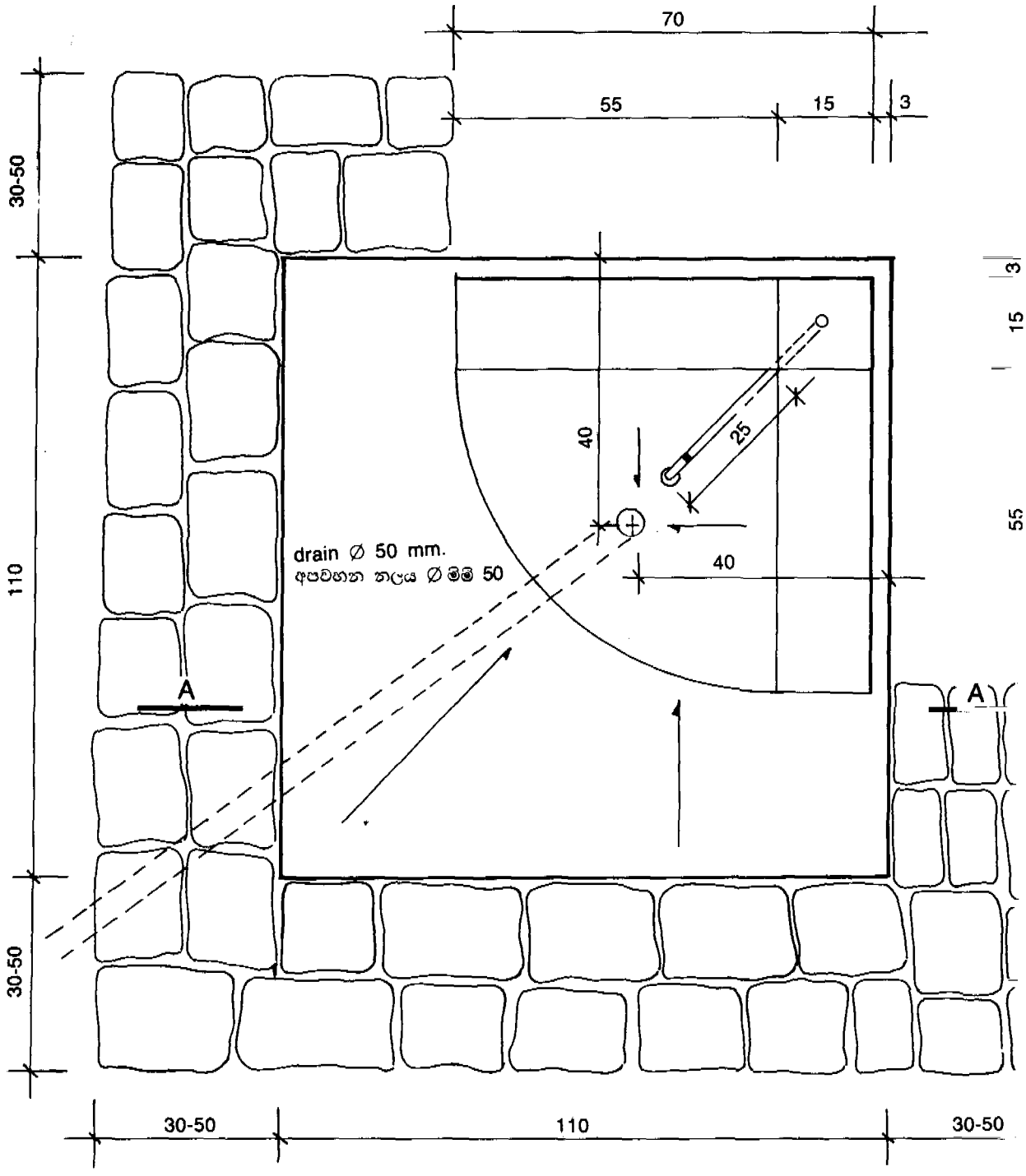
| | | | |
|---|---|---|---|
| සිමෙන්ති | cement | කොට්ට bags | 3.5 |
| වැලි | sand | $m^3$ | 0.3 |
| 3/4" මැටල් ගල් | metal | $m^3$ | 0.45 |
| | shaped line stones | pcs | 1 |
| සක්ක ගල් | unshaped stones | pcs | 200 |
| | rebar ø 6mm | kg | 4 |
| ජී. අයි. නල | G.I. pipe 1" | cm | 30 |



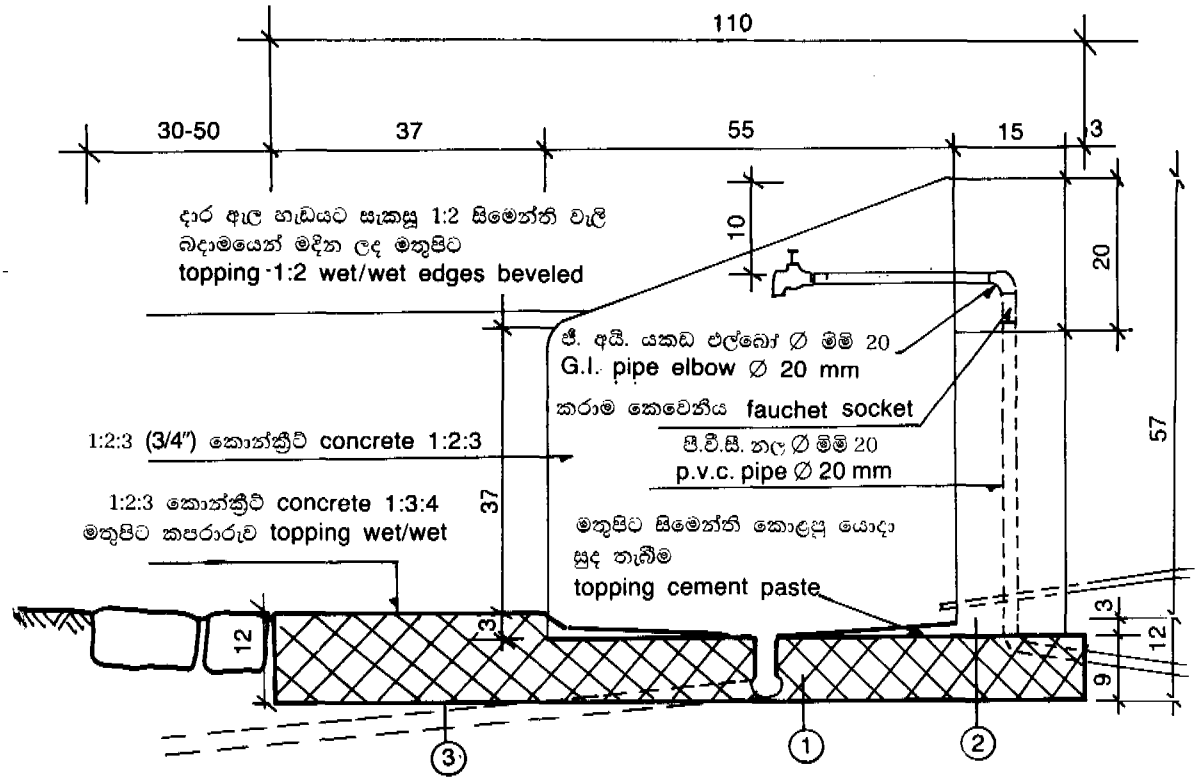

## සැලැස්ම PLAN VIEW




## A - A හරහා ඡේදීය පෙනුම SECTION A - A




සැලැස්ම **PLAN VIEW**




## A - A ඡේදය SECTION A - A

**පියවර (1)** කරාම කුළුණේ පහළ කොටස සෙ.මී. 9 ඝනකමට කොන්ක්‍රීට් වාත්තු කරන්න.

**පියවර (2)** 1:2:3 (3/4") කොන්ක්‍රීට් මිශ්‍රණයෙන් කරාම කුළුණ වාත්තු කරන්න.

**පියවර (3)** (පසුවදා) හැඩයම ගලවන්න. කරාම කුළුණෙහි ඉතිරි කොන්ක්‍රීට් වාත්තු කර (සෙ.මී. 12 ඝනක ස්ථාන වලට සිමෙන්ති කොළපුව සහ මතුපිට බදාම යොදා මැදීම කරන්න.

**Step (1)** cast 9 cm of concrete below the stand pipe.

**Step (2)** cast stand pipe pillar : concrete 1:2:3

**Step (3)** (The next following day) remove formwork and cast remaining part of s slab (12 cm) apply topping and cement paste

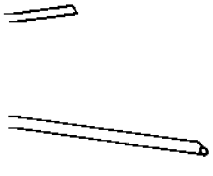
# කරාම කුළුණ 88″
# STAND POST 88″

| | | | | | | |
|---|---|---|---|---|---|---|
| ලසුම් අංකය: an No. | V - 03 | දිනය: Date: | *April 1992* | | දිනය Date: | විසින් By: |
| ර්මාණය: ale: | 1:10 | අඳිනු ලැබුවේ: Drawn by: | *Kumuduni* | සංශෝධන Amendments | | |
| තියම් පත්‍රය: ap Sheet: | — | සැලසුම් කළේ Designed by: | *H. Pf* | | | |

## ද්‍රව්‍ය ලැයිස්තුව List of Materials

| | | | |
|---|---|---|---|
| සිමෙන්ති | cement | කොට්ට bags | 1.75 |
| වැලි | sand | $m^3$ | 0.15 |
| මැටල් ගල් | metal | $m^3$ | 0.20 |
| කලුගල් | unshaped stones | pcs | 150 |
| ජී. අයි. පයිප්ප | G.I. pipe | 0.75" | 2.5 cm |
| ජී. අයි. එල්බෝ | G.I. elbow | 0.75" | 1 pc |
| ෆෝසට් කෙවනි | fauchet socket | | 1 pc |
| කරාම | tap | 0.75 " | 1 pc |

සෝදාව සහිත
with wash out



සෝදාව නොමැතිව
with out washout

මට) අදාල

and pipe