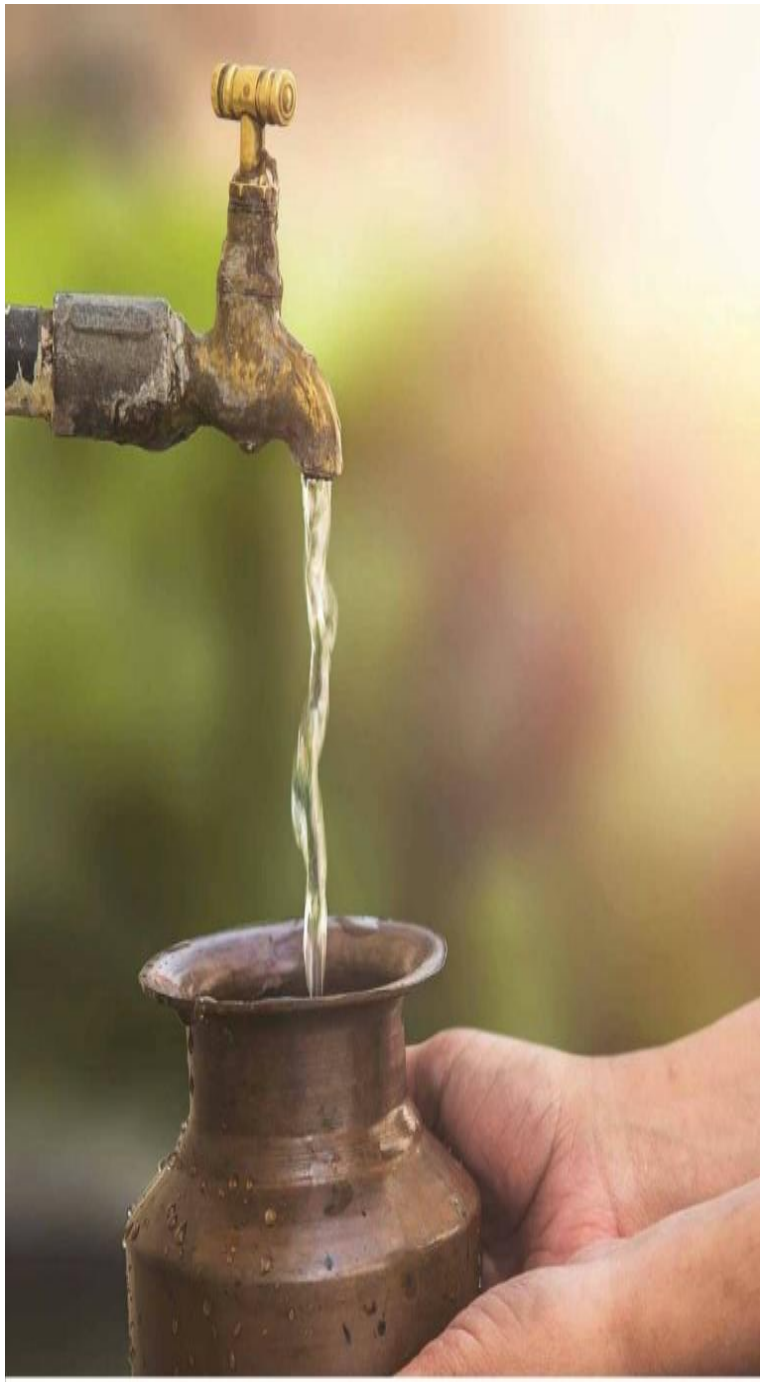


WORKSHOP SERIES ON KNOWLEDGE SHARING AND IDEATION-WORKSHOP 10

Presentation on :-

PLANNING & DESIG OF WATER SUPPLY SCHEME

On 24th of May, 2024.

PRESENTED BY:
ER. NAWAZ AHMAD BHAT
EXECUTIVE ENGINEER JALSHAKTI DIVISION KULGAM

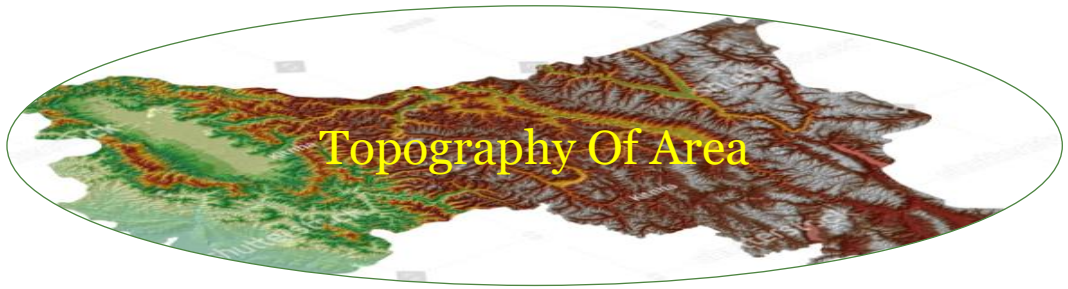
OBJECTIVES OF PLANNING

- To supply safe and clean water in adequate quantity conveniently and as economically as possible.

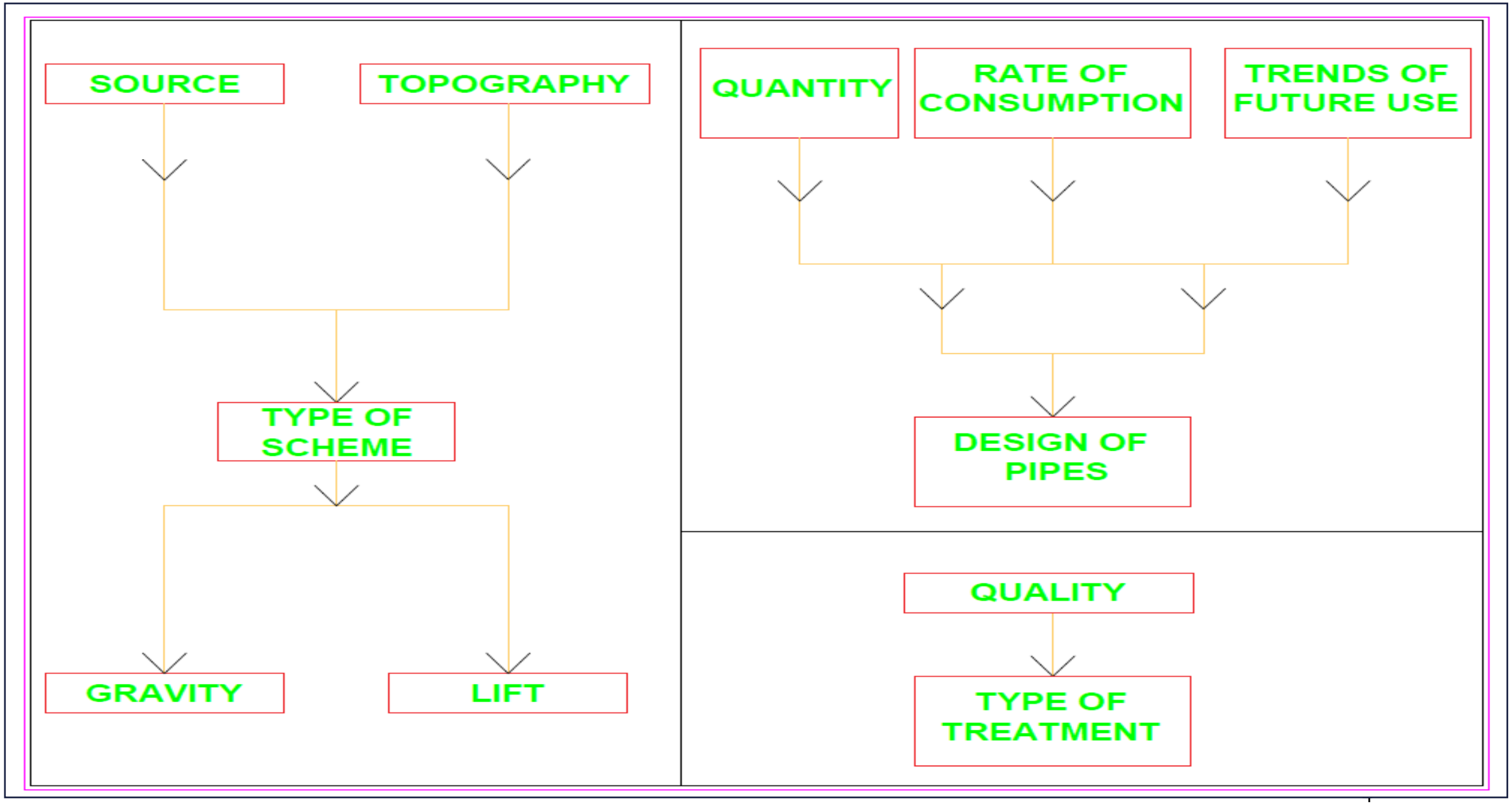
- Water supply projects formulated by various State Authorities differ in various aspects thus comparative study for cost benefit ratio are not amenable, thus a need to specify appropriate standards, planning and design criteria to avoid empirical approach.

PLANNING OF WATER SUPPLY SCHEME

- SOURCE
- QUANTITY
- QUALITY
- RATE OF CONSUMPTION
- TOPOGRAPHY OF AREA
- TRENDS OF FUTURE DEMAND



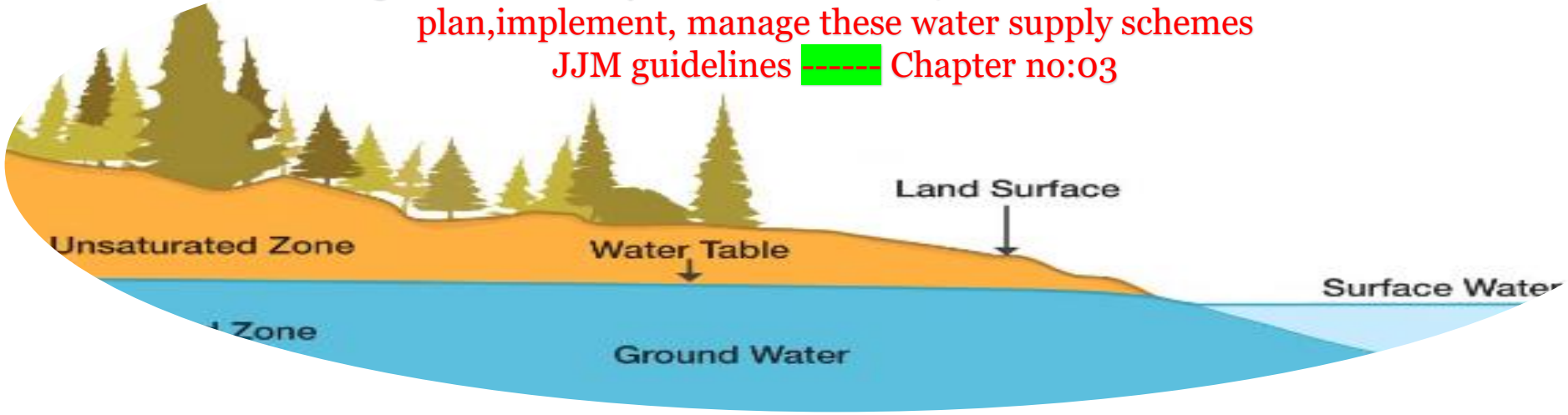
PLANNING OF WATER SUPPLY SCHEME



SOURCE OF WATER

- Selection of suitable source weather Surface water or Ground water based , should be free from all encumbrances like riparian rights.
- Existing source of scheme if existing needs to be augmented
- Selecting a source, local community shall prove very beneficial as they are having required knowledge of source / past experience.

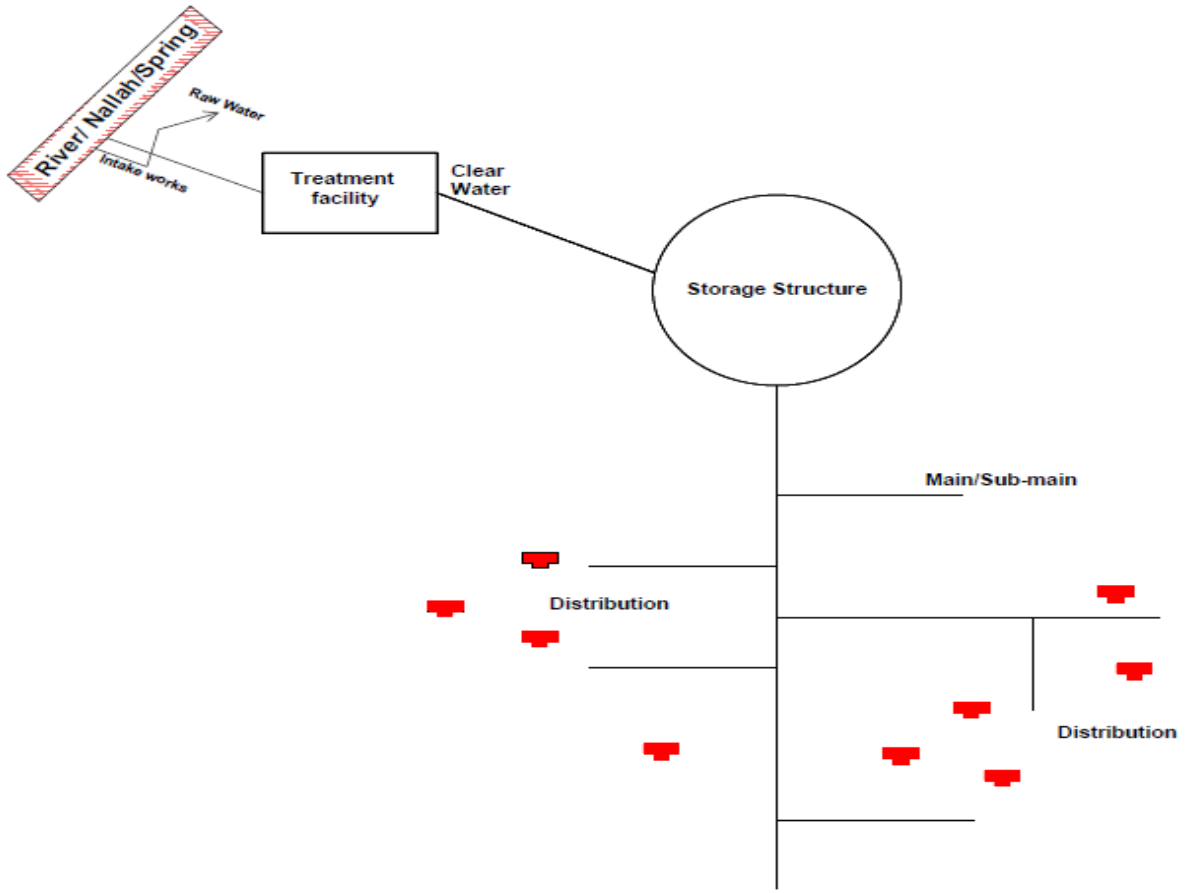
JJM guidelines clearly mention that GPS/ rural communities have to plan,implement, manage these water supply schemes
JJM guidelines ------ Chapter no:03



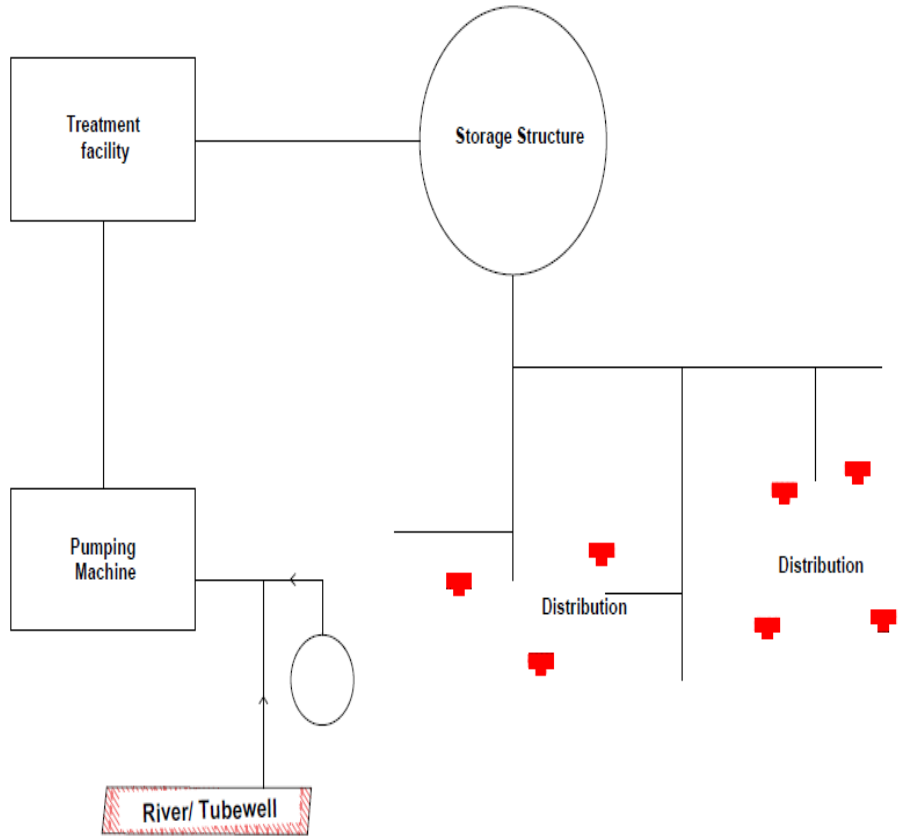
PLANT SITING / LOCATION OF STRUCTURES.

- For optimal & Economic utilization factors like topography, Soil condition and physical hazards should be considered.
- For Gravity schemes, Topography plays an important / governing factor.
- Flooding is another factor determining the location of treatment plants / pumping stations, HFL should be considered while selecting the plant location.
- Mechanization, instrumentation and automation are becoming more and more common in water works and should be taken in account in planning the system.

TYPICAL LAYOUT OF A GRAVITY SCHEME

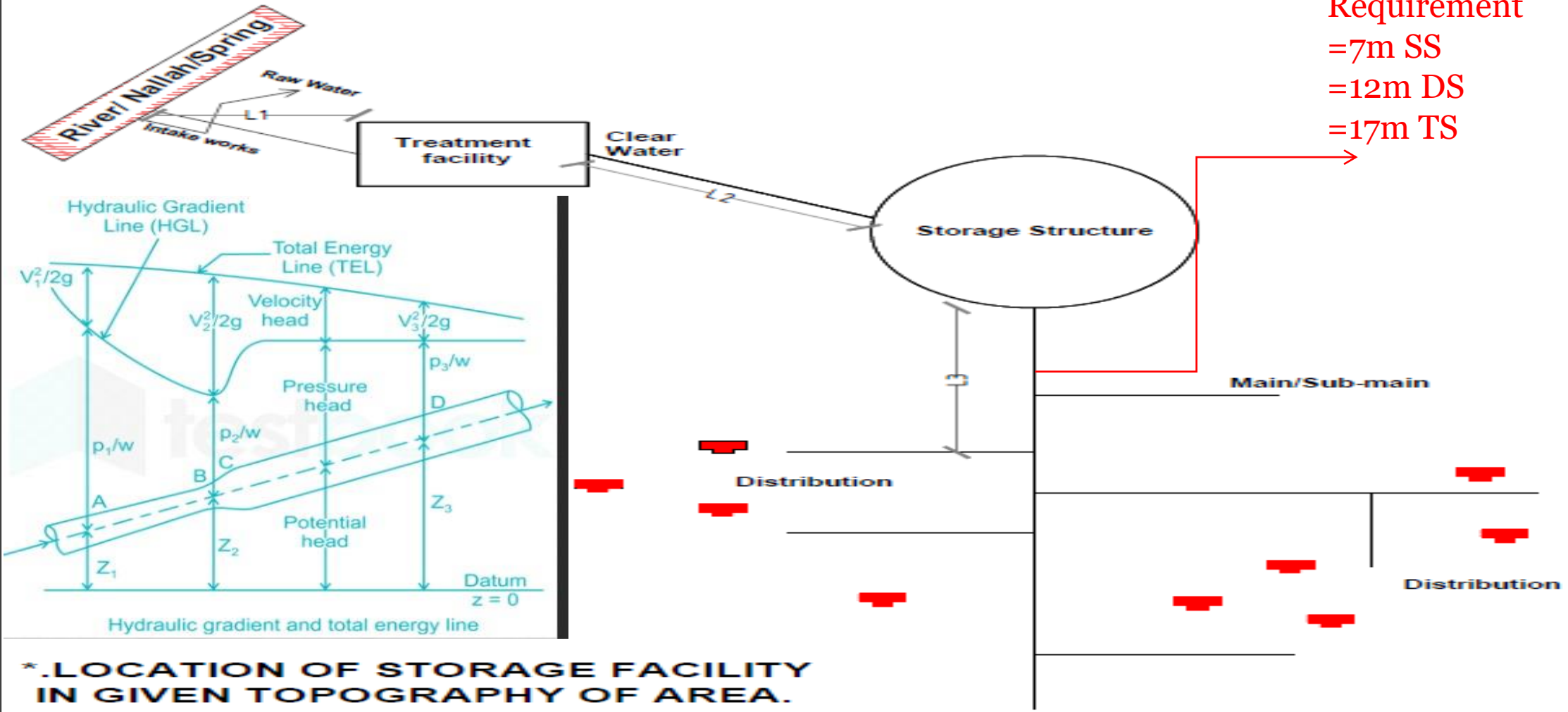


TYPICAL LAYOUT OF A LIFT SCHEME



TYPICAL LAYOUT OF A GRAVITY SCHEME

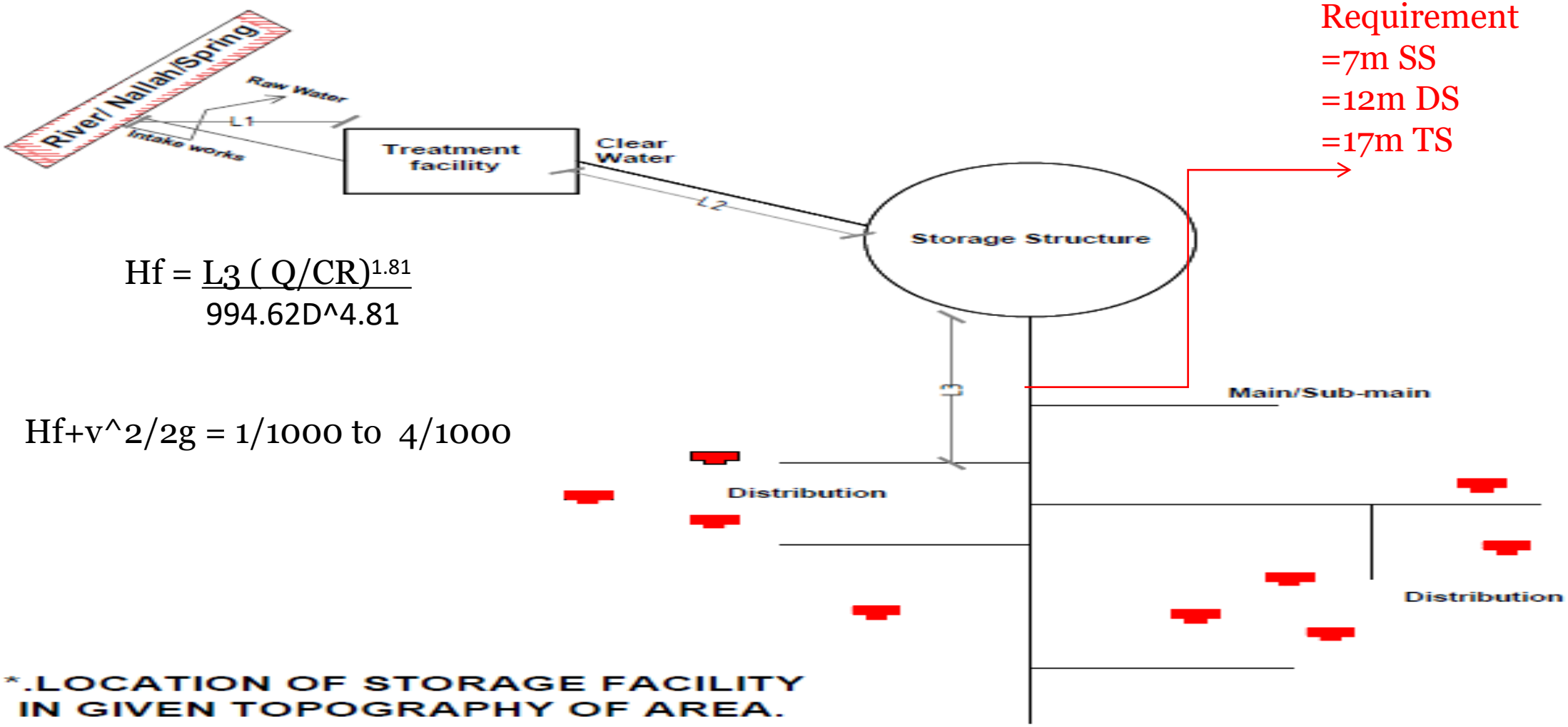
Pressure Requirement
=7m SS
=12m DS
=17m TS



*.LOCATION OF STORAGE FACILITY IN GIVEN TOPOGRAPHY OF AREA.

* .AS PER CPHEEO,SLOPE OF HYDRAULIC GRADE LINE SHOULD BE 1 TO 4 PER 1000

TYPICAL LAYOUT OF A GRAVITY SCHEME



$$Hf = \frac{L3\,(Q/CR)^{1.81}}{994.62D^{4.81}}$$

Hf+v^2/2g = 1/1000 to 4/1000

*.LOCATION OF STORAGE FACILITY IN GIVEN TOPOGRAPHY OF AREA.

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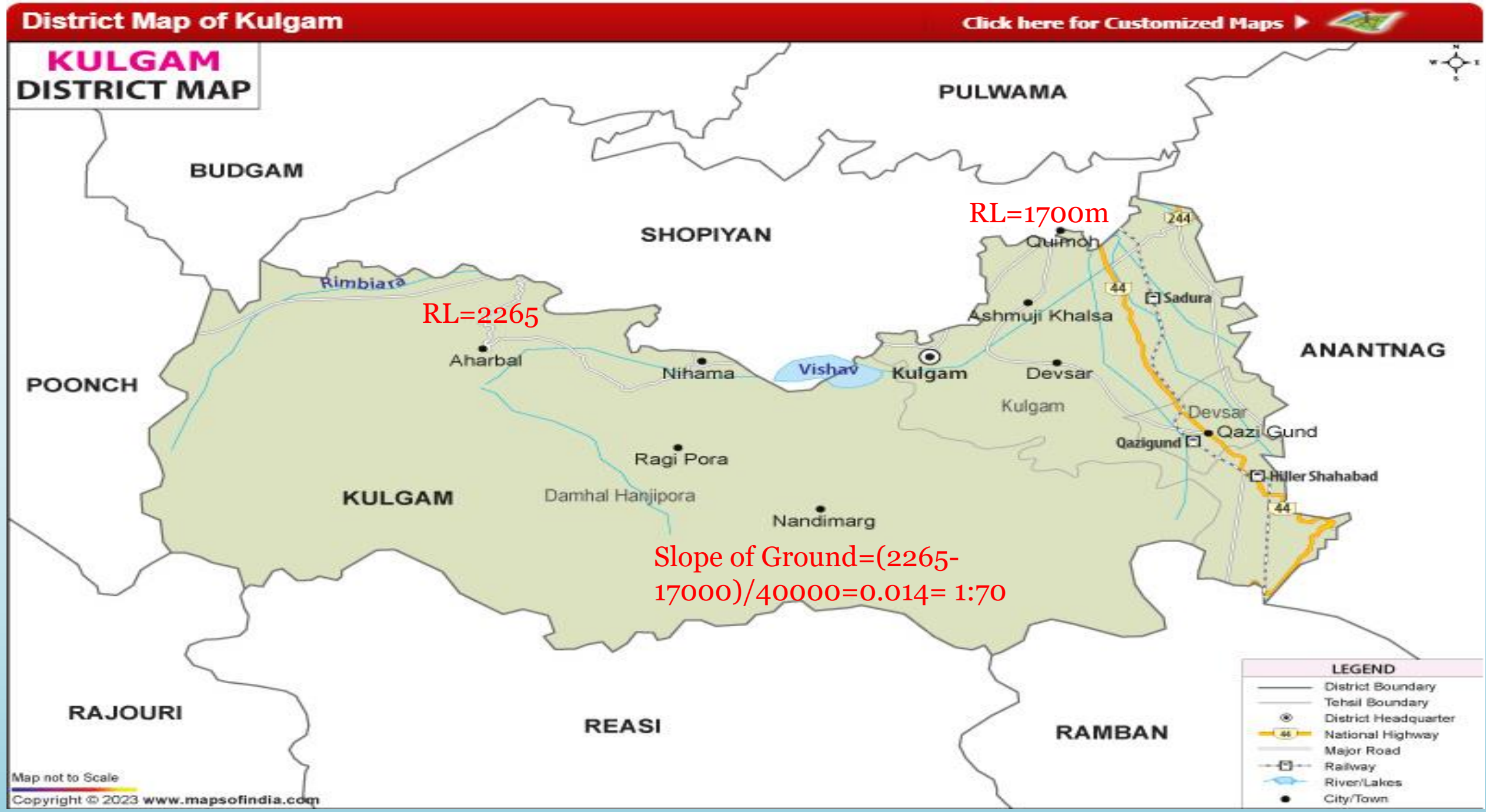
District Map of Kulgam
Click here for Customized Maps
KULGAM
DISTRICT MAP
PULWAMA
BUDGAM
SHOPIYAN
ANANTNAG
POONCH
KULGAM
RAJOURI
REASI
RAMBAN
RL=1700m
RL=2265
Slope of Ground=(2265-17000)/40000=0.014= 1:70
Rimbiara
Aharbal
Nihama
Vishav
Kulgam
Devsar
Ashmuji Khalsa
Sadura
Qazigund
Qazi Gund
Hiller Shahabad
Ragi Pora
Damhal Hanjipora
Nandimarg
244
44
LEGEND
District Boundary
Tehsil Boundary
District Headquarter
National Highway
Major Road
Railway
River/Lakes
City/Town
Map not to Scale
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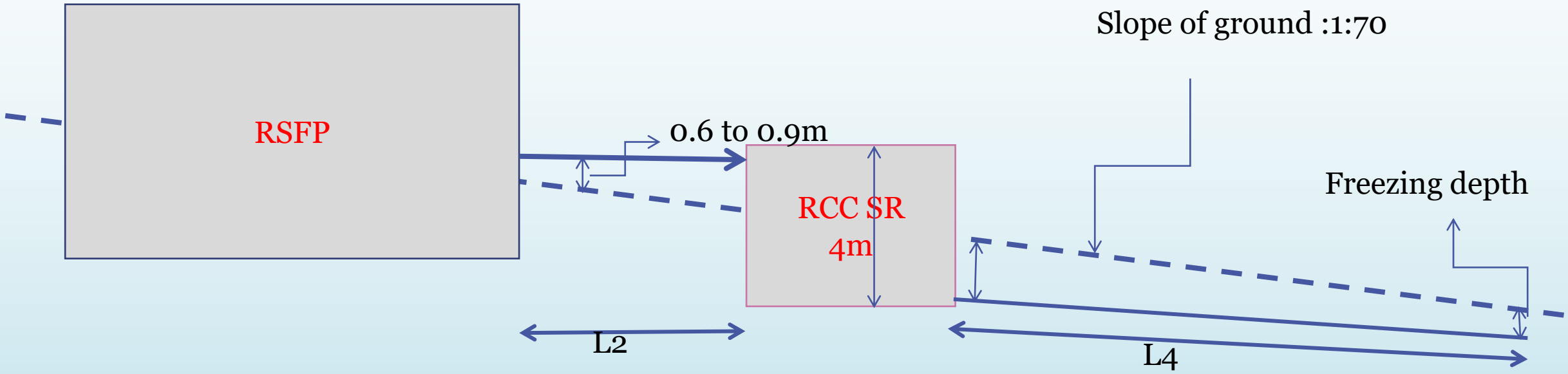
Feasible Location of Storage Structures:



Minimum value of L3= (LD-Pressure requirement at Consumer end-Head Loss in pipe)/70

Minimum value of L4= 4mx70= 280 m

QUANTITY OF WATER

- Minimum of 55 LPCD for Rural areas (JJM guidelines)
- In addition water requirement for Institutional needs be considered.
- CPHEEO Guidelines have the following recommended per capita water requirement.

S.No	Classification of Towns/cities	Recommended Max. water supply levels
1.	Towns provided with piped water supply but without sewerage system	70
2.	Cities provided with piped water supply where sewerage system is existing/contemplated.	135
3.	Metropolitan and Mega cities provided with piped water supply where sewerage system is existing/ contemplated	150

FIRE FIGHTING DEMAND

Fire fighting water demand = 100 √p
P= population in thousands
For P > 50000
→ 100 √50 ≈ 70 KL ≈ 1.5 Lac Gallon (Kuichling 's formula)
1/3 → service storage (0.50 lac gal.)

Each fire stream deliver 946 Litres/min.
700 √p x 3.78 Litres
Also refer IS -9668-1980

INSTITUTIONAL NEEDS OF WATER

S.No	Institutions	Litres per head per day
❖	Hospital (Including laundry) a). No. of beds exceeding 100 b). No. of beds not exceeding 100	 450 per Bed 340 per Bed
❖	Hotels	180 per Bed
❖	Hostels	135
❖	Nurses home & medical quarters	135
❖	Boarding schools / colleges	135
❖	Restaurants	70 per Seat
❖	Airports & Sea ports	70
❖	Junction Stations & Intermediate stations where mail or express stoppage (both Railways & Bus Stations) is provided	70
❖	Terminal stations	45
❖	Intermediate Stations (Excluding Mail & Express stops)	45 (could be reduced to 25 where bathing facilities are not provided

S.No	Institutions	Litres per head per day
❖	Day schools / collages	45
❖	offices	45
❖	factories	45 (cloud be reduced to 30 where no bathrooms are provided)
❖	Cinema concert, halls & theatres	15

PRESSURE REQUIREMENT

- Design of pipe water supply scheme shall be designed for following head (Pressure requirement) Residual pressure

DESIGN PERIOD

- Project components may be designed to meet requirement of the following periods

S.No	Items	Design period in year
01.	Storage by Dams	50
02.	Infiltration works	30
03.	Pumping:- a). Pump House (civil works) b). Electric motors and pumps	 30 15
04.	Water Treatment units	15
05.	Pipe connection to several treatment units and other small appurtenances	30
06.	Raw water & Clear water conveying Mains	30
07.	Clear water reservoirs at the head works balancing tanks and service reservoirs (overhead or ground level)	15
08.	Distribution system	30

TRANSMISSION OF WATER

OPEN CHANNEL

Open channels flow has to follow the gradient, thus there is rescheduled use of these channels. Open channel flows have rescheduled use in water works because of:-

- Losses due to percolation & Evaporation
- Possibility of pollution
- Misuse of water
- Have to flow natural surface profile, which may not be favorable always.

PRESSURE CONDUITS

Pressure conduits :- Pipeline flow is governed by coefficient of roughness which intern effects the head loss in pipe line

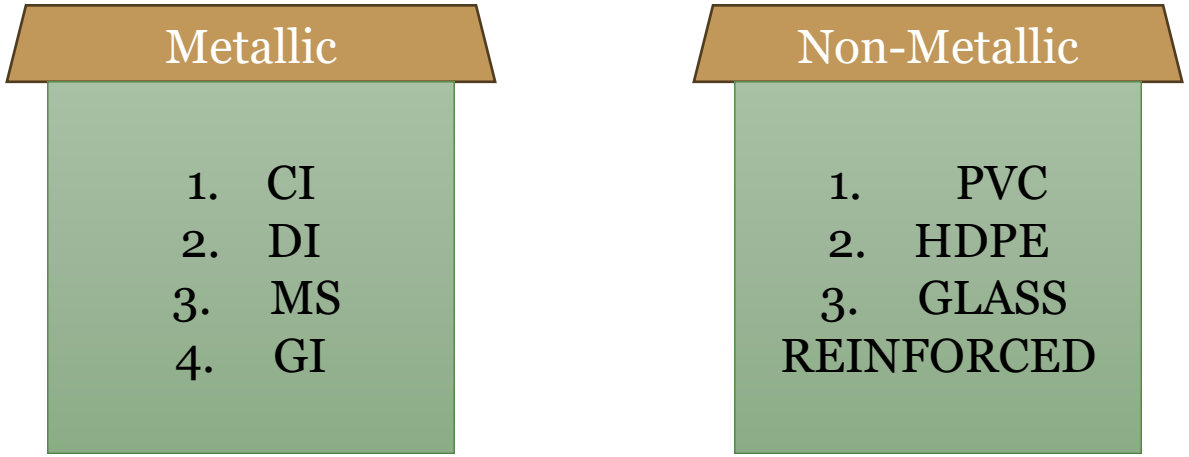
$$Hf = \frac{L\,(Q/CR)^{1.81}}{994.62D^{4.81}}$$

VALUE OF CR FOR VARIOUS PIPE MATERIAL IS GIVEN:-

S.No	Pipe Material	CR value when New	Cr value for Design period of 30 years.
1.	RCC	1.0	1.0
2.	AC	1.0	1.0
3.	HDPE & PVC	1.0	1.0
4.	CI/DI	1.0	0.85*
6.	Metallic Pipes lined with cement mortar or epoxy (for water with negative Langelier's index)	1.0	1.0
7.	SGSW	1.0	1.0
8.	GI	0.87*	0.74

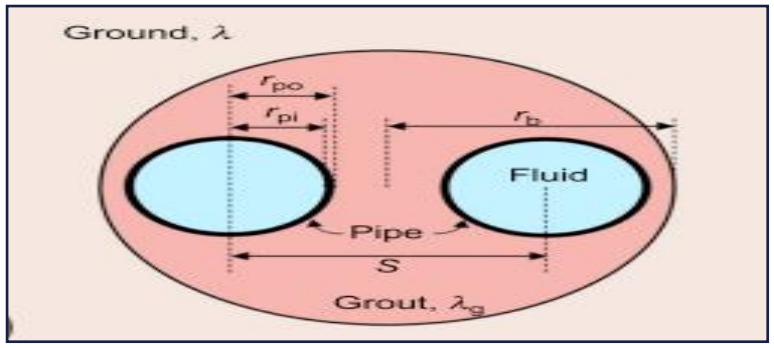
SELECTION OF PIPE MATERIAL

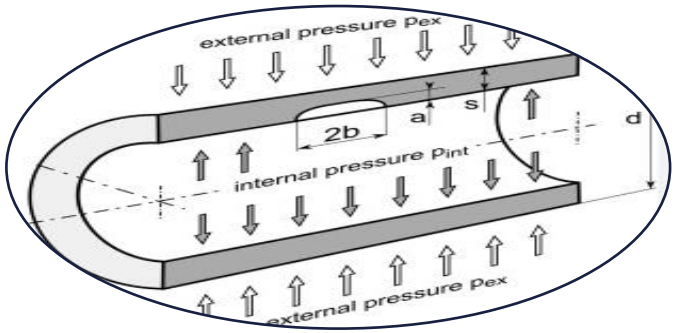
- Pipes constitute a major investment in water supply projects. Pipes are thus to be selected judiously from the point of view of:-
- Durability
- Life span
- Installation / Maintenance cost
- Laying / jointing
- Choice of pipe material:-

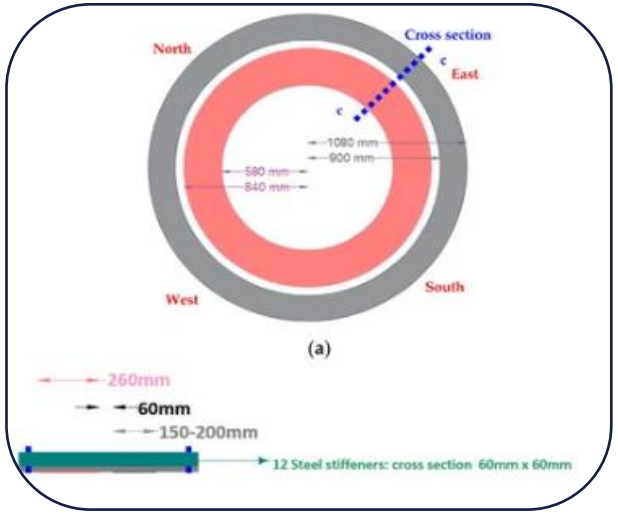


FACTORS GOVERNING CHOICE OF PIPES

- Internal pressure resistance
- C^r coefficient of roughness
- Life & durability of pipe
- Ease in operation , maintenance, transportation, handling, laying 7 jointing under conditions of topography, geology & other prevailing conditions.
- Safety, economy & availability of manufacturer & Sizes.







DI PIPES (mostly being used in water supply schemes

- Mainly because of easy in jointing, flexibility in negotiating curves
- Codes of practice for these pipes are IS-8329-2000.
- Pipes are Designed as K^7,K^8,K^9-------
- The prefix “K” is a whole number used for thickness class designation.

K	Min wall Thickness of pipe
7	5
8	6
12	7

$\mu = K(0.5+0.001\ Dn)$

μ = Wall thickness

Dn = Normal diameter

K= Whole Number Coefficient.

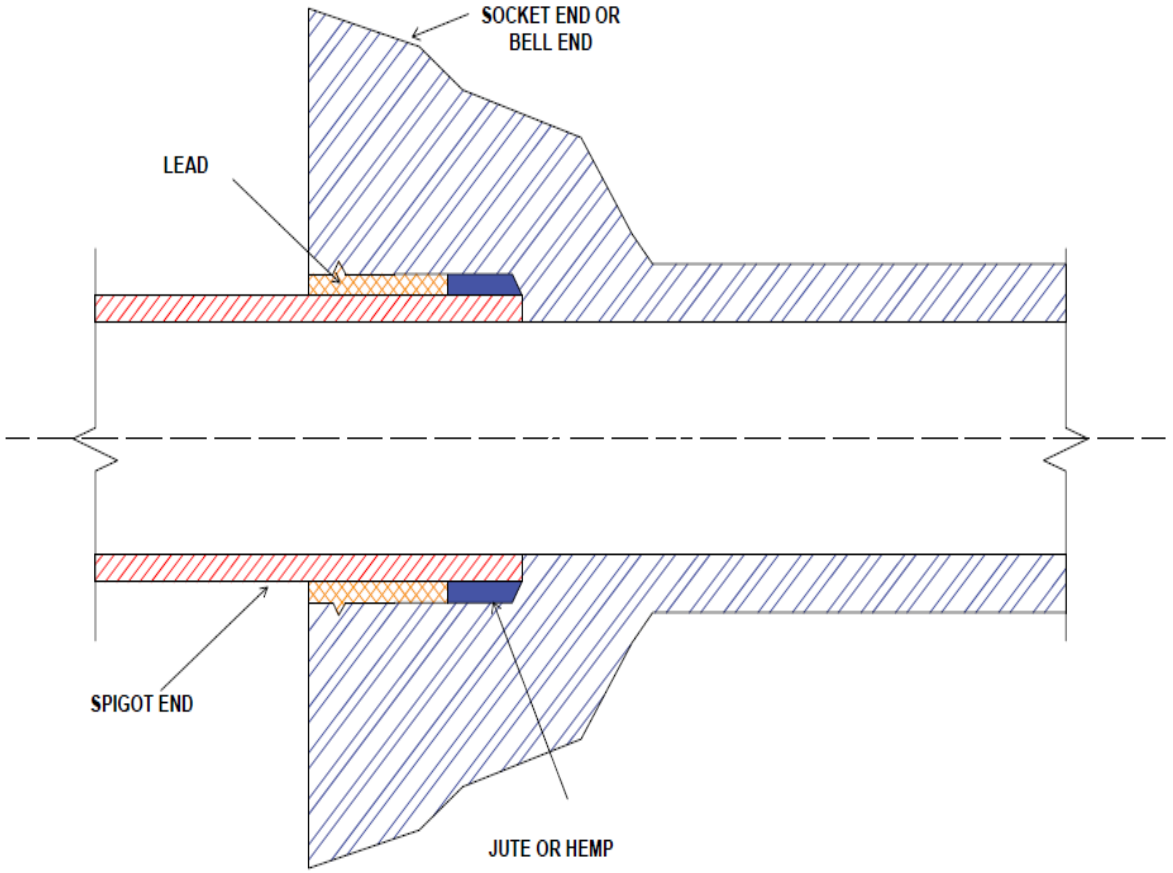
USE OF DI PIPES FOR DIFFERENT SERVICE CONDITIONS

Class	Value of K	Service Condition
K^7	7	(WP= 0.6 MPA)
K^8	8	(WP= 1.2 MPA)
K^9	9	(WP= 1.8 MPA)

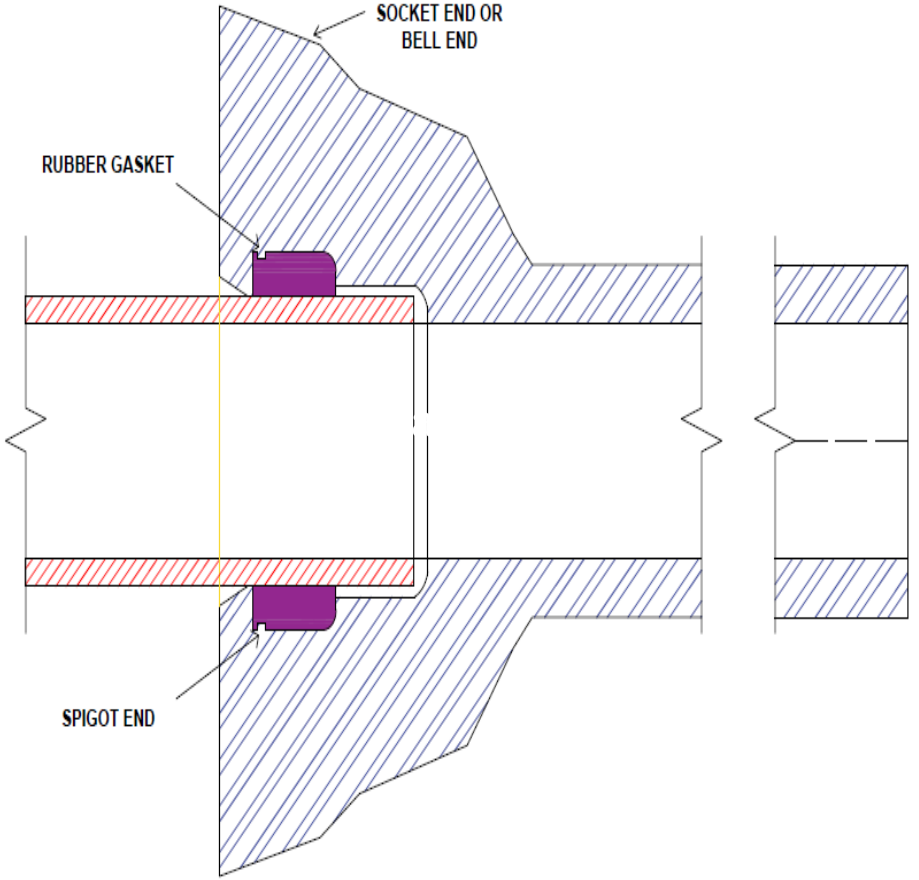
EASY IN JOINTING

Push on flexible joint allow rapid progress in pipe fitting as compared to lead caulked Joint.

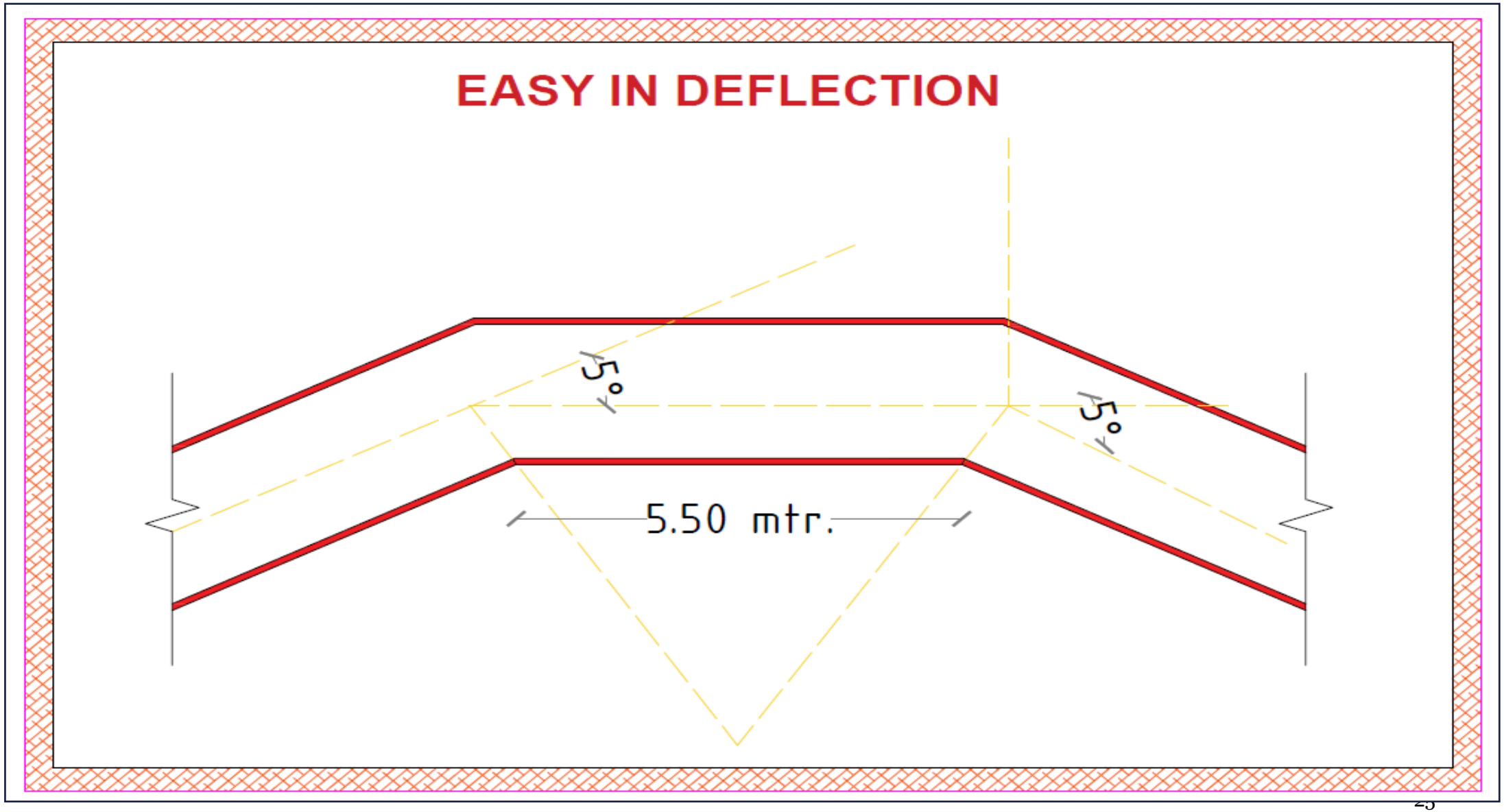
LEAD CAULKED JOINT



PUSH ON FLEXIBLE JOINT



EASY IN DEFLECTION



PIPE DESIGN:- Pipe Design is governed by

- Modified Hazen-Williams formula which is given as:-

$$H_L = L(Q/C_R)^{1.81} / 994.62\, d^{4.81}$$

$$d^{4.81} = L(Q/C_R)^{1.81} / 994.62h$$

In order to avoid deposition / corrosion resulting in deterioration in quality minimum velocity in pipe line adopted is 0.60 m/sec.

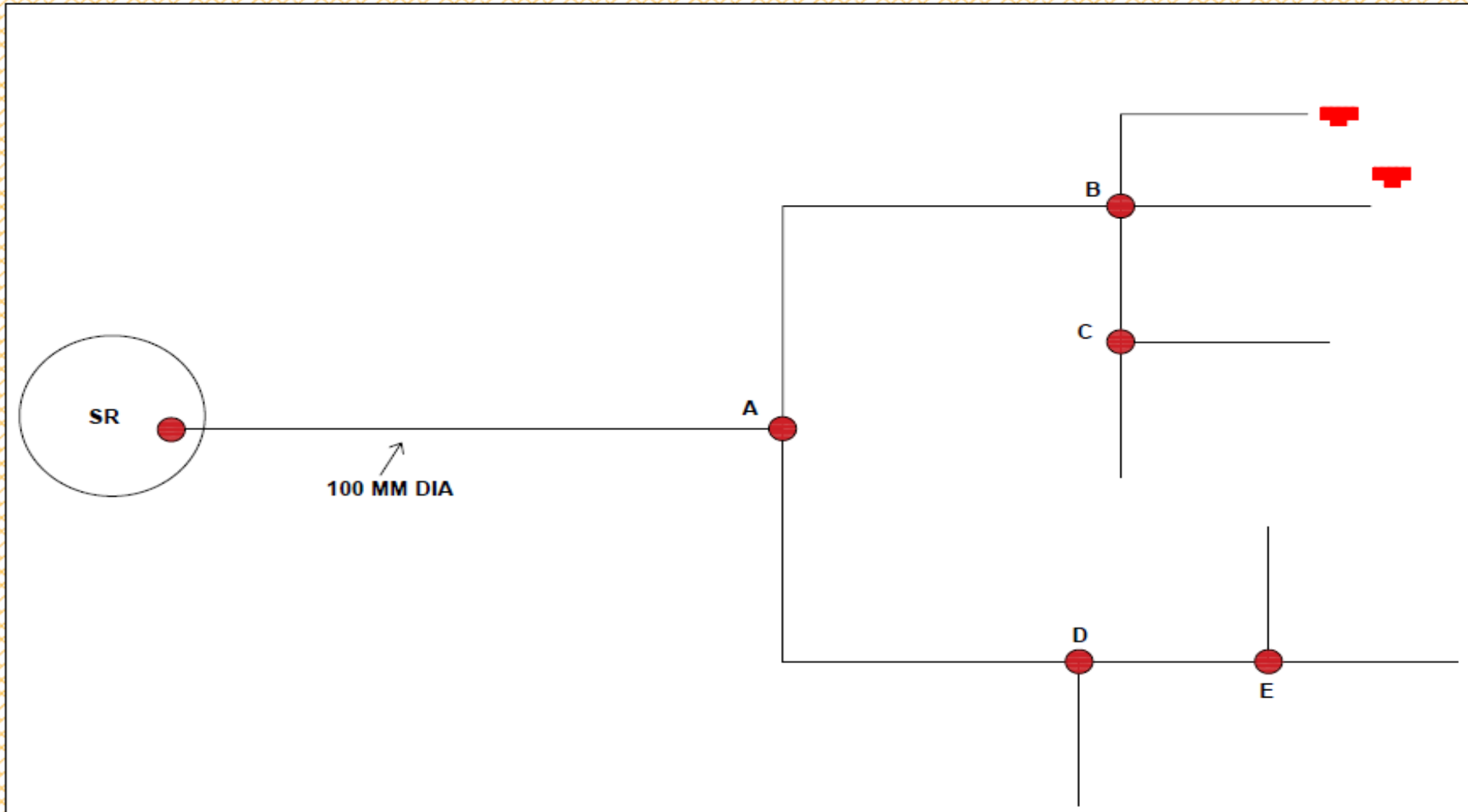
$Q = AV$,

$AV = Q$, $V = Q/A$

$V \geq 0.6$ m/sec., $Q/(\pi/4 * d^2) \geq 0.6$ m/sec.

$D^2 \leq 4Q/\pi * 0.6$

RESSURE REQUIREMENT



DESIGN OF DISTRIBUTION SYSTEM

- Consumption of water varies with season, month & hour.
- Distribution system is designed taking this variation in account.
- A factor called peak factor is to be introduced to design distribution pipes.
- CPEEO manual recommends following peak factor.

S.No	Population	Peak Flow
1.	< 50,000	3.00
2.	50,000 to 200,000	2.50
3.	> 200,000	2.00
4.	For small water supply scheme	3.00

WATER TREATMENT

- The aim of water treatment is to produce & maintain water that is hygienically safe, aesthetically attractive & palatable in an economic manner.
- METHODS OF TREATMENTS ADOPTED

a). AERATION

b). SEDIMENTATION.

c). RAPID MIXING.

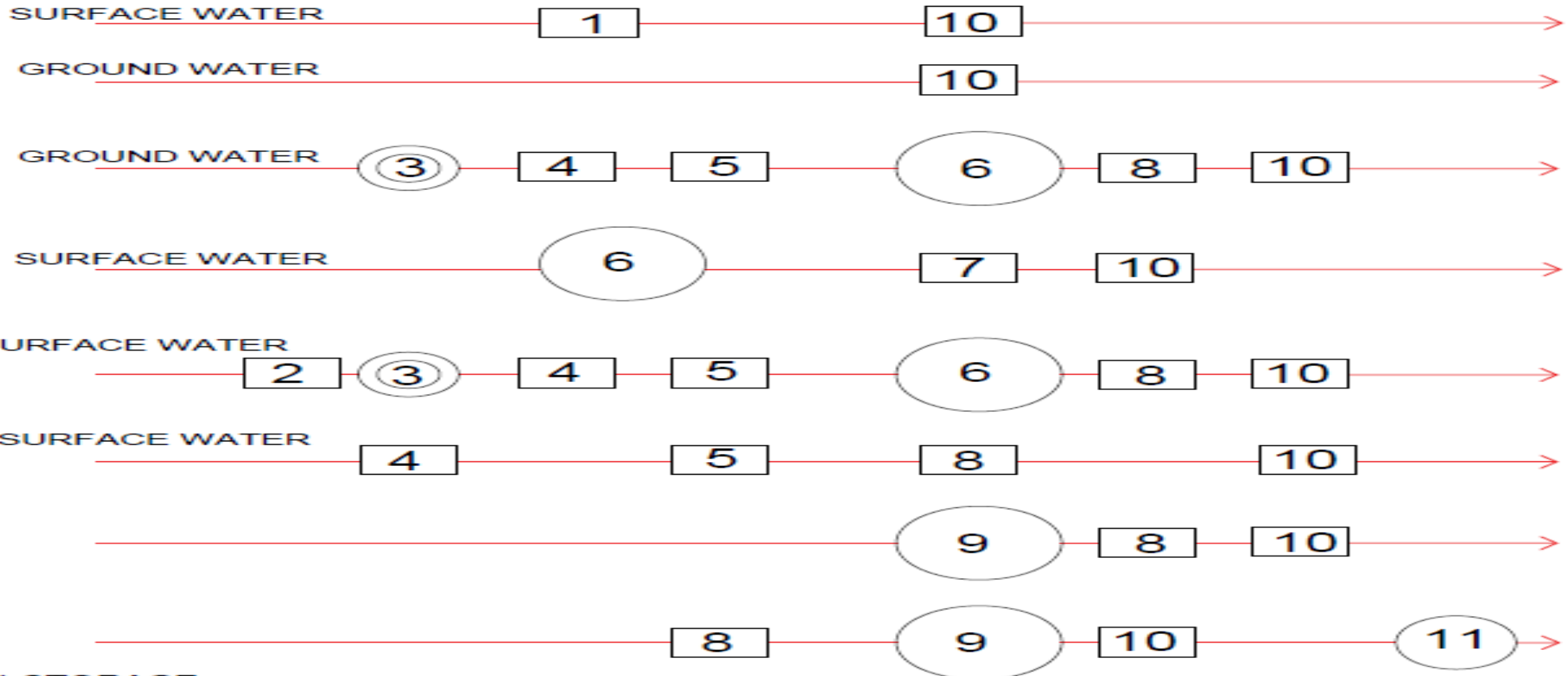
d). SLOW SAND FILTRATION.

e). RAPID SAND FILTRATION .

f). CHLORINATION.

*. Different methods of treatment are to be adopted either alone or in combination.
*. CPHEEO recommends following combinations of Filtration.

UNIT OPERATIONS IN WATER TREATMENT

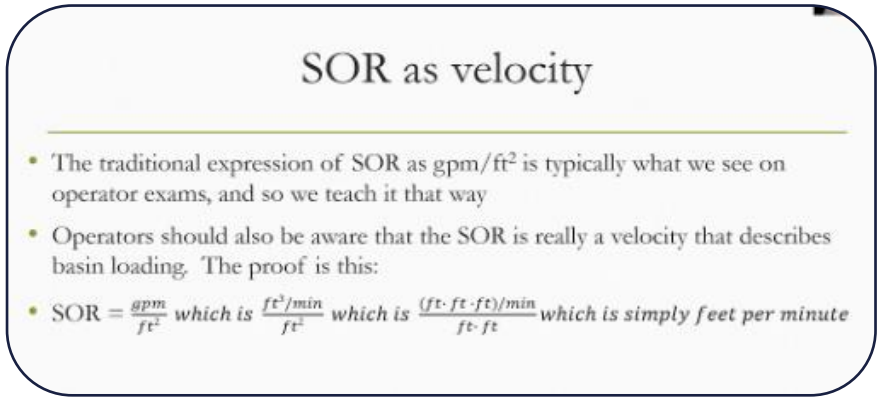


1.STORAGE
2. CHLORINATION (PRE)
3. AERATION
4. RAPID MIXING
5. FLOCCULATION-SLOW MIXING
6. SEDIMENTATION.
7. SLOW SAND FILTRATION
8. RAPID SAND FILTRATION
9. SOFTENING
10.CHLORINATION (POST)
11. DEMINERALIZATION.

SEDIMENTATION

- Sedimentation is the process in which water is retained in a tank or basin so that suspended particles may settle under action of gravity.
- Design consideration.
- a). Detention period 3 to 4 hours for plain sedimentation & 2 to 2.5 hours for sedimentation with coagulation.
- b). Surface overflow rate.

SOR = Q/BL ≥ 15-30 $m^3/m^2/sec$.



Settling velocity	Percentage of particles removed
settling velocity ≥ surface overflow rate	100% removed
Settling velocity < surface overflow rate	$\frac{V_s}{V_0} \times 100$

AERATION

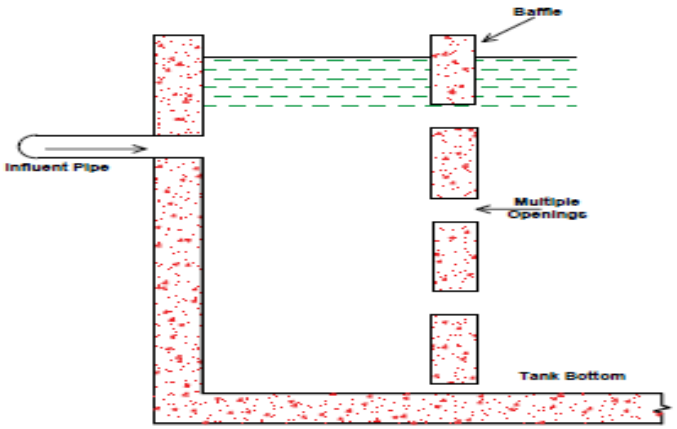
- Cascade Aeration.

RAPID MIXING / SLOW MIXING

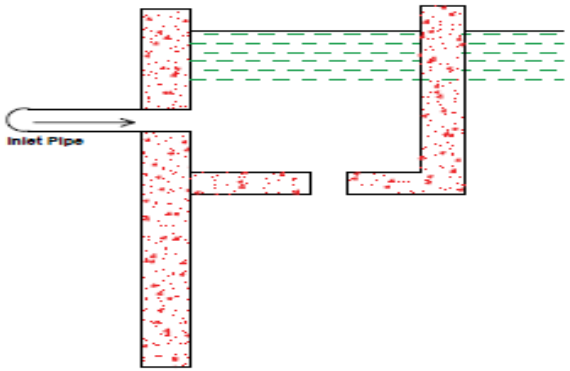
- Process used for mixing of chemicals to react with direct & get flocked / settled.
- Aluminum ferrous sulphate popularly known as alum used for flocculation.
- The general chemical formula for Alum is $Al_2(SO_4)_3 \cdot 18H_2O$.
- Reaction Mechanism
- $Al_2(SO_4) \cdot 18H_2O + 3CA(--Co_3)_2$
- $AL(OH)_3 + 3CaSo + 6Co_2 + 18H_2O$.
- SOR= 30 to 40 m^3/m^2/day for sedimentation with coagulation.

Inlet & Outlet arrangement of tanks.

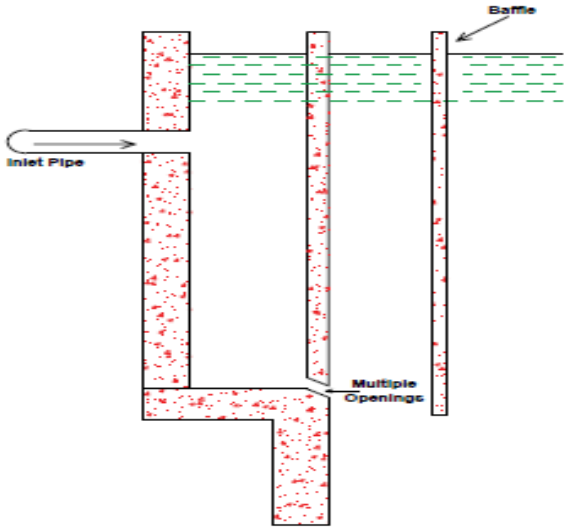
- Inlet & Outlet arrangements recommended are given as per CPHEEO



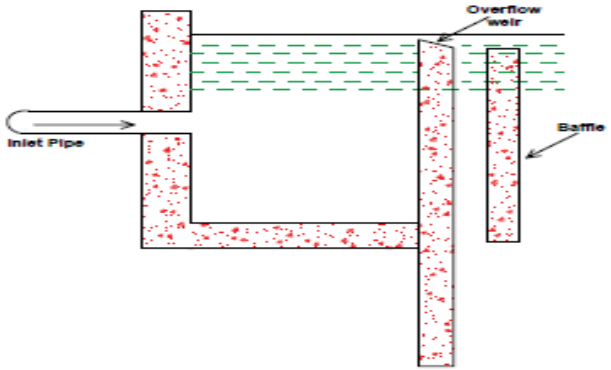
Diffuser wall with slots or perforated Baffles



Influent channel with Bottom openings



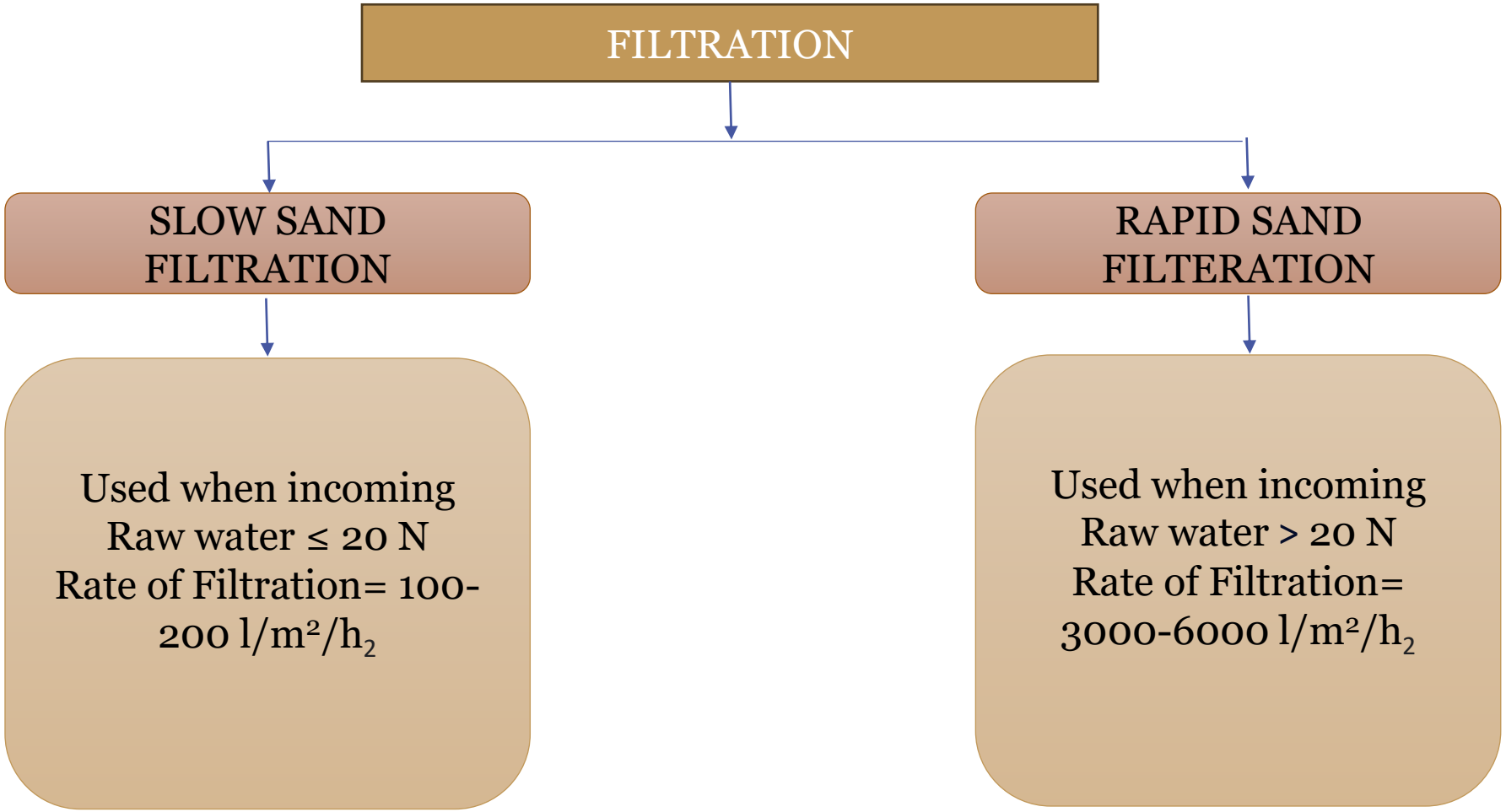
Influent channel with submerged Orifices in the inside channel wall.



Overflow weir followed by a Buffle

FILTRATION.

- Filtration is the process of passing water through thick layers of porous media which in most of cases in layer of sand supported on bed of gravel.



Filter troubles:-.

- Some of potential filter troubles encountered are:-
- A). Formation of Mud balls.
- B). Cracking & clogging of filter media.
- C). Air binding

1. Cracking and clogging of filter bed

- Surface clogging and cracking are usually caused by rapid accumulation of solids on the top of filter media
- Cracks are more at wall junctions

2. Formation of mud balls

- Mud balls are formed because of conglomeration of turbidity, floc, sand and other binders
- Formed because of insufficient washing of sand grains
- Size may be pea size to 2 to 5 cm or more in dia

3. Air binding

- It is caused by release of dissolved gases and air from water to form bubbles

Power Consumption in a rapid sand filteration plant

- Various units requiring power in a Rapid sand filtration are as follows:-

S.No	Particulars of item	capacity
01.	Air blower	7-10 HP
02.	Backwash pump	5 HP
03.	Bleaching Chlorination / Mixing unit	1-2 HP
04.	Alum mixing unit	2 HP
05.	Rotating Bridge motor	2 HP

SLOW SAND FILTRATION PLANT

- Recommended number of slow Sand filters for given plain area.

Area in m^2	Number of Beds
Upto 20	2
20-249	3
250-649	4
650-1200	5
1201-2000	6

SLOW SAND FILTRATION PLANT

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Area in m^2	Number of Beds
Upto 20	2
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650-1200	5
1201-2000	6

COMPARISION OF SLOW SAND & RAPID SAND FILTRATION PLANT.

S.No	Item	Slow sand Filters	Rapid Sand Filters (gravity type)
❖	Size of filter bed	Varies from 10 m ^{2} to 2000 m^{2}or more	Varies from 10 m ^{2}to 50m ^{2}
❖	Filter media of sand	Sand grains are finer. Effective size: 0.25 to 0.35 mm Uniformity coefficient 3 to 5 Thickness: 90 to 110 cm Reduced to not less than 40 cm by scrapping.	Sand grains are slightly coarser. Effective size: 0.45 to 0.70 mm Uniformity coefficient: 1.3 to 1.7 Thickness: 60 to 75 cm Not reduced by washing.
❖	Base material of gravel	Size: 3 to 65 mm Thickness: 30 to 75 cm	Size: 2 to 50 mm Thickness: 45 to 60 cm Essential
❖	Coagulation	Normally not required	Essential
❖	Underdrainage system	Open jointed pipes or drains covered with perforated blocks	Perforated pipe laterals discharging into main header
❖	Size of each unit	50 to 200 sq.m	10 to 100 sq.m

S.No	Item	Slow sand Filters	Rapid Sand Filters (gravity type)
❖	Rate of filtration	100 to 200 Lph/sq.m	4800 to 7200 Lph/sq.m
❖	Suitability	For water supply to rural areas & small towns	For public water supply to towns and cities
❖	Methods of cleaning	• Scrapping and removing schmutzdecke and 1.5 to 3 cm thick sand layer • Laborious	• Backwashing with or without compressed air agitation. • Simple and easy
❖	Quantity of wash water required	0.2 to 0.5 % of total water filtered	1 to 5 % of the total water filtered
❖	Cleaning interval	Three to four months	One to two days

THANKS