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MINISTRY OF AGRICULTURE

National Specification and Bill of Quantity for Household and Micro Irrigation Technology

Small Scale Irrigation Development

Directorate

April, 2019

Addis Ababa, Ethiopia

Bill of quantity and Specification for Household and Micro Irrigation Technology

SMALL-SCALE IRRIGATION DEVELOPMENT & EXPANSION DIRECTORATE

MINISTRY OF AGRICULTURE

(MoA)

April, 2019

Addis Ababa, Ethiopia

National Household and Micro Irrigation Technology Detail Specification

A guiding Menu for Experts in supporting farmers for technology supply in Ethiopia

First Edition

April, 2019

SMALL-SCALE IRRIGATION DEVELOPMENT DIRECTORATE

MINISTRY OF AGRICULTURE (MOA)

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1. Introduction

Irrigation technologies play an important role in the promotion of household and micro irrigation in Ethiopia. Success and failure stories have been reported in the past with regard to the implementation of household and micro irrigation technologies. National BOQ and specification induce implementers to select appropriate technology at the right place. Moreover, for sustainable use of HHMI technologies, the right directions need to be set to get answer for frequently asked questions. Since most technologies were not manufactured in our country, it is often difficult for Kebele and Woreda level experts to right decision in provision and implementation of HHMI technologies due to technical gaps.

Therefore, this document aims to guide experts to prepare simple and practical HHMI bill of quantity and specifications. This will in turn support technology suppliers, farmers and irrigation development partners in Ethiopia so as to use appropriate irrigation technologies at right time for the specific location. It has three components of HHMI technologies. First, different scenario based on water sources development; namely spring development, farm pond, roof top water harvesting and hand dug well and manual tube wells. In connection with this, different water lifting technologies including; manual pumps (treadle & rope and washer pump), low head solar pumps and engine pumps. Finally, water application technology (drip) is addressed.

2. Objectives

The general objective is to guide development agents and experts at all level in selecting appropriate specification for HHMI technology.

The specific objective is to prepare specification and BOQ for water abstraction/lifting and water application HHMI technologies.

3. Rationale

Major challenge in implementation of HHMI technology is lack of knowledge in preparation of specification and bill of quantity. As a result of this, there was a problem on ordering and purchasing appropriate technologies in the sector. In addition, some of the technologies purchased by the woreda were found to be poor quality during implementation.

Therefore, this national bill of quantity and specification document is prepared to solve the above challenges and support development agents and experts at all level during preparation of appropriate bill of quantity and specification.

4. Scope

The scope of this document is limited to household and micro irrigation technologies which can be applied to individual farmers or a group of farmers depending on the size or capacity of water source and irrigable land up to 5 hectares. Most of the technologies included in this document are commonly used by the farmers in the country while some others are incorporated to demonstrate and further scale up. This specification can be used by development agent and experts at all level.

5. Bill of quantity and specification

Bill of quantities and specification for spring development, hand dug well, manual tube well drilling, rooftop rainwater harvesting pond, farm pond water harvesting, manual pump, small engine/motor pump, solar water pump and low head family drip irrigation are described in this section with different cases.

5.1. Spring Development

The bill of quantities for a spring development varies from spring to spring since the size of the capping structure required to develop a spring is different for each spring depending on the nature/type & yield of a spring, topography of the area, geological condition and other factor. Thus, the bill of quantities presented in the table below is a typical one representing one specific situation. The plan and section of the capping structure along with the dimension (drawing) used for the estimation of bill of quantities is annexed in this document for reference. Therefore, it has to be noted that this BoQ should not use for other condition and BoQ should be prepared for each spring capping structure in similar way like this.

Table 1. Specification and BOQ for a spring capping structure

S.N	Description of item	Unit	quantity	Remark
1	**Earthwork**			
1.1	Site clearing of the spring capping structure up to a depth of 20 cm	m^2	100	
1.2	Excavation of the spring capping structure	m^3	5	*
1.3	Backfill around the structure	m^3	2	
1.4	Cart away excess material away from the capping structure	m^3	3	
2	**Masonry work**			
2.1	Wet masonry (1:3) for wing wall and front side wall of the capping structure	m^3	5.875	
2.2	Dry masonry wall for the inspection manhole	m^3	0.78	
2.3	Plastering (1:3) the inside wall of wing wall & front side of a spring capping	m^2	6.075	
2.4	Pointing (1:3) the external side of the wing wall and front side wall of a capping structure	m^2	6.33	
3	**Concrete work**			
3.1	5 cm thick lean concrete (1:3:6) below the foundation of the wing wall/sidewall and front side wall (barrage) and for the foundation of inspection manhole of a capping structure as per the drawing	m^3	0.37	
3.2	10 cm thick mass concrete (1:2:4) for roof cover slab of spring capping structure as per the dimension specified in the drawing.	m^3	1.3	
3.3	10 cm thick RC concrete(1:2:3) for the slab of inspection manhole	m^3	0.049	
3.4	Provide ,cut, bend & fix ϕ 10 mm reinforced bar for the inspection manhole	kg	4.7	
4	**Gravel filling & hardcore**			
4.1	Filling different size of gravel as filter for spring capping	m^3	3.2	
4.2	Hardcore for the inspection manhole & below the mass concrete of roof slab	m^3	1.95	
5	**Pipe work**			
5.1	Supply & install all necessary pipes and fittings for out let, drainage and over flow system	LS		
6	**Fencing & other work**			
6.1	Fencing the spring capping structure with barbed wire (7m x 7m)	m^2	49	

NB: The type of material to be excavated could be soft soil or hard formation depending on site. To protect the entrance of runoff to the capping structure, diversion ditch should be constructed at about 5to 8 m away from the capping structure.

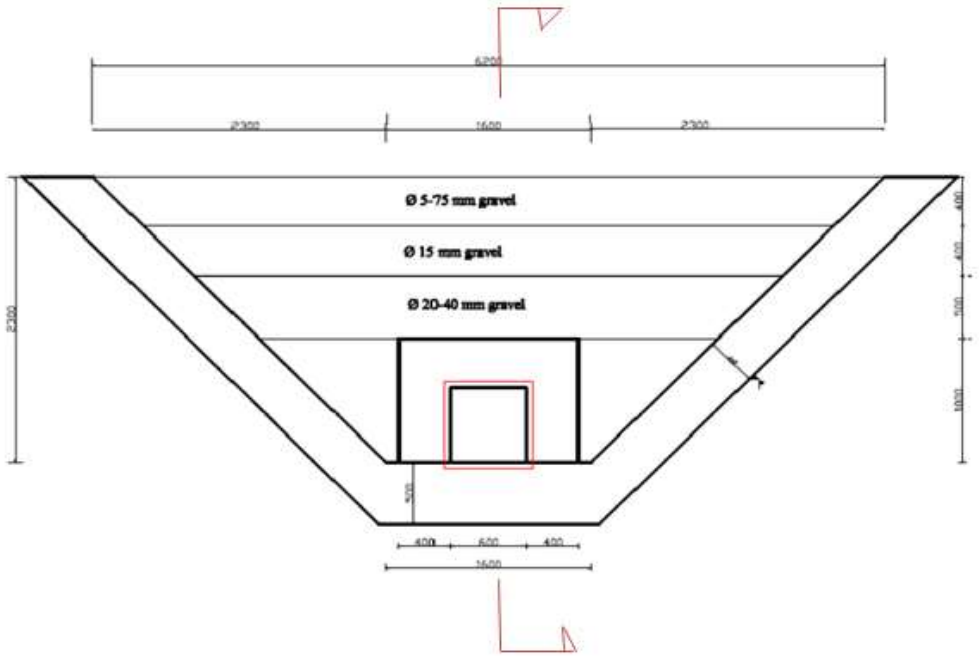


Figure 1. Detail of plan of spring capping structure with dimension

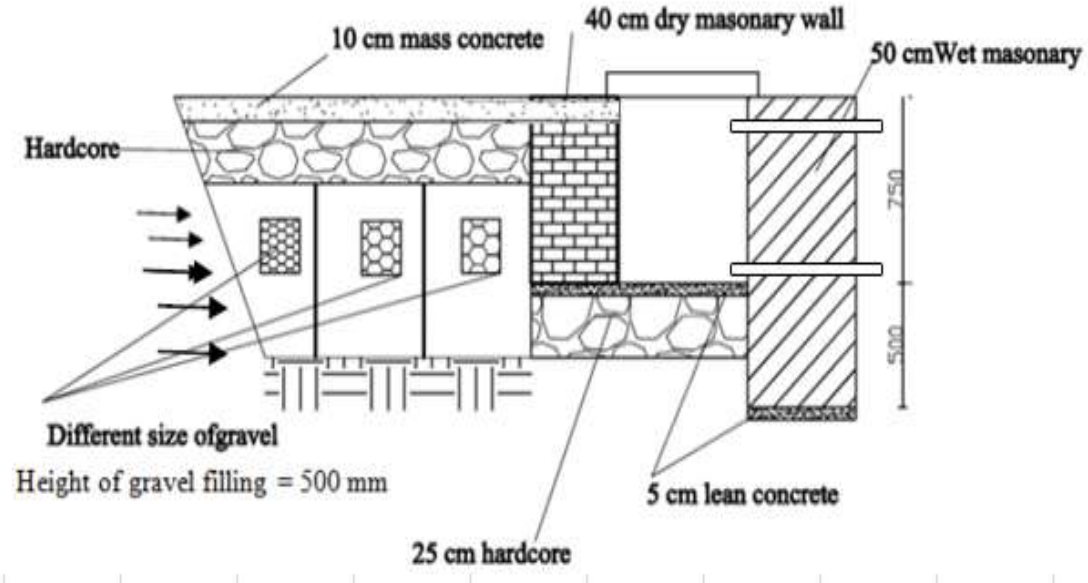


Figure 2. Detail of section of spring capping structure

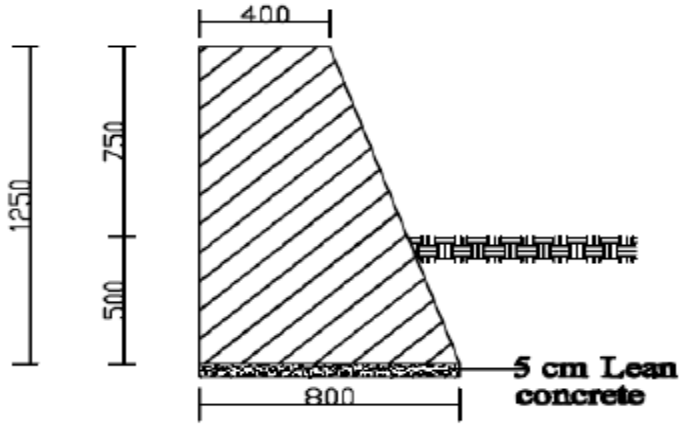


Figure 3. Section of the wing wall

5.2. Hand dug well

Bill of quantities and specification of hand dug well is described with inner diameter of 1 & 0.6 meter and with diameter of 4 & 6 meter.

With inner diameter of 1 & 0.6 meter five different cases such as Case 1: 0-10 depth with full casing inner diameter 1.0m, Case 2: 10-15 depth with full casing inner diameter 1.0m, Case 3: 15-20 depth with full casing inner diameter 1m, Case 4: 20-25 depth with full casing inner diameter 1m and Case 5: 20-25 depth with full casing inner diameter 0.6m are described their bill of quantity, specification and drawings.

With diameter of 4 & 6 meter four different cases such as Case 1: 6 meter diameter of soft & medium soil formation well, Case 2: 4 meter diameter of soft & medium soil formation well, Case 3: 6 meter diameter of soft, medium & hard soil formation well and Case 4: 4 meter diameter of soft, medium & hard soil formation well are described their bill of quantity, specification and drawings.

5.2.1. Hand dug well with inner diameter of 1 & 0.6 meter

Case 1: 0-10 depth with full casing inner diameter 1.0m

a. Excavation

$$V = \frac{\pi}{4}(D^2 d) = \frac{\pi}{4}(1.5^2) * 10 = 17.67m^3$$

b. Reinforced concrete (1:2:4)

RC ring production

Number of concrete rings = 2 x depth of the well

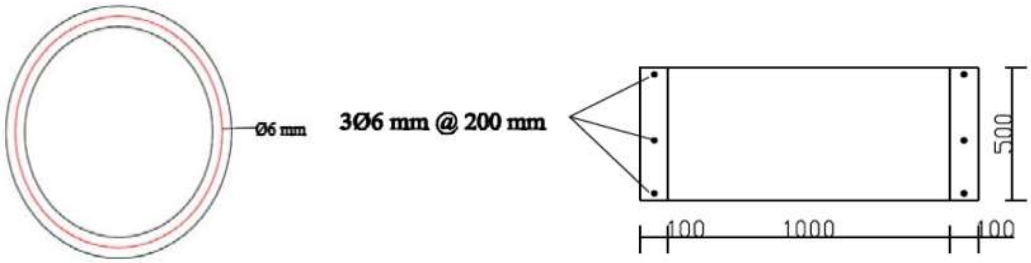
= 2 x 10 = 20

$$Ac = \frac{\pi}{4}(OD^2 - ID^2) = \frac{\pi}{4}(1.2^2 - 1.0^2) = 0.35m^2$$

Volume of concrete for one ring = 0.35 x 0.5 = 0.17 m^3

Total volume of concrete, V = 0.17 x 20 = 3.46 m^3

Reinforcement for concrete rings (ϕ 6 mm)



Length of one re-red = circumference of rings

L = π D, D = diameter of rings embedded in concrete = 1000 + 50 + 50 = 1100 mm = 1.1 m

L = π x 1.1 = 3.45575 m

Overlap = 60Φ (overlap of plain bar is 60Φ while it is 40 Φ for deformed bar)

Length of overlap = 60 x 6 = 360 mm = 0.36 m

Length of one re-rod = 3.45575 + 0.36 = 3.8 m

Length of re-rod for one concrete rings = 3 x 3.8 = 11.4 m (no of ring bar in one ring = 3)

Length of re rod for 10 m (20 rings) = 20 x 11.4 = 228.95 m

Weight (+ 5% wastage) = 1.05 x 228.95 m x 0.222 kg/m = 53.37 kg

Summary

Excavation = 17.67

RC ring

RC (1:2:4) =3.46 m^3

Reinforcement Φ6 mm =53.37

Table 2. Bill of Quantity for inner diameter of 1.0m hand dug well (HDW) (for depth up to 10m)

S/N	Descriptions	Unit	Qty	**Remark**
1	**Earth Work**			**1**
1.1	Clearing of site to remove top soil to a depth of 200 mm	m2	4.91	**1.1**
1.2	Excavation of hand dug well; 1.5m width and 10 m depth	m3	17.67	**1.2**
1.3	Cart away and deposit excavated surplus material	m3	17.67	**1.3**
2	**Concrete Work RC concrete**			**2**
2.1	volume of concrete for 0.5 m RC ring casing for 10 m depth	m^3	3.46	**2.1**

2.2	Reinforcement for concrete rings (ϕ 6 mm)	kg	53.37	**2.2**
3	**Lowering support**			**3**
3.1	Supply, assemble and fix in position eucalyptus wood post for lowering support	No	5	**3.1**
3.2	Supply and fix pulley nailed into eucalyptus wood post	no	1	**3.2**
4	Back fill and compaction	m3	1.91	**4**
5	gravel pack	m3	4.45	**5**

Table 3. Materials requirement

S.N	Material	Unit	Quantity
1	Cement	quintals	9.7
2	Sand	M3	1.14
3	Coarse aggregate	M3	4.64
4	River gravel	M3	4.45
5	Φ 6 mm reinforcement	kg	53.37
6	Wire	kg	5
7	Formwork	pcs	4
8	Nails	kg	5
9	Eucalyptus wood post	pcs	5
10	Pulley	pcs	1

Case 2: 10-15 depth with full casing inner diameter 1.0m

a. Excavation

$$V = \frac{\pi}{4}\left(D_1{}^2 d\right) = \frac{\pi}{4}(1.5^2) * 15 = 26.51m^3$$

b. Reinforced concrete (1:2:4)

RC ring production

Number of concrete rings = 2 x depth of the well

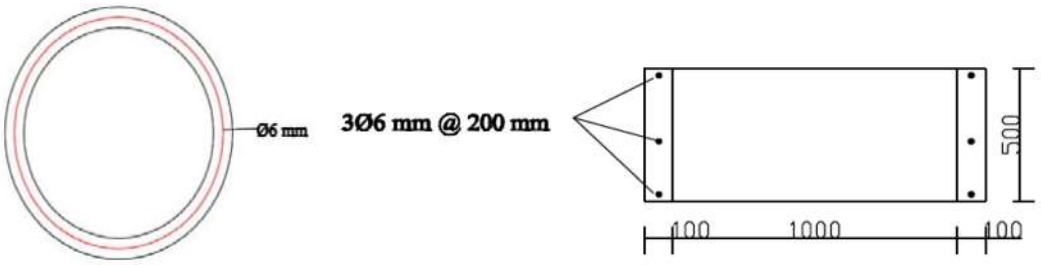
= 2 x 15 = 30

$$Ac = \frac{\pi}{4}(OD^2 - ID^2) = \frac{\pi}{4}(1.2^2 - 1.0^2) = 0.35m^2$$

Volume of concrete for one ring = 0.35 x 0.5 = 0.17 m^3

Total volume of concrete, V = 0.17 x 30 = 5.18 m^3

Reinforcement for concrete rings (ϕ 6 mm)



Length of one re-red = circumference of rings

L = π D, D = diameter of rings embedded in concrete = 1000 + 50 + 50 = 1100 mm = 1.1 m

L = π x 1.1 = 3.45575 m

Overlap = 60Φ (overlap of plain bar is 60Φ while it is 40 Φ for deformed bar)

Length of overlap = 60 x 6 = 360 mm = 0.36 m

Length of one re-rod = 3.45575 + 0.36 = 3.8 m

Length of re-rod for one concrete rings = 3 x 3.8 = 11.4 m (no of ring bar in one ring = 3)

Length of re rod for 15 m (30 rings) = 30 x 11.4 = 343.42 m

Weight (+ 5% wastage) = 1.05 x 343.42 m x 0.222 kg/m = 80.05 kg

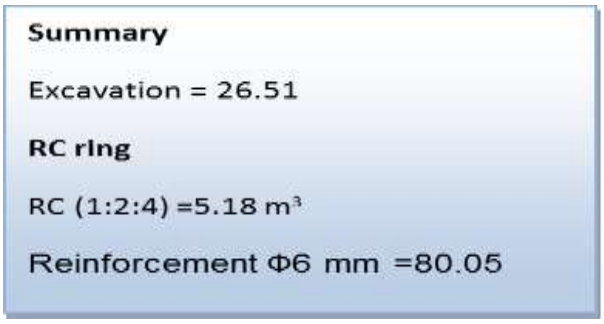


Table 4. Bill of Quantity for inner diameter of 1.0m hand dug well (HDW) (for depth up to 15m)

S/N	Descriptions	Unit	Qty	Remark
1	**Earth Work**			
1.1	Clearing of site to remove top soil to a depth of 200 mm	m2	4.91	
1.2	Excavation of hand dug well; 1.5m width and 10 m depth	m3	26.51	
1.3	Cart away and deposit excavated surplus material	m3	26.51	
2	**Concrete Work RC concrete**			
2.1	volume of concrete for 0.5 m RC ring casing for 10 m depth	m^3	5.18	
2.2	Reinforcement for concrete rings (ϕ 6 mm)	kg	80.05	
3	**Lowering support**			
3.1	Supply, assemble and fix in position eucalyptus wood post for lowering support	No	5	
3.2	Supply and fix pulley nailed into eucalyptus wood post	no	1	
4	Back fill and compaction	m3	3.18	
5	gravel pack	m3	6.36	

Table 5. Material requirement

S.N	Material	Unit	Quantity
1	Cement	quintals	14.56
2	Sand	M^3	1.7
3	Coarse aggregate	M^3	3.41
4	River gravel	M^3	6.36
5	Φ 6 mm reinforcement	kg	80.05

6	Wire	kg	5
7	Formwork	pcs	4
8	Nails	kg	5
9	Eucalyptus wood post	pcs	5
10	Pulley	pcs	1

Case 3: 15-20 depth with full casing inner diameter 1m

1. **Excavation**

$$V = \frac{\pi}{4}\left(D_1{}^2 d\right) = \frac{\pi}{4}(1.5^2) * 20 = 51.05m^3$$

2. Reinforced concrete (1:2:4)

RC ring production

Number of concrete rings = 2 x depth of the well

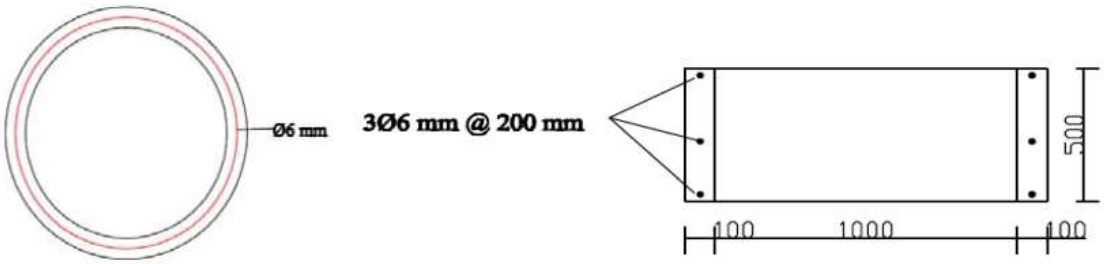
= 2 x 20 = 40

$Ac = \frac{\pi}{4}(OD^2 - ID^2) = \frac{\pi}{4}(1.2^2 - 1^2) = 0.35m^2$

Volume of concrete for one ring = 0.35 x 0.5 = 0.17m^3

Total volume of concrete, V = 0.17 x 40 = 6.91 m^3

Reinforcement for concrete rings (ϕ 6 mm)



Length of one re-red = circumference of rings

L = π D, D = diameter of rings embedded in concrete = 1000 + 50 + 50 = 1100 mm = 1.1 m

L = π x 1.1 = 3.45575 m

Overlap = 60Φ (overlap of plain bar is 60Φ while it is 40 Φ for deformed bar)

Length of overlap = 60 x 6 = 360 mm = 0.36 m

Length of one re-rod = 3.45575 + 0.36 = 3.8 m

Length of re-rod for one concrete rings = 3 x 3.8 = 11.4 m (no of ring bar in one ring = 3)

Length of re rod for 20 m (40 rings) = 40 x 11.4 = 457.89 m

Weight (+ 5% wastage) = 1.05 x 457.89 m x 0.222 kg/m = 106.73 kg

Table 6. Bill of Quantity for inner diameter of 1.0m hand dug well (HDW) (for depth up to 20m)

S/N	Descriptions	Unit	Qty	Remark
1	**Earth Work**			
1.1	Clearing of site to remove top soil to a depth of 200 mm	m2	4.91	
1.2	Excavation of hand dug well; 1.5m width and 10 m depth	m3	51.05	
1.3	Cart away and deposit excavated surplus material	m3	51.05	
2	**Concrete Work RC concrete**			
2.1	volume of concrete for 0.5 m RC ring casing for 10 m depth	m^3	6.91	
2.2	Reinforcement for concrete rings (ϕ 6 mm)	kg	106.73	
3	**Lowering support**			
3.1	Supply, assemble and fix in position eucalyptus wood post for lowering support	No	5	
3.2	Supply and fix pulley nailed into eucalyptus wood post	no	1	
4	Back fill and compaction	m3	3.18	
5	Gravel pack	m3	9.54	

Table 7. Material requirement

S.N	Material	Unit	Quantity
1	Cement	quintals	19.41
2	Sand	M3	2.27
3	Coarse aggregate	M3	4.54
4	River gravel	M3	9.54
5	Φ 6 mm reinforcement	kg	106.73
6	Wire	kg	5
7	Formwork	pcs	4
8	Nails	kg	5
9	Eucalyptus wood post	pcs	5
10	Pulley	pcs	1

Summary

Excavation = 51.05

RC ring

RC (1:2:4) =6.91 m^3

Reinforcement Φ6 mm =106.73

Case 4: 20-25 depth with full casing inner diameter 1m

a. Excavation

$$V = \frac{\pi}{4}\left(D_1{}^2 d\right) = \frac{\pi}{4}(1.5^2) * 25 = 63.81 m^3$$

b. Reinforced concrete (1:2:4)

RC ring production

Number of concrete rings = 2 x depth of the well

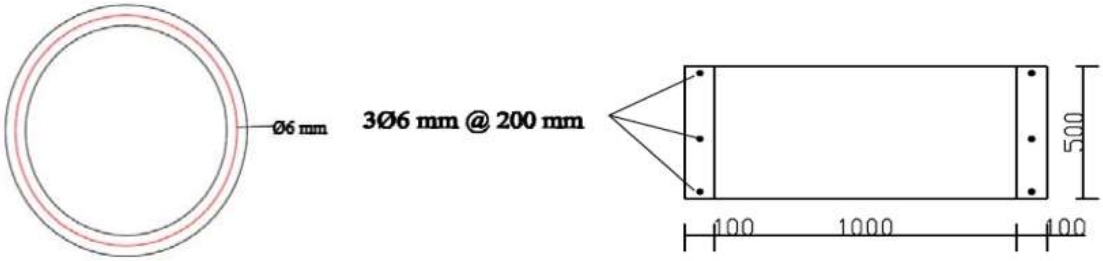
= 2 x 25 = 50

$Ac = \frac{\pi}{4}(OD^2 - ID^2) = \frac{\pi}{4}(1.2^2 - 1^2) = 0.35m^2$

Volume of concrete for one ring = 0.35 x 0.5 = 0.17m^3

Total volume of concrete, V = 0.17 x 50 = 8.64 m^3

Reinforcement for concrete rings (ϕ 6 mm)



Length of one re-red = circumference of rings

L = π D, D = diameter of rings embedded in concrete = 1000 + 50 + 50 = 1100 mm = 1.1 m

L = π x 1.1 = 3.45575 m

Overlap = 60Φ (overlap of plain bar is 60Φ while it is 40 Φ for deformed bar)

Length of overlap = 60 x 6 = 360 mm = 0.36 m

Length of one re-rod = 3.45575 + 0.36 = 3.8 m

Length of re-rod for one concrete rings = 3 x 3.8 = 11.4 m (no of ring bar in one ring = 3)

Length of re rod for 25 m (50 rings) = 50 x 11.4 = 572.36 m

Weight (+ 5% wastage) = 1.05 x 457.89 m x 0.222 kg/m = 133.42 kg

Table 8. Bill of Quantity for inner diameter of 1.0m hand dug well (HDW) (for depth up to 20m)

S/N	Descriptions	Unit	Qty	remark
1	**Earth Work**			
1.1	Clearing of site to remove top soil to a depth of 200 mm	m2	4.91	
1.2	Excavation of hand dug well; 1.5m width and 10 m depth	m3	63.81	
1.3	Cart away and deposit excavated surplus material	m3	63.81	
2	Concrete Work RC concrete			
2.1	volume of concrete for 0.5 m RC ring casing for 10 m depth	m^3	8.64	
2.2	Reinforcement for concrete rings (ϕ 6 mm)	kg	133.42	
3	Lowering support			
3.1	Supply, assemble and fix in position eucalyptus wood post for lowering support	No	5	

3.2	Supply and fix pulley nailed into eucalyptus wood post	no	1	
4	Back fill and compaction	m3	3.18	
5	Gravel pack	m3	12.72	

Table 9. Material requirement

S.N	Material	Unit	Quantity
1	Cement	quintals	24.26
2	Sand	M3	2.84
3	Coarse aggregate	M3	5.68
4	River gravel	M3	12.72
5	Φ 6 mm reinforcement	kg	133.42
6	Wire	kg	5
7	Formwork	pcs	4
8	Nails	kg	5
9	Eucalyptus wood post	pcs	5
10	Pulley	pcs	1

Summary

Excavation = 63.81

RC ring

RC (1:2:4) =8.64 m^3

Reinforcement Φ6 mm =133.42

Case 5: 20-25 depth with full casing inner diameter 0.6m

a. Excavation

$$V = \frac{\pi}{4}\left(D_1{}^2 d\right) = \frac{\pi}{4}(1^2) * 25 = 26.70m^3$$

b. Reinforced concrete (1:2:4)

RC ring production

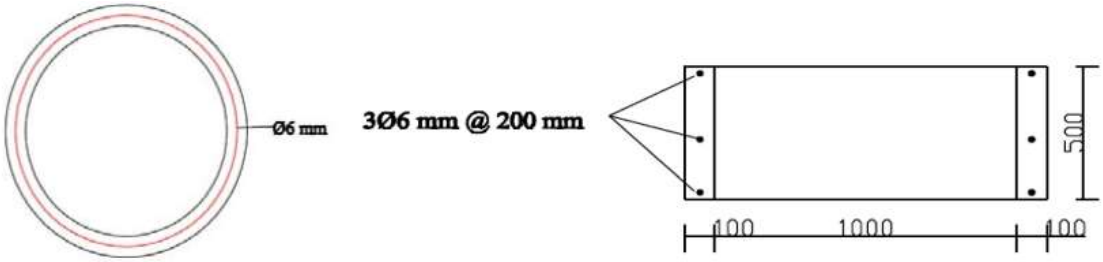
Number of concrete rings = depth of the well = 25

$Ac = \frac{\pi}{4}(OD^2 - ID^2) = \frac{\pi}{4}(0.8^2 - 0.6^2) = 0.22m^2$

Volume of concrete for one ring = 0.22 x 1 = 0.22m^3

Total volume of concrete, V = 0.22 x 25 = 5.50 m^3

Reinforcement for concrete rings (ϕ 6 mm)



Length of one re-red = circumference of rings

L = π D, D = diameter of rings embedded in concrete = 600 + 50 + 50 = 700 mm = 0.7 m

L = π x 0.7 = 2.1991 m

Overlap = 60Φ (overlap of plain bar is 60Φ while it is 40 Φ for deformed bar)

Length of overlap = 60 x 10 = 600 mm = 0.6 m

Length of one re-rod = 2.1991 + 0.6 = 2.80 m

Length of re-rod for one concrete rings = 5 x 2.80 = 14.0 m (no of ring bar in one ring = 5)

Length of re rod for 25 m (25 rings) = 25 x 2.80 = 349.89 m

Weight (+ 5% wastage) = 1.05 x 349.89 m x 0.222 kg/m = 81.56 kg

Table 10. Bill of Quantity for inner diameter of 1.0m hand dug well (HDW) (for depth up to 25m)

S/N	Descriptions	Unit	Qty	Remark
1	**Earth Work**			
1.1	Clearing of site to remove top soil to a depth of 200 mm	m^2	3.14	
1.2	Excavation of hand dug well; 1.5m width and 10 m depth	m^3	26.70	
1.3	Cart away and deposit excavated surplus material	m^3	26.70	
2	Concrete Work RC concrete			
2.1	volume of concrete for 0.5 m RC ring casing for 10 m depth	m^3	5.50	
2.2	Reinforcement for concrete rings (ϕ 6 mm)	kg	81.56	
3	Lowering support			
3.1	Supply, assemble and fix in position eucalyptus wood post for lowering support	#	5	
3.2	Supply and fix pulley nailed into eucalyptus wood post	#	1	
4	Back fill and compaction	m^3	1.41	
5	gravel pack	m^3	5.65	

Table 11. Material requirement

S.N	Material	Unit	Quantity
1	Cement	Quintals	15.44
2	Sand	M3	1.81
3	Coarse aggregate	M3	3.61
4	River gravel	M3	5.65
5	Φ 6 mm reinforcement	kg	81.56
6	Wire	kg	5
7	Formwork	pcs	4
8	Nails	kg	5

9	Eucalyptus wood post	pcs	5
10	Pulley	pcs	1

Summary

Excavation = 26.70

RC ring

RC (1:2:4) =5.50 m^3

Reinforcement Φ6 mm =81.56

5.2.2. Hand dug well with diameter of 4 & 6 meter

a) Determination of Work Quantities of A Well:

- Site clearing , $A = \frac{\pi d^2}{4}$

  Where, A is area, d is diameter

- Excavation:
  - ✓ Soft formation , $V = \frac{\pi dav^2}{4} * h_S$,

    where, $d_{av}=(d_T+d_B)/2$, d_{av} is average diameter, d_T is well top diameter & d_B is well bottom diameter
  - ✓ Medium formation , $V = \frac{\pi dav^2}{4} * h_m$,

    Where, $d_{av}=(d_T+d_B)/2$, d_{av} is average diameter, d_T is well top diameter & d_B is well bottom diameter
  - ✓ Hard formation , $V = \frac{\pi dav^2}{4} * h_h$,

    where, $d_{av}=(d_T+d_B)/2$, d_{av} is average diameter, d_T is well top diameter & d_B is well bottom diameter
- Compaction , $V = \frac{\pi * (\frac{dexT+dexB}{2} + \frac{dinT+dinB}{2})^2}{4}$,

  where ,$d_{ex}T$ is top external diameter, $d_{ex}B$ is bottom external diameter, $d_{in}T$ is top internal diameter &$d_{in}B$ is bottom internal diameter.
- Masonry:
  - ✓ Wet masonry:

- Well ,$V = \frac{\pi * h * (dexav^2 - dinav^2)}{4}$

  where, $d_{exav}=(d_{exT}+d_{exB})/2$, d_{exav} is external average diameter, d_{exT} is external well top diameter &d_{exB} is well bottom diameter

  $d_{inav}=(d_{inT}+d_{inB})/2$, d_{inav} is internal average diameter, d_{inT} is internal well top diameter &d_{inB} is internal well bottom diameter

- Pump seat, , $Vp = 2 * hs\left(ws * ls + \frac{1}{2} * ws * ls\right) + wb * lb * hb$

  where, h is height side wall, w is width (thickness)of side wall, l is length of side wall, wb is width of pump seat bed , lb is length of pump seat bed &hb height (thickness) of pump seat bed.

- Dry masonry: ,$Vd = \frac{\pi * h * (dexav^2 - dinav^2)}{4}$

  where, -$d_{exav}=(d_{exT}+d_{exB})/2$, d_{exav} is external average diameter, d_{exT} is external well top diameter,d_{exB} is well bottom diameter, h is height (depth) of dry masonry & v is volume of dry masonry

  -$d_{inav}=(d_{inT}+d_{inB})/2$, d_{inav} is internal average diameter, d_{inT} is internal well top diameter &d_{inB} is internal well bottom diameter

  -$d_{inT}=d_{exT}-2*T_{tw}$,where $T_{tw}$is top well wall thickness

  -$d_{inB}= d_{exB}-2*T_{bw}$,where $T_{bw}$is bottom well wall thickness

- Gravel,$V = \frac{\pi * (\frac{dexT+dexB}{2} + \frac{dinT+dinB}{2})^2}{4}$,

  where ,d_{ex}T is top external diameter, d_{ex}B is bottom external diameter, d_{in}T is top internal diameter &d_{in}B is bottom internal diameter.

- Amount of cement, sand & stone
  - ✓ Cement for 1:4 mortar, in quintal = 1/5*Vc*ϱc*1.35/100

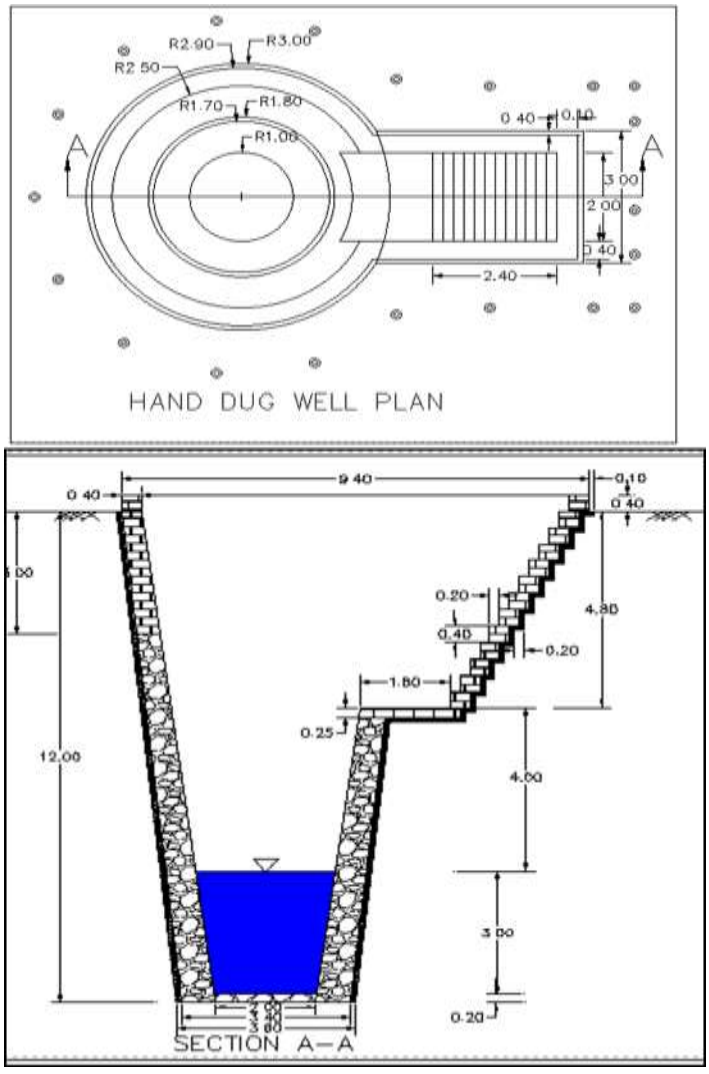
    Where, Vc is volume of cement, ϱc is density of cement which is 1440kg/m^3, 1/5 is cement ratio factor & 1.35 is wastage & shrinkage factor

    Sand,for 1:4 mortar in m^3 = 4/5*Vs*1.15

    Where, Vs is volume of sand, 4/5 is sand ratio factor& 1.15 is wastage factor
  - ✓ Stone, in m^3= (Vw+Vd)*1.05, Vw is wet masonry volume, Vd is dry masonry volume & 1.05 is wastage factor

For this type of hand dug well there will be four cases based on the well diameter & type of soil formation of the proposed well type.

Case 1: 6 meter diameter of Soft & Medium soil formation well



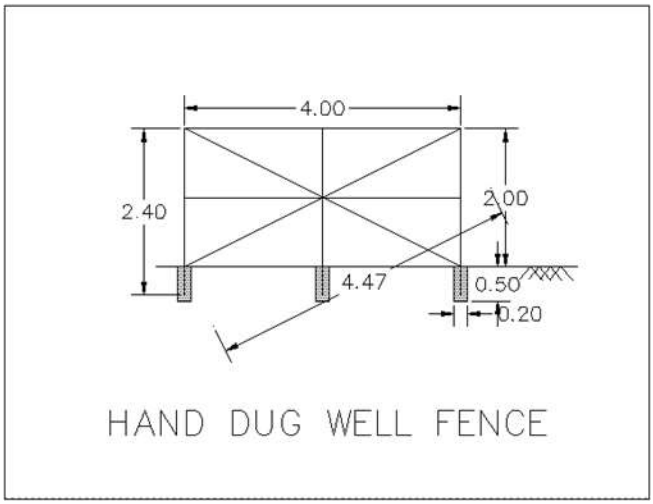


Figure 4. Plan and section view of 6 meter diameter of soft & medium soil formation well

Table 12. BOQ of Case 1: 6 meter diameter of Soft & Medium soil formation well

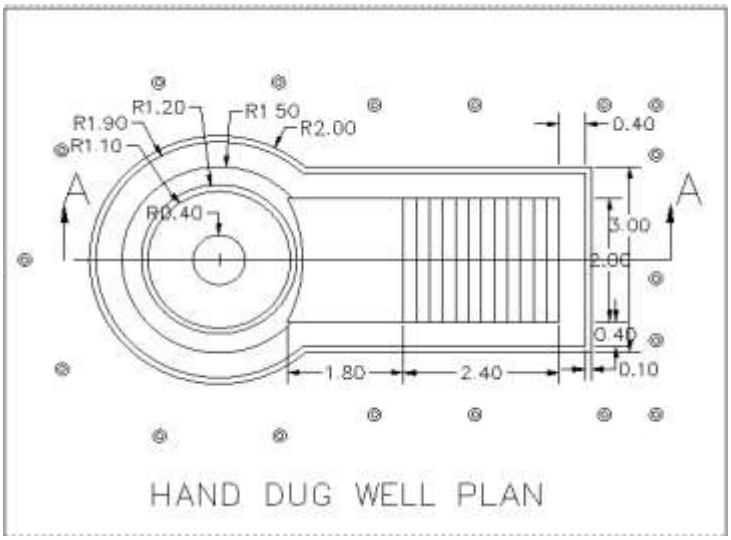
S.No	Descriptions	Unit	Qty	Remark
1	**Site clearing**	m^2	38.485	
2	**Earth work**			
2.1	**Excavation**			
2.1.1	Soft formation(pi*d_{av}^2/4*h)	m^3	76.808	
2.1.2	Medium Formation	m^3	143.775	
2.1.4	Pump seat excavation as shown in design	m^3	46.293	
2.2	Compaction (pi*h/4*(((${d_{ex}}$T+${d_{ex}}$B)/2+(${d_{in}}$T+${d_{in}}$B)/2))^2	m^3	6.491	
2.3	Cart away excavated material	m^3	266.876	
3	**Masonry work**			
3.1	Wet masonry (1:4 ratio mortar)			
3.1.1	Well	m^3	25.784	
3.1.2	Pump seat			
3.1.2.1	Bed	m^3	1.511	
3.1.2.2	Side wall (both sides) & staircase	m^3	16.541	
3.2	Dry masonry	m^3	72.229	
4	**Gravel & Hardcore**			
4.1	Gravel at the back of dry masonry	m^3	11.943	
4.2	Hardcore at the bottom of the well	m^3	2.036	
5	**Fence at 1 meter radius from the well**			
5.1	Concrete (1:2:6)	m^3	0.314	
5.2	Eucalypts 2.4 meter 10cm diameter	#	20	
5.3	Eucalypts 4.5 meter 5cm diameter	#	20	
5.4	Eucalypts 4 meter 5cm diameter	#	20	
5.5	Nail (#12)	kg	1.5	

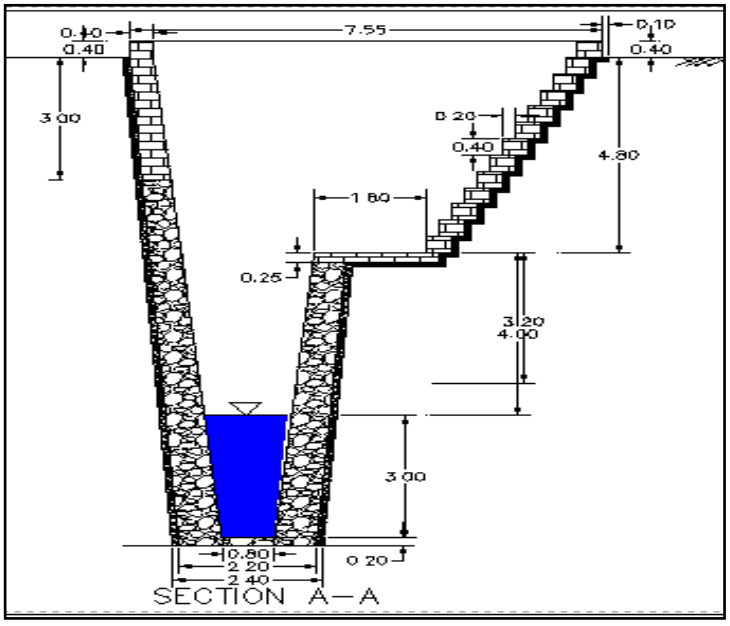
5.6	Nail for door	kg	0.5	
5.7	Iron sheet (2*1)	#	1	
5.8	Long lock with key	#	1	

Construction materials needed

Material type	Unit	Qty
Cement	Qtl	60.5
Sand	m^3	14.22
Gravel	m^3	12.87
Stone	m^3	124.01

Case 2: 4 meter diameter of Soft & Medium soil formation well





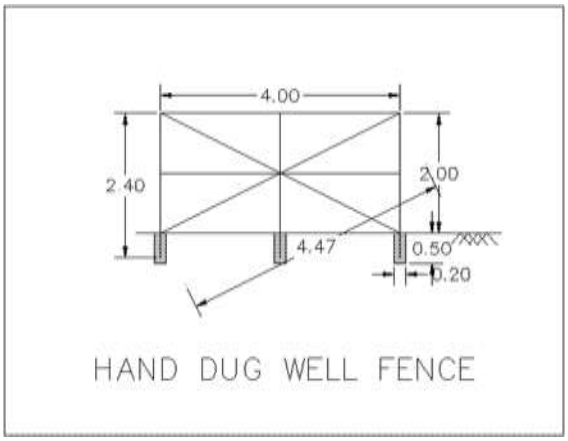


Figure 5. Plan and section view of 4 meter diameter of soft & medium soil formation well

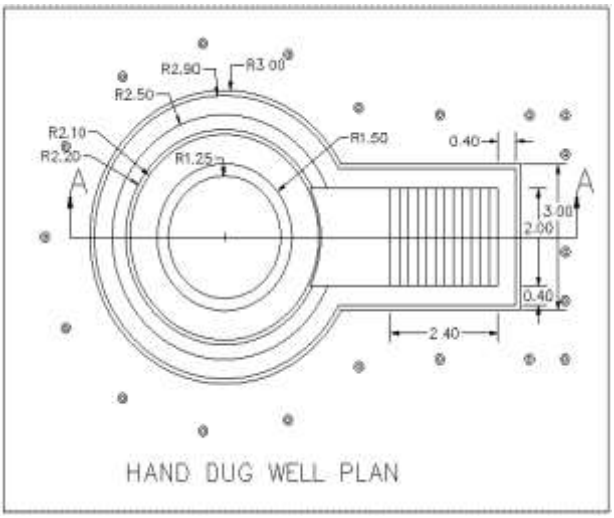
Table 13. BOQ of Case 2: 4 meter diameter of Soft & Medium soil formation well

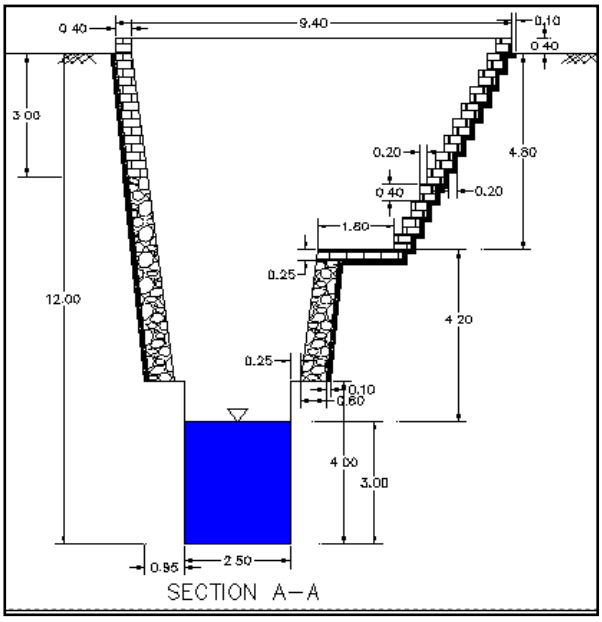
S.No	Descriptions	Unit	Qty	Remark
1	**Site clearing**	m^2	19.635	
2	**Earth work**			
2.1	**Excavation**			
2.1.1	Soft formation($pi*d_{av}^2/4*h$)	m^3	34.137	
2.1.2	Medium Formation	m^3	63.900	
2.1.4	Pump seat excavation as shown in design	m^3	47.429	
2.2	Compaction ($(pi*h/4*(((d_{ex}T+d_{ex}B)/2+(d_{in}T+d_{in}B)/2))$^2)	m^3	4.671	
2.3	Cart away excavated material	m^3	145.466	
3	**Masonry work**			
3.1	Wet masonry (1:4 ratio mortar)			
3.1.1	Well	m^3	14.793	
3.1.2	Pump seat			
3.1.2.1	Bed	m^3	1.511	
3.1.2.2	Side wall (both sides) & staircase	m^3	16.541	
3.2	Dry masonry	m^3	42.835	
4	**Gravel & Hardcore**			
4.1	Gravel at the back of dry masonry	m^3	7.683	
4.2	Hardcore at the bottom of the well	m^3	0.905	
5	**Fence at 1 meter radius from the well**			
5.1	Concrete (1:2:4)	m^3	0.283	
5.2	Eucalypts 2.4 meter 10cm diameter	#	18	
5.3	Eucalypts 4.5 meter 5cm diameter	#	18	
5.4	Eucalypts 4 meter 5cm diameter	#	18	
5.5	Nail (#12)	kg	1.25	
5.6	Nail for door	kg	0.5	
5.7	Iron sheet for door(2*1)	#	1	
5.8	Long lock with key	#	1	

Table 14. Construction materials needed

Material type	Unit	Qty
Cement	Qtl	45.48
Sand	m^3	10.67
Gravel	m^3	8.36
Stone	m^3	80.41

Case 3: 6 meter diameter of Soft, Medium & Hard soil formation well





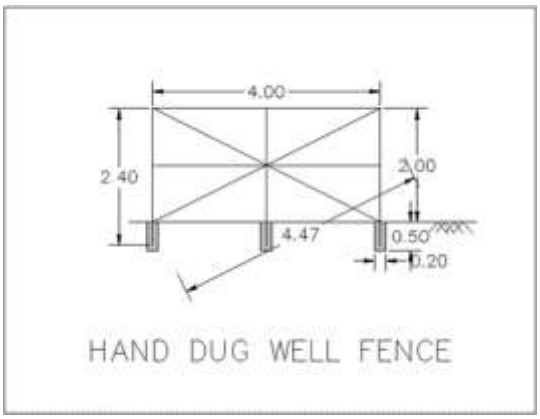


Figure 6. Plan and section view of 6 meter diameter of soft, medium & hard soil formation well

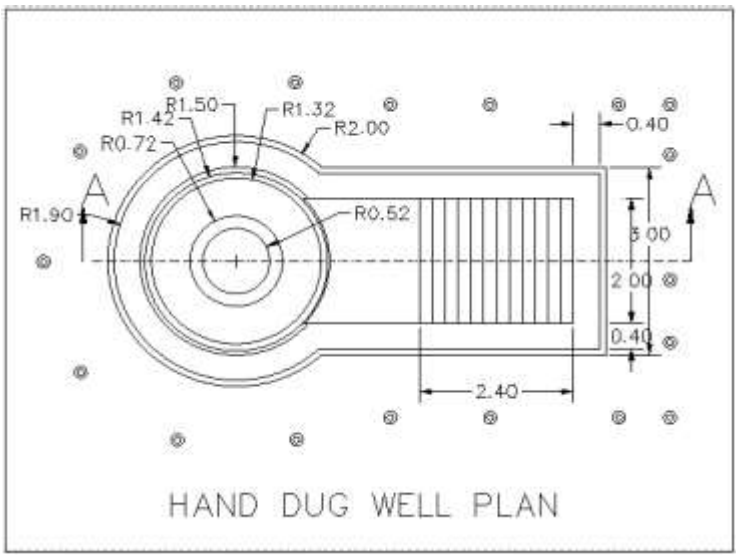
Table 15. BOQ of Case 3: 6 meter diameter of Soft, Medium & Hard soil formation well

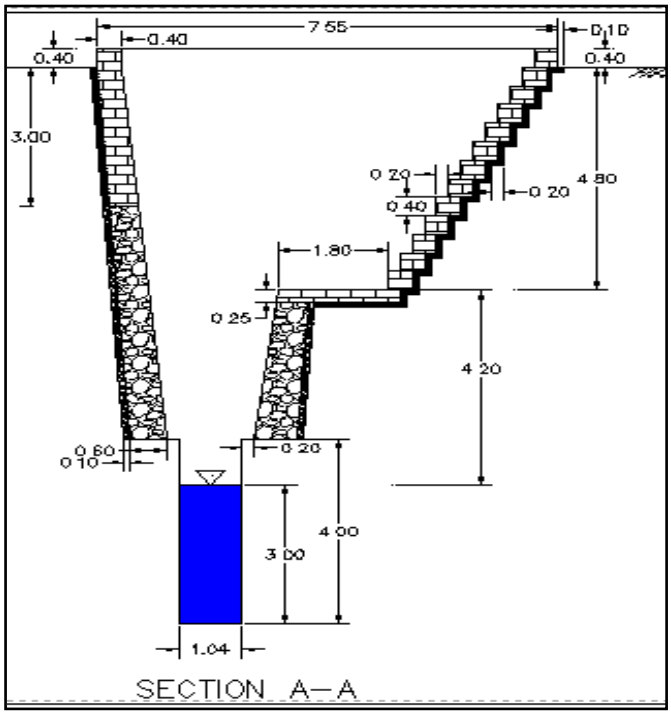
S.No	Descriptions	Unit	Qty	Remark
1	**Site clearing**	m^2	38.485	
2	**Earth work**			
2.1	**Excavation**			
2.1.1	Soft formation(pi*d_{av}^2/4*h)	m^3	79.527	
2.1.2	Medium Formation	m^3	98.764	
2.1.3	Hard Formation	m^3	19.635	
2.1.4	Pump seat excavation as shown in design	m^3	46.293	
2.2	Compaction (pi*h/4*((((d_{ex}T+d_{ex}B)/2+(d_{in}T+d_{in}B)/2))^ 2	m^3	6.587	
2.3	Cart away excavated material	m^3	244.218	
3	**Masonry work**			
3.1	Wet masonry (1:4 ratio mortar)			
3.1.1	Well	m^3	26.363	
3.1.2	Pump seat			
3.1.2.1	Bed	m^3	1.511	
3.1.2.2	Side wall (both sides) &staircase	m^3	16.541	
3.2	Dry masonry	m^3	41.663	
4	**Gravel & Hardcore**			
4.1	Gravel at the back of dry masonry	m^3	7.206	
4.2	Hardcore at the bottom of the well	m^3	3.041	
5	**Fence at 1 meter radius from the well**			
5.1	Concrete (1:2:6)	m^3	0.314	
5.2	Eucalypts 2.4 meter 10cm diameter	#	20	
5.3	Eucalypts 4.5 meter 5cm diameter	#	20	
5.4	Eucalypts 4 meter 5cm diameter	#	20	
5.5	Nail (#12)	kg	1.5	
5.6	Nail for door	kg	0.5	
5.7	Iron sheet (2*1)	#	1	
5.8	Long lock with key	#	1	

Table 16. Construction materials needed

Material type	Unit	Qty
Cement	Qtl	61
Sand	m^3	14.40
Gravel	m^3	7.90
Stone	m^3	93.58

Case 4: 4 meter diameter of Soft, Medium & Hard soil formation well





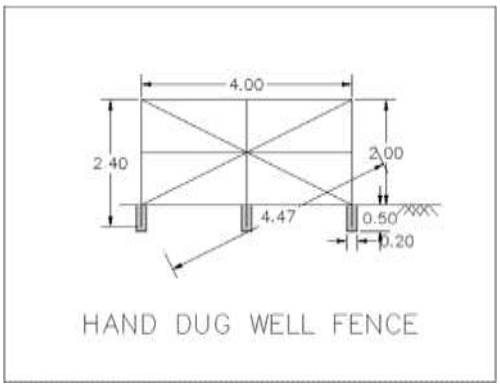


Figure 7. Plan and section view of 4 meter diameter of Soft, Medium & Hard soil formation well

Table 17. BOQ for Case 4: 4 meter diameter of Soft, Medium & Hard soil formation well

S.No	Descriptions	Unit	Qty	Remark
1	**Site clearing**	m^2	19.63	
2	**Earth work**			
2.1	**Excavation**			
2.1.1	Soft formation(pi*d_{av}^2/4*h)	m^3	33.42	
2.1.2	Medium Formation	m^3	40.03	
2.1.3	Hard Formation	m^3	3.40	
2.1.4	Pump seat excavation as shown in design	m^3	47.43	
2.2	Compaction (pi*h/4*((d_{ex}T+d_{ex}B)/2+(d_{in}T+d_{in}B)/2))^2	m^3	4.63	
2.3	Cart away excavated material	m^3	124.28	
3	**Masonry work**			
3.1	Wet masonry (1:4 ratio mortar)			
3.1.1	Well	m^3	14.56	
3.1.2	Pump seat			
3.1.2.1	Bed	m^3	1.51	
3.1.2.2	Side wall (both sides) & staircase	m^3	16.54	
3.2	Dry masonry	m^3	23.18	
4	**Gravel & Hardcore**			
4.1	Gravel at the back of dry masonry	m^3	4.30	
4.2	Hardcore at the bottom of the well	m^3	0.17	
5	**Fence at 1 meter radius from the well**			
5.1	Concrete (1:2:4)	m^3	0.28	
5.2	Eucalypts 2.4 meter 10cm diameter	#	18	
5.3	Eucalypts 4.5 meter 5cm diameter	#	18	
5.4	Eucalypts 4 meter 5cm diameter	#	18	
5.5	Nail (#12)	kg	1.25	
5.6	Nail for door	kg	0.5	
5.7	Iron sheet for door(2*1)	#	1	
5.8	Long lock with key	#	1	

Table 18. Construction materials needed

Material type	Unit	Qty
Cement	Qtl	45.17
Sand	m^3	10.59
Gravel	m^3	4.81
Stone	m^3	58.76

NB: For all the above hand dug well cases, the following materials & equipment's are 30m & 5m measuring tapes, shovel, pickaxe, digging hoe, bucket (1large & 2 small), hammer, chisel, wheelbarrow, rope (12mm steel or 25mm timber), shovel, nylon rope, tripod, trowel, float, carpenter and masonry tools, cement, sand, aggregate(gravel), reinforcing bars, wire, stone, water, timber, planks, timber poles, formwork and gauge box.

5.3. Manual Tube Well Drilling

This bill of quantity and specification for manual tube well describes tools and equipment required for pump house excavation, drilling, casing, screening and gravel pack.

Table 19. Tools and Equipment Required for Manual tube well drilling

S/N	Items	Unit– Pieces (Pcs)	Quantity
1	**Tools and Equipment Required for Pump House Excavation**		
1.1	Measuring tape(30 m)	Pcs	1
1.2	Measuring tape (5 m)	Pcs	1
1.3	Nylon rope (thin-for layout) – 3 mm	Roll	1
1.4	Spade	Pcs	5
1.5	Hoe	Pcs	5
1.6	Wooden or metal ladder (7 – 8 m long)	Pcs	1
2	**Drilling Tools and Equipment Required by Drill Crews**		
2.1	Measuring tape(5 m)	Pcs	1
2.2	Working cloth, boots and helmet	Set	6
2.3	First aid kit	Kit	1
2.4	Pipe wrench, 36', 24" and 18"	Set	1
2.5	Chain pipe wrench	Pcs	2
2.6	Pipe cutter (½ – 4")	Pcs	1
2.7	Pipe thread maker (½ – 2'')	Pcs	1
2.8	Metal hack saw frame with blade	Pcs	1

2.9	Mason hammer (1 kg)	Pcs	1
2.10	File (flat)	Pcs	1
2.11	Metal bucket (16 lit)	Pcs	2
2.12	Chain (12 mm)	m	12
2.13	Chain (6 mm)	m	5
2.14	Nylon rope (thick) – 12 mm	m	25
2.15	shovel	Pcs	1
2.16	Drilling pipe, each with 1.5m length, made of GI pipe JAGAL, and 10cm long and at least 4mm thick heat treated black steel welded on both ends with metric thread	Pcs	20
2.17	Pin, Metal type used to fix wooden poles with the hande	Pcs	1
2.18	1 ½ Coupling, full thread, metric	Pcs	20
3	**Reaming**		
3.1	GIP (20 cm long 3“ GIP welded with 1½“ coupling) Pure steel	Pcs	1
3.2	GIP (20 cm long 4“ GIP welded with 20 cmlong3" GIP welded with 1½“ coupling) Pure steel	Pcs	1
3.3	GIP (20 cm long 5“ GIP welded with 20cm long3" GIP welded with 1½“ coupling) Pure steel	Pcs	1
Materials Required by the User for Tube Well Installation			
4	**Casing and screening and gravel pack**		
4.1	Wood poles (14 cm diameter and 3.10 m long– 2 pieces), (10 cm diameter and 1.80 m long, 1 piece), 8 cm diameter and 2.8 m long, 1 piece)	Set	4
4.2	PVC/GIP –3” diameter and 6 m long B-Class, 42 kg). Based on the aquifer characteristics, some portion of this material could be perforated at local workshop.	Set	2 – 3
4.3	Coupling (3")	Pcs	3
4.4	Galvanized mesh wire screen (coffee mesh size), if required	m	1 – 3
4.5	River gravel (1– 2 mm diameter), if required	m^3	1
5	**Pump installation**		
5.1	Diesel pump (3", 5 hp, 30 m total head, 15litre per second(l/s)	Pcs	1
5.2	Poly Vinyl Chloride PVC reinforced flexible suction hose (5 mm thickness)	m	25
5.3	20 cm long 2½" galvanized pipe welded with 3" galvanized pipe coupling	Pcs	1
5.4	PVC reinforced flexible suction hose (5 mm thickness)	m	1.5
5.5	Hose clap, 3"	Pcs	3

5.6	Hose connector (aluminum), 3"	Pcs	1
5.7	Screw driver (flat and Philips)	Set	1
5.8	Teflon, medium	Roll	3
5.9	Diesel fuel for pump test	Littre	20
5.1	Oil for diesel pump	Littre	2
6	**List of equipment and tools for percussion drilling**		
6.1	Tripod with pulley	set	It can stay longer with minor maintenance
6.2	Percussion drilling bits/40kg &60kg/	pcs	It can drill up to 100wells only by replacing sharp tips
6.3	Bailer	pcs	Optional
6.4	Chain block (5ton)	pc	optional
6.5	Rope 20mm dia	m	

5.4. Rooftop Rainwater harvesting pond

The bill of quantity and specification for rooftop rain water harvesting storage facility is described with above ground cistern and underground pond.

5.4.1. Above ground cistern for rooftop rainwater harvesting pond

The bill of quantity and specification for above ground cistern for rooftop rainwater harvesting pond will replaced.

Table 20. Material specification and quantity required for aboveground rainwater tank ($12m^3$)

No	Item Description and specification	Unit	Unit Qty	Unit Rate	Total cost
2	Cement	Quintal	15		
3	Water	Barrel	5		
4	Stone	M^3	1		
5	Sand	M^3	8		
6	Pumis for Brick production	M^3	7.5		
7	Gravel (01mm)	M^3	2		
9	PVC pipe (110mm)	Pcs	5		
10	PVC Elbow (110mm)	pcs	3		
11	PVC T (110mm)	pcs	2		
12	gutter	m	30		
13	Chicken mesh wire	m^2	60		
14	cover (60*60)	pcs	1		
15	GIS Pipe (1/2 inch) - class – B	pcs	0.5		
16	GIS Elbow (1/2 inch)	pcs	0.5		
17	GIS T (1/2 inch)	pcs	1		
18	GIS Nipples (1/2 inch)	pcs	1		
19	Gate valve (1/2 inch)	pcs	1		
20	Foucet (1/2 inch)	pcs	1		

	Labor				
21	Excavation work	m^3	2		
22	Gutter worker	pd	4		
23	Assistance Gutter worker	pd	4		
24	Masonary work	pd	8		
25	Assistant Mason	pd	8		
26	Plumber	pd	3		
27	Assistant Plumber	pd	3		
28	Brick production wage	Bricks	800		
	Total				

Table 21. Material specification and quantity required for aboveground rainwater tank ($35m^3$)

No	Item Description	Unit	Quantity	Unit Rate	Total cost
1	Cement	Qntl	30		
2	Water	Barrel	8		
3	Stone	M3	1		
4	Sand	M3	8		
5	Pumis for Brick production	M3	10		
6	Gravel (01mm)	M3	2		
7	Gravel (02mm)	M4	1		
8	PVC pipe (110mm)	Pcs	5		
9	PVC Elbow (110mm)	pcs	3		
10	PVC T (110mm)	pcs	2		
11	gutter	m	30		
12	Chicken mesh wire	m2	60		
13	cover (85*85)	pcs	1		
14	Man hole with cover	pcs	1		
	Labour				
15	Excavation work	m3	35		
16	Gutter worker	pd	4		
17	Assistance Gutter worker	pd	4		
18	Masonary work	pd	8		
19	Assistant Mason	pd	8		
20	Plumber	pd	3		
21	Assistant Plumber	pd	3		
22	Brick production wage	Bricks	1500		
	Total				

Table 22. Fixed material cost for rainwater tank, irrigation equipment and hand tools-$12m^3$

S/N	Item	Unit	Qty	Unit cost (ETB)	Total cost (ETB)	Life span (year)	CRF	Total annual cost recovery (ETB)
1	**Aboveground tang,**							

	and irrigation equipment							
1.1	Above ground rainwater tank	Number	1					
1.2	Flexible hose	meter	20					
1.3	Watering can	Number	1					
1.4	Rope and washer pump	Number	1					
2	**Farm tools**							
2.1	Hoe	Number	1					
2.2	Shovel	"	1					
2.3	Chemical sprayer	"	1					
2.4	Rake	"	1					
	Total annual fixed costs							

- 1US$=10 ETB (January, 2009)
- Bank interest rate =14%
- 50% of its capacity is considered to be utilized for other purposes, cost of structure in this case is 2295.67 Birr/m^3 of water storage capacity

5.4.2. Underground Rooftop rainwater harvesting pond

Case 1: Underground roof water harvesting HH pond lined with Geo-membrane (V= 33.1 m^3) roof top water harvesting

Dimension of the pond

- Depth of the pond , D = 2 m
- Bottom width, b = 1.9 m
- Side slope = 1:1 (1V:1H)
- Top width, T = 5.9 m

Specification of Geo-membrane for the pond

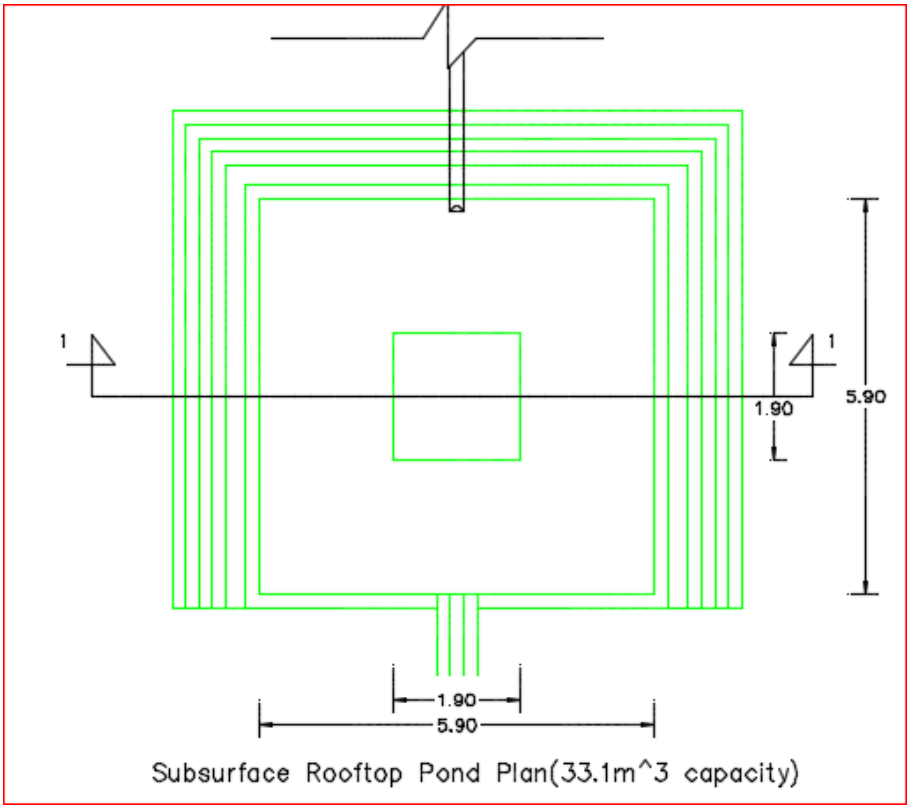
- Dimension of geo-membrane = 10.3 m x 11.9 m (width x length)
- Material = LLDPE (Linear Low Density Polyethylene)
- Colour = black
- Thickness = 0.75 mm

Table 23. Bill of quantity and specification for HH pond lined with Geo-membrane (V= 33.1 m^3) roof top water harvesting

S.N	Description of item	unit	quantity	Remark
1	**Pond**			
1.1	Site clearing of the pond area	m2	64	

1.2	Excavation of the pond (min)	m3	50.52	*
1.3	Excavation of the anchor trench for geo-membrane (width and depth of the anchor key is assumed to be 0.2 m)	m3	1.024	
1.4	Fill for the trench key	m3	1.024	
1.5	Embankment at the top of the pond (the height of the embankment is assumed to be 0.2 m while the top & bottom width of the embankment are 0.3 m & 0.7 m respectively)	m3	2.36	
1.6	Laying geo-membrane to the pond	m2	122.6	
4	**Spillway**			
4.1	Excavation of the spillway (the length of the spillway is assumed to be 10m while the height and width is 0.3m)	m3	3.5	
4.2	Dry stone pitching for the spillway	m3	2.6	

NB: The type of material to be excavated could be soft soil or hard formation depending on site**.** The excavation volume is calculated assuming that the topography of the pond site is flat which otherwise the excavation volume can be changed depending on the slope of the pond site**.** The pond should be fenced and covered with material available in the location.



Subsurface Rooftop Pond Plan(33.1m^3 capacity)

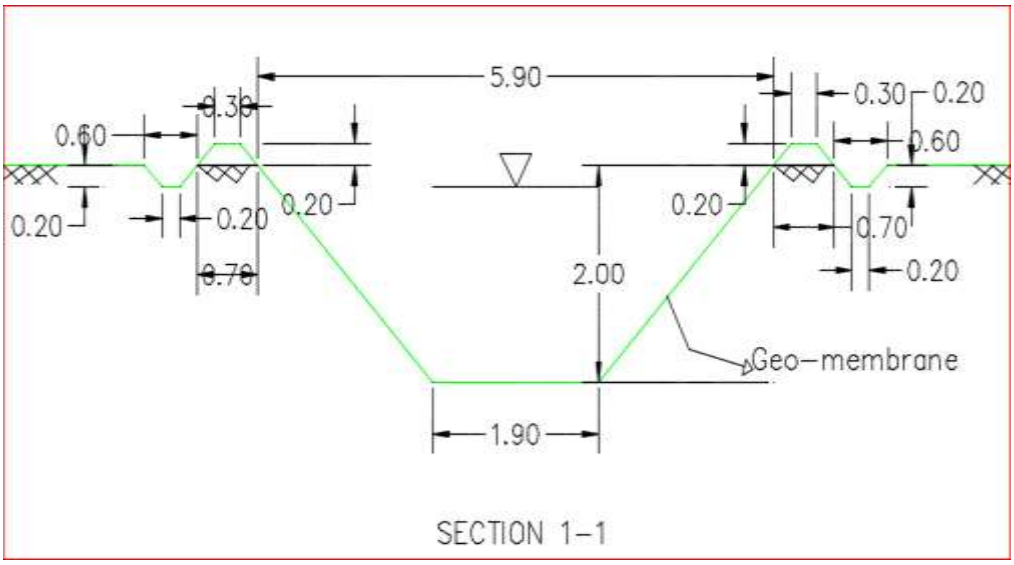


Figure 8. Plan & section of underground roof water harvesting HH pond lined with Geo-membrane

Case 2: Underground pond bill of quantity for HH pond lined with masonry (V = 33.1 m^3) for roof top water harvesting

Dimension of the pond

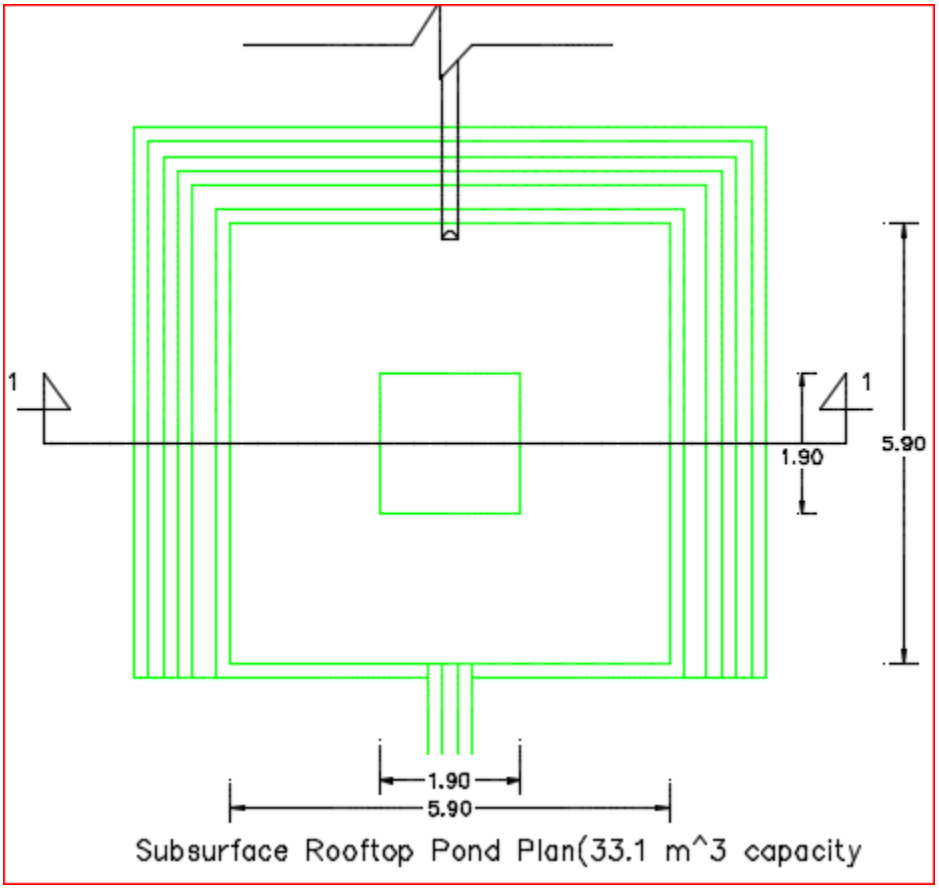
- Depth of the pond , D = 2 m
- Bottom width, b = 1.9 m
- Side slope = 1:1 (1V:1H)
- Top width, T = 5.9 m

Table 24. Bill of quantity and specification for HH pond lined with masonry (V = 33.1 m3) for roof top water harvesting

S.N	Description of item	unit	quantity	Remark
1	**Pond**			
1.1	Site clearing of the pond area	m2	64	
1.2	Excavation of the pond (min)	m3	50.52	*
1.3	Wet masonry (1:4) for the pond	m3	16.8	
1.4	Concrete at the bed of the pond on top of masonry, thickness = 6cm	m3	2.2	
1.5	Plastering the exposed surface of masonry (1:3)	m2	42	
2	**Spillway**			

2.1	Excavation of the spillway (the length of the spillway is assumed to be 10m while the height and width is 0.3m)	m3	3.5	
2.2	Dry stone pitching for the spillway	m3	2.6	

NB: The type of material to be excavated could be soft soil or hard formation depending on site**.** The excavation volume is calculated assuming that the topography of the pond site is flat which otherwise the excavation volume can be changed depending on the slope of the pond site**.** The pond should be fenced and covered with material available in the location.



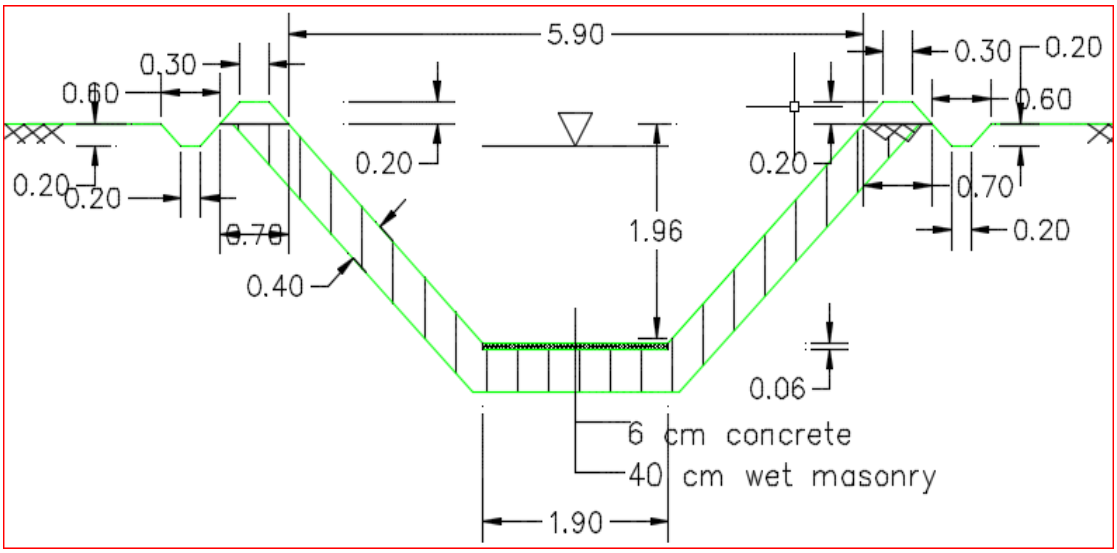


Figure 9. Plan & section of underground pond bill of quantity for HH pond lined with masonry

5.5. Farm Pond Water Harvesting

Bill of quantity and specification for farm pond water harvesting is described by five cases such as case1: HH pond lined with geo-membrane (V= 80.8 m3) & silt trap lined with masonry, case 2: HH pond lined with Geo-membrane (V= 84 m3) & silt trap lined with masonry, case 3:HH pond lined with geo-membrane (V = 80.8m3) & silt trap lined with geo-membrane, case 4: HH pond lined with masonry (V = 80.8m3) & silt trap lined with masonry, case 5: HH pond lined with masonry (V = 84 m3) & silt trap lined with masonry, case 6: HH pond lined with masonry (V = 156 m3) & silt trap lined with masonry and case 7: HH pond lined with masonry (V = 201 m3) & silt trap lined with masonry.

Case 1: HH pond lined with Geo-membrane (V= 80.8 m^3) & silt trap lined with masonry

Dimension of the pond

- Depth of the pond , D = 2.5 m
- Bottom width, b = 3
- Side slope = 1:1 (1V:1H)
- Top width, T = 8 m

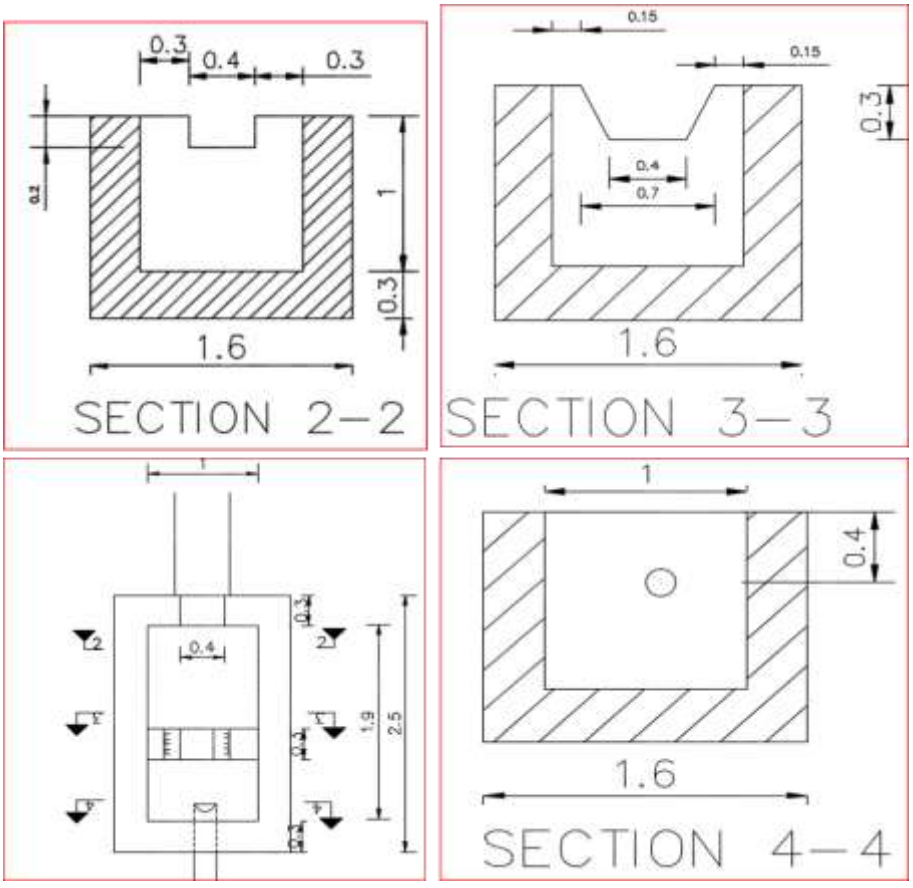
Specification of Geo-membrane for the pond

- Dimension of geo-membrane = 12.4 m x 14 m (width x length)
- Material = LLDPE (Linear Low Density Polyethylene)
- Colour = black
- Thickness = 0.75 mm

Table 25. Bill of quantity and specification HH pond lined with Geomembrane (V= 80.8 m^3) & silt trap lined with masonry

S.N	Description of item	Unit	Quantity	Remark
1	**Pond**			
1.1	Site clearing of the pond area	m2	100	
1.2	Excavation of the pond (min.)	m3	80.8	*
1.3	Excavation of the anchor trench for geo-membrane (width and depth of the anchor key is assumed to be 0.2 m)	m3	1.44	
1.4	Fill for the trench key	m3	1.44	
1.5	Embankment at the top of the pond (the height of the embankment is assumed to be 0.2 m while the top & bottom width of the embankment are 0.3 m & 0.7 m respectively)	m3	3.76	
1.6	Laying geo-membrane to the pond	m2	173.6	
2	**Silt trap**			
2.1	Excavation for the silt trap	m3	5.2	
2.2	Wet masonry (1:4) for the silt trap	m3	3.55	
2.3	Plastering (1:3) for the silt trap	m2	9.80	
3	**Inlet channel from the silt trap to the pond**			
3.1	Excavation for the inlet channel (the length of the inlet channel is assumed to be 5m while the width & height are 0.3m & 0.2 m respectively)	m3	0.3	
3.2	Laying HDPE pipe with diameter ranging from 110 to 150 mm from silt trap to the pond	pcs	1	1pcs = 6m
4	**Spillway**			
4.1	Excavation of the spillway (the length of the spillway is assumed to be 10m while the height and width is 0.3m)	m3	3.5	
4.2	Dry stone pitching for the spillway	m3	2.6	
5	**Channel from the catchment to the silt trap**			
5.1	Excavation of channel from the catchment to silt trap to guide the runoff to silt trap (the length of the channel is assumed to be 30 m while the width and height is 0.3m)	m3	2.7	

NB: The type of material to be excavated could be soft soil or hard formation depending on site**.** The excavation volume is calculated assuming that the topography of the pond site is flat which otherwise the excavation volume can be changed depending on the slope of the pond site**.** The pond & silt trap should be fencing with material available in the location**.** The size of the silt trap could be varying depending on the silt load entering from the catchment.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0.3
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1
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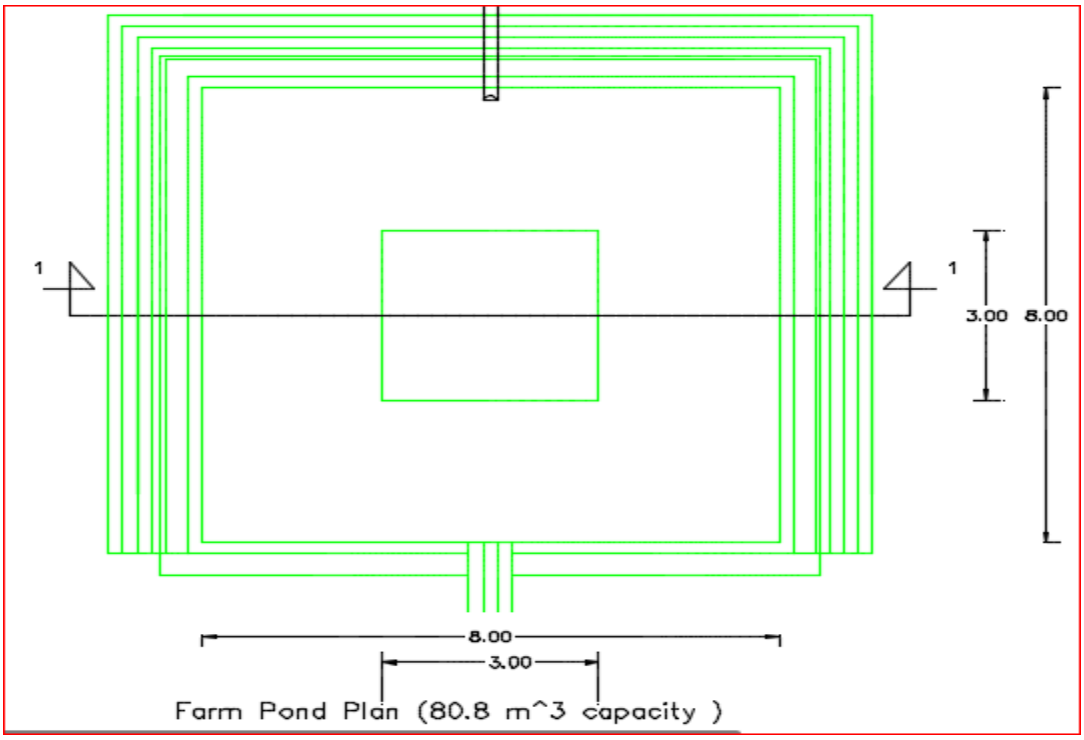
1.6
SECTION 2–2
0.15
0.15
0.3
0.4
0.7
1.6
SECTION 3–3
1
0.4
1.6
SECTION 4–4
0.4
1.9
2.5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3.00
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Farm Pond Plan (80.8 m^3 capacity)

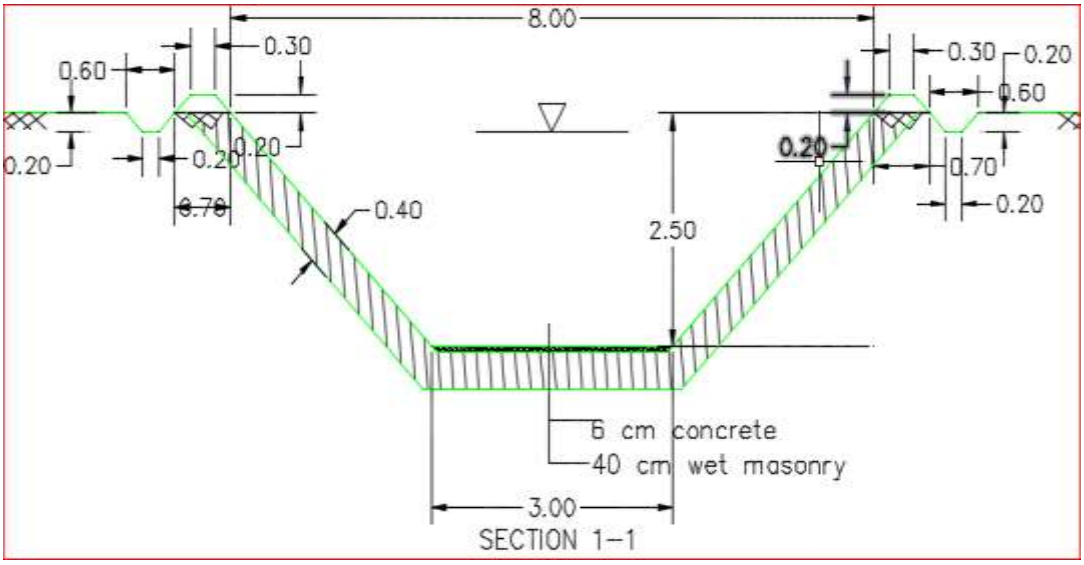


Figure 10. Plan & section of HH pond lined with Geo-membrane & silt trap lined with masonry

Case 2: HH pond lined with Geo-membrane (V= 84 m^3) & silt trap lined with masonry

Dimension of the pond

- Depth of the pond , D = 3 m
- Bottom width, b = 2 m
- Side slope = 1:1 (1V:1H)
- Top width, T = 8 m

Specification of Geo-membrane for the pond

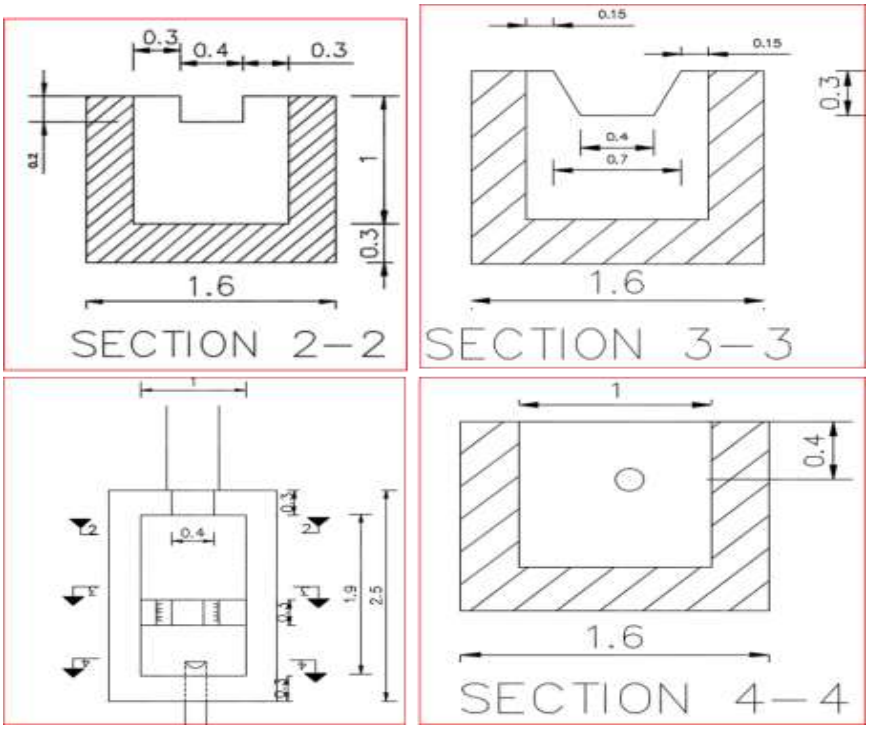
- Dimension of geo-membrane = 13.5 m x 13.5 m (width x length)
- Material = LLDPE (Linear Low Density Polyethylene)
- Colour = black
- Thickness = 0.75 mm

Table 26. Bill of quantity and specification of HH pond lined with Geo-membrane (V= 84 m^3) & silt trap lined with masonry

S.N	Description of item	unit	quantity	Remark
1	**Pond**			
1.1	Site clearing of the pond area	m2	100	
1.2	Excavation of the pond (min.)	m3	84.0	*
1.3	Excavation of the anchor trench for geo-membrane (width and depth of the anchor key is assumed to be 0.2 m)	m3	1.44	
1.4	Fill for the trench key	m3	1.44	

1.5	Embankment at the top of the pond (the height of the embankment is assumed to be 0.2 m while the top & bottom width of the embankment are 0.3 m & 0.7 m respectively)	m3	3.76	
1.6	Laying geo-membrane to the pond	m2	182.25	
2	**Silt trap**			
2.1	Excavation for the silt trap	m3	5.2	
2.2	Wet masonry (1:4) for the silt trap	m3	3.55	
2.3	Plastering (1:3) for the silt trap	m2	9.80	
3	**Inlet channel from the silt trap to the pond**			
3.1	Excavation for the inlet channel (the length of the inlet channel is assumed to be 5m while the width & height are 0.3m & 0.2 m respectively)	m3	0.3	
3.2	Laying HDPE pipe with diameter ranging from 110 to 150 mm from silt trap to the pond	pcs	1	1pcs = 6m
4	**Spillway**			
4.1	Excavation of the spillway (the length of the spillway is assumed to be 10m while the height and width is 0.3m)	m3	3.5	
4.2	Dry stone pitching for the spillway	m3	2.6	
5	**Channel from the catchment to the silt trap**			
5.1	Excavation of channel from the catchment to silt trap to guide the runoff to silt trap (the length of the channel is assumed to be 30 m while the width and height is 0.3m)	m3	2.7	

NB: The type of material to be excavated could be soft soil or hard formation depending on site. The excavation volume is calculated assuming that the topography of the pond site is flat which otherwise the excavation volume can be changed depending on the slope of the pond site. The pond & silt trap should be fencing with material available in the location. The size of the silt trap could be varying depending on the silt load entering from the catchment.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0.4
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1
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1.6
SECTION 2–2
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0.15
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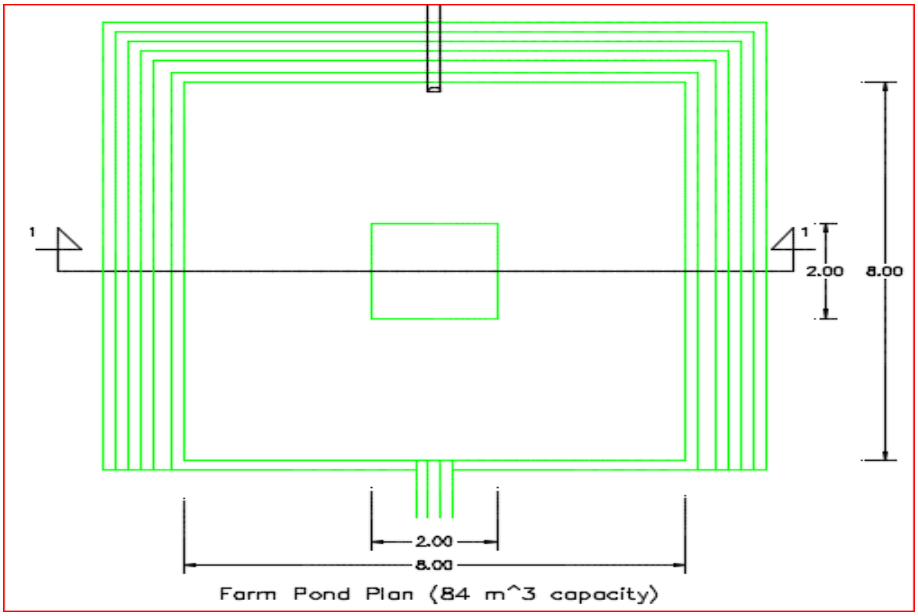
1.6
SECTION 3–3
1
0.4
1.6
SECTION 4–4
0.4
1.9
2.5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Farm Pond Plan (84 m^3 capacity)

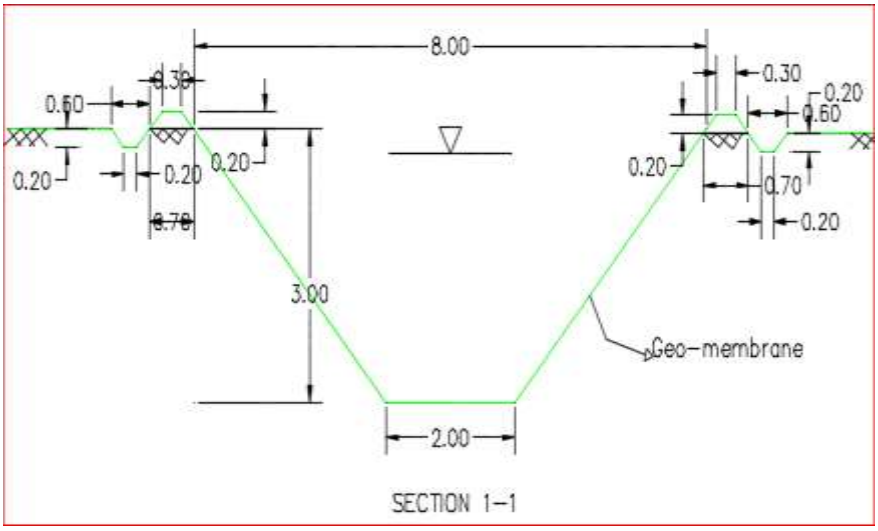


Figure 11. Plan & section HH pond lined with Geo-membrane & silt trap lined with masonry

Case 3: HH pond lined with geo-membrane (V = 80.8m³) & silt trap lined with geo-membrane

Dimension of the pond

- Depth of the pond , D = 2.5 m
- Bottom width, b = 3 m
- Side slope = 1:1 (1V:1H)
- Top width, T = 8 m

Specification of Geo-membrane for the pond

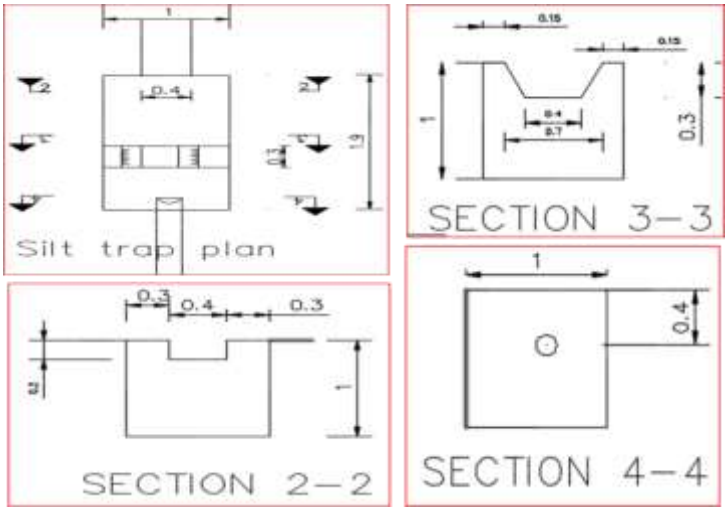
- Dimension of geo-membrane = 12.4 m x 14 m (width x length)
- Material = LLDPE (Linear Low Density Polyethylene)
- Colour = black
- Thickness = 0.75 mm

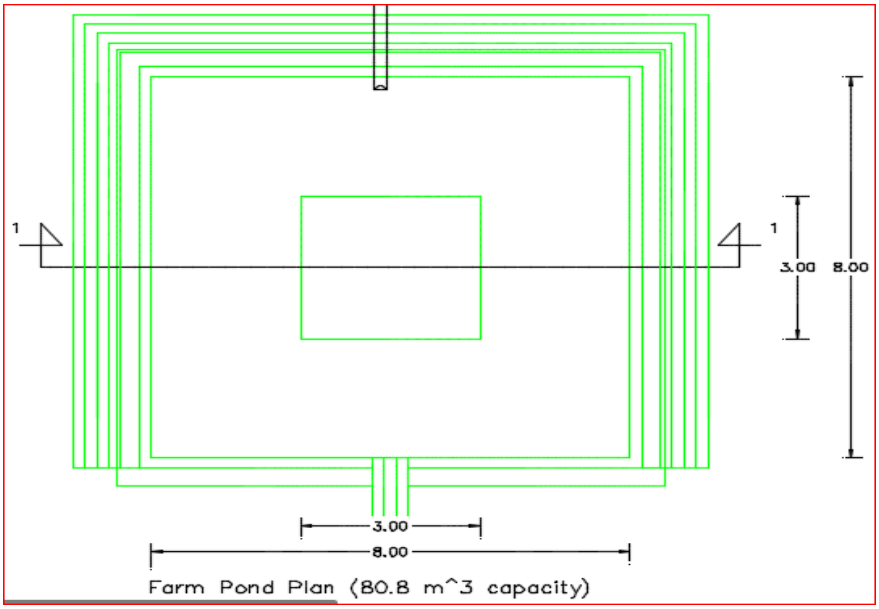
Table 27. Bill of quantity and specification for case 3

S.N	Description of item	unit	quantity	Remark
1	**Pond**			
1.1	Site clearing of the pond area	m2	100	
1.2	Excavation of the pond (min)	m3	80.8	*
1.3	Excavation of the anchor trench for geo-membrane (width and depth of the anchor key is assumed to be 0.2 m)	m3	1.44	
1.4	Fill for the trench key	m3	1.44	
1.5	Embankment at the top of the pond (the height of the embankment is assumed to be 0.2 m while the top & bottom width of the	m3	3.76	

	embankment are 0.3 m & 0.7 m respectively)			
1.6	Laying geo-membrane to the pond	m2	173.6	
2	**Silt trap**			
2.1	Excavation for the silt trap	m3	1.6	
2.2	Laying geo-membrane for the sit trap	m2	11.60	
3	**Inlet channel from the silt trap to the pond**			
3.1	Excavation for the inlet channel (the length of the inlet channel is assumed to be 5m while the width & height are 0.3m & 0.2 m respectively)	m3	0.3	
3.2	Laying geo-membrane for the inlet channel	m2	6.5	
4	**Spillway**			
4.1	Excavation of the spillway (the length of the spillway is assumed to be 10m while the height and width is 0.3m)	m3	3.5	
4.2	Dry stone pitching for the spillway	m3	2.6	
5	**Channel from the catchment to the silt trap**			
5.1	Excavation of channel from the catchment to silt trap to guide the runoff to silt trap (the length of the channel is assumed to be 30 m while the width and height is 0.3m)	m3	2.7	

NB: The type of material to be excavated could be soft soil or hard formation depending on site**.** The excavation volume is calculated assuming that the topography of the pond site is flat which otherwise the excavation volume can be changed depending on the slope of the pond site**.** The pond & silt trap should be fencing with material available in the location. The geo-membrane to be used for the silt trap and inlet is supposed to be getting by cutting the extra dimension of the geo-membrane from the pond area**.** The size of the silt trap could be varying depending on the silt load entering from the catchment.





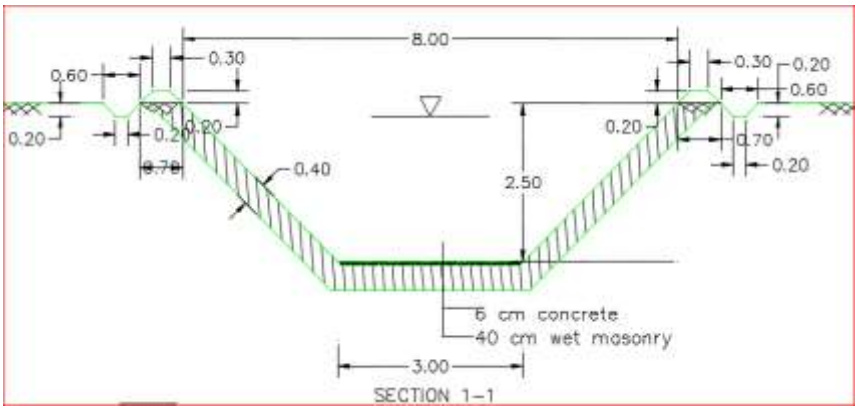


Figure 12.Plan & section of HH pond lined with geo-membrane (V = 80.8m^3) & silt trap lined with geo-membrane

Case 4: HH pond lined with masonry (V = 80.8m^3) & silt trap lined with masonry

Dimension of the pond & specification

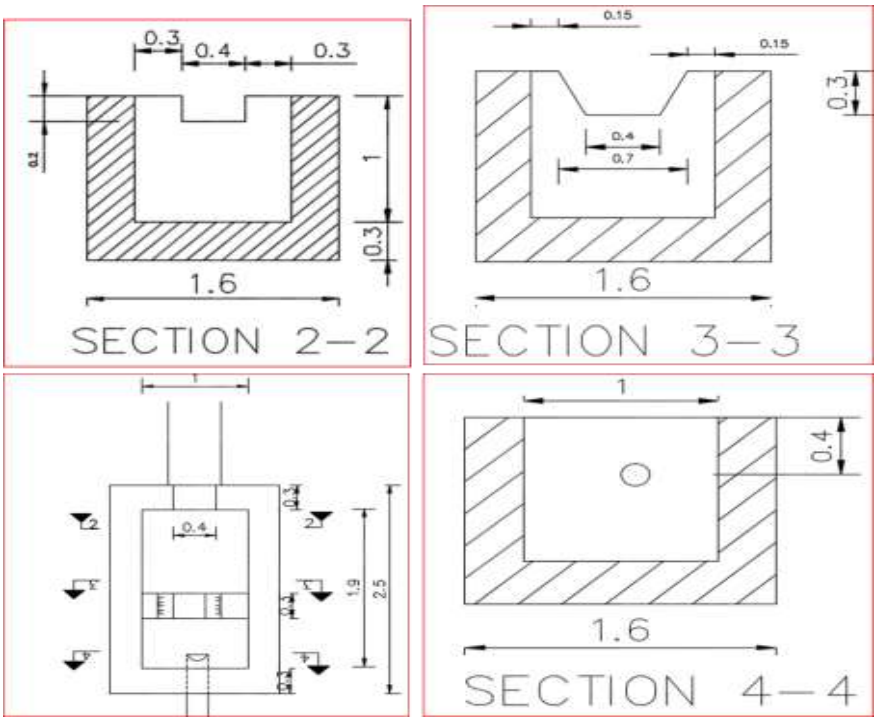
- Depth of the pond , D = 2.5 m
- Bottom width, b = 3 m
- Side slope = 1:1 (1V:1H)
- Top width, T = 8 m
- Thickness of masonry = 0.4 m
- Mix ratio of mortar for wet masonry = 1:4
- Thickness of concrete = 6 cm
- Mix ratio of concrete: 1:2:4

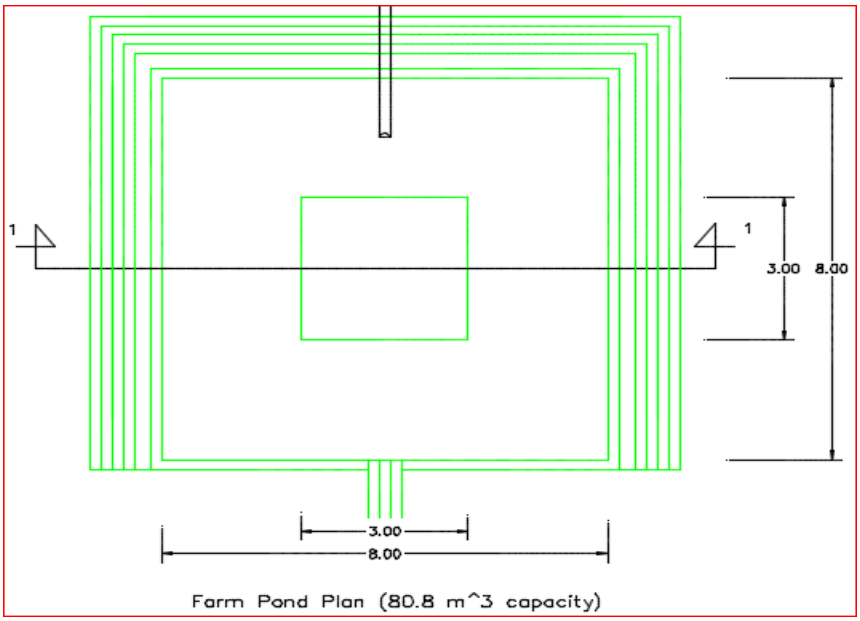
Table 28. Bill of quantity and specification for case 4

S.N	Description of item	unit	quantity	Remark
1	**Pond**			
1.1	Site clearing of the pond area	m2	100	
1.2	Excavation of the pond (min)	m3	121.1	*
1.3	Wet masonry (1:4) for the pond	m3	44.53	
1.4	Concrete at the bed of the pond on top of masonry, thickness = 6cm	m2	9	
1.5	Plastering the exposed surface of masonry (1:3)	m2	60.6	
2	**Silt trap**			
2.1	Excavation for the silt trap	m3	5.2	
2.2	Wet masonry (1:4) for the silt trap	m3	3.55	
2.3	Plastering (1:3) for the silt trap	m2	9.80	
3	**Inlet channel from the silt trap to the pond**			
3.1	Excavation for the inlet channel (the length of the inlet channel is assumed to be 5m while the width & height are 0.3m & 0.2 m respectively)	m3	0.3	
3.2	Laying HDPE pipe with diameter ranging from 110 to 150 mm from silt trap to the pond	pcs	1	1pcs = 6m
4	**Spillway**			
4.1	Excavation of the spillway (the length of the spillway is assumed to be 10m while the height and width is 0.3m)	m3	3.5	
4.2	Dry stone pitching for the spillway	m3	2.6	
5	**Channel from the catchment to the silt trap**			
5.1	Excavation of channel from the catchment to silt trap to guide the runoff to silt trap (the length of the channel is assumed to be 30 m	m3	2.7	

	while the width and height is 0.3m)			

NB. The type of material to be excavated could be soft soil or hard formation depending on site**.** The excavation volume is calculated assuming that the topography of the pond site is flat which otherwise the excavation volume can be changed depending on the slope of the pond site. The pond & silt trap should be fencing with material available in the location**.** The size of the silt trap could be varying depending on the silt load entering from the catchment.





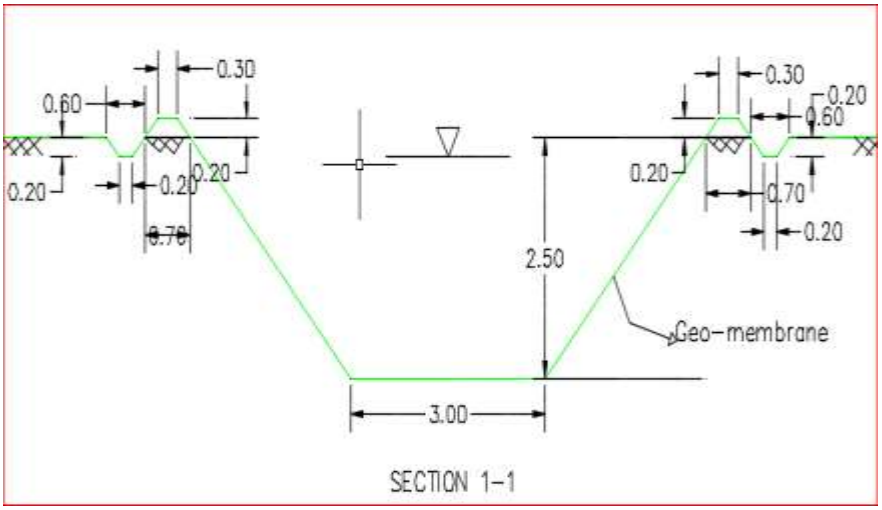


Figure 13.Plan & section of HH pond lined with masonry (V = 80.8m^3) & silt trap lined with masonry

Case 5: HH pond lined with masonry (V = 84 m^3) & silt trap lined with masonry

Dimension of the pond & specification

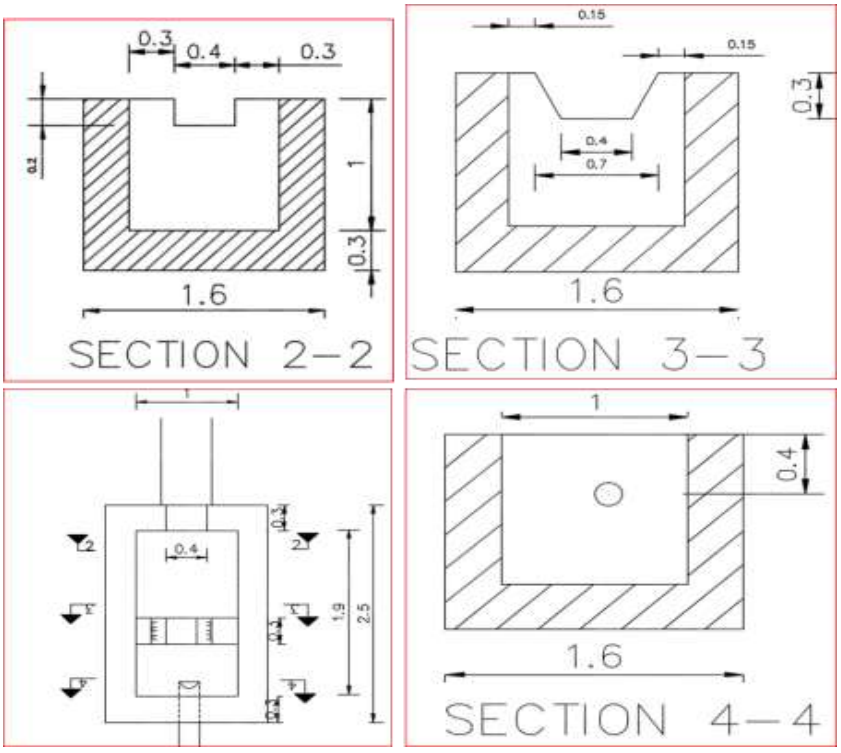
- Depth of the pond , D = 3 m
- Bottom width, b = 2 m
- Side slope = 1:1 (1V:1H)
- Top width, T = 8 m
- Thickness of masonry = 0.4 m
- Mix ratio of mortar for wet masonry = 1:4
- Thickness of concrete = 6 cm
- Mix ratio of concrete = 1:2:4

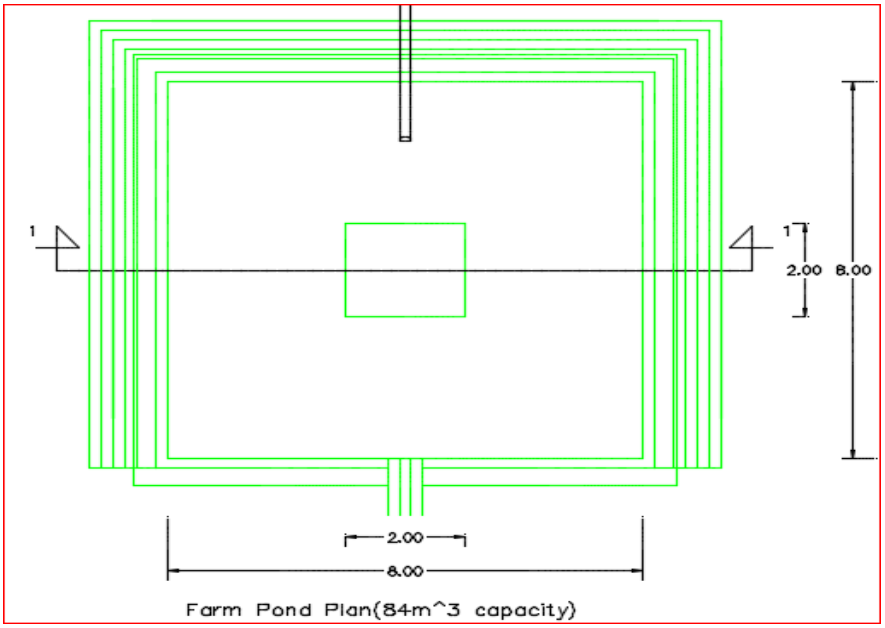
Table 29. Bill of quantity and specification for case 5

S.N	Description of item	unit	quantity	Remark
1	**Pond**			
1.1	Site clearing of the pond area	m2	100	
1.2	Excavation of the pond (min)	m3	124.6	*
1.3	Wet masonry (1:4) for the pond	m3	44.80	
1.4	Concrete at the bed of the pond on top of masonry, thickness = 6cm	m2	4	
1.5	Plastering the exposed surface of masonry (1:3)	m2	65.6	
2	**Silt trap**			
2.1	Excavation for the silt trap	m3	5.2	
2.2	Wet masonry (1:4) for the silt trap	m3	3.55	
2.3	Plastering (1:3) for the silt trap	m2	9.80	

3	**Inlet channel from the silt trap to the pond**			
3.1	Excavation for the inlet channel (the length of channel is assumed to be 5m while the width & height are 0.3m & 0.2m respectively)	m3	0.3	
3.2	Laying HDPE pipe with diameter ranging from 110 to 150 mm from silt trap to the pond	pcs	1	1pcs = 6m
4	**Spillway**			
4.1	Excavation of the spillway (the length of the spillway is assumed to be 10m while the height and width is 0.3m)	m3	3.5	
4.2	Dry stone pitching for the spillway	m3	2.6	
5	**Channel from the catchment to the silt trap**			
5.1	Excavation of channel from the catchment to silt trap to guide the runoff to silt trap (the length of the channel is assumed to be 30 m while the width and height is 0.3m)	m3	2.7	

NB: The type of material to be excavated could be soft soil or hard formation depending on site**.** The excavation volume is calculated assuming that the topography of the pond site is flat which otherwise the excavation volume can be changed depending on the slope of the pond site**.** The pond & silt trap should be fencing with material available in the location**.** The size of the silt trap could be varying depending on the silt load entering from the catchment.





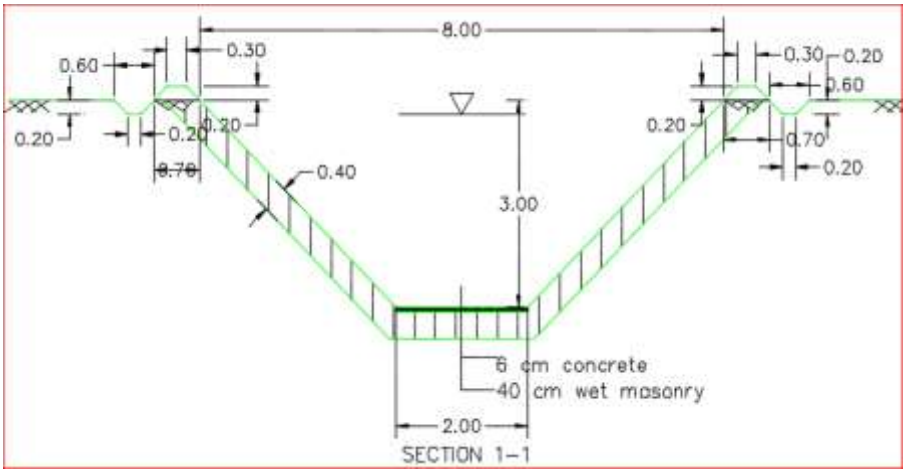


Figure 14.Plan & section of HH pond lined with masonry (V = 84 m^3) & silt trap lined with masonry

Case 6: HH pond lined with masonry (V = 156 m^3) & silt trap lined with masonry

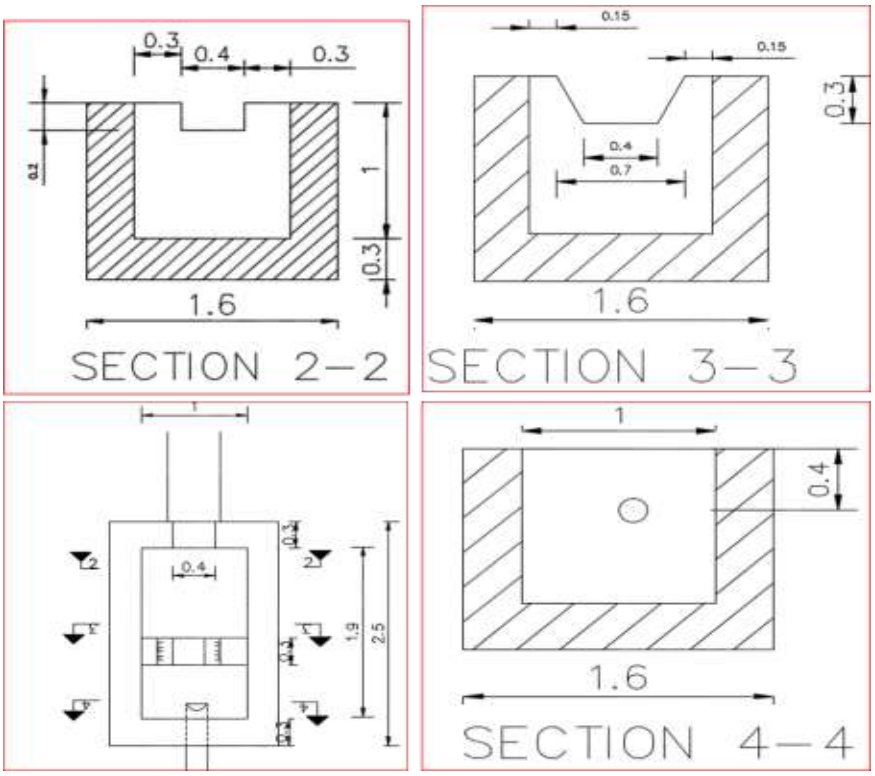
Dimension of the pond & specification

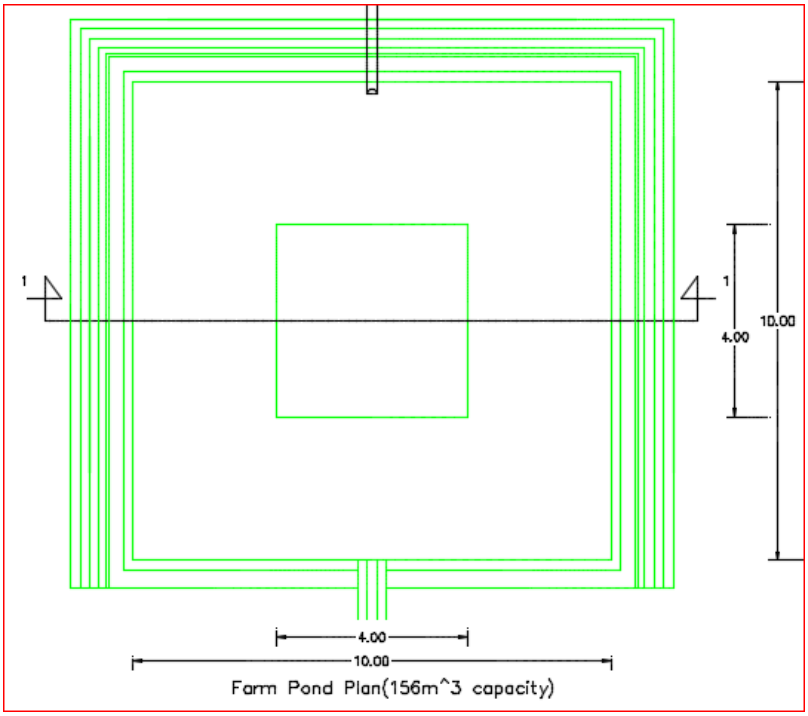
- Depth of the pond , D = 3 m
- Bottom width, b = 4 m
- Side slope = 1:1 (1V:1H)
- Top width, T = 10 m
- Thickness of masonry = 0.4 m
- Mix ratio of mortar for wet masonry = 1:4
- Thickness of concrete = 6 cm
- Mix ratio of concrete = 1:2:4

Table 30. Bill of quantity and specification for case 6

S.N	Description of item	unit	quantity	Remark
1	**Pond**			
1.1	Site clearing of the pond area	m2	144	
1.2	Excavation of the pond (min)	m3	217.1	*
1.3	Wet masonry (1:4) for the pond	m3	66.24	
1.4	Concrete at the bed of the pond on top of masonry, thickness = 6cm	m2	16	
1.5	Plastering the exposed surface of masonry (1:3)	m2	91.0	
2	**Silt trap**			
2.1	Excavation for the silt trap	m3	5.2	
2.2	Wet masonry (1:4) for the silt trap	m3	3.55	
2.3	Plastering (1:3) for the silt trap	m2	9.80	
3	**Inlet channel from the silt trap to the pond**			
3.1	Excavation for the inlet channel (the length of channel is assumed to be 5m while the width & height are 0.3m & 0.2m respectively)	m3	0.3	
3.2	Laying HDPE pipe with diameter ranging from 110 to 150 mm from silt trap to the pond	pcs	1	1pcs = 6m
4	**Spillway**			
4.1	Excavation of the spillway (the length of the spillway is assumed to be 10m while the height and width is 0.3m)	m3	3.5	
4.2	Dry stone pitching for the spillway	m3	2.6	
5	**Channel from the catchment to the silt trap**			
5.1	Excavation of channel from the catchment to silt trap to guide the runoff to silt trap (the length of the channel is assumed to be 30 m while the width and height is 0.3m)	m3	2.7	

NB: The type of material to be excavated could be soft soil or hard formation depending on site**.** The excavation volume is calculated assuming that the topography of the pond site is flat which otherwise the excavation volume can be changed depending on the slope of the pond site**.** The pond & silt trap should be fencing with material available in the location**.** The size of the silt trap could be varying depending on the silt load entering from the catchment.


0.3
0.4
0.3
0.2
1
0.3
1.6
SECTION 2–2
0.15
0.15
0.3
0.4
0.7
1.6
SECTION 3–3
0.4
1.9
2.5
1
0.4
1.6
SECTION 4–4


1
1
4.00
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Farm Pond Plan(156m^3 capacity)

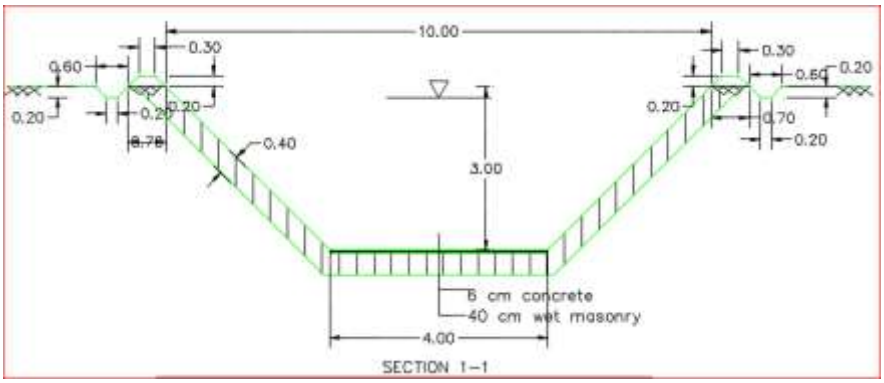


Figure 15.Plan & section of HH pond lined with masonry (V = 156 m^3) & silt trap lined with masonry

Case 7: HH pond lined with masonry (V = 201 m^3) & silt trap lined with masonry

Dimension of the pond & specification

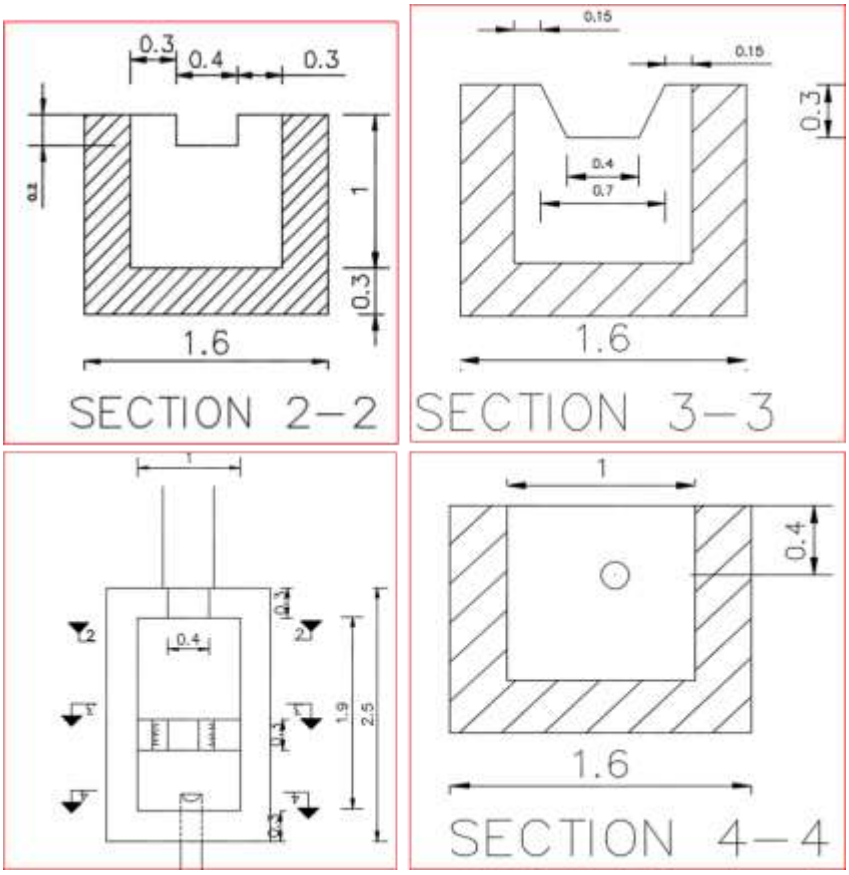
- Depth of the pond , D = 3 m
- Bottom width, b = 5 m
- Side slope = 1:1 (1V:1H)
- Top width, T = 11 m
- Thickness of masonry = 0.4 m
- Mix ratio of mortar for wet masonry = 1:4
- Thickness of concrete = 6 cm
- Mix ratio of concrete = 1:2:4

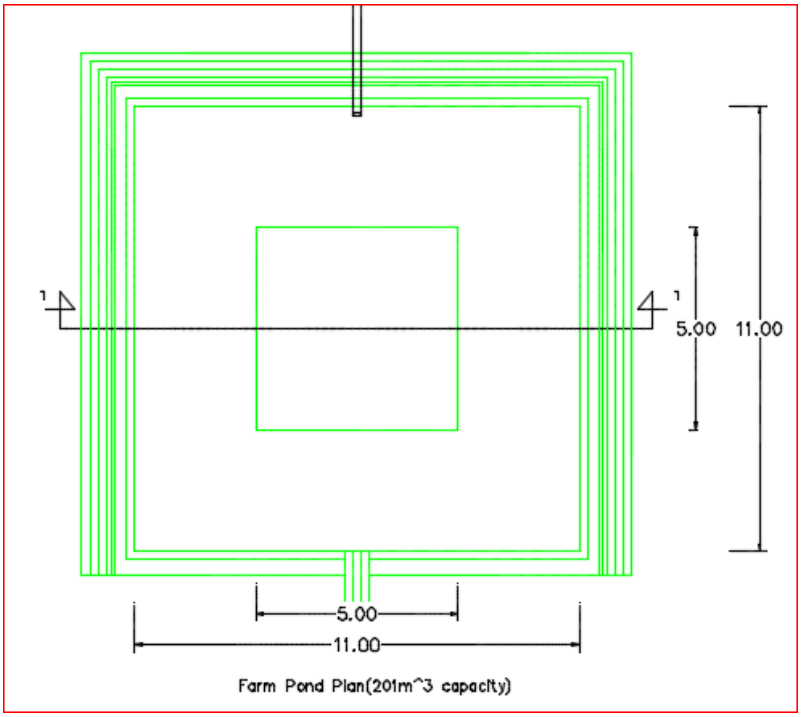
Table 31. Bill of quantity and specification for case 7

S.N	Description of item	unit	quantity	Remark
1	**Pond**			
1.1	Site clearing of the pond area	m2	169	
1.2	Excavation of the pond (min)	m3	273.5	*
1.3	Wet masonry (1:4) for the pond	m3	78.16	
1.4	Concrete at the bed of the pond on top of masonry, thickness = 6cm	m2	25	
1.5	Plastering the exposed surface of masonry (1:3)	m2	103.7	
2	**Silt trap**			
2.1	Excavation for the silt trap	m3	5.2	
2.2	Wet masonry (1:4) for the silt trap	m3	3.55	
2.3	Plastering (1:3) for the silt trap	m2	9.80	
3	**Inlet channel from the silt trap to the pond**			
3.1	Excavation for the inlet channel (the length of channel is assumed	m3	0.3	

	to be 5m while the width & height are 0.3m & 0.2m respectively)			
3.2	Laying HDPE pipe with diameter ranging from 110 to 150 mm from silt trap to the pond	pcs	1	1pcs = 6m
4	**Spillway**			
4.1	Excavation of the spillway (the length of the spillway is assumed to be 10m while the height and width is 0.3m)	m3	3.5	
4.2	Dry stone pitching for the spillway	m3	2.6	
5	**Channel from the catchment to the silt trap**			
5.1	Excavation of channel from the catchment to silt trap to guide the runoff to silt trap (the length of the channel is assumed to be 30 m while the width and height is 0.3m)	m3	2.7	

NB: The type of material to be excavated could be soft soil or hard formation depending on site**.** The excavation volume is calculated assuming that the topography of the pond site is flat which otherwise the excavation volume can be changed depending on the slope of the pond site**.** The pond & silt trap should be fencing with material available in the location**.** The size of the silt trap could be varying depending on the silt load entering from the catchment.





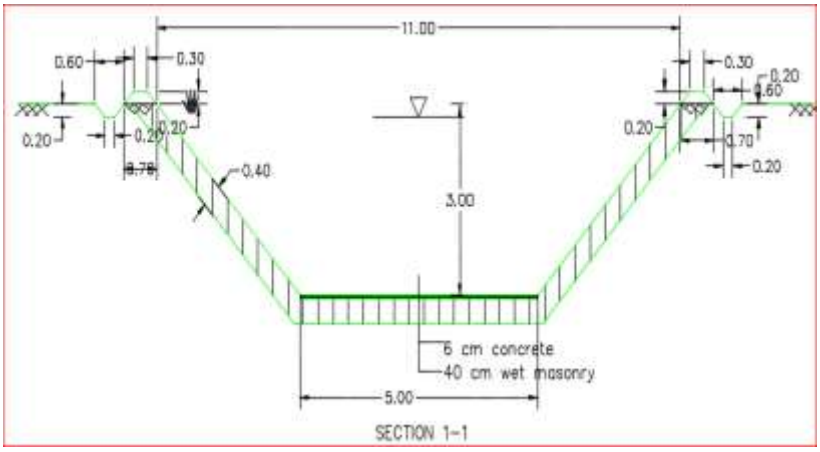


Figure 16.Plan & section of HH pond lined with masonry (V = 201 m^3) & silt trap lined with masonry

5.6. Manual Pumps

The specification and bill of quantity for manual pumps described here are treadle pump and rope and washer. For treadle pump two cases such as pressurized and Overflow are described.

5.6.1. Treadle pump

Case 1: Pressurized Treadle pump

The size of proposed pressurized treadle pump have maximum suction depth 5.5m, maximum pumping height 15m, maximum discharge 2500 liters/hours, maximum irrigation capacity 0.6ha, push water distance 200m(flat ground), weight 21kg and foot operated system.

Table 32. Bill of quantity and specification for pressurized treadle pump

S. N	Name	Dimension/Description	Qty	Picture
1	Valve Box with Sheet steel thickness of 3mm including accessories (Flat steel bar stock, brass hose fitting, conduit nut, Intake& outtake Hose Seals, Intake& outtake Shoulder Bolts, Flat Washer, Compression spring, Nylock Nut) & two cylinders with 12 cm diameter ,16.5 cm height &sheet thickness 3mm			
2	PTFE Tape or Plumbers Tape	1 role any size	1	
3	Pedaling system (Iron) with thickness of 2mm	A pair of metal rod pedals used to leverage the pedals up & down movement	2	
4	**Pistons**			
4.1	Nut	M3.5	4	
4.2	Rubber Sheet*	5x5x.3175 L x W x H	1	
4.3	Bolt	M3.5	4	
4.4	Flat washer	M3.5	4	

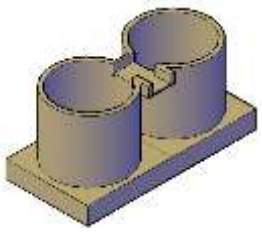
4.5	Piston Seal (m)	12.4 diameter polyurethane rubber	4	
5	**Suction hose (m)**			
	Length (m)	9	1	
	Type	PVC flexible reinforced suction hose, green transparent wall with white spiral		
	Internal Diameter (cm)	2.54		
	Wall thickness (mm)	3		
6	**Delivery hose**			
	Length (m)	25	1	
	Type	polyester reinforced flexible PVC flat hose		
	Internal diameter (cm)	2.54		
	Wall thickness (mm)	1.5		
7	Foot valve	Brass	1	
8	Hallow pipe T-Handle (thickness 2.5mm, height 130cm & pipe diameter 1.905cm)		1	
9	Hose clamp		3	

Case 2: Overflow Treadle pump

The size of proposed pressurized treadle pump have maximum suction depth 5.5m, maximum pumping height 5.5m, maximum discharge 4500 liters/hours, maximum irrigation capacity 1ha, push water distance 0m(flat ground), weight 16kg and foot operated system.

Table 33. Bill of quantity and specification for overflow treadle pump

S. N	Name	Dimension/Description	Qty	Picture

1	Valve Box with Sheet steel thickness of 3mm including accessories (Flat steel bar stock, Intake brass hose fitting , conduit nut, Intake Hose Seal, Shoulder Bolt, Flat Washer, Compression spring, Nylock Nut) & two cylinders with 12 cm diameter ,16.5 cm height &sheet thickness 3mm			
2	PTFE Tape or Plumbers Tape	1 role any size	1	
3	Pedaling system (Iron) with thickness of 2mm	A pair of metal rod pedals used to leverage the pedals up & down movement	2	
4	**Pistons**			
4.1	Nut	M3.5	4	
4.2	Rubber Sheet*	5x5x.3175 L x W x H	1	
4.3	Bolt	M3.5	4	
4.4	Flat washer	M3.5	4	
4.5	Piston Seal (m)	12.4 diameter polyurethane rubber	4	
5	**Suction hose (m)**			
5.1	Length (m)	9	1	
	Type	PVC flexible reinforced suction hose, green transparent wall with white spiral		
	Internal Diameter (cm)	2.54		
	Wall thickness (mm)	3		
6	Foot valve	Brass	1	

7	Hallow pipe T-Handle (thickness 2.5mm, height 130cm & pipe diameter 1.905cm)		1	
8	Hose clamp		2	

5.6.2. Rope and Washer

The bill of quantity and specification for rope and washer is described with six cases such as Case 1: Rope and Washer Pump for a well depth of 0-10m (Hand dug well), Case 2: Rope and Washer Pump for a well depth of 10-20m (Hand dug well), Case 3: Rope and Washer Pump for a well depth of 20-35m (Hand dug well), Case 4: Rope and Washer Pump for a Static water depth of 0-10m (Manual tube well), Case 5: Rope and Washer Pump for a Static water depth of 10-20m (Manual tube well) and Case 6: Rope and Washer Pump for a Static water depth of 20-35m (Manual tube well).

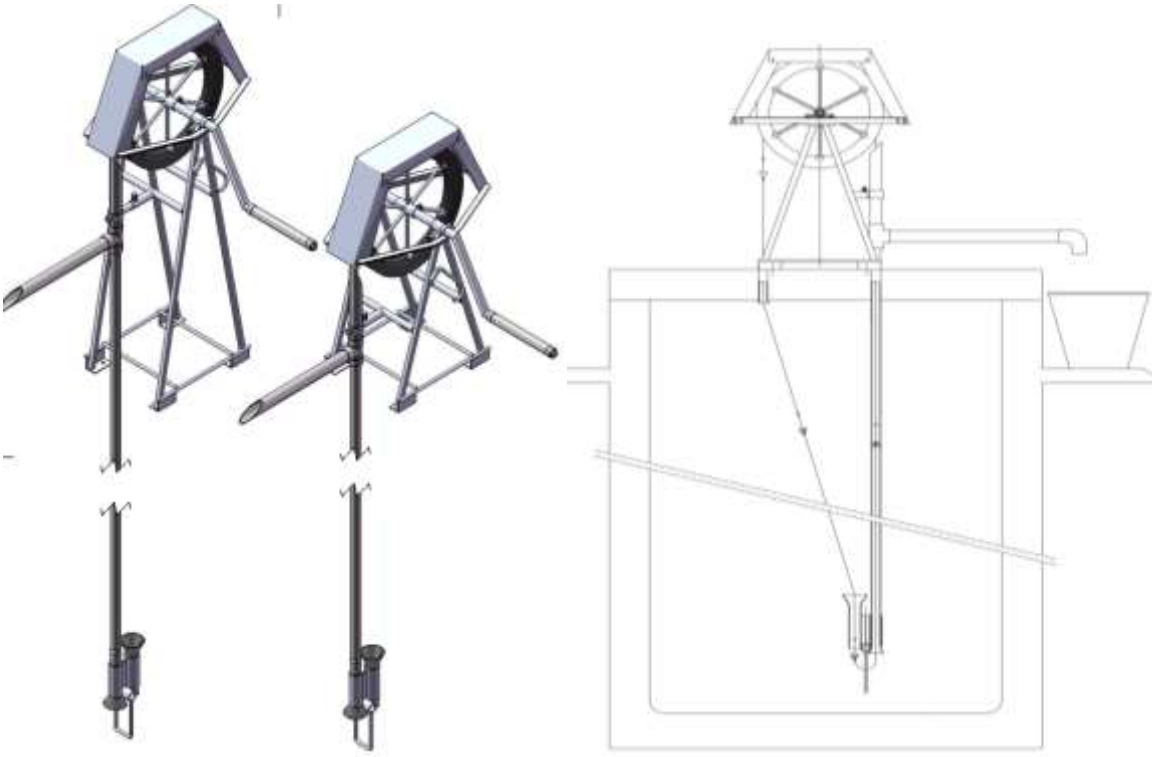
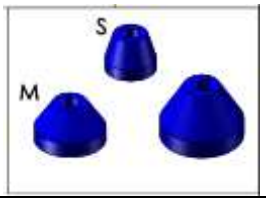


Table 34. Rope and Washer Pump specification & BoQ for a well depth of 0-10m (Hand dug well)

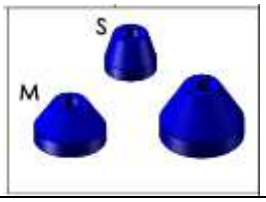
No Item	Item Description	unit	quantity	Picture

1	Pump structure 1" made of GI (wall thickness 3 – 3,5mm) pipe with legs. Painted properly with antirust and finishing blue paint.	pcs	1	
2	Pipe fitting for pump PVC Elbow 2"	pcs	1	
	PVC T-Joint 2"	pcs	1	
	Reducer from 2" to 1"	pcs	1	
3	Guide box for1" Rope & Washer Pump with well made PVC flares so that the rope and pistons move freely.	Pcs	1	
4	Reinforced Concrete well cover diameter =1.2m, 6cm thickness reinforced by 6mm round wire with embedded anchor bolt to fit the structure of the pump having two holes for each legs.	pcs	1	
5	Cone shaped Poly Ethylene (PE) Pistons for 1" pump (24 mm diameter piston)	Pcs	22	
6	Main riser discharge PVC pipe □=1"	Meter	12	
7	Water discharge PVC pipe □= 2 " , L=2 m	pcs	1	
8	Piston coner □=40 mm, L=2 m	pcs	1	
9	Hole coner funnel	pcs	1	
10	Rope made of Poly Propylene (PP) □=8mm	meter	25	

11	Pipe foot locker	pcs	1	
12	Wheel: rim 14 inches (356mm) reinforced by 12mm round bar at 6 points, flat bar 25x3mm,length55/64mm car tire □14" central pipe 1" GI (wall thickness 3 – 3,5mm)10cm length external diameter of the wheel not less than 44cm.	pcs	1	
13	The Axle &Handle 3/4" GI (wall thickness 3 – 3,5mm) with rings of 1¼" GI (wall thickness 3 – 3,5mm) pipe and angle of bending 110°, 27cm+ 23cm+27cm and the outer handling 27cm wall thickness of 3.5 mm is covered by PVC with frictionless bushing and having spacer ring.	pcs	1	
14	Wheel safety cover (shield) made of galvanized sheet 0.6-1mm thickness & bend angle 108°	pcs	1	
15	PVC gum	tin	1	
16	Cleaner	tin	1	

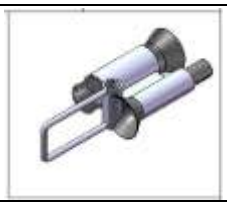
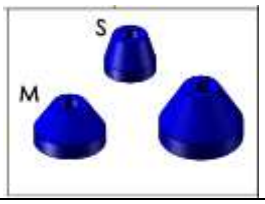
Table 35. Rope and Washer Pump specification & BoQ for a well depth of 10-20m (Hand dug well)

Sr No	Item Description	unit	quantity	Picture
1	Rope pump structure ¾" made of GI (wall thickness 3 – 3,5mm) pipe with legs. Painted properly with antirust and finishing blue paint.	Pcs	1	
2	Pipe fitting for pump PVC Elbow 1½"	pcs	1	
	PVC T-Joint 1½"	Pcs	1	
	Reducer from 1½" to ¾"	pcs	1	
3	Guide box for ¾" Rope & Washer Pump with well made PVC flares so that the rope and pistons move freely.	Pcs	1	

4	Reinforced Concrete well cover □=1.2m, 6cm thickness reinforced by 6mm □ round wire with embedded anchor bolt to fit the structure of the pump having two holes for each legs.	pcs	1	
5	Cone shaped Poly Ethylene (PE) Pistons for ¾" pump	pcs	42	
6	Main riser discharge PVC pipe a diameter of ¾"	meter	22	
7	Water discharge PVC pipe a diameter 1½" , L=2 m	pcs	1	
8	Pistón coner □=40 mm, L=2 m	pcs	1	
9	Hole coner / fanal/ flare/	pcs	1	
10	Rope made of Poly Propylene (PP) □=6mm	meter	50	
11	Pipe foot locker	pcs	1	
12	Wheel: rim 14 inches (356mm) reinforced by 12mm round bar at 6 points, flat bar 25x3mm,length55/64mm car tire f14" central pipe 1" GI (wall thickness 3 – 3,5mm)10cm length external diameter of the wheel not less than 44cm.	pcs	1	
13	The Axle &Handle 3/4" GI (wall thickness 3 – 3,5mm) with rings of 1" GI (wall thickness 3 – 3,5mm) pipe and angle of bending 110o, 27cm+ 23cm+27cm and the outer handling 27cm wall thickness of 3.5 mm is covered by PVC with frictionless bushing and having spacer ring.	pcs	1	
14	Wheel safety cover (shield) made of galvanized sheet 0.6-1mm thickness & bend angle 108°	pcs	1	

15	PVC gum	tin	1	
16	Cleaner	tin	1	

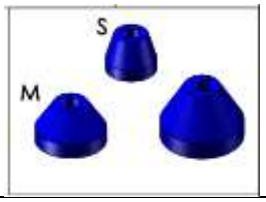
Case 3: Rope and Washer Pump specification & BoQ for a well depth of 20-35m (Hand dug well)

No Item	Item Description	unit	quantity	Picture
1	Rope pump structure ½"made of GI (wall thickness2.5 – 3,5mm) pipe with legs. Painted properly with antirust and finishing blue paint.	Pcs	1	
2	Pipe fitting for pump PVC Elbow 1"	Pcs	1	
	PVC T-Joint 1"	pcs	1	
	Reducer from ½" to 1"	Pcs	1	
3	Guide box for ½"Rope & Washer Pump with well made PVC flares so that the rope and pistons move freely.	Pcs	1	
4	Reinforced Concrete well cover □=1.2m, 6cm thickness reinforced by 6mm □ round wire with embedded anchor bolt to fit the structure of the pump having two holes for each legs.	Pcs	1	
5	Cone shaped Poly Ethylene (PE) Pistons for ½"pump	pcs	72	
6	Main riser discharge PVC pipe a diameter of ½"	meter	37	
7	Water discharge pipe PVC pipe a diameter of 1", L=2 m	pcs	1	
8	Piston coner □=40 mm, L=2 m	pcs	1	
9	Hole coner funnel	pcs	1	

10	Rope made of Poly Propylene (PP) □=4mm	meter	80	
11	Pipe foot locker welded on the structure	pcs	1	
12	Wheel: rim 14 inches (356mm) reinforced by 12mm round bar at 6 points, flat bar 25x3mm,length55/64mm car tire Diameter 14" central pipe 1" GI (wall thickness 3 – 3,5mm)10cm length external diameter of the wheel not less than 44cm.	pcs	1	
13	The Axle &Handle 3/4" GI (wall thickness 3 – 3,5mm) with rings of 1" GI (wall thickness 3 – 3,5mm) pipe and angle of bending 110o, 27cm+ 23cm+27cm and the outer handling 27cm wall thickness of 3.5 mm is covered by PVC with frictionless bushing and having spacer ring.	pcs	1	
14	Wheel safety cover (shield) made of galvanized sheet 0.6-1mm thickness & bend angle 108^{o}	pcs	1	
15	PVC gum	tin	1	
16	Cleaner	tin	1	

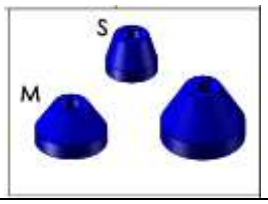
Table 36. Rope and Washer Pump specification & BoQ for a Static water depth of 0-10m (Manual tube well)

No Item	Item Description	unit	quantity	Picture
1	pump structure 1' made of GI (wall thickness 3 – 3,5mm) pipe with legs. Painted properly with antirust and finishing blue paint.	pcs	1	
2	Pipe fitting for pump PVC Elbow 2"	pcs	1	
	PVC T-Joint 2"	pcs	1	
	Reducer from 2" to 1"	pcs	1	
3	Guide box for1' Rope & Washer Pump with well made PVC flares so that the rope and pistons move freely.	Pcs	1	

4	Reinforced Concrete well cover diameter =1.2m, 6cm thickness reinforced by 6mm round wire with embedded anchor bolt to fit the structure of the pump having one hole for two legs.	pcs	1	
5	Cone shaped Poly Ethylene (PE) Pistons for 1' pump (24 mm diameter piston)	Pcs	22	
6	Main riser discharge PVC pipe for 1' pump	Meter	15	
7	Water discharge PVC pipe □= 2 " , L=2 m	pcs	1	
8	Piston coner □=40 mm, L=2 m	pcs	1	
9	Hole coner funnel	pcs	1	
10	Rope made of Poly Propylene (PP) □=8mm	meter	25	
11	Pipe foot locker	pcs	1	
12	Wheel: rim 14 inches (356mm) reinforced by 12mm round bar at 6 points, flat bar 25x3mm,length55/64mm car tire □14" central pipe 1" GI (wall thickness 3 – 3,5mm)10cm length external diameter of the wheel not less than 44cm.	pcs	1	
13	The Axle &Handle 3/4" GI (wall thickness 3 – 3,5mm) with rings of 1¼" GI (wall thickness 3 – 3,5mm) pipe and angle of bending 110º, 27cm+ 23cm+27cm and the outer handling 27cm wall thickness of 3.5 mm is covered by PVC with frictionless bushing and having spacer ring.	pcs	1	
14	Wheel safety cover (shield) made of galvanized sheet 0.6-1mm thickness & bend angle 108º	pcs	1	

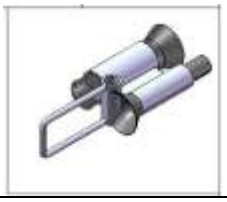
15	PVC gum	tin	1	
16	Cleaner	tin	1	

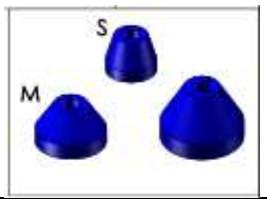
Table 37. Rope and Washer Pump specification & BoQ for a Static water depth of 10-20m (Manual tube well)

Sr No	Item Description	unit	quantity	Picture
1	Rope pump structure ¾" made of GI (wall thickness 3 – 3,5mm) pipe with legs. Painted properly with antirust and finishing blue paint.	Pcs	1	
2	Pipe fitting for pump PVC Elbow 1½"	pcs	1	
	PVC T-Joint 1½"	Pcs	1	
	Reducer from 1½" to ¾"	pcs	1	
3	Guide box for ¾" Rope & Washer Pump with well made PVC flares so that the rope and pistons move freely.	Pcs	1	
4	Reinforced Concrete well cover □=1.2m, 6cm thickness reinforced by 6mm □ round wire with embedded anchor bolt to fit the structure of the pump having one holes for two legs.	pcs	1	
5	Cone shaped Poly Ethylene (PE) Pistons for ¾" pump	pcs	42	
6	Main riser discharge PVC pipe a diameter of ¾"	meter	25	
7	Water discharge PVC pipe a diameter 1½" , L=2 m	pcs	1	
8	Pistón coner □=40 mm, L=2 m	pcs	1	
9	Hole coner / fanal/ flare/	pcs	1	

10	Rope made of Poly Propylene (PP) □=6mm	meter	50	
11	Pipe foot locker	pcs	1	
12	Wheel: rim 14 inches (356mm) reinforced by 12mm round bar at 6 points, flat bar 25x3mm,length55/64mm car tire f14" central pipe 1" GI (wall thickness 3 – 3,5mm)10cm length external diameter of the wheel not less than 44cm.	pcs	1	
13	The Axle &Handle 3/4" GI (wall thickness 3 – 3,5mm) with rings of 1" GI (wall thickness 3 – 3,5mm) pipe and angle of bending 110o, 27cm+ 23cm+27cm and the outer handling 27cm wall thickness of 3.5 mm is covered by PVC with frictionless bushing and having spacer ring.	pcs	1	
14	Wheel safety cover (shield) made of galvanized sheet 0.6-1mm thickness & bend angle 108º	pcs	1	
15	PVC gum	tin	1	
16	Cleaner	tin	1	

Table 38. Rope and Washer Pump specification & BoQ for a Static water depth of 20-35m (Manual tube well)

No Item	Item Description	unit	quantity	Picture
1	Rope pump structure ½"made of GI (wall thickness2.5 – 3,5mm) pipe with legs. Painted properly with antirust and finishing blue paint.	Pcs	1	
2	Pipe fitting for pump PVC Elbow 1"	Pcs	1	
	PVC T-Joint 1"	pcs	1	
	Reducer from ½" to 1"	Pcs	1	
3	Guide box for ½"Rope & Washer Pump with well made PVC flares so that the rope and pistons move freely.	Pcs	1	

4	Reinforced Concrete well cover □=1.2m, 6cm thickness reinforced by 6mm □ round wire with embedded anchor bolt to fit the structure of the pump having one holes for two legs.	Pcs	1	
5	Cone shaped Poly Ethylene (PE) Pistons for ½"pump	pcs	72	
6	Main riser discharge PVC pipe a diameter of ½"	meter	40	
7	Water discharge pipe PVC pipe a diameter of 1", L=2 m	pcs	1	
8	Piston coner □=40 mm, L=2 m	pcs	1	
9	Hole coner funnel	pcs	1	
10	Rope made of Poly Propylene (PP) □=4mm	meter	80	
11	Pipe foot locker welded on the structure	pcs	1	
12	Wheel: rim 14 inches (356mm) reinforced by 12mm round bar at 6 points, flat bar 25x3mm,length55/64mm car tire Diameter 14" central pipe 1" GI (wall thickness 3 – 3,5mm)10cm length external diameter of the wheel not less than 44cm.	pcs	1	
13	The Axle &Handle 3/4" GI (wall thickness 3 – 3,5mm) with rings of 1" GI (wall thickness 3 – 3,5mm) pipe and angle of bending 110o, 27cm+ 23cm+27cm and the outer handling 27cm wall thickness of 3.5 mm is covered by PVC with frictionless bushing and having spacer ring.	pcs	1	
14	Wheel safety cover (shield) made of galvanized sheet 0.6-1mm thickness & bend angle 108^{o}	pcs	1	
15	PVC gum	tin	1	

16	Cleaner	tin	1	

NOTE: For Manual tube well, the Rope and Washer Pump is designed based on the static water depth, while the well depth may deeper than the pump depth.

5.7. Small Engine/Motor Pump

The technical specification and bill of quantity for small engine/ motor pump is described with three different cases such as 2 inch, 3 inch and 4 inch diesel engine driven self-priming centrifugal irrigation water pump.

Table 39. Technical Specification of 2 inch Diesel Engine Driven Self Priming Centrifugal Irrigation Water Pump

Main Technical Parameter and Specification Type	Technical specification	Remark
1. Performance data		
Used to	Irrigation purpose	
Maximum suction head	8 meter	
Maximum head	26 meter	
Discharge	More than 600 Liter /minute	
Self-priming time (s/4m)	70	
Irrigable area	3-5 hectares	
2. Engine		
Type	Single cylinder 4-stroke	
Specific fuel consumption	287/211 Kg/kw/hour	
Compression ratio	20:01	
Con. power	4HP/3 KW	
Cooling system	Forced air cooled	
Engine speed	3000 rpm	
Displacement	211cc	
Bore	70mm	
Stroke	55mm	
Starting system	Recoil starter	
Governor system	Centrifugal wt. system	
Continues working hour	16 hrs	
Filter	Medium- dry type	
Fuel	**Diesel**	
Fuel tank capacity	2.5 Litre	
Lubrication oil capacity	0.75 Litre	

Net Weight	26 Kg	
3. Pump		
Type	Centrifugal pump	
Outlet diameter	2"	
Inlet diameter	2"	
Total head	26-28 meter	
Pump body made of	Cast iron (Al-alloy)	
Dry weight	Less than 40 kg	
Impeller	Special cast iron	
Gear	Direct connection with engine	
Mechanical seal	Carbon-ceramic	
Efficiency	Not less than 60% at the working point	
Capacity	Not less than 36 m^3/hour	
4. Suction Hose		
Type	Rigid and soft reinforced wall pvc	
Internal diameter	2"	
Wall thickness	4 mm	
Length	10 meter	
Working pressure	0.4Mpa	
Burst pressure	0.8 Mpa	
5. Delivery Hose		
Type	Plastic hose type	
Internal diameter	2"	
Wall thickness	1.5 mm	
Length	100 meter	
Working pressure	0.2Mpa	
Burst pressure	0.6 Mpa	
6. Frame		
Type	Mono block 2 support	
Material	Steel	
7.Stander accessories		
Stainless steel strainer	Diameter of 2"	
Inlet and outlet connector	Galvanized steel with thread connection	
Rubber seal washer for 2"		
Hose clamp for 2"		

□ Gasket		
8.Tool box		
□ One set standard basic tools		
□ Medium size flat screw driver tool		
□ Standard wrenches	Original from the manufacture	
9. Operational manual		
10. Brochure		
11. Spare parts catalogue		
12. Required quantity in number		

Table 40. Technical Specification of 3 inch Diesel Engine Driven Self Priming Centrifugal Irrigation Water Pump

Main Technical Parameter and Specification Type	**Technical specification**	**Remark**
1. Performance data		
· Used to	Irrigation purpose	
· Suction head	8 meter	
· Maximum head	25 meter	
· Discharge	More than 1000 Liter /minute	
· Self priming time (s/4m)	120	
· Irrigable area	5-7 hectares	
2. Engine		
· Type	Single cylinder 4-stroke	
· Specific fuel consumption	Less than 280.3/ 206 Kg/kw/hour	
· Compress ratio	20:01	
· Con. power	5.5HP/4KW	
· Cooling system	Forced air cooled	
· Engine speed	3000 rpm	
· Displacement	296 cc	
· Bore	78mm	
· Stroke	62mm	
· Starting system	Recoil starter	
· Governor system	Centrifugal wt. system	
· Continues working hour	16 hrs	
· Filter	Medium- dry type	
· Fuel	**Diesel**	
· Fuel tank capacity	3.5 Litre	

· Lubrication oil capacity	1.1Litre	
· Net Weight	33 Kg	
3. Pump		
· Type	Centrifugal pump	
· Outlet diameter	80mm (3")	
· Inlet diameter	80mm (3")	
· Total head	25-27 meter	
· Pump body made of	Cast iron (Al-alloy)	
· Dry weight	Less than 50 kg	
· Impeller	Special cast iron	
· Gear	Direct connection with engine	
· Mechanical seal	Carbon-ceramic	
· Efficiency	Not less than 60% at the working point	
· Capacity	Not less than 60 m^3/hour	
4. Suction Hose		
· Type	Rigid and soft reinforced wall pvc	
· Internal diameter	80mm (3")	
· Wall thickness	4 mm	
· Length	10 meter	
· Working pressure	0.6Mpa	
· Burst pressure	1.2 Mpa	
5. Delivery Hose		
· Type	Plastic hose type	
· Internal diameter	80mm (3")	
· Wall thickness	1.5 mm	
· Length	100 meter	
· Working pressure	0.3Mpa	
· Burst pressure	0.9 Mpa	
6. Frame		
· Type	Mono block 2 support	
· Material	Steel	
7.Stander accessories		
· Stainless steel strainer	With diameter of 3"	
· Inlet and outlet connector	Galvanized steel with thread connection	
· Rubber seal washer for 3"		

· Hose clamp for 3"		
· Gasket		
8.Tool box		
· One set standard basic tools		
· Medium size flat screw driver tool		
· Standard wrenches	Original from the manufacture	
9. Operational manual		
10. Brochure		
11. Spare parts catalogue		
12. Required quantity in number		

Table 41. Technical Specification of 4 inch Diesel Engine Driven Self Priming Centrifugal Irrigation Water Pump

Main Technical Parameter and Specification Type	Technical specification	Remark
1. Performance data		
· Used to	Irrigation purpose	
· Suction head	8 meter	
· Maximum head	31 meter	
· Discharge	More than1600 Liter/minute	
· Self priming time (s/4m)	180	
· Irrigable area	9-11 hectares	
2. Engine		
· Type	Single cylinder 4-stroke	
· Specific fuel consumption	Less than 273.5/ 201 Kg/kw/hour	
· Compress ratio	20:01	
· Con. power	9HP/6KW	
· Cooling system	Forced air cooled	
· Engine speed	3000 rpm	
· Displacement	406 cc	
· Bore	86mm	
· Stroke	70mm	
· Starting system	Recoil starter	
· Governor system	Centrifugal wt. system	
· Continues working hour	16 hrs	
· Filter	Medium- dry type	
· Fuel	**Diesel**	
· Fuel tank capacity	5.5 Liter	

· Lubrication oil capacity	1.65Litre	
· Net Weight	48 Kg	
3. Pump		
· Type	Centrifugal pump	
· Outlet diameter	4"	
· Inlet diameter	4"	
· Total head	31-33 meter	
· Pump body made of	Cast iron (Al-alloy)	
· Dry weight	Less than 70 kg	
· Impeller	Special cast iron	
· Gear	Direct connection with engine	
· Mechanical seal	Carbon-ceramic	
· Efficiency	Not less than 60% at the working point	
· Capacity	Not less than 96 m3/hour	
4. Suction Hose		
· Type	Rigid and soft reinforced wall pvc	
· Internal diameter	4"	
· Wall thickness	5 mm	
· Length	10 meter	
· Working pressure	0.8Mpa	
· Burst pressure	1.6 Mpa	
5. Delivery Hose		
· Type	Plastic hose type	
· Internal diameter	4"	
· Wall thickness	2 mm	
· Length	100 meter	
· Working pressure	0.4Mpa	
· Burst pressure	1.2 Mpa	
6. Frame		
· Type	Mono block 2 support	
· Material	Steel	
7.Stander accessories		
· Stainless steel strainer	With diameter of 4"	
· Inlet and outlet connector	Galvanized steel with thread connection	
· Rubber seal washer for 4"		
· Hose clamp for 4"		
· Gasket		

8.Tool box		
· One set standard basic tools		
· Medium size flat screw driver tool		
· Standard wrenches	Original from the manufacture	
9. Operational manual		
10. Brochure		
11. Spare parts catalogue		
12. Required amount in number		

5.8. Solar Water Pump

This solar pump bill of quantity and specification is prepared taken to account for shallow ground for 20m depth and the proposed pump type is submersible solar pump with sunshine hour of 5-6hrs. The size of the land supposed to be irrigated by solar pump ranges from 0.025 to 10 hectares.

Table 42. Specification and bill of quantity for 0.025 ha to 1ha

Bill of quantity for solar pump irrigation purpose									
No	**Description**	**Size of Land (M^2)**							**Remark**
		Unit	**250**	**500**	**1000**	**2500**	**5000**	**10000**	
1	PV panel array, poly crystalline (300 watt of each panel)	pcs	1	1	1	2	3	5	
2	Inverter	Kw	1	1	1	1	1	2	
3	Mounting structure for given PV panels, double coated with fixing accessories complete	LS	1	1	1	1	1	1	
4	Charge controller,	Kw	1	1	1	1	1	2	
5	1 Day battery, Deep Cycle type, 2V, 200Ah	pcs	1	1	1	2	2	4	
6	Battery rack, double coated	LS	1	1	1	1	1	1	
7	Schematic drawing details about PV system ,solar size , pump discharge VS Head (there should be details for materials proposed by the bidder)	LS							
	7.1) Details about PV system ,solar size , pump discharge VS Head								

	7.2) Distribution board size , surface mount with lockable door LPP-G, with 1pc X * XX Amp circuit breaker and X pcs X * XX Amp circuit breakers								
	7.3) Power cable X * XX from solar to Pump , Home and for solar power source installation								
	7.4) DC Disconnect								
	7.5) AC Disconnect								
	7.6) Battery room lay out / cover								
	7.7) Battery cable lay out (serious ,parrellel connections) , cable size								
	7.8) Inverter connection if applicable								
	7.9) Charge controller connection if applicable								

Table 43. Specification and bill of quantity for 2 to 7ha

N0	Description	Unit	Size of Land (M2)					
			20000	30000	40000	50000	60000	70000
1	PV panel array, polycristalline (300 watt of each panel)	pcs	7.00	11.00	14.00	18.00	21.00	24.00
2	Inverter	Kw	3.00	4.00	5.00	6.00	7.00	8.00
3	Mounting structure for given PV panels, double coated with fixing accessories complete	LS	1.00	1.00	1.00	1.00	1.00	1.00
4	Charge controller,	Kw	3.00	4.00	5.00	6.00	7.00	8.00
5	1 Day battery, Deep Cycle type, 2V, 200Ah	pcs	5.00	6.00	9.00	11.00	15.00	17.00
6	Battery rack, double coated	LS	1.00	1.00	1.00	1.00	1.00	1.00
7	Schematic drawing details about PV system ,solar size , pump discharge VS Head (there should be details for materials proposed by the bidder)	LS						
	7.1) Details about PV system ,solar size , pump discharge VS Head							
	7.2) Distribution board size , surface mount with lockable door LPP-G, with							

	1pc X * XX Amp circuit breaker and X pcs X * XX Amp circuit breakers							
	7.3) Power cable X * XX from solar to Pump , Home and for solar power source installation							
	7.4) DC Disconnect							
	7.5) AC Disconnect							
	7.6) Battery room lay out / cover							
	7.7) Battery cable lay out (serious ,parallel connections) , cable size							
	7.8) Inverter connection if applicable							
	7.9) Charge controller connection if applicable							

Table 44.Specification and bill of quantity for 8 to 10ha

N0	**Description**	**Size of Land (M^2)**			
		Unit	**80000**	**90000**	**100000**
1	PV panel array, polycristalline (300 watt of each panel)	pcs	29.00	32.00	36.00
2	Inverter	Kw	10.00	11.00	12.00
3	Mounting structure for given PV panels, double coated with fixing accessories complete	LS	1.00	1.00	1.00
4	Charge controller,	Kw	10.00	11.00	12.00
5	1 Day battery, Deep Cycle type, 2V, 200Ah	pcs	13.00	15.00	17.00
6	Battery rack, double coated	LS	1.00	1.00	1.00
7	Schematic drawing details about PV system ,solar size , pump discharge VS Head (there should be details for materials proposed by the bidder)	LS			
	7.1) Details about PV system ,solar size , pump discharge VS Head				
	7.2) Distribution board size , surface mount with lockable door LPP-G, with 1pc X * XX Amp circuit breaker and X pcs X * XX Amp circuit breakers				
	7.3) Power cable X * XX from solar to Pump , Home and for solar power source installation				
	7.4) DC Disconnect				
	7.5) AC Disconnect				
	7.6) Battery room lay out / cover				
	7.7) Battery cable lay out (serious ,parallel connections) , cable size				

	7.8) Inverter connection if applicable				
	7.9) Charge controller connection if applicable				

The following table is sample of detail technical specification of photovoltaic modules, combiner box: system over current protection, mounting structure, invertors, submersible centrifugal units, surface pump working with solar energy, gelley deep cycled batteries and ranking for 0.025 ha to 1ha. Similar table has to be prepared for other size of land up to 10 ha, but not included in this section.

Table 45. Specification and bill of quantity of photovoltaic modules, combiner boxes and rancking.

S.No	Description	Unit	Quantity						Remark
1.1	**PHOTOVOLTAIC MODULES:**								
	Numbers of solar panel if 300watt solar panel used	#	1	1	1	2	3	5	
	1.Compatibility:								
	a. Ensure components and materials are compatible with specified accessories and adjacent materials.								
	B. Module Performance at STC:								
	1. Minimum Power (Pmax):		156.45	190.41	216.1	393.24	705.76	1325.76	
	2. Minimum Module Efficiency:		15	15	15	15	15	15	
	3.Tolerance:		Minus 0 to plus 5	Minus 0 to plus 5	Minus 0 to plus 5	Minus 0 to plus 5	Minus 0 to plus 5	Minus 0 to plus 5	
	4. NOCT:		47.5	47.5	47.5	47.5	47.5	47.5	
	5. Maximum Series Fuse Rating:		not calculated	not calculated	not calculated	not calculated	not calculated	not calcula	
	6. Application Class,.		IEC 61730: Class A	IEC 61730: Class A	IEC 61730: Class A	IEC 61730: Class A	IEC 61730: Class A	IEC 61730: Class A	
	7. Maximum System								

	Voltage:								
	a. NEC Rating: .		600 V	600V	600V	600V	600V	600V	
	b. IEC Rating: .		1000V	1000V	1000V	1000V	1000V	1000V	
	C. Output cables:		12 AWG MC-4 connectors	12 AWG MC-4 connectors	12 AWG MC-4 connectors	12 AWG MC-4 connectors	12 AWG MC-4 connectors	12 AWG MC-4 connectors	

1.2	Combiner Box: SYSTEM OVERCURRENT PROTECTION	Pcs	1	1	1	1	1	1	
	1.Fuses: xx A		Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	
	2.Number of inputs (positive and negative): xx		Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	
	3.Number of outputs (positive and negative): xx		Calculated	Calculated	Calculated	Calculated	Calculated	Calculated	
	4.Cable size range: 4 – 6 AWG								
	5.Enclosure type: NEMA 3R								
1.3	Mounting structure	Pcs							
	A. Roof mounting racks shall be provided and installed as shown in the provided drawings.								
	1. Roof/surface based mounting structure.		√	√	√	√	√	√	
	2. 2 modules high, in portrait orientation		√	√	√	√	√	√	
	3.15 degree tilt to South		√	√	√	√	√	√	
	4. Bottom-mount module mounting		√	√	√	√	√	√	
	5. A minimum module clearance of 20cm		√	√	√	√	√	√	
	B.All structure shall be galvanized steel/aluminum. Posts and Top Chords are hot dipped to ASTM A123, purlins are pre-galvanized to a G140 minimum and brackets to a G90 minimum.		√	√	√	√	√	√	

	Module hardware is stainless steel and all other hardware is hot dipped galvanized.								
	A. PV modules and mounting systems shall be installed as shown in the provided site drawings								
	B.Flat-Roof or surface Mounting structure:								
	1. No roof penetrations for roof mounting		√	√	√	√	√	√	
	2. Self-ballasting.		√	√	√	√	√	√	
	3. Wind-tunnel tested to 100-km/h wind.		√	√	√	√	√	√	
	4.Service Life: xx years.		25	25	25	25	25	25	
	5. Freestanding system.		√	√	√	√	√	√	
	6. Dimensional tolerance for side-by-side solar modules up and down the rack shall be no greater than 0.5% of their stated width or length.		√	√	√	√	√	√	
	C.Accurately fit, align, securely fasten and install free from distortion or defects.		√	√	√	√	√	√	
1.4	CHARGE CONTROLLERS								
	A.Description:								
	1. Compatibility: Ensure components and materials are compatible with specified accessories and adjacent materials.		√	√	√	√	√	√	
	2. Design/components:								
	a. Integrated DC disconnect								
	B. Performance Criteria: xxkW Unit:		196.25	238.8	271	492.5	882.5	1658	
	1. DC input electrical characteristics:								
	a. Minimum DC power: xx W		196.25	238.8	271	492.5	882.5	1658	
	b. Number of inputs:		1	1	1	1	1	1	

	2. DC output electrical characteristics:								
	a.Rated input voltage: xx V		48	48	48	48	48	48	
	b.DC voltage range: xx V – xx V		41-63	41-63	41-63	41-63	41-63	41-63	
	c. Battery compatibility:		Lead acid	Lead acid	Lead acid	Lead acid	Lead acid	Lead acid	
	3. Protective devices:								
	a. DC reverse polarity protection		√	√	√	√	√	√	
	b. DC fuse		√	√	√	√	√	√	
	c. AC short-circuit		√	√	√	√	√	√	
	d. AC overload		√	√	√	√	√	√	
	e. Over temperature		√	√	√	√	√	√	
	f. Battery deep discharge		√	√	√	√	√	√	
	4. Maximum efficiency:		96%	96%	96%	96%	96%	96%	
	5. Operating Conditions:								
	a. Operating temperature range:		-25C to 60C	-25C to 60C	-25C to 60C	-25C to 60C	-25C to 60C	-25C to 60C	
	6. Features:								
	a. Charging:								
	1) State of charge calculation		√	√	√	√	√	√	
	2) Full charge		√	√	√	√	√	√	
	3) Equalization charge		√	√	√	√	√	√	
	b. Battery temperature sensor		√	√	√	√	√	√	
	c. Data cable		√	√	√	√	√	√	
1.5	INVERTERS								
	A. Description:								
	1. Compatibility: Ensure components and materials are compatible with specified accessories and adjacent materials.		√	√	√	√	√	√	
	2. Design/components:								

	a. Transformerless design		√	√	√	√	√	√	
	B. Design Criteria:								
	1. Certified in accordance with UL 1998		√	√	√	√	√	√	
	2. Certified in accordance with UL 1699B		√	√	√	√	√	√	
	3. Certified in accordance with IEEE1547		√	√	√	√	√	√	
	C. Performance Criteria: xxW Units:		196.25	238.8	271	492.5	882.5	1658	
	1. DC power characteristics:								
	a. Maximum DC power: xx W		196.25	238.8	271	492.5	882.5	1658	
	b. Rated input voltage: xx V		48	48	48	48	48	48	
	c. Number of inputs:		1	1	1	1	1	1	
	2. AC power characteristics								
	a. Rated AC power: x W / x VA		197	239	272	493	883	1658	
	b. Phases:		1-phase	1-phase	1-phase	1 or 3 - phase	1 or 3-phase	1 or 3 - phase	
	c. Nominal voltage: xx V		220 V	220 V	220 V	220 or 380 V	220 or 380 V	220 or 380 V	
	d. Frequency:		50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	
	e. Pure sine wave output		√	√	√	√	√	√	
	3. Protective devices:								
	a. DC reverse polarity protection		√	√	√	√	√	√	
	b. AC short-circuit current capability		√	√	√	√	√	√	
	c. All-pole-sensitive residual-current monitoring unit		√	√	√	√	√	√	
	d. Arc-fault circuit interrupter		√	√	√	√	√	√	
	4. Minimum efficiency:		90%	90%	90%	90%	90%	90%	

	5. Operating Conditions:								
	a. Operating temperature range:		-25C to 60C	-25C to 60C	-25C to 60C	-25C to 60C	-25C to 60C	-25C to 60C	
	b. Relative Humidity:		100 %	100%	100%	100%	100%	100%	
1.6	SUBMERSIBLE CENTRIFUGAL UNITS								
	A. Pump Type								
	1. Pumping units shall be single stage, vertical centrifugal type, suitable for service as specified and powered by solar energy		√	√	√	√	√	√	
	B. Rating Data								
	1. No. required: One at each site								
	2. Location: Various as indicated in SECTION 011000								
	3. Single Pump Operation								
	4. Capacity at rated head,	l/sec *	0.0964	0.193	0.39	0.7416	1.205	2.41	
	5. Rated head, TDH, m. of water: depending on site specific requirements*	M	23	23	25	25	30	30	
	6. Shut-off head, min.: in meter higher than the submersible pump level	m	0.5	0.5	0.5	0.5	0.5	0.5	
	7. Discharge dia., inches (min.):	inches/ mm	1 inches/ 25 mm	1 inches/ 25 mm	1 inches/ 25 mm	2 inches/50 mm	2 inches/50 mm	2 inches/50 mm	
	8. Type:		Submersible	Submersible	Submersible	Submersible	Submersible	Submersible	
	9. Enclosure Class	IP 68	IP 68	IP 68	IP 68	IP 68	IP 68	IP 68	
	10. Drive control	Manual/Auto	Manual/Auto	Manual/ Auto	Manual/Auto	Manual/ Auto	Manual/ Auto	Manual/ Auto	

	*Actual head conditions to be refined post pump test, when static and drawdown conditions have been determined								
	1.2 Submersible pump motor								
	A. The motor has been developed specifically for the pumping system and is designed according to the permanent-magnet principle with built-in electronic unit. The motor shall have a diameter of 3"								
	B. The motor shall include the following								
	1. Maximum power input of in Watt		W	54.32	118.1	227.1	443	885.7	
	2. Maximum current in A		A	0.31	0.67	1.29	2.52	5.03	
	3. Maximum speed of in rpm,		rpm	3600	3600	3600	3600	3600	
	4.The pump delivers its maximum performance when one of the above limitations is reached.								
	5. The motor shall operate at a flexible power supply and power range, and the motor can be supplied with either DC or AC voltage.								
	6. 30-300 VDC, PE								
	7. 1 x 90-240 V - 10 %/+ 6 %, 50/60 Hz, PE.								
	8. The pump shall be protected against dry running in order to prevent damage to the pump. The dry-running protection is activated by a water level electrode placed on the motor cable 0.3 - 0.6 m above the pump, depending on pump type.								
	9. The water level electrode measures the contact resistance to the motor sleeve through the water. When the water level falls below the water level electrode, the pump will be cut out. The pump will automatically cut in again 5 minutes after the water level is above the water level electrode.								
	10. The pump will be cut out if the voltage falls outside the permissible voltage range. The motor is automatically cut in when the voltage is again within the permissible voltage range.								
	11. In case the upper load limit is exceeded, the motor will automatically compensate for this by reducing the speed. If the speed falls below 500 rpm, the motor will be cut out automatically. The motor will remain cut out for 30 seconds after which period the pump will automatically attempt to restart.								
	12. The pumping system shall be capable of operating in a horizontal position.								
	13. The pump motor shall be equipped with a built-in temperature sensor. When the temperature rises above +85 °C, the motor is automatically cut out. When the temperature has dropped to +75 °C, the motor is automatically cut in again.								
1.7	**Surface pump working with solar energy(photo voltaic modules) and has :**								
	pump performance								
	Pumping hour		1	1	2	3	5		
	Minimum total head[m]		5	5	5	5	5		
	Minimum suction head[m]		4	5	6	7	8		

	Minimum flow rate[lps]		12	12	12	24	24	
	Shaft power		5.21	5.21	5.21	5.21	5.21	
	Pump efficiency		>80%	>80%	>80%	>80%	>80%	
	AC electric motor							
	Mounting designation		NEMA	NEMA	NEMA	NEMA	NEMA	
	Insulation class		F	F	F	F	F	
	Efficiency class*		For this specific motor power	For this specific motor power	For this specific motor power	For this specific motor power	For this specific motor power	For this specific motor power
	Enclosure class		TEFC - Totally Enclosed Fan Cooled	TEFC - Totally Enclosed Fan Cooled	TEFC - Totally Enclosed Fan Cooled	TEFC - Totally Enclosed Fan Cooled	TEFC - Totally Enclosed Fan Cooled	
	50 Hz standard voltages		2 x 220/208-230 V	3 x 220/208-230 V	4 x 220/208-230 V	5 x 220/208-230 V	6 x 220/208-230 V	
	RPM							
	Motor Power		0.6611	0.75033	1.365	2.45	4.60334	
	Motor efficiency		>95%	>95%	>95%	>95%	>95%	
1.8	1.1 GELLEY DEEP CYCLED BATTERIES							
	A. Total Quantities:							
	1.12V batteries with a minimum 100 Amp-hour Capacity at a 5-hour discharge rate.		1	1	2	2	4	
	1.2 ACCESSORIES							
	A. Connectors: Each battery system shall include the necessary inter-cell and inter-module connectors and terminal plates. The connectors shall be lead-tin plated copper and shall include stainless steel hardware							
	B. Module lifting straps							
	C. Anti-oxidation grease							
	D. Material Safety Data Sheets							
	E. Each module shall include an easily removable, transparent safety shield to cover all electrical connections.							
	A. Anchoring: Battery racking systems shall be anchored to the battery room floor as specified by the manufacturer							
	B. Connections							
	1. Post Preparation: The terminal posts of each battery are to be scoured to ensure the lowest resistance. The anti-oxidation grease supplied by the manufacturer shall be applied to all terminal mating surfaces in the manner specified by the manufacturer's installation instructions							
	2.2. Field tests							

	A.Commissioning: Batteries shall be given and initial full charge as part of the overall system commissioning.

5.9. Low Head Family Drip Irrigation

The specification and bill of quantity for low head family drip irrigation is prepared for the size of an area 250 m^2, 500 m^2, 1000 m^2, 2000 m^2, 2500 m^2, 5000 m^2 (0.5 ha) and 10000 m^2 (1ha). The type of system considered in this drip irrigation is gravity feed from header water tank.

Case 1: For Field size (25mx10m) = 250 m^2

- Length of manifold = 25 m
- Length of lateral = 10 m
- Spacing of laterals on manifold = 0.5m & 1.0 m
- Number of laterals = 51 & 26 at spacing of 0.5m & 1.0 m respectively
- Emitter discharge = 2 to 2.8 lph
- Emitter spacing on the laterals = 0.3 m
- Type of system = gravity fed system from header water tank

Table 46. Specification and BoQ for 250 m2 plot size* (Case 1)

S.No.	Item along with description & specification	Unit	Quantity for a given lateral spacing		Remark
			0.5m	1.0m	
1	Water tanker (Rotto) 500 liter with drain plug & hole punched for drain outlet. The water tank should be made from material which protect UV radiation for longer life & black in colour	Pcs	1	1	
2	Nipples (Drain Outlet) 3/4'' male threads on both sides made of brass or polypropylene (PP), PN 6 bars	Pcs	1	1	
3	Ball Valve 3/4'' female thread on both sides made of polypropylene (PP) or brass, PN 6 bars	Pcs	3	3	*
4	Screen or Disc Filter 3/4', male thread on sides, 130 micron/120 meshes, PN 6 bars. It can be made of either plastic or galvanized metal with epoxy cover & anti-corrosion painting (The inlet & outlet are at 180 degrees and the filter body is inclined)	Pcs	1	1	
5	Elbow 90° female 25mm x 3/4" compression type fitting made of polypropylene (PP), PN 6 bars	Pcs	1	1	

6	Black HDPE Riser pipe/mainline 25mm OD, 1.8-2.3 mm wall thickness, PN 4 bars	m	10	10	**
7	Tee 25mm x 25mm x 25mm OD equal female compression made of polypropylene (PP), PN 6 bars	m	1	1	
8	Submain/Manifold black HDPE pipe 25mm OD, 1.8-2.3 mm wall thickness, PN 4 bars	m	25	25	
9	End cap 25mm compression made of polypropylene, PN 6 bars	Pcs	2	2	
10	Off take with grommet 16mm to connect lateral with the sub-main, made of polypropylene (PP)	Pcs	51	26	***
11	Black LDPE Drip Lateral/Drip line 16mm OD, 1-1.2 mm wall thickness and PN 4 bars with inline dripper made from high quality plastic material at spacing of 30 cm with a 2-2.8 lph flow rate at 1 bar or 1-1.2 lph at 2m	m	510	260	***
12	Line end 16mm OD made of polypropylene or equivalent plastic material	Pcs	51	26	
13	Straight connector barbed 16mm to connect the same size lateral pipes	Pcs	10	10	****

NB: The layouts of drip system vary from place to place depending on the topography and layout of the field. Accordingly the types, quantity & size of the components required for the drip system can be different from the given figure for the same plot size. Two additional ball valves are used to divide the system in two in conjunction with T-joint so that the area is divided in two for operation. The length of the riser/mainline pipe could be varying depending on the height of the header tank and relative distance of the water tank from the manifold. Additional 10% can be included in the BoQ for laterals, off take with grommet and other item for reserve as deemed necessary. Straight connector included in BoQ is supposed to be used if there is damage on the drip line/maintenance. Tools required for installation include cutter, puncher, inserter, pipe wrench and teflon.

Case 2: For Field size (25mx20m) = 500 m^2

- Length of manifold = 25 m
- Length of lateral = 20 m
- Spacing of laterals on manifold = 0.5m & 1.0 m
- Number of laterals = 51 & 26 at spacing of 0.5m & 1.0 m respectively

- Emitter discharge = 2 to 2.8 lph
- Emitter spacing on the laterals = 0.3 m
- Type of system = gravity fed system from header water tank

Table 47. Specification and BoQ for 500 m^2 plot size* (Case 2)

S.No.	Item along with description & specification	Unit	Quantity for a given lateral spacing		Remark
			0.5m	1.0m	
1	Water tanker (Rotto) 1000 liter with drain plug & hole punched for drain outlet. The water tank should be made from material which protect UV radiation for longer life & black in colour	Pcs	1	1	
2	Nipples (Drain Outlet) 3/4'' male threads on both sides made of brass or polypropylene (PP), PN 6 bars	Pcs	1	1	
3	Ball Valve 3/4'' female thread on both sides made of polypropylene (PP) or brass, PN 6 bars	Pcs	3	3	**
4	Screen or Disc Filter 3/4', male thread on both sides, 130 micron/120 mesh, PN 6 bars. It can be made of either plastic or galvanized metal with epoxy cover & anti-corrosion painting (The inlet & outlet are at 180 degrees and the filter body is inclined)	Pcs	1	1	
5	Elbow 90° female 25mm x 3/4" compression type fitting made of polypropylene (PP), PN 6 bars	Pcs	1	1	
6	Black HDPE Riser pipe/mainline 25mm OD, 1.8-2.3 mm wall thickness, PN 4 bar	m	10	10	***
7	Tee 25mm x 25mm x 25mm OD equal female compression made of polypropylene (PP), PN 6 bars	m	1	1	
8	Submain/Manifold black HDPE pipe 25mm OD, 1.8-2.3 mm wall thickness, PN 4 bars	m	25	25	
9	End cap 25mm compression made of polypropylene, PN 6 bars	Pcs	2	2	

10	Off take with grommet 16mm to connect lateral with the submain, made of polypropylene (PP)	Pcs	51	26	****
11	Black LDPE Drip Lateral/Drip line 16mm OD, 1-1.2 mm wall thickness and PN 4 bars with inline dripper made from high quality plastic material at spacing of 30 cm with a 2-2.8 lph flow rate at 1 bar or 1-1.2 lph at 2m	m	1020	520	****
12	Line end 16mm OD made of polypropylene or equivalent plastic material	Pcs	51	26	
13	Straight connector barbed 16mm to connect the same size lateral pipes	Pcs	10	10	*****

NB: The layouts of drip system vary from place to place depending on the topography and layout of the field. Accordingly the types, quantity & size of the components required for the drip system can be different from the given figure for the same plot size. Two additional ball valves are used to divide the system in two in conjunction with T-joint so that the area is divided in two for operation. The length of the riser/mainline pipe could be varying depending on the height of the header tank and relative distance of the water tank from the manifold. Additional 10% can be included in the BoQ for laterals, off take with grommet and other item for reserve as deemed necessary. Straight connector included in BoQ is supposed to be used if there is damage on the drip line/maintenance. Tools required for installation include cutter, puncher, inserter, pipe wrench and teflon.

Case 3: For Field size (40mx25m) = 1000 m^2

- Length of manifold = 40 m
- Length of lateral = 25 m
- Spacing of laterals on manifold = 0.5m & 1.0m
- Number of laterals = 81 & 41 at spacing of 0.5m and 1m respectively
- Emitter discharge = 2 to 2.8 lph
- Emitter spacing on the laterals = 0.3m
- Type of system = gravity fed system from header water tank

Table 48. Specification and BoQ for 1000 m2 plot size* (Case 3)

S.No.	Item along with description & specification	Unit	Quantity for a given lateral	Remark

			spacing		
			0.5m	1.0m	
1	Water tanker (Rotto) 2000 liter with drain plug & hole punched for drain outlet. The water tank should be made from material which protect UV radiation for longer life & black in colour	Pcs	1	1	
2	Nipples (Drain Outlet) 1'' male threads on both sides made of brass or polypropylene (PP), PN 6 bars	Pcs	1	1	
3	Ball Valve 1'' female thread on both sides made of polypropylene (PP) or brass, PN 6 bars	Pcs	3	3	**
4	Screen or Disc Filter 1', male thread on sides, 130 micron/120 meshes, PN 6 bars. It can be made of either plastic or galvanized metal with epoxy cover & anti-corrosion painting (The inlet & outlet are at 180 degrees and the filter body is inclined)	Pcs	1	1	
5	Elbow 90° female 32mm x 1" compression type fitting made from polypropylene (PP), PN 6 bars	Pcs	1	1	
6	Black HDPE Riser pipe/mainline 32mm OD, 2-3.5 mm wall thickness, PN 4 bar	m	10	10	***
7	Tee 32mm x 32mm x 32mm OD equal female compression made of polypropylene (PP), PN 6 bars	m	1	1	
8	Submain/Manifold black HDPE pipe 32mm OD, 2-3.5 mm wall thickness, PN 4 bars	m	40	40	
9	End cap 32mm compression made from polypropylene, PN 6 bars	Pcs	2	2	
10	Off take with grommet 16mm to connect lateral with the submain, made from polypropylene (PP)	Pcs	81	41	****
11	Black LDPE Drip Lateral/Drip line 16mm OD, 1-1.2 mm wall thickness and PN 4 bars with inline dripper made from high quality plastic material at spacing of 30 cm with a 2-2.8 lph	m	2025	1025	****

	flow rate at 1 bar or 1-1.2 lph at 2m				
12	Line end 16mm OD made of polypropylene or equivalent plastic material	Pcs	81	41	
13	Straight connector barbed 16mm to connect the same size lateral pipes	Pcs	10	10	*****

NB: The layouts of drip system vary from place to place depending on the topography and layout of the field. Accordingly the types, quantity & size of the components required for the drip system can be different from the given figure for the same plot size. Two additional ball valves are used to divide the system in two in conjunction with T-joint so that the area is divided in two for operation. The length of the riser/mainline pipe could be varying depending on the height of the header tank and relative distance of the water tank from the manifold. Additional 10% can be included in the BoQ for laterals, off take with grommet and other item for reserve as deemed necessary. Straight connector included in BoQ is supposed to be used if there is damage on the drip line/maintenance. Tools required for installation include cutter, puncher, inserter, pipe wrench and teflon.

Case 4: Field size (50mx40m) = 2000 m^2

- Length of manifold = 50 m
- Length of lateral = 40 m
- Spacing of laterals on manifold = 0.5m & 1.0 m
- Number of laterals = 101 & 51 at spacing of 0.5m & 1.0 m respectively
- Emitter discharge = 2 to 2.8 lph
- Emitter spacing on the laterals = 0.3 m
- Type of system = gravity fed system from header water tank

Table 49. Specification and BoQ for 2000 m^2 plot size*(Case 4)

S.No.	**Item along with description & specification**	**Unit**	**Quantity for a given lateral spacing**		**Remark**
			0.5m	1.0m	
1	Water tanker (Rotto) 3000 liter with drain plug & hole punched for drain outlet. The water tank should be made from material which protect UV radiation for longer life & preferably black in colour	Pcs	1	1	

2	Nipples (Drain Outlet) 2'' male threads on both sides made of brass or polypropylene (PP), PN 6 bars	Pcs	1	1	
3	Ball Valve 2'' female thread on both sides made of polypropylene (PP) or brass, PN 6 bars	Pcs	3	3	**
4	Screen or Disc Filter 2", male thread on sides, 130 micron/120 mesh, PN 6 bars. It can be made of either plastic or galvanized metal with epoxy cover & anti-corrosion painting (The inlet & outlet are at 180 degrees and the filter body is inclined)	Pcs	1	1	
5	Elbow 90° female 50mm x 2" compression type fitting made from polypropylene (PP), PN 6 bars	Pcs	1	1	
6	Black HDPE Riser pipe/mainline 50mm OD, 2-3.5 mm wall thickness, PN 4 bar	m	10	10	***
7	Tee 50mm x 50mm x 50mm OD equal female compression made of polypropylene (PP), PN 6 bars	m	1	1	
8	Submain/Manifold black HDPE pipe 50mm OD, 2-3.5 mm wall thickness, PN 4 bars	m	50	50	
9	End cap 50mm compression made of polypropylene, PN 6 bars	Pcs	2	2	
10	Off take with grommet 16mm to connect lateral with the submain, made from polypropylene (PP)	Pcs	101	51	****
11	Black LDPE Drip Lateral/Drip line 16mm OD, 1-1.2 mm wall thickness and PN 4 bars with inline dripper made from high quality plastic material at spacing of 30 cm with a 2-2.8 lph flow rate at 1 bar or 1-1.2 lph at 2m	m	4040	2040	****
12	Line end 16mm OD made of polypropylene or equivalent plastic material	Pcs	101	51	
13	Straight connector barbed 16mm to connect the same size lateral pipes	Pcs	10	10	*****

NB: The layouts of drip system vary from place to place depending on the topography and layout of the field. Accordingly the types, quantity & size of the components required for the drip

system can be different from the given figure for the same plot size. Two additional ball valves are used to divide the system in two in conjunction with T-joint so that the area is divided in two for operation. The length of the riser/mainline pipe could be varying depending on the height of the header tank and relative distance of the water tank from the manifold. Additional 10% can be included in the BoQ for laterals, off take with grommet and other item for reserve as deemed necessary. Straight connector included in BoQ is supposed to be used if there is damage on the drip line/maintenance. Tools required for installation include cutter, puncher, inserter, pipe wrench and teflon.

Case 5: Field size (50mx50m) = 2500 m^2

- Length of manifold = 50 m
- Length of lateral = 50 m
- Spacing of laterals on manifold = 0.5m & 1.0 m
- Number of laterals = 101,& 51 at spacing of 0.5m & 1.0 m respectively
- Emitter discharge = 2 to 2.8 lph
- Emitter spacing on the laterals = 0.3 m
- Type of system = gravity fed system from header water tank

Table 50. Specification and BoQ for 2500 m^2 plot size* (Case 5)

S.No.	Item along with description & specification	Unit	Quantity for a given lateral spacing		Remark
			0.5m	1.0m	
1	Water tanker (Rotto) 3000 liter with drain plug & hole punched for drain outlet. The water tank should be made from material which protect UV radiation for longer life & preferably black in colour	Pcs	1	1	
2	Nipples (Drain Outlet) 2'' male threads on both sides made of brass or polypropylene (PP), PN 6 bars	Pcs	1	1	
3	Ball Valve 2'' female thread on both sides made of polypropylene (PP) or brass, PN 6 bars	Pcs	3	3	
4	Screen or Disc Filter 2", male thread on sides, 130 micron/120 mesh, PN 6 bars. It can be made of either plastic or galvanized metal with	Pcs	1	1	

	epoxy cover & anti-corrosion painting (The inlet & outlet are at 180 degrees and the filter body is inclined)				
5	Elbow 90° female 63mm x 2" compression type fitting made of polypropylene (PP), PN 6 bars	Pcs	1	1	
6	Black HDPE Riser pipe/mainline 63mm OD, 2.4-3 mm wall thickness, PN 4 bar	m	10	10	**
7	Tee 63mm x 63mm x 63mm OD equal female compression made of polypropylene (PP), 6 bars	m	1	1	
8	Submain/Manifold black HDPE pipe 63mm OD, 2.4-3 mm wall thickness, PN 4 bars	m	50	50	
9	End cap 63mm compression made of polypropylene, PN 6 bars	Pcs	2	2	
10	Off take with grommet 16mm to connect lateral with the submain, made from polypropylene (PP)	Pcs	101	51	***
11	Black LDPE Drip Lateral/Drip line 16mm OD, 1-1.2 mm wall thickness and PN 4 bars with inline dripper made from high quality plastic material at spacing of 30 cm with a 2-2.8 lph flow rate at 1 bar or 1-1.2 lph at 2m	m	4040	2040	***
12	Line end 16mm OD made of polypropylene or equivalent plastic material	Pcs	101	51	
13	Straight connector barbed 16mm to connect the same size lateral pipes	Pcs	10	10	****

NB: The layouts of drip system vary from place to place depending on the topography and layout of the field. Accordingly the types, quantity & size of the components required for the drip system can be different from the given figure for the same plot size. Two additional ball valves are used to divide the system in two in conjunction with T-joint so that the area is divided in two for operation. The length of the riser/mainline pipe could be varying depending on the height of the header tank and relative distance of the water tank from the manifold. Additional 10% can be included in the BoQ for laterals, off take with grommet and other item for reserve as deemed necessary. Straight connector included in BoQ is supposed to be used if there is damage on the

drip line/maintenance. Tools required for installation include cutter, puncher, inserter, pipe wrench and teflon.

Case 6: For Field size (50mx50m for 1 block & 100 m x 50 m for 2 blocks) = 5000 m^2 (0.5 ha) (Case 6)

- The system is dived into 2 blocks each has an area of 2500 m^2. In line with this 2 separate header tanks have been provided for each block.
- Length of manifold for one block = 50 m
- Length of lateral for one block = 50 m
- Spacing of laterals on manifold = 0.5m & 1.0 m
- Number of laterals for one block = 101 & 51 at spacing of 0.5m & 1.0 m respectively.
- Emitter discharge = 2 to 2.8 lph
- Emitter spacing on the laterals = 0.3 m
- Type of system = gravity fed system from header water tank

Table 51. Specification and BoQ for 5000 m^2 plot size*

S.No.	Item along with description & specification	Unit	Quantity for a given lateral spacing		Remark
			0.5m	1.0m	
1	Water tanker (Rotto) 3000 liter with drain plug & hole punched for drain outlet. The water tank should be made from material which protect UV radiation for longer life & preferably black in colour	Pcs	2	2	
2	Nipples (Drain Outlet) 2'' male threads on both sides made of brass or polypropylene (PP), PN 6 bars	Pcs	2	2	
3	Ball Valve 2'' female thread on both sides made of polypropylene (PP) or brass, PN 6 bars	Pcs	6	6	
4	Screen or Disc Filter 2", male thread on sides, 130 micron/120 mesh, PN 6 bars. It can be made of either plastic or galvanized metal with epoxy cover & anti-corrosion painting (The inlet & outlet are at 180 degrees and the filter body is inclined)	Pcs	2	2	

5	Elbow 90° female 63mm x 2" compression type fitting made of polypropylene (PP), PN 6 bars	Pcs	2	2	
6	Black HDPE Riser pipe/mainline 63mm OD, 2.4-3 mm wall thickness, PN 4 bar	m	20	20	**
7	Tee 63mm x 63mm x 63mm OD equal female compression made of polypropylene (PP), 6 bars	m	2	2	
8	Submain/Manifold black HDPE pipe 63mm OD, 2.4-3 mm wall thickness, PN 4 bars	m	100	100	
9	End cap 63mm compression made of polypropylene, PN 6 bars	Pcs	4	4	
10	Off take with grommet 16mm to connect lateral with the submain, made from polypropylene (PP)	Pcs	202	102	***
11	Black LDPE Drip Lateral/Drip line 16mm OD, 1-1.2 mm wall thickness and PN 4 bars with inline dripper made from high quality plastic material at spacing of 30 cm with a 2-2.8 lph flow rate at 1 bar or 1-1.2 lph at 2m	m	10100	5100	***
12	Line end 16mm OD made of polypropylene or equivalent plastic material	Pcs	202	102	
13	Straight connector barbed 16mm to connect the same size lateral pipes	Pcs	20	20	****

NB: The layouts of drip system vary from place to place depending on the topography and layout of the field. Accordingly the types, quantity & size of the components required for the drip system can be different from the given figure for the same plot size. Two additional ball valves are used to divide the system in two in conjunction with T-joint so that the area is divided in two for operation. The length of the riser/mainline pipe could be varying depending on the height of the header tank and relative distance of the water tank from the manifold. Additional 10% can be included in the BoQ for laterals, off take with grommet and other item for reserve as deemed necessary. Straight connector included in BoQ is supposed to be used if there is damage on the drip line/maintenance. Tools required for installation include cutter, puncher, inserter, pipe wrench and teflon.

Case 7: Field size (50mx50m for 1 block & 100m x100m for 4 block) = 10000 m^2 (1ha) (Case 7)

- The system is dived into 4 blocks each has an area of 2500 m^2. In line with this 4 separate header tanks have been provided for each block.
- Length of manifold for one block = 50 m
- Length of lateral for one block = 50 m
- Spacing of laterals on manifold = 0.5m & 1.0 m
- Number of laterals for one block = 101 & 51 at spacing of 0.5m & 1.0 m respectively.
- Emitter discharge = 2 to 2.8 lph
- Emitter spacing on the laterals = 0.3 m
- Type of system = gravity fed system from header water tank

Table 52. Specification and BoQ for 10000 m^2 plot size

S.No.	Item along with description & specification	Unit	Quantity for a given lateral spacing		Remark
			0.5m	1.0m	
1	Water tanker (Rotto) 3000 liter with drain plug & hole punched for drain outlet. The water tank should be made from material which protect UV radiation for longer life & preferably black in colour	Pcs	4	4	
2	Nipples (Drain Outlet) 2'' male threads on both sides made of brass or polypropylene (PP), PN 6 bars	Pcs	4	4	
3	Ball Valve 2'' female thread on both sides made of polypropylene (PP) or brass, PN 6 bars	Pcs	12	12	
4	Screen or Disc Filter 2", male thread on sides, 130 micron/120 mesh, PN 6 bars. It can be made of either plastic or galvanized metal with epoxy cover & anti-corrosion painting (The inlet & outlet are at 180 degrees and the filter body is inclined)	Pcs	4	4	
5	Elbow 90° female 63mm x 2" compression type fitting made of polypropylene (PP), PN 6 bars	Pcs	4	4	

6	Black HDPE Riser pipe/mainline 63mm OD, 2.4-3 mm wall thickness, PN 4 bar	m	40	40	**
7	Tee 63mm x 63mm x 63mm OD equal female compression made of polypropylene (PP), 6 bars	m	4	4	
8	Submain/Manifold black HDPE pipe 63mm OD, 2.4-3 mm wall thickness, PN 4 bars	m	200	200	
9	End cap 63mm compression made of polypropylene, PN 6 bars	Pcs	8	8	
10	Off take with grommet 16mm to connect lateral with the submain, made from polypropylene (PP)	Pcs	404	204	***
11	Black LDPE Drip Lateral/Drip line 16mm OD, 1-1.2 mm wall thickness and PN 4 bars with inline dripper made from high quality plastic material at spacing of 30 cm with a 2-2.8 lph flow rate at 1 bar or 1-1.2 lph at 2m	m	20200	10200	***
12	Line end 16mm OD made of polypropylene or equivalent plastic material	Pcs	404	204	
13	Straight connector barbed 16mm to connect the same size lateral pipes	Pcs	40	40	****

NB: The layouts of drip system vary from place to place depending on the topography and layout of the field. Accordingly the types, quantity & size of the components required for the drip system can be different from the given figure for the same plot size. Two additional ball valves are used to divide the system in two in conjunction with T-joint so that the area is divided in two for operation. The length of the riser/mainline pipe could be varying depending on the height of the header tank and relative distance of the water tank from the manifold. Additional 10% can be included in the BoQ for laterals, off take with grommet and other item for reserve as deemed necessary. Straight connector included in BoQ is supposed to be used if there is damage on the drip line/maintenance. Tools required for installation include cutter, puncher, inserter, pipe wrench and teflon.