စိမ့်စမ်းရေသွယ်လုပ်ငန်း
Gravity Flow Water Supply

Presented by
U Than Shwe Tun
RSE 2987 (Water Supply and Sanitation)

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Rural Water Supply
Division
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Rural Water Supply
Stations
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Taung Zin
Water Supply
(Aided by ADAB)
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* Village Group
Water Supply
(Aided by
Netherlands)
* Gravity Flow
Water Supply
(Aided by UNICEF)
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Tube Well Drillings
(Aided by
WHO and ADAB)
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Gravity Flow Water Supply Systems

Ministry of Agriculture	Ministry of Agriculture and Irrigation	Ministry of Agriculture, Live Stock and Irrigation
Rural Water Supply Division	Water Resources Utilization Department	Irrigation and Water Utilization Management Department
Taung Zin Water Supply Project and Drillings	→	Department of Rural Development
Gravity Flow Water Supply Systems (Aided by UNICEF)	⇒	Ministry of Boder Area Affairs

Village Group Piped Water Supply Schemes

Tube Well 5000gals/hr. And more.

40ft high Steel Trestle, 7000gals

Ground Tanks @ Villages

Gravity Flow Water Supply Systems

Intake Structure
@
Spring or Stream
Source

Reservoir on the Hill near the Village

Tap Stands
in the Village

Gravity Flow Water Supply Systems

No Need Fuel

No Need Electricity

24 hrs. Available

Impotant to Maintain the Pipeline System and to Protect Source & Surrounding Area

Technical Point

Economic Point

Social Point

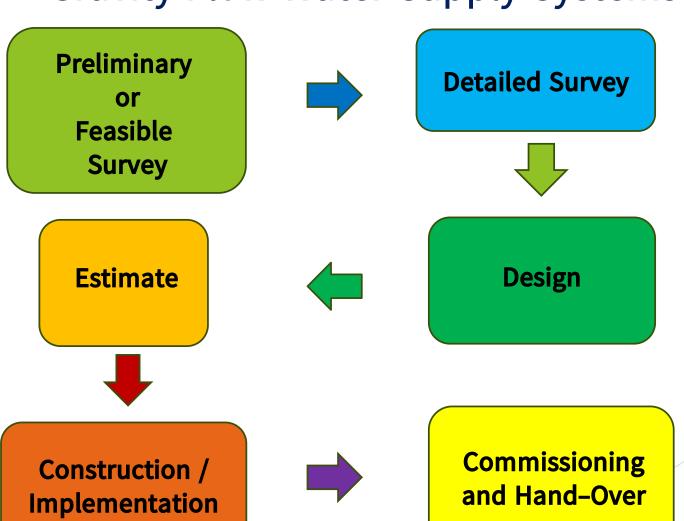# Gravity Flow Water Supply Systems
Community Participation

Government provides

**Skilled Engineers
and
Transportation up to Village**

UNICEF supplies

**all Pipes & Fittings
and
Technical Trainings**

**Villagers contribute
Local Materials, carrying up to Site
and
Digging Pipeline Trench**

Gravity Flow Water Supply Systems

Gravity Flow Water Supply Systems

Preliminary or Feasible Survey

* Water Demand according to Population

* Water Source Yield and Source Situation

* Water Source Elevation above the Village

* Water Source Distance from the Village

* Pipeline Route Situation

Gravity Flow Water Supply Systems

- Demand = (10 / 20 . . .)gals per capital per day
  x population
- Safe Yield (Source Yield gpm. x 60 x 24 hr.) must
  be equal or grater than Daily Demand
- Basic consideration between Source and Village
  should be 25 ft Head for 1 mile distance
- * Safe Yield shall be the Design Flow Rate of Main
  Pipeline (Source to Village)

Gravity Flow Water Supply Systems

Detailed Survey

* Surveying by Measuring Tape & Auto Level or Total Station OR

* Measuring on Google Earth and UTM Map

* Marking Pipeline Route (Survey Notes)
* Defying High Points, Low Points and Obstacles
* **Water Supply Sense is important**

Gravity Flow Water Supply Systems

Design

Hydraulic Theory

Pipeline Construction

Civil Structures

Head

Flow

Gravity Flow Water Supply Systems

Specific Weight of Water   =   **1 gm/cc**

1 gm per cubic centimeter

1 gm per cm square @ 1 cm height

100 gm per cm square @ 100 cm height

1000 gm per cm square @ 1000 cm height

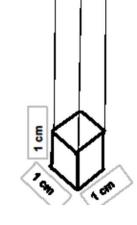**1kg per cm square @ 10 M height**   **= 10 M Head**

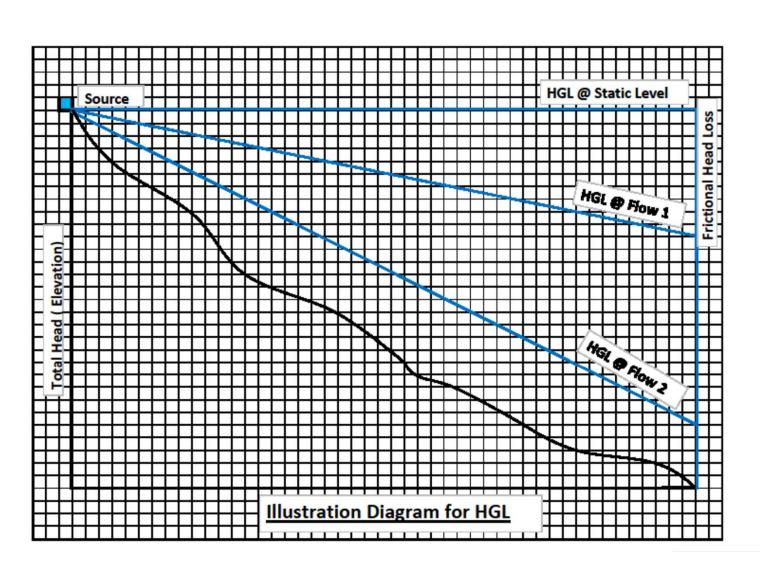**6 kg pee cm square**   **= 60 M Head**

10 kg per cm square   **= 100 M Head**

10 M Head   **= 32.81 ft Head**

               = 0.98 bar

               = 14.22 psi

               = 98.06 kPa

Gravity Flow Water Supply Systems

Illustration Diagram for HGL

Gravity Flow Water Supply Systems

Illustration Diagram for HGL

Gravity Flow Water Supply Systems
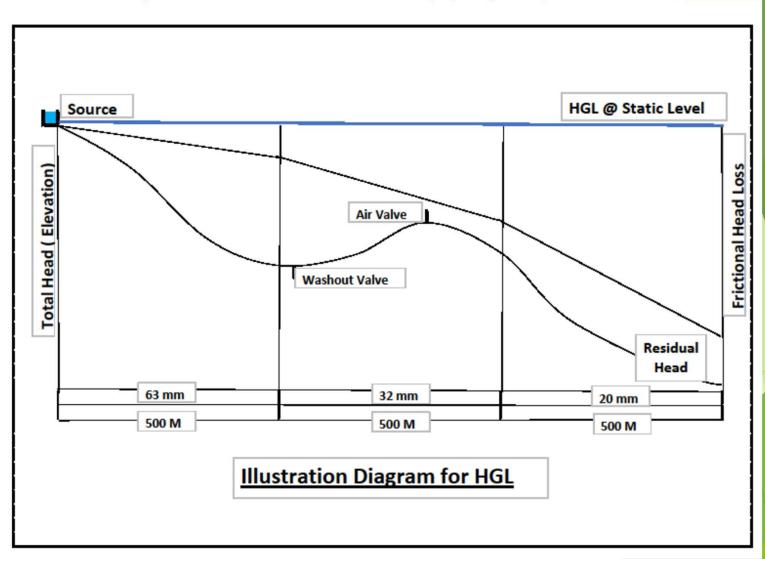
**In the Pipe Flow Systems,
Frictional Head Loss is depending on
Pipe Flow Rate, Pipe Size and Pipe Class**

Assume Residual Head @ Discharge Point
6 M or 20 ft. Head and calculate the Pipe Size
Combination to meet required Residual Head

Residual Head @ the High Point
should be at least 3 M or 10 ft. Head

Air Valves are needed to be installed @
Vertex Position, Long Length and Low Head

Gravity Flow Water Supply Systems

- When the Pipe Flow starts, Frictional Head Loss (Hf) happens in the Pipeline and the HGL drops from Static Level
- Hf value is greater in High Flow Rate and less in Low Flow Rate
- Hf value is greater in Small Pipe Size and less in Large Pipe Size
- Hf value is greater in Metal Pipe Class and less in Non–metal Pipe Class

Gravity Flow Water Supply Systems

Frictional Head Loss (ft) for 1000 ft of uPVC / HDPE Pipeline

Note: C value = 140

Flow Rate (gpm)	Pipe Size						
	20 mm	25 mm	50 mm	62 mm	90 mm	110 mm	160 mm
3	348.48	11.95	1.66	0.41			
6		43.09	5.99	1.48	0.21		
9		91.24	12.69	3.13	0.44	0.11	
12		158.3	21.6	5.33	0.74	0.18	
15		234.75	26.05	8.05	1.12	0.28	
18			45.74	11.28	1.57	0.39	
21			60.84	15.01	2.09	0.51	
24			77.89	19.21	2.67	0.66	
27			96.85	23.89	3.32	0.82	
30			117.69	29.03	4.04	1.00	0.14
33			140.38	34.63	4.82	1.19	0.17
36			164.9	40.68	5.66	1.40	0.19
39			191.22	47.17	6.56	1.62	0.23
42			219.32	54.10	7.52	1.86	0.26
45				61.46	8.55	2.11	0.29

Design Criteria

Hazen-Williams Fomula

$$hf = 0.002083 \times L \times (100/C)^{1.85} \times (gpm^{1.85} / d^{4.8655})$$

Where

hf	=	**25.57** ft	(head loss in feet of water)
L	=	8700 ft	(length of pipe in feet)
C	=	140	(friction coefficient)
gpm	=	400	gallons per minute (USA gallons, not imperial gallons)
d	=	8 inches	(inside diameter of pipe in inches)

0.002	8700	0.537	65134	24773	2.629

1UK gallon (Imperial gal) = 1.2 USA gallons

The friction loss results are only valid for fluids with a kinematic viscosity of 1.13 centistokes, where the velocity of flow is less than 10 feet per sec, and where the pipe diameter has a size greater than 2 inches.

Notes: Water at 60° F (15.5° C) has a kinematic viscosity of 1.13 centistokes.

Common Friction Factor Values of C hw used for design purposes are:

Asbestos Cement 140
Brass tube 130
Cast-Iron tube 100
Concrete tube 110
Copper tube 130
Corrugated steel tube 60
Galvanized tubing 120
Glass tube 130
Lead piping 130
Plastic pipe 140
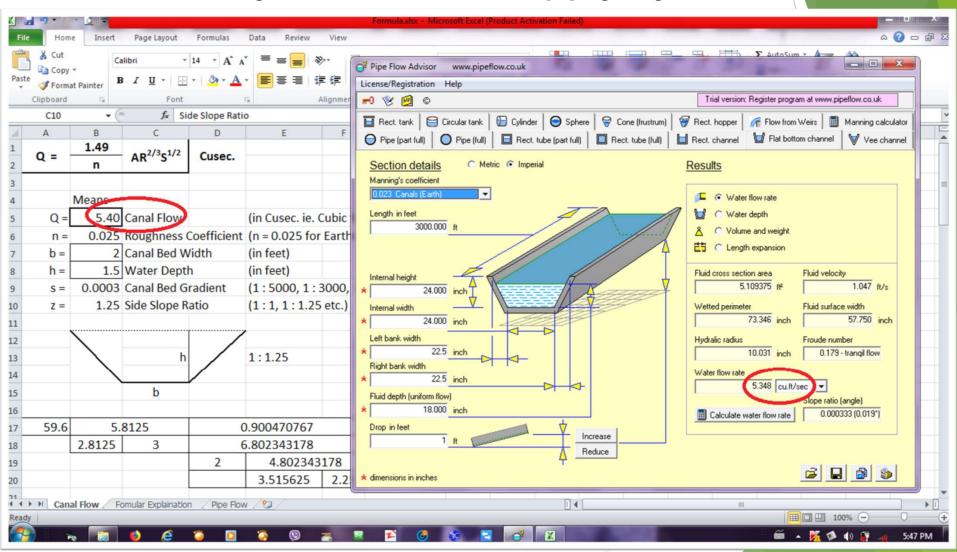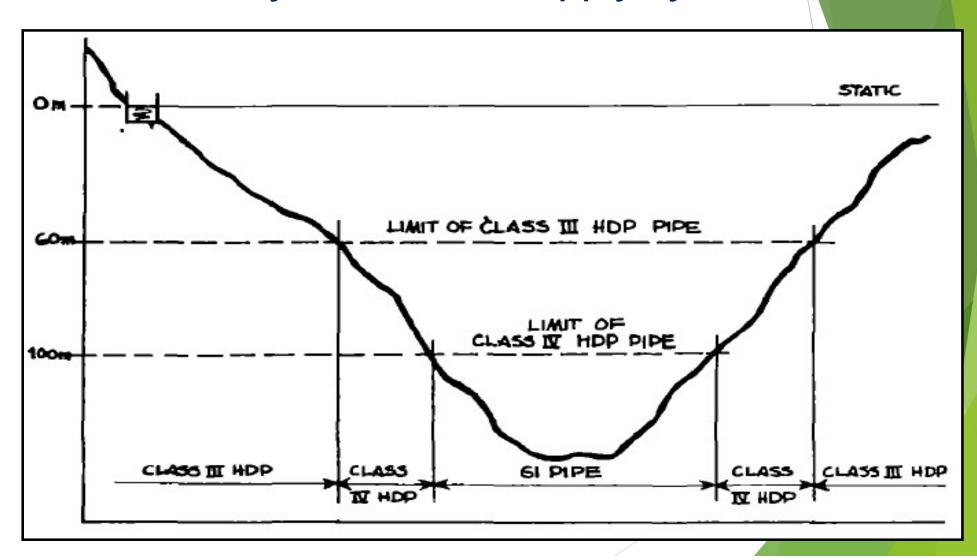PVC pipe 150
General smooth pipes 140
Steel pipe 120
Steel riveted pipes 100
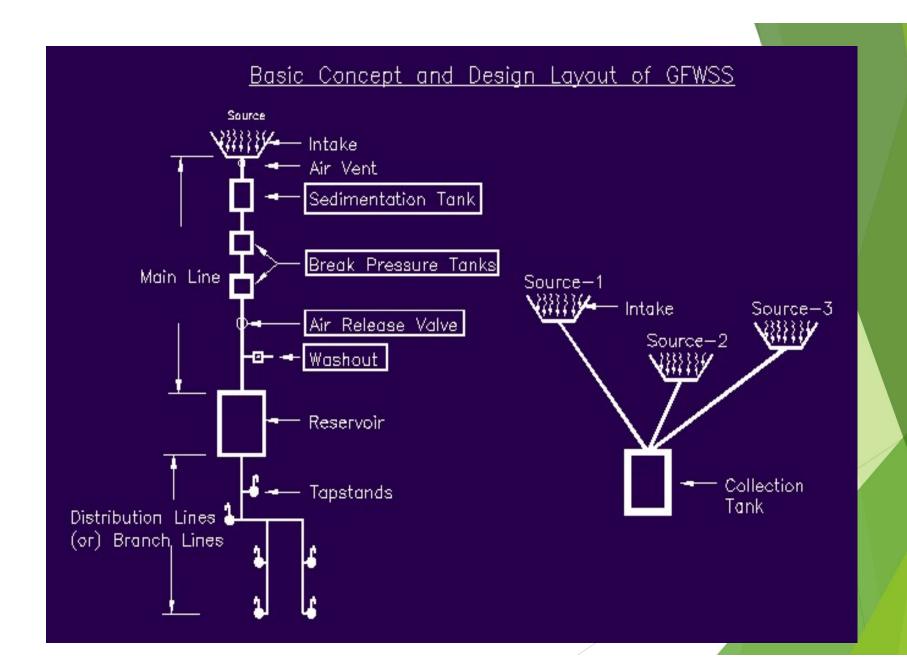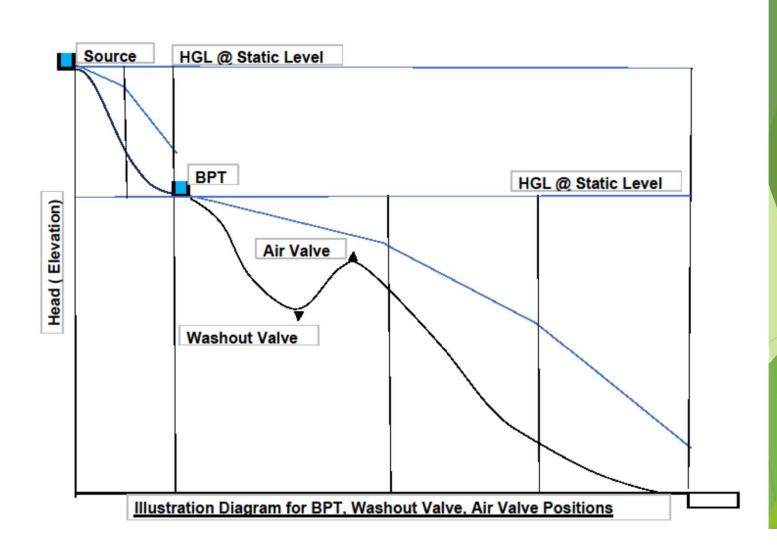Tar coated cast iron tube 100
Tin tubing130
Wood Stave 110
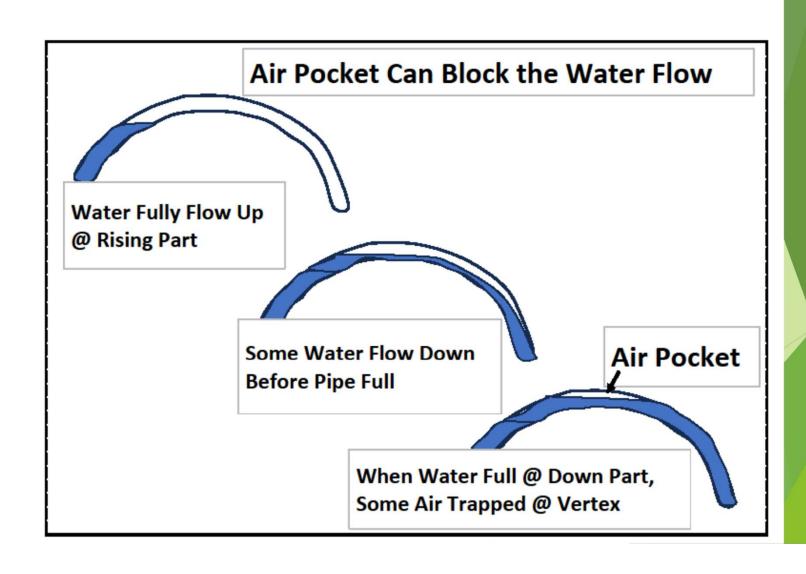
These C hw values provide some allowance for changes to the roughness of internal pipe surface, due to pitting of the pipe wall during long periods of use and the build up of other deposits.

Gravity Flow Water Supply Systems

Gravity Flow Water Supply Systems

Basic Concept and Design Layout of GFWSS

Gravity Flow Water Supply Systems

Illustration Diagram for BPT, Washout Valve, Air Valve Positions

Gravity Flow Water Supply Systems

Gravity Flow Water Supply Systems

Gravity Flow Water Supply Systems

Gravity Flow Water Supply Systems

Determining the Storage Capacity of Reservoir Tank

Schedule - 1

Example

(Say - Total Daily Demand is 10gal 7capital x 1000 = 10000gals and Safe Yield of the Source is 7 gpm)

	Time Period		Demand		Supply	Difference
	6:00 AM To 8:00 AM	(2 hr.)	30% of Total Daily Water Demand	3000	840	- 2160
	8:00 AM To 4:00 PM	(8 hr.)	40% of Total Daily Water Demand	4000	3360	- 640
	4:00 PM To 6:00 PM	(2 hr.)	30% of Total Daily Water Demand	3000	840	- 2160
	6:00 PM To 6:00 AM	(12 hr.)	Negligible Water Demand			

Largest Difficency =   - 4960

Select 5000gals Capacity of Reservoir Tank

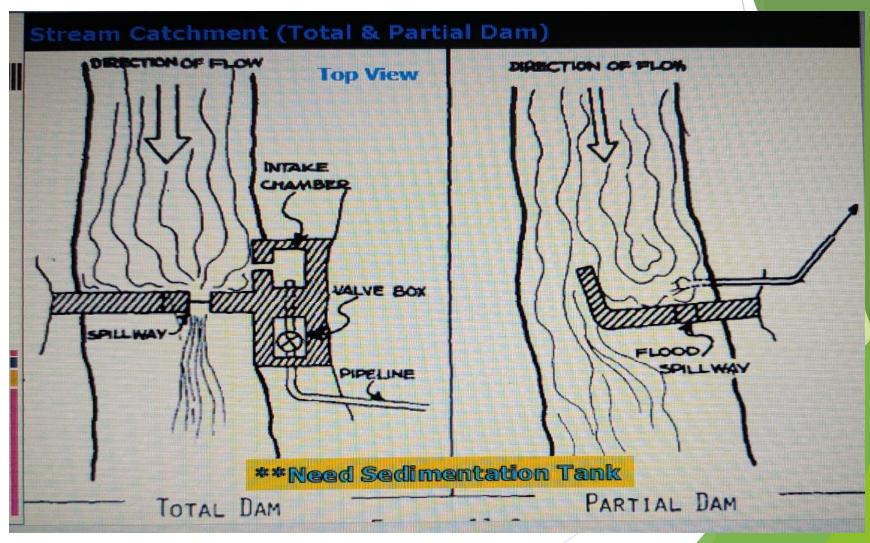# Gravity Flow Water Supply Systems

Determining the Storage Capacity of Reservoir Tank

Schedule - 2

Example

(Say - Total Daily Demand is 10gal 7capital x 1000 = 10000gals and Safe Yield of the Source is 7 gpm)

Time Period		Demand		Supply	Difference
5:00 AM To 7:00 AM	(2 hr.)	10% of Daily Demand	1000	840	- 160
7:00 AM To 11:00 AM	(4 hr.)	25% of Daily Demand	2500	1680	- 820
11:00 AM To 1:00 PM	(2 hr.)	35% of Daily Demand	3500	840	- 2660
1:00 PM To 5:00 PM	(4 hr.)	20% of Daily Demand	2000	1680	- 320
5:00 PM To 7:00 PM	(2 hr.)	35% of Daily Demand	1000	840	- 160
7:00 PM To 5:00 AM	(10 hr.)	Negligible Water Demand			

Largest Difficency =   - 4120

Select 5000gals Capacity of Reservoir Tank

Gravity Flow Water Supply Systems

Gravity Flow Water Supply Systems
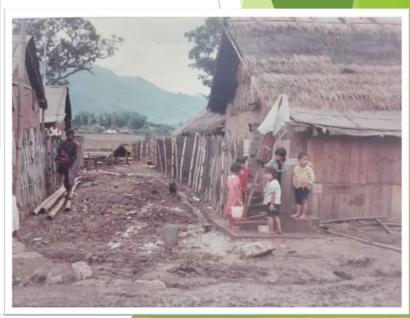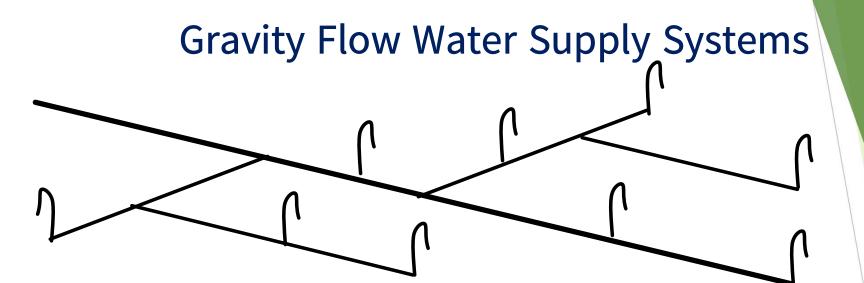
Gravity Flow Water Supply Systems

- Provide Tap Stands 1 no. per 10 House–hold
- Provide 1 each for School, Health Centre, Monastery etc.
- Assume the Flow Rate 3 gpm @ each Tap Stand
- Manage the Pipe Size to balance the different Head between High and Low points, (Install Gate Valve @ Low Point Tap Stand if necessary)

Gravity Flow Water Supply Systems

<u>Open Type Systems Without Faucets</u>
Continual, 24 hrs. Flow from the Taps
Arises out of the copies amount of
Wastewater issuing all day and night

<u>Open Type Systems With Faucets</u>
More Desirable Type, since it requires no Reservoir Tank,
provides more than sufficient water for the Villagers
And minimal waste water problems

Estimate

Pipes

Fittings

Hand Tools

Labour Charges

Construction Materials

Transportation Charges

Gravity Flow Water Supply Systems

OD = Outer Diameter

DN = Inner Diameter

PN = Pressure Rating

PE = Material Class

uPVC : Rubber Seal, PVC Solvent

HDPE : Rubber Seal, Butt Fusion

GI   : Thread Socket, Flange Gasket
          Welding Joint

Brand Selected

PE100

Nominal Outside Diameter(dn)	Nominal Wall Thickness & Pressure(mm & bar)				
	SDR26(PN6)	SDR21(PN8)	SDR17(PN10)	SDR13.6(PN12.5)	SDR11(PN16)
20					2.0
25				2.0	2.3
32			2.0	2.4	3.0
40			2.4	3.0	3.7
50			3.0	3.7	4.6
63		3.0	3.8	4.7	5.8
75		3.6	4.5	5.6	6.8
90	3.5	4.3	5.4	6.7	8.2
110	4.2	5.3	6.6	8.1	10
125	4.8	6	7.4	9.2	11.4
140	5.4	6.7	8.3	10.3	12.7
160	6.2	7.7	9.5	11.8	14.6
180	6.9	8.6	10.7	13.3	16.4
200	7.7	9.6	11.9	14.7	18.2
225	8.6	10.8	13.4	16.6	20.5
250	9.6	11.9	14.8	18.4	22.7
280	10.7	13.4	16.6	20.6	25.4
315	12.1	15	18.7	23.2	28.6
355	13.6	16.9	21.1	26.1	32.2
400	15.3	19.1	23.7	29.4	36.3
450	17.2	21.5	26.7	33.1	40.9
500	19.1	23.9	29.7	36.8	45.4
560	21.4	26.7	33.2	41.2	50.8
630	24.1	30	37.4	46.3	57.2
710	27.2	33.9	42.1	52.2	64.5
800	30.6	38.1	47.4	58.8	72.6
900	34.4	42.9	53.3	66.2	
1000	38.2	47.7	59.3	72.5	
1200	45.9	57.2	67.9		

TECHNICAL DATA

Sr	Description	Material	Remark
1	Type	PE-100	For Drinking Water
2	Nominal Outside Diameter	225 mm	O D
3	Nominal Inside Diameter	198.2 mm	I D
4	Thickness	13.4 mm	
5	Pressure	PN-10	
6	Unit Weight	44.33	Kg per Meter

Gravity Flow Water Supply Systems
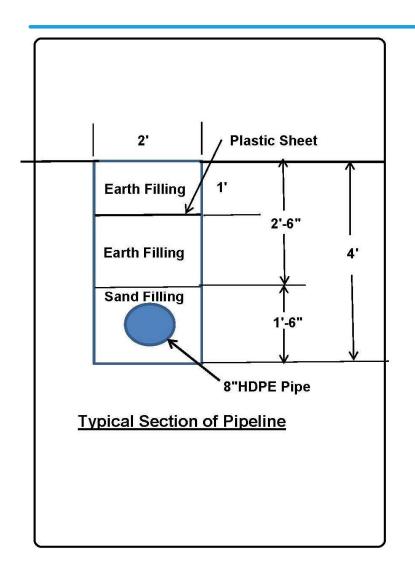
Construction / Implementation

Implementation

Typical Section of Pipeline

2' · Plastic Sheet · Earth Filling · 1' · 2'-6" · Earth Filling · 4' · Sand Filling · 1'-6" · 8"HDPE Pipe

Steps of Pipeline Installation

- Laying out Pipeline Alignment
- Digging Pipeline Trench
- Sand Bed Filling
- Pipe Laying work
- Sand Filling
- Laying Plastic Sheet
  (as Marking of Pipeline)
- Compacted Earth Filling
- Placing Guide Post
  (as Marking of Pipeline)

Butt Fusion Jointing Procedure

- Adjust the Pipes Alignment
- Grinding both Pipe Ends
- Cleaning both Pipe Ends
- Setting Temperature 210 +/- 5ᵒC

- Melting the Pipe Ends by Heat Plate
   (approximately 2.5 min with 2 bars)
   (Lip Rings will be formed @ Both Ends)

- Replacing Heating Plate and
   Touching the Melted Pipe Ends
   (approximately 25 min with 2 bars)
   (Lip Rings of Pipes should be 2.5 mm)
* Lay down the Jointed Pipe carefully

Implementation

Butt-fusion Machine Set

Working Temperature

Grinding both Pipe Ends by Motor Knife

Melting both Pipe Ends by Heat Plate

Implementation
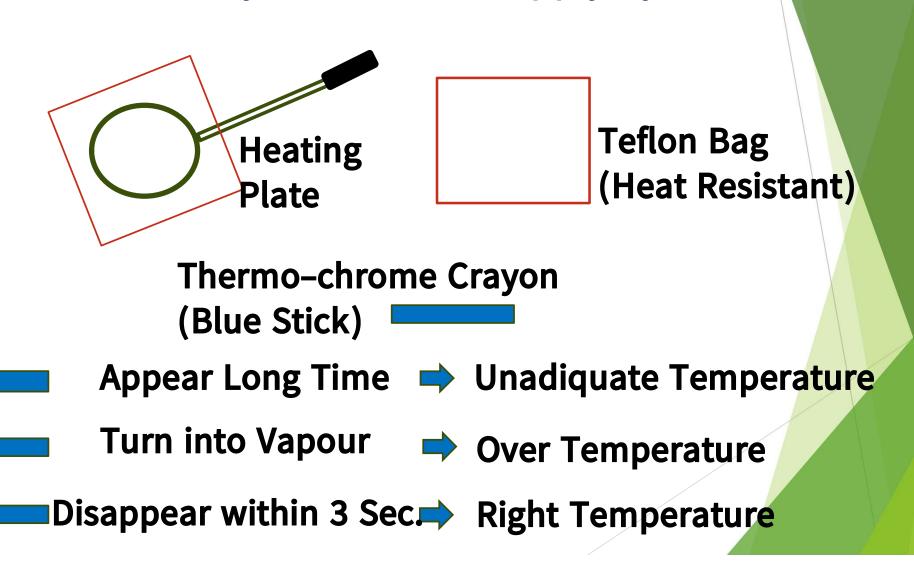
Motor Driven Rotary Knife blades

Pressure Regulator & Heat Controller   Nan-stick Coating Heating Plate

Gravity Flow Water Supply Systems

Heating Plate

Teflon Bag (Heat Resistant)

Thermo–chrome Crayon (Blue Stick)

Appear Long Time ➡ Unadiquate Temperature

Turn into Vapour ➡ Over Temperature

Disappear within 3 Sec. ➡ Right Temperature

Gravity Flow Water Supply Systems

Gravity Flow Water Supply Systems

Gravity Flow Water Supply Systems

Cost Evaluation

HDPE Pipes can be laid as Large Curve Without any Bends

Gravity Flow Water Supply Systems

- PVC Solvent is a PVC Conpound. It is reacted @ both pipes and made them to be only one pipe.

- Setting Time is approx. : 3 min.

- Waiting Time for moving is 1 hr.

- And for Heavy Duty is 24 hr.

Gravity Flow Water Supply Systems

Note PVC Pipes Jointing Procedure

1. Ensure that Inside of the Pipe is Clear
2. Clean the Both Adaptor End and Socket Ends
3. Mark the Pipe Joint as Fit Position
4. The Jointing Surfaces Must be Dry Before Applying Glue
5. Apply the PVC Solvent @ Jointing Surfaces Thoroughly
6. Hold the just jointed pipes in still position until set
7. After Setting Time, lay down the jointed pipes carefully
8. **If the Pipeline work is to be interrupted before complete, cover the open end with a temporary cap**

Checking together with DRRD Officials for Road Crossing

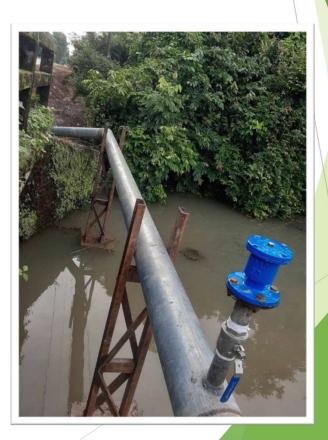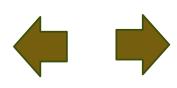Cutting, Crushing, Digging and
Rehabilitation after Pipe Laying

Stream/Pond Crossing GI Pipe with Supportings

Gravity Flow Water Supply Systems

Quality Control ← → **Time Control**

Gravity Flow Water Supply Systems

Commissioning and Hand–Over

Administrative Organization   **Water User Association**

Sustainable Water Supply System

Horizontal, Directional, Drilling (HDD) Machine

HDD Machine was carried by Crane Truck
and Sat @ Work Place

Horizontal, Directional, Drilling (HDD) Machine

Pump Suction Side

Drilling Side

Horizontal, Directional, Drilling (HDD) Machine

Horizontal, Directional, Drilling (HDD) Machine

Drilling Bid is going through about 6' below the Road Surface.

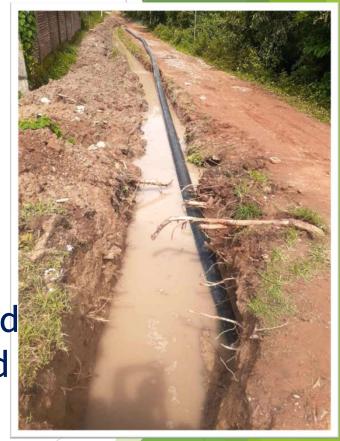The Leader checks the Bid Position by Detecting Device and controls the Operator to adjust the Bid Direction.

Horizontal, Directional, Drilling (HDD) Machine

After reaching to End Side, Drilling Bid is changed as Enlarging Bid and Drilling is driven to Back ward.

Horizontal, Directional, Drilling (HDD) Machine

After enlarging the Pipeline–hoe to the Required Size, the pre–jointed HDPE Pipes are connected after Enlarging Bid. And then, the Bid is driven to Back work and the HDPE Pipeline is already pulled through under the Road.

Horizontal, Directional, Drilling (HDD) Machine

- Drilling Bid is a Drug Bid (Wedge Shape) with Water Jet.
- Detecting Device is installed after the Bid so that the Leader can detect the Pipeline direction situation from the Road Surface.
- Only First One Drilling is Forward Direction and other steps such as Enlarging the Hoe, Pulling the Pipeline are Back ward Direction.
- At the End of Procedure, the HDPE Pipeline is Already Placed Through under the Road.
- Cover Pipe is not contained but the HDPE Pipeline at this section should be PN 12.5 instead of PN 10.

Thanks