LOWLAND WATER, SANITATION AND HYGIENE ACTIVITY

ENGINEERING DESIGN GUIDELINES FOR RURAL WATER SUPPLY SYSTEMS

SEPTEMBER 2017

This publication was produced for review by the United States Agency for International Development. It was prepared by AECOM International Development for the USAID Lowland Water, Sanitation and Hygiene Activity, Contract Number AID-663-TO-16-00001/AID-663-TO-16-00001.

USAID Lowland Water, Sanitation and Hygiene Activity

ENGINEERING DESIGN GUIDELINES FOR RURAL WATER SUPPLY SYSTEMS

Submitted to:

USAID Ethiopia

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AECOM International Development

DISCLAIMER:

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ACRONYMS

CDCS	Country Development and Cooperation Strategy
DED	Detail Engineering Design
FtF	Feed the Future
GI	Galvanized Iron
GoE	Government of Ethiopia
GPS	Global Positioning System
GTP	Growth and Transformation Plan
HGL	Hydraulic Grade Line
IDIQ	Indefinite Delivery Indefinite Quantity (contracting mechanism for USAID)
L/C/D	Liters per Capita per Day
L/H/D	Liters per Head per Day
NGO	Non-Governmental Organization
OWNP	One WASH National Program
PRV	Pressure Reducing Valve
PV	Photovoltaic
SNNP	Southern Nations, Nationalities and Peoples
USAID	United States Agency for International Development
WASH	Water, Sanitation and Hygiene
WASHCO	Water, Sanitation and Hygiene Committee (at community level), previously called WMC (Water Management Committee)

1. INTRODUCTION

1.1 AUTHORIZATION

AECOM International Development was contracted by USAID/Ethiopia under the Water and Development Indefinite Delivery Indefinite Quantity (WADI IDIQ) Contract to implement the USAID Lowland Water, Sanitation and Hygiene Activity (also called Lowland WASH). The period of performance of this activity is from December 1, 2015 until November 30, 2019.

1.2 ACTIVITY PURPOSE

The purpose of Lowland WASH is to accelerate the expansion of improved, sustainable drinking water supply and sanitation access and to catalyze enhanced hygiene behaviors, while also expanding sustainable water use for agriculture in Somali, Afar and SNNP (lowland areas) regions of Ethiopia with populations vulnerable to drought and climate change. The Activity is aligned with USAID's Water and Development Strategy (2013-18) that aims to save lives and advance development through improvements in WASH and through sound management and use of water for food security. Moreover, the activity is aligned with USAID/Ethiopia's Country Development and Cooperation Strategy (CDCS) Development Objective One, "increased economic growth with resilience in rural Ethiopia," Feed the Future's (FtF) goal of "reducing hunger and malnutrition in Ethiopia," and the FtF objective of "increased resilience of vulnerable communities and households."

1.3 ACTIVITY COMPONENTS

Lowland WASH will work with national and regional GoE institutions and stakeholders and provide technical services, small-scale infrastructure, and related resources. Lowland WASH will undertake technical activities grouped under four integrated components:

1) Increased access to improved drinking water supply sources on a sustainable basis;
2) Increased adoption of key hygiene behaviors and increased access to improved, sustainable sanitation;
3) Improved efficiency and sustainability of food production from irrigated and rain-fed agricultural systems; and
4) Improved water resource governance and data management.

1.4 PURPOSE OF THIS DOCUMENT

This complements the Lowland WASH Construction Quality Control Plan by providing key concepts, guiding principles and specific steps for engineering design for the construction or rehabilitation of rural water supply systems. These engineering design guidelines have been compiled from field experience and have also been discussed with the regional governments in Afar, SNNP and Somali. They represent best local practices, given the local context and the very remote areas where Lowland WASH will work. These guidelines also comply with the Ethiopian Building Code Standard.

1.5 TARGET AREAS & TECHNICAL ACTIVITIES

Lowland WASH focuses on the lowland areas of Ethiopia, specifically Afar, Somali, and SNNP regions. As water systems are identified, confirmed, and built or rehabilitated, exact locations and technical characteristics will be provided to GoE agencies and USAID. The types of water systems to be rehabilitated and built include:

- Shallow wells equipped with hand-pumps;
- Deep wells to be rehabilitated (with either existing or pre-drilled boreholes) or new construction;
- Gravity spring-fed systems.

Simple systems may only have a hand-pump and a standpipe, while larger systems will have submersible pumps, reservoirs, generator sets, conveying pipes, several standpipes, and possibly solar panels or desalination schemes, if necessary.

2. DESIGN PRINCIPLES FOR RURAL WATER SUPPLY SYSTEMS

For both construction and rehabilitation of rural water supply systems, Lowland WASH will follow a process with several steps to ensure quality, as described in the Construction Quality Control Plan. Specific steps include:

1. Estimation of target population;
2. Definition of water demand;
3. Choice of water system;
4. System planning and mapping.

2.1 TARGET POPULATION

The design population is the targeted number of people that will be served under the considered water system. That population will be assessed based on:

- Population data from the kebele or woreda administration and compared against updated Central Statistics Agency (CSA) figures; and
- Preparation of base maps (community mapping using local knowledge and/or using Google Earth) to be correlated with population density and average household size.

The design period for water supply systems under Lowland WASH is considered 10 years for on spot spring developments and shallow/dug wells fitted with hand pumps, and 15 years for larger systems with distribution networks. The formula used to determine the design or projected population will be:

$$\text{Proj Pop} = \text{Curent Pop} \times (1 + GR)^n$$

- GR = annual growth rate = 2.6% (As per Ethiopia Demography and Health Survey, 2011)
- n = Project design period/life (10 to 15 years)

2.2 WATER DEMAND

Lowland WASH will comply for all new systems with the new Growth and Transformation Plan II (GTP-2) standard of 25 liters/capita/day (l/c/d) within a distance of 1 km from water delivery. This amount is generally limited to domestic uses, i.e., drinking, cooking, cleaning, washing and bathing.

Water for livestock will also be included when technically (i.e. there is sufficient water flow) and financially feasible, as livestock is a critical livelihood asset in lowland areas. Moreover, supplying institutional facilities such as public schools and health centers will also be considered depending again on technical feasibility, cost and budget availability.

Such water demands will be estimated as follows:

- Health post/clinic connection (outpatient) = 5 l/c/d
- School connection = 3.5 l/c/d (in general one tap should be provided for every 100 students)
- Livestock:
  - Camel = 50 liters/head/day (l/h/d)
  - Cattle = 30 l/h/d
  - Sheep/goats = 5 l/h/d

The total demand is the sum of the domestic, institutional and livestock consumptions expressed in cubic meter per day (m3/day). A 10 and 15 percent leakage/loss factor for systems with on-spot distribution and systems with transmission respectively will also be included. In situation where the capacity of the source of water is a limiting factor, then the population that can be served by the sources will be estimated based on these standards and discussed with the benefitting community.

2.3 CHOICE OF WATER SYSTEM

Both the type and capacity of the source and the water demand are the main factors in deciding what system to build. The standards from the One WASH National Program (OWNP) will be applied as outlined in Table 1.

Table 1. Standards on Number of Users per a Water System (OWNP, 2013)

Type of System	Population to be served (Individuals)
Dug well fitted with hand pump	270
Spring protection, on spot distribution	350
Spring protection, with distribution system	4,000
Shallow well with hand pump	500
Shallow well/borehole with submersible pump	1,500
Deep well/borehole with distribution system	3,500
Multi village system with distribution system	5,000

Water supply systems under Lowland WASH will be of two types in terms of complexity and water delivery to the beneficiary community:

1. Point source: a protected well or a developed spring with an outlet, without a distribution system. Users go to the source to fetch water which is delivered directly (spring) or through a pump (dug and shallow wells).
2. Water systems with public tap stands: This type of system is composed of a source (deep/shallow well, spring, dug well), a pumping unit for a motorized system, a reservoir, a piped distribution network, and public tap stands. Users go to one of the public/communal tap stands to fetch water. To define the number of public faucets per tap stand, Lowland WASH will consider a maximum number of 150 users per tap or faucet.

2.4 SYSTEM PLANNING

Once a beneficiary community and a viable water source have been identified, the next step is to map the community geography, which can have several small settlements. Any settlement with a population of at least 150 people should be equipped with a tap stand, the number of taps at each tap stands being, as mentioned above, about one tap per 150 people. Surveying of the area is then carried out using a handheld GPS (elevation accuracy 3m), surveying Level, Theodolite or Total Station in order to map the position of the reservoir, the main pipeline, and the distribution pipes to the tap stands. This is sketched on a community map or, if possible, by overlaying coordinates using WGS1984 datum on Google Earth so as

to view and print aerial images of the area being designed. A base map is produced with the proposed system laid out on it.

The design engineer will conduct a visual inspection of the whole activity area to verify and validate the base map. The resulting base map shall include positions and information on community settlements, roads, rivers, elevations etc. The final system configuration of the proposed water supply scheme normally contains the different system facilities including location of the source, pipe layout, reservoir, beneficiary community settlements, and public tap stands.

3. DESIGN OF SPECIFIC WATER SYSTEM COMPONENTS

The components of water systems include source development, conveyance networks, distribution structures, and electro-mechanical equipment.

3.1 WATER SOURCES

3.1.1 SPRING DEVELOPMENT

A spring is a place where ground water emerges naturally from the earth's surface, usually along hillsides, at the base of slopes, or in low lying areas.

Lowland WASH will assess the approximate spring box design and depth based on local geology and topography. We will design any spring box as a watertight concrete or stone masonry structure ensuring protection from surface contaminants. The spring box will include a heavy, non-removable cover, while providing access for disinfection and maintenance through a manhole. The following will be considered when developing or improving a spring box:

- Location: The spring box will be close to the spring, and pollution sources such as sewage systems, barnyards, livestock pastures, and others will be identified. (The USAID Lowland WASH Environmental Mitigation and Monitoring Plan provides more information on mitigating groundwater contamination.)
- Capping structure:
  - For artesian springs, the spring box will include a pervious bottom for collecting water;
  - For gravity type springs, the spring box will have a single permeable side to ensure non obstructed flow;
  - For seeping springs, an infiltration gallery (semi-perforated pipe) will be built across the flow to capture lateral infiltrations and capped to prevent surface contamination; a collection box immediately downstream will be equipped with taps.

Depending on technical feasibility and need, a collection chamber will be installed or constructed close to the spring box. In addition, around 10 meters upslope from the spring box, a diversion ditch will be constructed to divert surface runoff away from the spring box. To prevent access by animals, fencing will also be constructed using community participation from locally available materials with a radius of at least 10 meters around the spring box. Based on the topography, beneficiary number and settlement, and safe yield of the spring, the spring system will be designed either with on spot distribution or with a transmission system (gravity or motorized). Each spring will be constructed with proper drainage systems, including drainage channels and soak away pits. Each water point will have a concrete apron with proper slope to drain excess water.

At construction time, Lowland WASH will excavate the spring area through the following steps:

1. Clear the flow zone to locate precisely the water outlets;
2. Excavate towards the source of the water, while not obstructing the flow;
3. Stopping excavation when the impermeable level is reached:
4. If the flow is clearly localized and shallow (less than 2 m), construct a spring box retaining wall to protect the structure;
5. If the flow is deeper, construct a dam wall with a drain behind it; and

6. Position outlets and overflows below the discharge level.

Lowland WASH will abide by the following rules while constructing a spring catchment:

- *The catchment must never be subject to back-pressure*: The water level in the spring box or infiltration gallery must always be below the initial discharge level. The catchment must drain the aquifer, while allowing extraction from the piezometric level, but must not increase pressure or the spring could be lost. A reference peg can be used (set far enough away not to interfere with the excavation) to mark the initial discharge level. The outlet and overflow will be set below this level. Moreover, to avoid accidental back-pressurization, it is essential to create an overflow; in the absence of information on the maximum flow, the overflow must be over-sized.
- *The dam must be located on impermeable terrain*: The excavation must reach down to the substratum. This sometimes requires substantial excavation, but is essential to ensure that water does not eventually pass under the catchment.
- *The catchment must be protected*: The protective works are part of the catchment works. It is necessary to take care over sealing, especially the drain cover (clay, plastic sheeting, etc.), and the construction of the spring box or collection chamber.

For further details, refer to *Typical Drawing 1: Spring Capping.*

3.1.2 SHALLOW/DEEP WELL

Before drilling a well, Lowland WASH will initiate a geophysical survey to identify viable sites for borehole/well exploration, engaging experienced Ethiopian consultants with local knowledge. The survey will also provide information to guide well design and drilling methods and allow an estimation of drilling costs. (As appropriate, Lowland WASH will also use groundwater information provided by the United States Geological Survey to identify viable sites.)

Drilling will be carried out at a location where geophysical and hydrogeological studies have established a high probability of yielding a productive well/borehole, commencing at a wide diameter (usually 12” or 14”). The surface casing is set through the overburden and sealed by pressure grouting. Drilling will continue at a reduced diameter (usually 10”) through the unstable zone and an inner blind or screen casings will be installed depending on location and depth of the aquifer and the well. Upon completing the drilling and determining that the well/borehole is productive, a uniform diameter casing and screen assemblies (6 or 8” steel or uPVC casing depending on depth and geological formation) will be lowered into the borehole. All larger diameter casings are recovered apart from the grouted surface steel casing. The annular space between the completion casings and the borehole wall is then gravel filter packed and cement grouted at the surface. A wellhead will be constructed in C25 mix concrete with adequate depth and surface dimensions of 1 meter length, 1 meter width and 0.5 meters height.

After drilling is completed, a pumping test will be done for each new productive well. The objective of the test is to determine the actual performance of the well (yield and water quality). The minimum duration of pumping tests with a constant pumping rate is 24 hours for wells in unconsolidated formations. Pumping tests will be designed and directly supervised by a hydrogeologist from Lowland WASH or seconded from the regional water bureau. To determine the appropriate constant pumping rate for the pumping test, a step test should precede the actual pumping test period. While siting, Lowland

WASH will maintain the minimum recommended distances (at least 100 m) between a well and potential sources of contamination.

For further details, refer to:
Annex-1: Specification of works for borehole/ well drilling
Typical Drawing-2: Well head apron and hand pump, and
Typical Drawing-3: Borehole head and Casing Arrangement.

3.1.3 HAND-DUG WELLS

Lowland WASH will construct hand-dug wells where the water table is shallow and people traditionally use them. Hand-dug wells of 1.2-1.5 meters (m) in diameter may reach up to 25m deep. Wells will be constructed during the dry season when the water table is at its minimum level of seasonal variation. The water bearing zones of the wells will be equipped with perforated concrete rings and packed gravel to provide filtered water, free of sand particles. The rest of the well will be sustained with 10 cm thick concrete lining rings. The annular space between the concrete rings and the well wall will be back filled with puddled clay and grouted using mass concrete for 1.5m to 3m from the surface. A proper masonry apron will be constructed to protect the well from surface water infiltration. All wells will be fenced using locally available construction materials to prevent access by animals. Proper drainage systems, including drainage channels and soak away pits, will also be constructed to avoid stagnant water and bogs forming around the well, which can become malarial breeding grounds.

For further details, refer to:
Typical Drawing-4: Dug Well Head and Apron for further details.

In rural areas, water sources are contaminated due to improper well siting with respect to soil type and the proximity of contamination sources. Lowland WASH will maintain the minimum recommended distances (at least 100 m) between wells and potential sources of contamination.

For detailed information of installing Afridev and India Mark III handpump, refer to the link below;

http://www.rural-water-supply.net/en/resources/details/286
http://www.rural-water-supply.net/_ressources/documents/default/INDIA-MARK-III_Installation-Manual_Ed-2008.pdf

3.2 CONVEYANCE STRUCTURES

Water will be conveyed from the source to the treatment plant, if any, and to the distribution points through one of two methods:

- **Gravity flow**: This is the favored solution when the water source is at a higher elevation than the area to be served. The operation cost is very low as it does not require energy costs.
- **Pumping with storage**: Water is pumped to an elevated storage tank and then is distributed by gravity from the tank to the consumers using public tap stands.

3.2.1 CONVEYANCE SYSTEM

For systems with a storage reservoir with a capacity of 30 percent of average daily demand, the transmission pipeline is designed at a carrying capacity of the maximum daily demand. Once the supply rate is determined and the plan and profile of the transmission pipeline route are plotted, the pipe diameter(s) and Hydraulic Grade Line (HGL) shall be determined using the Hazen- Williams head loss (HL) formula:

- HL = head loss due to friction (m)
- L= Length of pipe (m)
- C= Hazen-Williams C value
- D= internal pipe diameter (m)
- Q = flow rate (m^3/sec)

In addition, 10% of HL will be considered to factor friction loss allowances for fittings and bends.

For further details, refer to:
Annex -2: Water Scheme Design Spreadsheet, HWC tab for Hazen-Williams Coefficient chart for C values

For Lowland WASH, operating pressure for distribution pipes will be kept between 10 m to 70 m. Velocity of flow in transmission and distribution pipes will be between 0.6 m/s to 2 m/s. Residual water pressure at delivery points or taps will be between 2 m and 5 m.

The pipe material will be selected to withstand the highest possible pressure that can occur in the pipeline. For a gravity system, the worst-case scenario is for pressure to be at its maximum during shut-off conditions (shut-off at downstream end) when the static pressure is too high. In such schemes, Lowland WASH will train operators and community-based WASH Committees (WASHCOs) to shut off the transmission lines at the source facility during major repairs and emergency situations, practically draining the line of water and minimizing whatever static pressure remains in the line. At any point in the transmission line, the maximum HGL should not be over the allowable maximum pressure of the pipe (250m for Medium class G.I. Pipe).

To limit the maximum pressure, as needed, Lowland WASH may install break pressure tanks, chambers or pressure relief valves, along distribution system and/or at tap stands.

3.2.2 DISTRIBUTION SYSTEM: USE OF EPANET

The design shall consider valves at major branches to ensure that if any section of the distribution main fails or needs repair, that section can be isolated without completely disrupting service.

In the design of a distribution system, open pipe network analysis shall be done to determine the flow rates and pressure drops in the individual sections of the network, thus providing the basis for selecting pipe diameters.

Lowland WASH will use the EPANET software (developed by the U.S. Environmental Protection Agency) for design due its ease of usage and its public domain availability. EPANET requires the designer to create a water supply system model by entering information such as pipe lengths, junction or node elevations, connectivity of the pipes and nodes, demand in each node, information on pumps, elevation of reservoirs, elevations and yield of sources.

The design process using EPANET usually involves the (a) layout of the system configuration including locations of sources and storage facilities, (b) determination of the distribution of demands to the nodes, input of network data, running hydraulic simulation, viewing results in any of the variety of formats, modifying the model by editing the network data, and modifying the model until the design criteria are met.

Below are basic steps to follow while designing a distribution system using EPANET:

- Using the base map, the designer should develop a tentative layout of the pipe network, which should also show the positions of the source facilities and reservoir(s), community boundaries and the service area delineation. Once the tentative layout (with nodes) is plotted on the base map, the service area should be subdivided into node areas. This will give the designer a working idea of the respective number of houses (individuals) within the area covered by each node. Nodes are placed at locations for pipe junctions, road junctions and intersections, locations for public faucets, demand centers, etc. Draw-offs will be determined at each nodal points and then a flow distribution over the various pipes can be assumed and the required pipe diameters will be estimated. Average flow rate that meets demands at each node will be inserted, taking into consideration the relative number of houses (individuals) for the different node areas. The following key assumption will be considered in determining demands at each node:
    - On average, one public tap/faucet will serve 150 individuals. This is taking in to account below assumptions
        - Average flow rate of a public faucet = 0.125 lit/sec
        - On average, a public tap stand provides service 8 to 10 hours per day
    - Recommended head at taps = 2 m - 5 m
    - Maximum velocity of flow in pipes = 2.0 m/s
    - Minimum velocity of flow in pipes = 0.6 m/s
- Pipe data will be the assigned pipe number, pipe diameter (mm), C-value, the pipe nodes, and length (m). Node data are node number, elevation (m), and water demand (lps).
- Once all the data required have been inputted by the designer, the EPANET software shall proceed with its hydraulic run. The software computes the head losses (m) in each pipe, the rate of head loss (m/km) in each pipe, the flow velocities (m/s), and the pressure in each node (m).
- Based on the results of the computer simulation, the designer will improve the network model by adjusting the pipe and node data for specific elements, particularly for those that did not meet the design criteria. For example, for pipes that have high resulting head losses, the designer will have to increase the pipe size to the next larger diameter. If there is a system pressure that is below 3 m, the designer could replace some of the pipes leading to the affected node with a larger diameter.
- The adjusted model will be run again in the software. After this run, the results are examined and the model readjusted. The above cycle is done until an acceptable hydraulic model is achieved.

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3.2.3 PIPE MATERIAL

Lowland WASH shall use Galvanized Iron pipes and/or High Density Polyethylene pipes, depending on local availability and costs. The following minimum criteria will be used in selection of pipe material:

- Galvanized Iron (GI) Pipes, medium class and joined by threaded couplings:
  - For riser and long transmission mains;
  - When it is necessary to lay pipes above ground; and
  - When higher pressure resistance is needed.
- High Density Polyethylene, PN12.5 – PN16:
  - Usually for distribution network with lower pressure ratings (less than 100m));
  - When corrosion can be an issue; and
  - When soil conditions allow excavation to the required depth (average 90cm), and where it is easy to get good quality bedding materials.

Intake pipes or conduits crossing streams can be installed above the stream bottom by means of anchoring the pipes or conduits adequately to the bottom after being floated in place, or they can be installed underground with minimum of 1.0 m cover over the top of the crown.

For further details, refer to:
Annex 3: Typical specification for medium class GI Pipes.

3.2.4 VALVES

Lowland WASH will use the below valves to control the movement of water through a pipeline. Valves can be classified into four general categories as follows:

1. **Isolation Valves**: Will be used to block the flow of water by manually closing. Isolation valves include gate valves and globe valves. Gate valves will be installed at the outlet of reservoirs, at main branches, and at public tap stands.
2. **Directional Valves**: Also called check valves, directional valves are used to ensure that water can flow only in one direction through a pipeline. Check valves will be installed along main conveyance pipelines (every 1,000m).
3. **Air Release Valves**: Will be installed in system high points, where trapped air settles, and at changes in grade, where pressures are most likely to drop below ambient or atmospheric conditions to release trapped air during system operation.
4. **Pressure Reducing Valves**: Pressure reducing valves (PRVs) throttle automatically to prevent the downstream hydraulic grade from exceeding a set value, and are used in situations where high downstream pressures could cause damage. PRVs can be used to separate pressure zones.
5. **Wash-out Valves**: Wash-out valves (ball valves can be used) will be installed in the network's lowest points, to be able to drain the pipes and to evacuate the possible deposits.
6. **Flow Meter Valves**: Flow meter valves will be installed at the outlet pipe of water reservoir tank to record the accurate flow measurement data.

3.2.5 RESERVOIRS

Lowland WASH will use ground level reservoirs constructed out of reinforced masonry designed by government partners, pioneer tanks or fiberglass water tanks placed on a stone masonry seat. The reservoirs shall be strong enough to withstand all loads, such as hydrostatic pressure, earth pressure, wind loads, seismic loads and other dead or live loads. The reservoir should be covered to avoid pollution and growth of algae.

The size of the inlet line is determined by the supply and demand requirements. The inlet line on all reservoirs must have a shut-off valve located adjacent to the reservoir. Like the inlet line, the size of the outlet line is determined by the supply and demand requirements. The upstream-end of the outlet pipe is usually installed at least 5 cm above the floor of the reservoir to create a dead volume of water. This dead volume of water at the bottom of the reservoir acts as settling zone, where particles are allowed to settle and kept from entering the water distribution line. These dead volumes of water are drained via a drainage pipe. The outlet line must also have a shut-off valve and flow meter valve located adjacent to the reservoir.

Draining should be done through the inlet–outlet line by shutting off the valve controlling the flow in the main line and opening the drain valve. To facilitate cleaning, the floor of the reservoir is sloped towards the drain. Ventilation facilities are provided in reservoirs to allow the air to escape fast enough to prevent pressure from building up inside the reservoir during filling, and to prevent a vacuum from forming when water is being drawn out. The ventilation facilities should be designed to keep rain and surface water from entering, and they should be screened to keep out insects. Overflow and drainage pipes should be designed with a valve chamber to prevent rodents from entering the reservoir.

Reservoirs should be provided with an overflow line large enough to allow the maximum anticipated overflow (pump or spring capacity) and should be properly screened and covered like an air vent. Manholes and covers will be installed in reservoirs to provide entry access during repair, cleaning and maintenance. To prevent the entry of surface water that may contain pollutants, manholes should be installed slightly raised above the roof level and must be equipped with an overlaying cover.

For further details, refer to:

Typical Drawing-5: Masonry Reservoir (50 m^3).
Typical Drawing: 19 m^3Pioneer Water Tank

3.3 DELIVERY STRUCTURES

3.3.1 PUBLIC FAUCETS OR TAP STANDS

Tap stands will be designed with firm, unobstructed footing in the area immediately around the standpipe. As a minimum requirement, there will be a level, secure concrete platform below the tap to ensure proper access, as well as a waist-high shelf for supporting containers being filled. The standpipe support column will be designed to provide rigidity needed to keep the standpipe upright.

The design of taps should consider proper drainage systems, including drainage channels and soak away pits, and will also be constructed to avoid stagnant water and bogs forming around the tap stand, which can become malarial breeding grounds.

Lowland WASH will design and construct tap stands using the following criteria:

- Tap stands will be a maximum walking distance of 1km from the farthest home;
- A maximum of 150 people will be served by a tap/faucet;
- The flow rate of a tap/faucet will not be less than 0.125 liters/sec;
- The minimum head will be 3m when 100% of the taps in the system are open;
- The maximum head at the taps should be 5m;
- An isolating valve will be provided at each standpipe;
- The tap will be high enough for a 20 liter container to fit underneath;
- Distance between the tap and the platform or shelf will be enough to allow easy positioning of containers under the tap, while small enough to reduce spilling during filling from a spread-out water jet; and
- A concrete plinth will drain the water into a soak-away sump with crushed stone.

For further details, refer to:
Typical Drawing- 6 a&b: Public tapstands

3.3.2 CATTLE TROUGHS

Lowland WASH will design and construct cattle troughs where the water source has sufficient capacity to serve both domestic and livestock needs. In situations where the water source capacity is limited, the benefitting community will be advised to water their livestock from open water sources, including nearby streams, rivers, ponds, etc.

Cattle troughs will be designed and constructed out of reinforced concrete structure with partitions for cattle and small ruminants. The design of cattle troughs should consider proper drainage systems, including drainage channels and soak away pits, and will also be constructed to avoid stagnant water and bogs forming around the trough, which can become malarial breeding grounds.

For further details, refer to:
Typical Drawing 7b a & b - Cattle trough
Typical Drawings 7 c – Goat and Sheep trough

3.3.3 WATER FILLING STATION FOR WATER TRUCKS

Lowland WASH will design and construct if needed, water filling stations for water tankers where there is need for distributing water to remote locations by water trucks to serve for both domestic and livestock needs.

Filling stations will be designed and constructed out of reinforced concrete foundation and steel frame for mounting and extending the GI pipe to reach up on to top of filling points over the water tanks. The design of water filling stations should consider proper stone fill area below the water filling pipe to drain the excess water and avoid stagnant water as well.

For further details, refer to:
Typical Drawing- Water filling station for water tankers

3.3.4 WATER RESERVOUIR MASONRY STAND

Lowland WASH will design and construct masonry stand with reinforced slab and foundation for installing 25,000 liters fiber glass water tanks to serve for both domestic and livestock needs.

Masonry stand will be designed to resist live and dead loads and constructed reinforced concrete foundation, good quality stone masonry wall and reinforced concrete slab on top of it. Fiber glass tank shall be secured to the connections points left on the slab using steel wires.

For further details, refer to:
Typical Drawing- Water reservoir masonry stand

3.4 ELECTRO-MECHANICAL EQUIPMENT

Pumps and generators are essential equipment to pump and convey water.

3.4.1 GENERATOR/PUMP CONTROL HOUSE

The generator/control house will consist of a building structure constructed of concrete blocks. It will have rooms for the generator and control panel, guard house and storage area. The building floor should be gently sloped and provided with a floor drain sufficiently designed to keep the station functioning and accessible during emergency spill/leakage situations. The generator seat shall be designed and constructed out of reinforced concrete to stand load and vibration from the generator set. The generator house will have a ramp constructed out of masonry and mass concrete at the main gate for easy installation and/or removal of the generator set.

The generator house will provide adequate space for all installations to enable access and working space for the generator and pump control unit. This includes space required to maneuver tools and equipment necessary to perform the entire spectrum of operation and maintenance procedures. The generator house will be properly ventilated ensuring proper air circulation.
Exhaust pipe should be extended outside the generator house building using additional pipe
Electrical control panel must be installed independent of the generator and vertically aligned (cannot lie flat). Control panel shall be installed on a steel frame mounted on to the wall.
Self standing steel frame control panel shall be manufactured and control panel shall be mounted onto the steel frame.
C02 type 10 kg fire extinguisher shall be provided and located inside the generator house

For further details, refer to:
Typical Drawing 8- Generator house
Typical Drawing Generator control panel (bolted and hanging type)

3.4.2 PUMP DESIGN AND SELECTION

Pumps will only be used in situations where gravity flow is not possible. The two types that will be used under Lowland WASH are hand pumps and electric submersible pumps.

In order to obtain a pumping system that will meet requirements in an efficient manner, Lowland WASH will match the pump to the piping system and required flow rate. Lowland WASH will procure and install submersible pump brands that are technically appropriate and familiar to the region. Submersible pumps shall use enclosed impellers and are easy to install and maintain. The specific type will be chosen based on capacity needs as well as local availability, spare parts availability and local maintenance capacity. The total pumping head shall be calculated taking into account the static and friction heads.

- Total Head (Ht) = *Static head (Hs)+ Friction head (Hf)*
- *Static head* is the total vertical head through which the water is to be pumped, Hs = Service reservoir inlet elevation (m) - Dynamic water level for design discharge (M)
- *Friction head* for pipes is calculated using Hazen-Williams Formula, *Hf*
- $Hf = 10.67(L)*(Q^{1.85})*(C^{-1.85})*(D^{-4.87})$*Friction head* for fittings and bends = 10% of *Hf* will be considered

Each pump will be procured together with all relevant and appropriate accessories, including the control panel depending on the starting system (direct on-line, autotransformer, star delta, etc.), appropriate length and diameter electric cable, water level sensors and electrode cable. Each pump is provided with an appropriate type and size manual control unit. To reduce inrush currents during pump starts, pumps/motors of 7.5 kW or more will be controlled through autotransformer or star delta starter.

For further details, refer to:
Annex -4: Typical specification for the procurement of electric submersible pump
Annex -5: Typical specification for the procurement of solar pumping unit

3.4.3 POWER SOURCE FOR PUMPS

Solar, electric, gasoline or diesel engines are commonly used as power sources for pumps. The power source will be designed to cope with the peak running load and the increased load during starting. Equipment and supply and control systems should be properly designed, constructed and maintained in order to ensure satisfactory operation and safety to personnel. As general rule, the size of a genset in kilo –volt-Ampere (KAV) required to run an electric submersible pump with star delta and reactance/autotransformer will be 2 to 2.5 times Kilowatt (KW) of the submersible pump. Lowland WASH will procure and install brands of genset and photovoltaic (PV) pumping units that are technically appropriate and familiar to the region.

Lowland WASH will provide detailed specifications of the submersible pump (KW and starting system) and installation location details (altitude, humidity, etc.) to suppliers for them to specify the genset matching the requirements. In case of PV pumping units, details of the well and water system will be provided to suppliers to come up with PV pumping units matching the requirement

For further details, refer to:
Annex 6- Typical specification for supply of diesel engine generator set

3.5 BRANDING OF PROJECT SITES

All water schemes must have a USAID properly branded project sign in English and local language in opposite side. The printing painted onto the sign shall be U resistant and long lasting type of paint. The sign will be mounted on galvanized steel posts which will be anchored to the ground using concrete. The location of the sign should be in a highly visible location associated with the project.

For further details, refer to:
Branding of project sites

4. ANNEXES AND TYPICAL DRAWINGS

ANNEX 1- DESIGN SPECIFICATIONS FOR BOREHOLE DRILLING

Borehole design and construction

Drilling will be carried out at the location agreed with the Lowland WASH supervisor within the area where both geophysical and hydrogeological studies have been conducted and have established a high probability of yielding a productive borehole. Drilling will commence at a wide diameter and surface casing is set through the overburden and sealed by pressure grouting. Drilling will continue at a reduced diameter through the unstable zone and an inner casing will be installed through the unstable zone. Further reduction in drilled hole and casing will continue as required to case off several unstable zones above the aquifer. Finally, a uniform diameter steel casing and screen assemblies will be lowered into the borehole and all larger diameter casings are recovered, apart from the grouted surface casing. The annular space between the completion casing and the borehole wall is then back filled and grouted at the surface.

Sampling

During the process of drilling, rock/soil samples shall be collected every 2 meters and as the lithology changes, for further analysis, identification of the water-bearing zone and to make decisions regarding the setup of the blind and screen casings. The samples shall be stored in a graduated sample box designed for such purpose. The drilling report shall include detailed records of the lithology, drilling rate and borehole construction.

Drilling method

DTH is the preferred method of drilling, however, the drilling company may use any rotary or mud drilling technique that s/he feels applicable to achieve the depth and diameter required, provided that the techniques used are those specified in her/his proposal or are approved by the Lowland WASH supervisor. The use of lost circulation agents or any form of plugging materials that may ultimately affect the production capacity of the water bearing strata will not be permitted. Any drilling fluids additives must be approved by the Lowland WASH drilling supervisor.

Drilling diameter and depth

Drilling diameter shall be as specified in the detail bills of quantities. Borehole drilling shall be classified as soft, medium and hard formation as defined below:

- *Soft Formation*: Shall mean unconsolidated sediments, like surface soils, alluvium and laurite sediments, unconsolidated volcanic material like volcanic ash, tuff, etc. and decomposed igneous indicted sedimentary and metamorphic rocks.
- *Medium Formation*: Shall mean unconsolidated materials of grain size greater than cobble, moderately weathered rocks and moderately soft rocks.
- *Hard Formation*: Shall mean fresh not weathered igneous indicated sedimentary rocks and metamorphic rocks.

Water supply and auxiliary services for drilling

The drilling company shall make his own arrangements for obtaining, storing, transporting and pumping of water required for the drilling purposes and for use by the drilling crew at their campsite. The contractor shall provide light and all necessary equipments and auxiliaries for drilling or any other necessary equipments or tools to avoid unnecessary delays and work stoppages.

Environmental protection of site

Care must be taken in handling and storage of all drilling fuels, oils, greases and fluids on site, to avoid

any environmental degradation. The drilling company shall dispose of any toxic materials, drilling fluids, and other additives, cuttings and discharged water in a manner approved by the Lowland WASH field team so as not to create damage to public and private property, and shall adhere to the Lowland WASH "Environmental Guidelines for Drilling and Test Pumping Operation[s]." The drilling company's adherence to these guidelines will be closely monitored by Lowland WASH supervisors, and any infringement by the drilling company may render unacceptable the particular portion of the works to which it applies. The drilling company shall ensure that all his personnel are aware of these environmental guidelines.

Blind and screen casing material

Based on this data, the Lowland WASH shall instruct the drilling company on the type, number and position of screen casings. The screen casings and blind casings shall have be of 6 5/8" external diameter and 6" internal diameter, and shall be of the same specification as detailed in the bid documents and as the sample provided to Lowland WASH before the signing of the contract. The drilling company shall ensure that the borehole is cased throughout its depth, with a small (1-2% of the total depth of the borehole) allowance for settling.

Casing Installation

The drilling company shall provide for Lowland WASH data obtained during drilling regarding the depth and thickness of the water-bearing zone, the water struck depth/level, and the static water level. Based on this data, Lowland WASH shall instruct the drilling company on the number and position of screen casings. The screen casings and blind casings shall be of the same specification as specified above and as the sample provided to Lowland WASH before the signing of the contract. The drilling company shall ensure that the borehole is cased throughout its depth, with a small (1-2% of the total depth of the borehole) allowance for settling.

All casing shall be joined by screwing them together; screwing should move easily without force thus ensuring verticality is maintained. To strengthen the joints, the outer side of the joint of all steel casings shall be welded with a 4mm metal strip to connect adjoining casing. A proper casing shoe, approved by the Lowland WASH supervisor, shall be fitted to the bottom of the first casing before lowering.
Casing installation shall only be done in the presence of the Lowland WASH supervisor.

Observation Pipe Installation

One water level observation pipe should be installed in each well to be drilled. The observation pipes should preferably be 3/4" diameter GI pipe. The observation line should reach approximately as deep as the bottom of the housing line or as determined by the Lowland WASH supervisor. The bottom most observation pipe shall be slotted at a distance 2m above the bottom and thereafter slots shall be at an interval of 10m. Each slotted section (screen) shall be 2m length. The uppermost slotted section should be 10m below the static water level.

If observation pipe screens are made by hand, slots may be cut with hack saws. Slots may be arranged on two opposite sides in an alternating manner. The slot spacing on each side being about 2cm apart, care should be taken to ensure the slots are clean and without residues. Drilling holes or torch-cuts are not permitted. Under all circumstance, observation pipes will be installed in the borehole in a rectilinear way to allow the free passage of probes.

Well Plumbness/Verticality and Alignment Testing

Drilled boreholes will be tested for verticality and alignment by means of running a dummy down the casing. The dummy shall consist of a cylinder 10m long with a diameter 20mm less than the well casing. The dummy must pass freely through the entire length of the cased borehole. In the absence of a dummy,

testing will be done by running two iron discs at least 3mm thick and of equal diameter or no more than 13mm less than the internal diameter of the borehole casing. The iron discs shall be connected from their centers by at least 3m of steel pipe of at least 25mm diameter. The dummy or the discs and pipe will be supplied by the drilling company and will be lowered to the bottom of the borehole by means of a steel wire passing over a pulley suspended from the machine winch or tripod and connected to the exact center of the dummy or the center of one of the top disc. The discs should easily pass down the whole depth of the borehole. The deviation of the steel wire connected to the center of the dummy or top disc from the center of the borehole shall not exceed one quarter of the internal diameter of the borehole casing. If these requirements are not met and if the borehole is determined more than 3% out of alignment, the drilling company will, if possible, correct the defects. If not, the Lowland WASH has the right to reject the borehole and no payments will be made for its drilling and completion.

Well Development and Gravel Packing

In addition to the cleaning and development of the well before casing installation, the well will be developed continually during filter gravel packing. Washed and well-rounded river gravel, of diameter range 6-9mm and uniformity coefficient in the range 2.5-5 will be packed between the annular space of the casing and the well from the bottom until 6m below the ground surface. To avoid bridging of the gravel, which may lead to severe damage of the permeability of the aquifer or damage the borehole wall, it is forbidden to fill-in gravel by mechanized equipment. The gravel shall be inserted into the borehole by hand using a shovel.

After packing is complete, the well will be developed by air-lifting, alternating continuous and surging, for a minimum of 24 hours. During well development, the position of the air outlet (at the bottom of the drill pipe if a drilling apparatus is used for air-lifting) shall be in the blind casing below the lowest screen casing. The drilling company shall ensure that the casing string is adequately supported at the top if necessary and is not damaged. Any casing and/or screen damage during installation and well development shall be the responsibility of the drilling company, who shall make the necessary corrections/repairs without additional cost to the Lowland WASH. The airlift well development shall proceed systematically from top to bottom until the water is clear to the satisfaction of the Lowland WASH supervisor. When well development is completed, the gravel packing will be topped up if it is found settling below the required depth. Well development and gravel packing shall not be undertaken in the absence of the Lowland WASH supervisor.

Pumping Tests

Pumping Test Unit: The test pump unit shall consist of an appropriate submersible pump with a capacity determined by the Lowland WASH supervisor based on the estimates of borehole yield determined from airlift or a bailer. The pump shall have appropriate number of stages to make it adequate to tackle the dynamic head. The test pump shall have an appropriate power source (generator) to run it, pipe on which to set the pump and all necessary tools and equipment to carry out pumping tests with an accurate measurement of water discharge and water level in the well. A turbine pump unit, run by an easily throttled diesel engine with the capability of discharging the estimated discharge range is considered as advantageous over types. For measurement of water levels in wells, electric water level indicators shall be used. The equipment and crew shall be as stated in the bid document, capable of performing the test pumping to the satisfaction of the Lowland WASH supervisor.

Water level gauges: The drilling company should have on the site at least 2 electric gauges suitable for maximum depth of borehole. The device should fit into the observation pipe and should permit direct, convenient and accurate reading of depth of static and dynamic water level.

Pumping testing methods: Two types of pumping test shall be undertaken once the borehole is completed and developed. After measuring the static water level, a constant rate pumping test and recovery

measurement shall be undertaken using an appropriate electrical submersible pump and generator for a minimum of 24 hours, although the duration can vary according to the rate of the drawdown. The recovery test shall continue until a minimum of 90% recovery is achieved. The discharge shall be measured using a suitable-sized water container and a stopwatch, with suitable time intervals agreed beforehand with Lowland WASH. The drilling company will follow the instructions of the Lowland WASH supervisor regarding the duration of the constant rate pumping and recovery tests. The field measurements obtained shall be analyzed in order to identify the hydraulic characteristics of the well, optimum yield and the corresponding dynamic water level. Based on the analysis result, the capacity of the pump and pump installation depth will be determined. In addition, the capacity of the generator that is required to drive the pump will also be recommended.

A step drawdown test shall also be conducted with a minimum of 5 different pumping rates and for a minimum duration of 12 hours. The discharge shall be measured using a v-notch weir apparatus. A step drawdown test shall start with measuring the static water level. Then the tests should commence with the lowest discharge step. After a constant flow and stabilized dynamic water level are reached the discharge will be increased and the second step will be run until similar conditions of flow and water level are obtained, followed by the 3rd …..n^{th} steps.

During or after the test, the Lowland WASH supervisor shall, based on the results, decide whether the test is satisfactory or if further development is needed to be followed by a new test. Test pumping shall not be conducted in the absence of the Lowland WASH supervisor.

Test pumping shall be conducted without interruption. The contract shall ensure that there is adequate backup equipment on site to continue test pumping without interruption. If interruptions occur because of failure of the drilling company's equipment or personnel, the operation will resume afresh.

Discharge measurement: Discharge measurement shall be made by means of standard circular orifice on standard size pipe or by using a weir in combination with timing the filling of a container of known volume. If the later method is used, the container shall be large enough so that the time of filling is not less than 30 seconds. Discharge measurements by a water meter will not be allowed.

Disposal of pumped water: Pumped water must not be allowed to filtrate into the vicinity of the wells. The water should be disposed of by means of discharge pipes towards a nearby natural drain (e.g. stream, river) over a distance of at least 200m downstream from the well being tested. Pools should not be allowed to form. Improper discharge water disposal may result in a non-acceptance of the pumping test.

Grouting and Well Head Construction

After completion of the pumping test, removal of the test pumping unit and after the last water level recovery observations have been made, the level of the gravel pack will again be checked to see if there is any settlement below the required depth. If it is found below the required depth, it will be topped up to the appropriate level. Based on the actual situation, the annular space between the well and the permanent casing will be cement grouted down to at least 6m from the surface in order to prevent contamination of the borehole by surface run-off water.
A sanitary seal surrounding must be excavated until an adequately firm formation is reached and constructed in C25 mix concrete with surface dimensions of 1 meter length, 1 meter width and 0.5 meters height. In such a case as a firm formation is not available close to the surface on which the concrete block can rest, the space around the casing up to 1.5 meters below the surface casing must be filled with C25 mix concrete block. The surface casing must protrude 0.2 meters above the concrete block and shall be capped with a welded steel cover.

Borehole Disinfection

Once the borehole has been completed and tested, the drilling company will sterilize the borehole with a chlorine solution yielding at least 50mg/l of active chlorine in all parts of the well. The chlorine solution may be prepared from calcium hypochlorite (HTH), sodium hypochlorite or gaseous chlorine. The chlorine solution should stay in the well for at least 4 hours at the specified concentration.

Miscellaneous

Abortive boreholes: Any borehole, which on completion yields less water than in the opinion of the Lowland WASH supervisor is necessary to render it of use shall be considered as an abortive borehole. In this case, the drilling company will be paid for drilling the borehole at the appropriate rate in the Bill of Quantities .The abandoned borehole shall be sealed as described below.

Failure to complete a borehole: Should the drilling company fail to complete the borehole due to loss of tools or any other cause, thus resulting in the borehole being abandoned, the Lowland WASH supervisor shall have the right to instruct the drilling company to commence a new borehole as near as practicable to the abandoned one at the drilling company's cost as stipulated in said article.

Sealing of abandoned or abortive borehole: Filling materials shall consist of cuttings from the borehole, concrete, grout cement, clay or sand. In the event that abandoned or abortive boreholes are in a water bearing formation that consists of coarse gravel and producing wells are nearby, care must be taken to select sealing materials that will not affect the producing wells. Concrete may be used if the producing wells can be shut down for a sufficient time to allow the concrete to set. Clean, disinfected sand or gravel may also be used as fill material in the water-bearing formation. The remainder of the well, especially the upper portion, shall be filled with clay, concrete, grout, or neat cement to exclude surface water. The latter method, using clay as the upper sealing material, is especially applicable.

Recovery of screen and casing: Casing and screens from an unsuccessful well due to the drilling company's fault will be recovered by pulling using the hoist line on the drilling rig or an appropriate hydraulic jack. The production line recovery will be attempted first (only in case of "bayonet" disconnect) and later the housing line, unless the casing are telescopically installed.

The casing is pulled using a wire rope strap and it is cut into appropriate lengths for use on the next hole. Where casing cannot be pulled back, the drilling company may use hydraulic jacks with appropriate auxiliary equipment to pull casings. Before being returned to inventory or before being used on the next hole, recovered casings shall be inspected by the Lowland WASH supervisor.

Finishing for lost or stuck tools and equipment: Finishing will be done using the most appropriate techniques and finishing tools, in order to minimize the time required for fishing and with minimum damage to the hole and to the items being fished. Standard fishing tools as well as special tools fabricated on site or in a shop may be used in a situation where drilling tools and equipment are lost or stuck in a hole. The Lowland WASH supervisor shall decide whether it is in the interest of Lowland WASH to carry out operations in order to salvage a hole or for any other reason. If in the opinion of the Lowland WASH supervisor it is not in the interest of Lowland WASH, the drilling company may fish to recover tools and other equipment at his own expense, without creating any delays to the contract schedule.

Records

The drilling company shall, for each well, keep daily activity records. The records shall contain the information as specified below. In addition, separate records should be supplied for each borehole upon completion.

- Site name

- GPS coordinates of the borehole
- Date of reporting
- Names of foremen and drillers
- Method of drilling
- Diameter of hole and depth of changes in diameter
- Depth of hole at start and end of shift or working day
- Description of strata drilled with depth of transitions encountered
- Depth at which water is struck
- Water level at the start of each working day
- Yield of air lifted water when drilling or developing with air
- Time log showing rate of penetration in minutes per meter, type of bit, standby time due to breakage.
- Depth at which formation samples are taken
- Records of components and quantities used or added to the drilling fluid or air
- Electric conductivity measurements during pumping tests
- Problems encountered during drilling
- Details of installations in the borehole (if any)
- Depth and description of well casing and screens
- Details of work to be invoiced at hourly rate (e.g. pumping tests)

A copy of the Daily Record shall be made available daily to the Lowland WASH field team, and should include any other pertinent data as may be requested by the Lowland WASH Supervisor.

Report Compilation

A detailed drilling report, including the drilling log, screen and casing arrangement, pumping test analyses, authenticated water quality test results, problems encountered and all required suggestions and recommendations shall be compiled and submitted in a bound report in three hard copies and one electronic copy to Lowland WASH, before final payment is made to the drilling company.

Sample Bills of Quantities for Drilling of Borehole/s, Estimated depth = 130m

No.	Work Description	Unit	QTY	Unit Price (etb)	Total Price (etb)
1	General Items				
1.1	Mobilization of equipments, manpower and construction material and demobilization	Ls	1		
1.2	Inter-site mobilization[1]	Number	1		
1.3	Site cleaning, rigging up & excavation of mud pit	Ls	1		
2	Drilling				
2.1	Drilling upper section with 14" bit in the unconsolidated formation	m	12		
2.2	Drilling in all types of formation (10") for well casing	m	118		
3	Logging				
3.1	Lithological Logging	LS	1		
4	Supply and Installation of Material				
4.1	Supply and install retrievable 12" steel surface casing	m	12		
4.2	Supply and install 6 inch ID heavy duty uPVC blind casing	m	88		
4.3	Supply and install 6 inch ID heavy duty uPVC screen casing	m	42		
4.4	Supply and installation 3/4" G. Iron observation pipe (B-class)	m	110		
5	Well Completion and Sanitary Protection Work				
5.1	Supply and install clean well rounded and sorted river gravel in to annular space and/or casing	m3	3.8		
5.2	Well development	hrs	24		
5.3	Grout with mass concrete to a depth of 4m	m3	0.5		
5.4	Construct well head	Ls	1		
6	Pumping Tests including result analysis and Reporting				
6.1	Constant discharge test	hrs	24		
6.2	Monitoring Recovery	hrs	24		
6.3	Step draw-down test (Variable discharge)	hrs	12		
6.4	Supply and install well cap	pcs	1		
6.5	Well disinfection with chlorine	LS	1		
6.6	Water quality analysis	Ls	1		
6.7	Reporting and submission of 4 copies	Ls	1		
	Total (A)				
	15% VAT (B)				
	Grand Total including 15% VAT (A+B)				

[1] Note: Quote for this item shall include the unit cost; and total cost of this item will not be factored in the Grand Total Cost.

ANNEX 2 - WATER SCHEME DESIGN SPREADSHEET

Refer to attached Excel file.

ANNEX 3- DESIGN SPECIFICATIONS FOR GALVANIZED IRON PIPES

General

Galvanized steel, screwed and socketed pipes conforming to (ISO-65-1973) specification and screw-threaded to ISO 7+.

Sockets

Minimum length and outside diameter in with ISO-50.

Length

Each should be 6 meters.

Additional Equipment

- Wooden plug
- Thread protectors

Fittings

Forged (seamless) galvanized steel fittings, threaded to ISO-7, as specified in the bill of quantity.

Packing

Packed for extra protection with pipes and protectors in wooden frames bound together in standard weight bundles. Fittings should be packed in standard sized box.
Pipe sockets and fittings shall be separately packed in wooded boxes. Pipes shall be packed without sockets but with pipe thread protectors.

All packing should be adequate to protect pipes and fittings from contact with water, salt, dirt and other materials that could cause deterioration in quality during transport.

Technical Information to be provided by Offeror

Offer must contain the following information for each of the types and diameters of pipes and fittings to be supplied (see bill of quantities for more specifications):

- The country of origin and make;
- The designate pipe class (A, B, C…);
- The international or national standards to which the pipe abides;
- The maximum allowable instantaneous pressure for the pipes, sockets and fittings;
- The maximum allowable operating pressure for the pipes, sockets and fittings;
- The internal and external pipe diameters;
- The wall thickness;
- The length of each piece of pipe;
- The manufacturers quoted roughness coefficient (Hazen-Williams coefficient) for new pipe, if available;
- A description of the material construction and treatment of the pipes and fittings.

ANNEX 4 – DESIGN SPECIFICATIONS FOR ELECTRIC SUBMERSIBLE PUMP

Installation Site Location (Kebele/village, Woreda, Zone and Region)	
Quantity	
Preferred Brand[2]	

The electric submersible pump shall have a performance capacity to deliver a design discharge of [XX] liter per second at [XX] meters of total pumping head at duty point.

Type of Pump

The pump shall be a **re-windable or replaceable** electric submersible pump that can be installed in a [XX] inch [XX] mm) diameter [uPVC/steal] casing with G.I. riser pipe.
The pump will be coupled directly to a wet type submersible motor, suitable for operation on a 380/400 volt, three phase, 50 Hertz, A.C. diesel-powered generator power supply.

- The motor should have an adequate overload margin over the rated pump power.
- The permissible sand content of the pumped water shall be at least 25g/m3.
- The temperature of the water to be pumped shall be around 30°C.
- The diameter of the pump should fit in to [XXX] inch casing.

Accessories

- The pump shall come complete with submersible cable, water level guard cable, upper and lower electrodes for automatic cut-off and re-start, and a control panel.
- The pump should be complete with [XX] **meters** of suitable 3 core flat/round type **(flat type is highly preferred**) submersible cable (double or single according to the type of connection and starter to be used). The submersible cable diameter should be such that the voltage drop at the maximum depth setting is not more than 2.5%. The submersible cable should be of suitable diameter and should resist the maximum pumped liquid temperature of 35°Celcius.
- The pump should be complete with a strainer, non-return valve and screwed connection for riser pipes conforming to BS-1387 and threaded to BS-21.

Control Panel and Starter

- The pump is to be provided with a control panel (**imported and EU origin highly preferred**) which should consist of a TPN (Tri-Pole and Neutral) switch with replaceable fuses, phase indicators, voltmeter, ammeter and a suitable starter. The starter should be an automatic air break type of suitable amperage with provision for a relay and ampere setting.
- The pump is to be supplied with cable clamps, whose number shall be the equivalent of 1 clamp per 6m of pump depth
- The pump is to be supplied with 2 pairs of pipe clamps, with nuts and bolts for the size of the delivery pipe / rising main of [**XXX]** inch

[2] Scanned copy of relevant documents to be attached (e.g. letter from RWB) if there is/are specific brand recommended

- The pump is to be supplied with a cable jointing kit with quick dry epoxy resin compound. The cable jointing with the **[XXX]** inches riser main pipe should inserted in **[XXX]** inch casing.

Field Kits of Spare Parts
All recommended spare parts shall be provided in the offer.

Manuals and documentation
The operation and maintenance manual, the installation manual, and circuit diagrams of the control panel and the motor shall be supplied at the time of delivery of the goods to the Purchaser.

Technical Information to be supplied with the offer
The following technical information shall be supplied with the bid:

- Pump discharge and total head at the duty point;
- Pump efficiency at the duty point;
- The complete set of performance curves for the pump over its entire range of operation, including:
    - Discharge versus head curve,
    - Efficiency versus discharge curve,
    - Input power versus discharge curve.
- Pump power (hp and KW);
- Motor power (hp and KW);
- Number of stages of the pump;
- Total combined length of the pump and motor;
- Pump diameter/motor diameter;
- Outlet connection diameter;
- Type of impeller;
- Impeller, pump shaft, motor and pump casing material;
- Type, length and diameter of submersible cable;
- Origin, manufacturer, make and model of the pump and the motor.

Warranty
The supplier shall provide an appropriate warranty for the electric submersible pumps offered.

ANNEX 5- DESIGN SPECIFICATION FOR SOLAR WATER PUMPING UNIT

Panels and Accessories

The purpose of this Terms of Reference (ToR) document is to outline the scope of work and requirements from suppliers/service providers towards training, supply and installation of solar water pumping unit for domestic water supply provision at rural villages/kebele of [XXX], [XXX] Woreda, [XXX] Zone, [XXX] region, Ethiopia under USAID Lowland Water, Sanitation and Hygiene Activity (Lowland WASH). Objectives of Lowland WASH is to accelerate the expansion of improved and sustainable drinking water supply and sanitation access and to catalyze enhanced hygiene behaviors, while also expanding sustainable water use for agriculture in Somali, Afar and SNNP (lowland areas) regions of Ethiopia with populations vulnerable to drought and climate change.

As part of the above activity, [XXX] would like to install solar water pumping unit at [XXX], with the objective of providing access to safe water to target communities. [XXX] is therefore looking for suppliers for supply and installation of [XXX] solar water pumping unit/s and to train community level operators, and staff from local government partners on operation and maintenance of these units.

Feasibility of solarisation of system

Using data from Table-1 below, the potential supplier is expected to review the whole philosophy of the solar pumping unit to identify key design parameters and highlight issues to be incorporated into design, procurement and construction phases.

Activities

- Analysis of the different types of solar pumps (Grundfos, Mono, Lorentz, etc) looking at cost, flow rates at duty point, sustainability, local availability, warranty, land requirement (as related to number of solar panels), etc
- Provide detailed site specific design sheets showing recommended pump type, size and speed, motor size, MPPT size, drive ratio, system size (Wattage), number of solar panels and their arrangement (wiring), cable type, size, length and power loss factor, average daily flow rate (daily, hourly etc) according to determined monthly and location irradiation.
- Provide pump performance curves at the rated system size.

Table [XXX]: Detail working condition of solar pumping units

Parameter	
Installation Site Location (GPS Coordinate) (Lat, Lon)	[XXX]
Borehole ground elevation (m)	[XXX]
Reservoir elevation (m)	[XXX]
Borehole depth (m)	[XXX]
Casing diameter (mm)	[XXX]
Casing material type	[XXX]
Safe yield of borehole (L/sec)	[XXX]
SWL (m)	[XXX]
DWL (m)	[XXX]
Pump position at safe yield (M, from ground level)	[XXX]
Riser pipe material	[XXX]

Size of raiser pipe (mm)	[XXX]
Desired discharge (M^3/day)	[XXX]
Length of pipe line (m) from borehole ground level to reservoir	[XXX]

Solar Equipment Specifications

Without giving expert description and designs, which is what the potential supplier is expected to do, it is expected that solar equipment should at a minimum meets the following requirements:

Submersible pump:

- The pump should be capable of delivering the required discharge in **M^3/day** at the stated head per site with duty point just to the right of maximum efficiency of the pump.
- The pump will be coupled directly to a sealed, water cooled AC or DC[3] submersible motor, suitable for operation on the determined system size (Wattage from the proposed size and number of solar panels);
- The pump and motor should be built from 316 stainless steel; preferably brushless and filled with environmentally friendly oil; the details of the oil should be stated in the dozer;
- The pump and motor should be of a size that will fit in the diameter of the stated borehole;
- The motor should have an adequate overload margin over the rated pump power;
- The pump shall have capacity to pump water with permissible sand content of at least 25g/m^3;
- The pump and motor shall perform at full capacity at least at temperature of 30°Celsius of the water to be pumped.

Solar Motor Controller (SMC) or/and Invertors:

- Shall be submersible DC motor pump set (whenever applicable and most preferred) or submersible AC motor pump set,
- The SMC or/and Invertors shall be compatible with the proposed pump and motor, monitor their operating and be able to regulate; over current, under voltage, over speed, over temperature, reverse polarity and flow rate, it shall have indicator leads and preferably an alarm function for some or all of the regulated parameters.
- SMC shall have an inbuilt Maximum Power Point Tracker (MPPT) to maximise the power from the arrays in all weather conditions. Where MPPT is not inbuilt, the SMC shall have plugs and sockets for its connection and this would be supplied as a component of SMC.
- The SMC or/and Invertors shall be housed in a damp proof enclosure with external display for reading data
- The SMC or/and Invertors shall offer facilities for electronic pressure and water level controls to enable automatic shutdown when water levels drop low in the borehole.
- The SMC or/and Invertors shall have plugs and sockets for easy of connection to other system components and probing handheld tools.

Solar panels:

The supplier shall quote for solar panels, frames and stands including detail specifications.
Specifications for solar panels include

[3] DC motor is most preferred whenever applicable

- Shall be mono or polycrystalline Photovoltaic (PV) solar panels, they must have bypass diodes an efficiency not less than 18%.
- Shall be rated to have a Power Output Warranty (POW) of 25 years plus
- Each panel shall be of a power not less than 175W with a power tolerance of not less than +5% and optimum operating voltage of 24VDC
- Shall have a length x width size not exceeding 1612mm by 810mm and aluminum frame thickness not less than 34mm and the corners of the aluminum frame shall be anodized
- The back sheet shall be homogenous, intact, tidy and smooth.
- Shall have a working temperature of 150 to 500 Celsius, with a temperature coefficient not exceeding 0.5%

Accessories:

Each pump unit shall have the following accessories:

- Appropriately sized (diameter and length) submersible power cable, capable of resisting the maximum pumped water temperature of 30°Celsius
- High pressures float stops and water level guard/sensor cables with upper and lower electrodes for automatic shutdown.
- The pump should be complete with a strainer, non-return valve and screwed connection or adaptor for riser pipes
- Borehole plate adaptor
- Array isolation switch
- 6 or 8mm stainless steel flexible safety cable of appropriate length (equivalent of pump position + 10m allowances)
- Adequate number of cable clamps, calculated at a spacing of 1 for every 3 meters
- Cable jointing kit with quick dry epoxy resin compound
- A good reliable switch suitable for each pump offered;
- Appropriate diameter cable of sufficient length for each pump set between the PV array and the motor pump set.

Spare parts and tools:

Spare parts and tools to supply as stock for the six schemes shall include; handheld fault finder, motors, rotors, controllers, stators, shafts and tools for maintenance.

Manuals and documentation:

The operation and maintenance manual, the installation manual, and wiring diagrams of each pump and motor shall be supplied at the time of delivery of the goods to [XXX].

Clearance and freight handling:

The supplier's quotation shall include all related costs including transportation of all equipments and materials to [XXXX].

Installation and training costs:

Supplier shall quote installation works and training costs (two operators and two government staff people per site, including all labor fees, travels and all related costs and accommodation. [XXX] shall source and provide appropriate capacity (specification to be provided by supplier) tri-pod and chain block required to install quoted submersible pumps. In addition, the [XXX] shall facilitate inter site travels between [XXX] and to boreholes sites mentioned above.

ANNEX 6 – DESIGN SPECIFICATIONS FOR DIESEL ENGINE GENERATOR SET

Installation Site Location (Kebele/village, Woreda, Zone and Region)	
Quantity	
Preferred Brand[4]	

Essential Specifications

- **General Working Conditions:**
  - Max Altitude: XXX] meter a.s.l
  - Max Ambient air temperature: up to [XXX]^{0}C
  - Max Air Humidity: up to [XXX] %

The genset is required to run an electric submersible pump with the following specifications:

- 3 Phase electric submersible motor
- Maximum power requirement of the submersible pump motor = [XXX]kw
- Speed of rotation = [XXX] rpm
- Starting system of the pump: [Autotransformer/ Reactance, Star Delta, DOL]

The supplier is expected to provide offers & specify diesel generator for the above mentioned starting systems, and the generator set must be matched to the above stated pump and operation conditions.

IMPORTANT!

In order to maximize the life of the generator and minimize fuel consumption, the supplier is requested to select the generator size/rating such that under normal operating conditions it will be operating at its maximum efficiency point (usually around 70-80% of its maximum power rating). Any offer containing generators operating above their maximum efficiency power output will be at a serious disadvantage, regardless of any price advantage.

Engine and Generator

- The engine shall be a water-cooled or air cooled diesel engine type.
- The governor (speed control mechanism) shall preferably be a mechanical system.
- The generator shall be skid mounted.
- The engine should use cartridge type fuel and oil filters with water traps.
- Paper element-type air filters are preferred.
- The generator shall be a diesel driven direct injection type.
- The generator shall be self-excited brush-less generator.
- The generator shall be insulated with class H insulation system.
- The generator air intake design shall be drip proof that ensures no moisture entry to the engine.

[4] Scanned copy of relevant documents to be attached (e.g. letter from RWB) if there is/are specific brand recommended

- The motor should have an adequate overload margin over the rated pump power, but note that this should be more than covered by the margin required for the generator set to be operating at its maximum efficiency point during normal pump operation.

Control system

- Control panel shall be key start enclosed with sheet steel enclosure with lockable door
- The control system shall be vibration isolated.

Mounting arrangement

- The mounting arrangement shall be fabricated steel base with anti-vibration pads. Lifting points shall be welded on the frame to assure easy management during transport and installation.
- Base frame designs of the generator sets shall incorporate an integral fuel tank with capacity sufficient for over 10 hours of operation at normal operational load.

Exhaust system

- Company fabricated exhaust silencer with all other accessories shall be supplied together with the generator sets.

Cooling system

- The engine shall be a water-cooled or air cooled diesel engine type
- The fan, fan drive, and the alternator shall be fully guarded.

Voltage regulator

The generator set should be equipped with a voltage regulation system that regulates the voltage to within ± 0.5%.

Factory testing

The generator sets shall be factory tested to a design specification at full load condition. Copy of the test certificate produced by the **company in the country of origin/manufacture** shall be supplied with the generator sets during delivery to the Lowland WASH.

Field tool kits

Basic tools required for regular field level maintenance shall be provided for the generator sets.

Spare parts

The supplier should quote spare parts required to run the system for the first one year of operation considering an average of 8 hrs of operation per day.

Manuals and documentation

Original (not a copy) operation and maintenance manual, the installation manual, and circuit wiring diagrams, and commissioning/fault finding instruction leaflets produced by the **company in the country of origin** shall be supplied at the time of delivery of the goods to the Purchaser.

Warranty

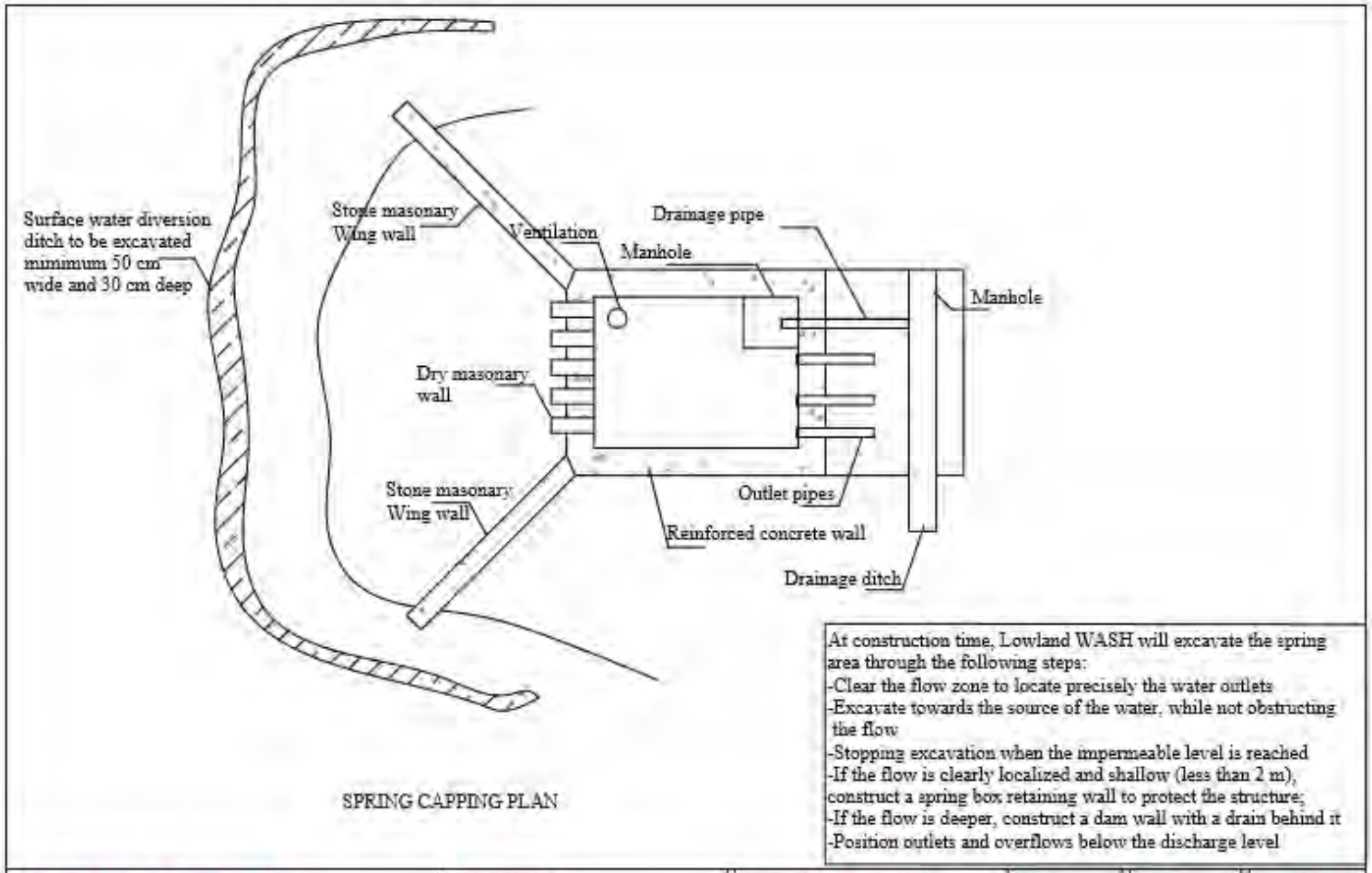
The supplier shall provide an appropriate warranty for the generator sets supplied.

Summary of Technical Information to be Supplied with Bid/Offer

The following technical information must be supplied with the bid for each generator set:

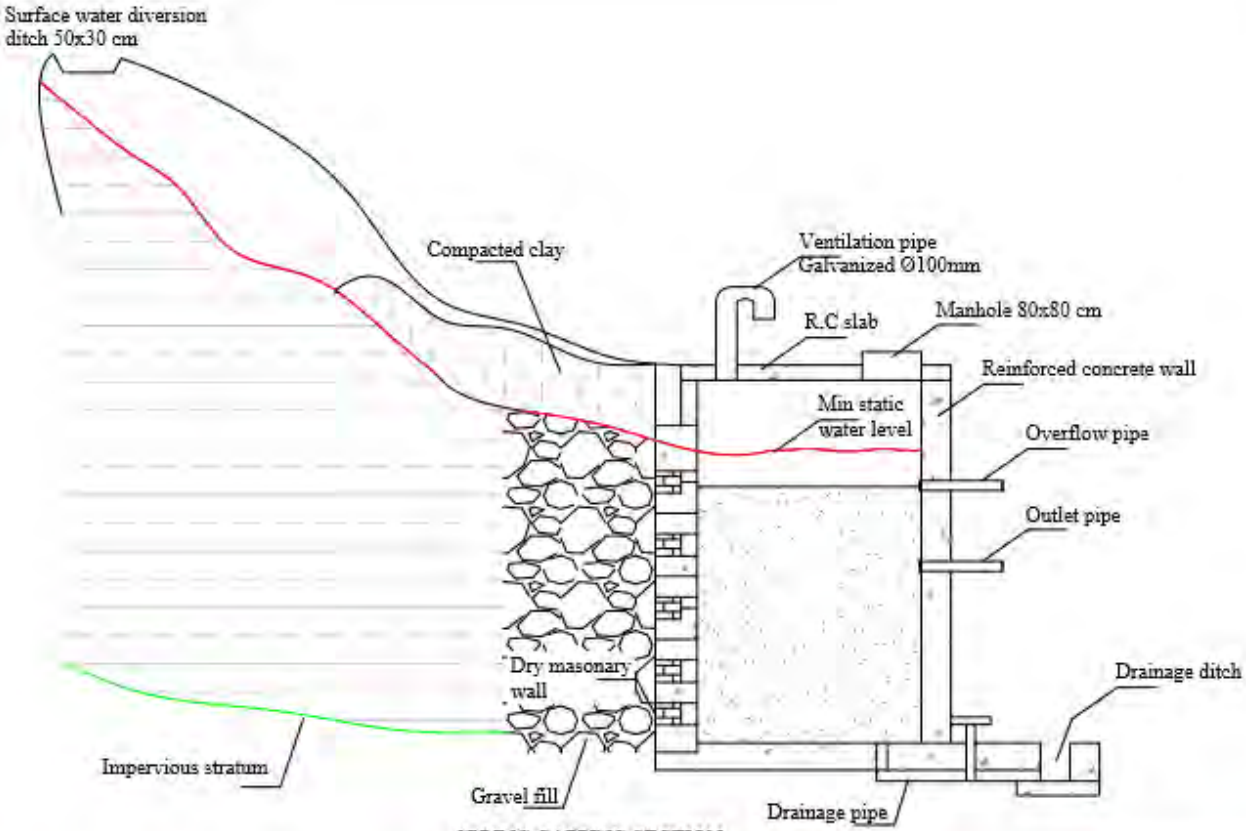
- A photograph and mechanical drawings;
- Output rating (KVA);
- De-rating Curve/ table and/or calculations;
- Engine Model;
- No. cylinders;
- Bore/stroke volume;
- Aspiration;
- Compression ratio;
- Cooling system type;
- Engine speed and generator frequency;
- Max. continuous power at flywheel at 1500 rpm;
- Fuel consumption (prime at normal operational load);
- Type of injection system;
- Fuel tank capacity;
- Lubrication oil system;
- Exhaust system;
- Mounting arrangement;
- Starting system;
- Governor type;
- Type of oil, fuel and air filters;
- Technical data of Alternator;
    - Alternator model;
    - Rated output;
    - Rated voltage;
    - Rated frequency;
    - Rated speed;
    - Power factor;
    - Phase;
    - Connection;
    - Excitation;
    - Insulation;
    - Voltage regulation;
- Details of the control panel;
- Circuit breaker rating;
- Make and type of starter;
- Country of origin, manufacturer, make, and model of the generator sets;
- Tools and spare parts included in the bid.

TYPICAL DRAWING 1 – SPRING CAPPING



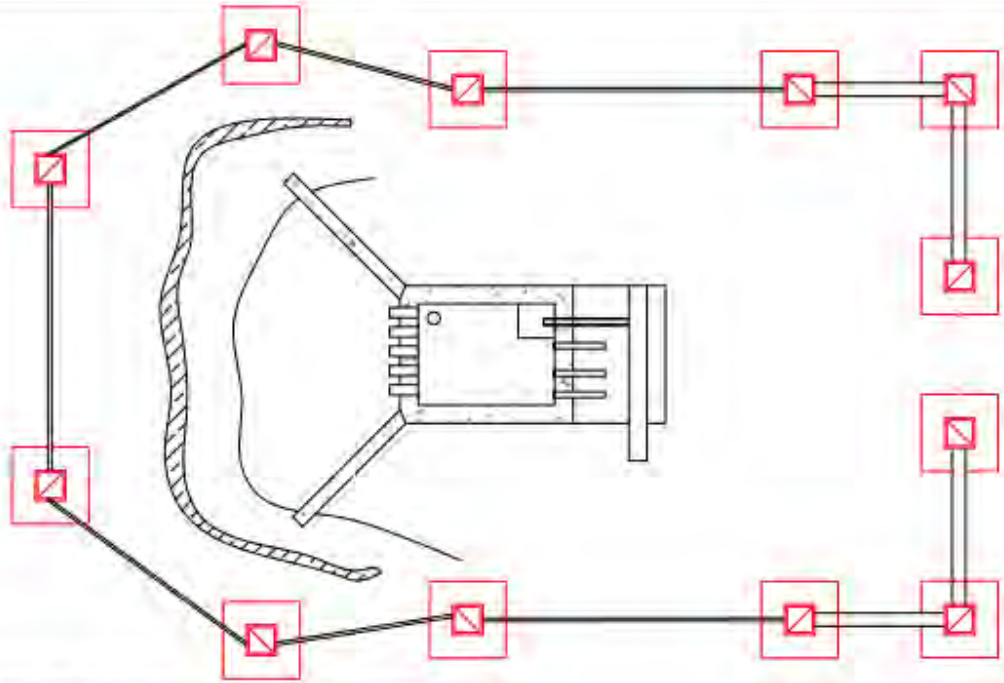
At construction time, Lowland WASH will excavate the spring area through the following steps:
-Clear the flow zone to locate precisely the water outlets
-Excavate towards the source of the water, while not obstructing the flow
-Stopping excavation when the impermeable level is reached
-If the flow is clearly localized and shallow (less than 2 m), construct a spring box retaining wall to protect the structure;
-If the flow is deeper, construct a dam wall with a drain behind it
-Position outlets and overflows below the discharge level

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 1-SPRING CAPPING	LOWLAND WASH ENGINEERS	MAY 2017	CM	1/4



SPRING CAPPING SECTION

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 1:SPRING CAPPING	LOWLAND WASH ENGINEERS	MAY 2017	CM	2/4



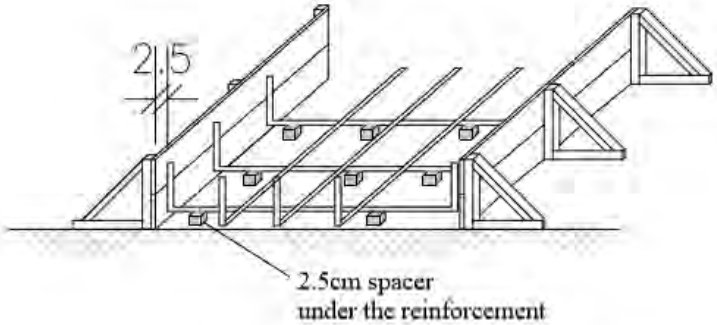
General layout with fence

Note: Lowland WASH will assess the approximate spring box design and depth based on local geology and topography
The width of the manhole shall be minimum 150 cm
Spring box wall width should be minimum 15 cm
Spring box reinforced concrete walls shall be C20 class concrete
Concrete walls vertical reinforcement shall be Dia 20mm and be placed in every 15 cm
Horizontal reinforcement shall be Dia 8 mm and be placed in every 10 cm

Note: To prevent access by animals, fencing will also be constructed using community participation from locally available materials with a radius of at least 10 meters around the spring box

LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 1-SPRING CAPPING	LOWLAND WASH ENGINEERS	MAY 2017	CM	3/4

Formwork and Bracing



Detail-A

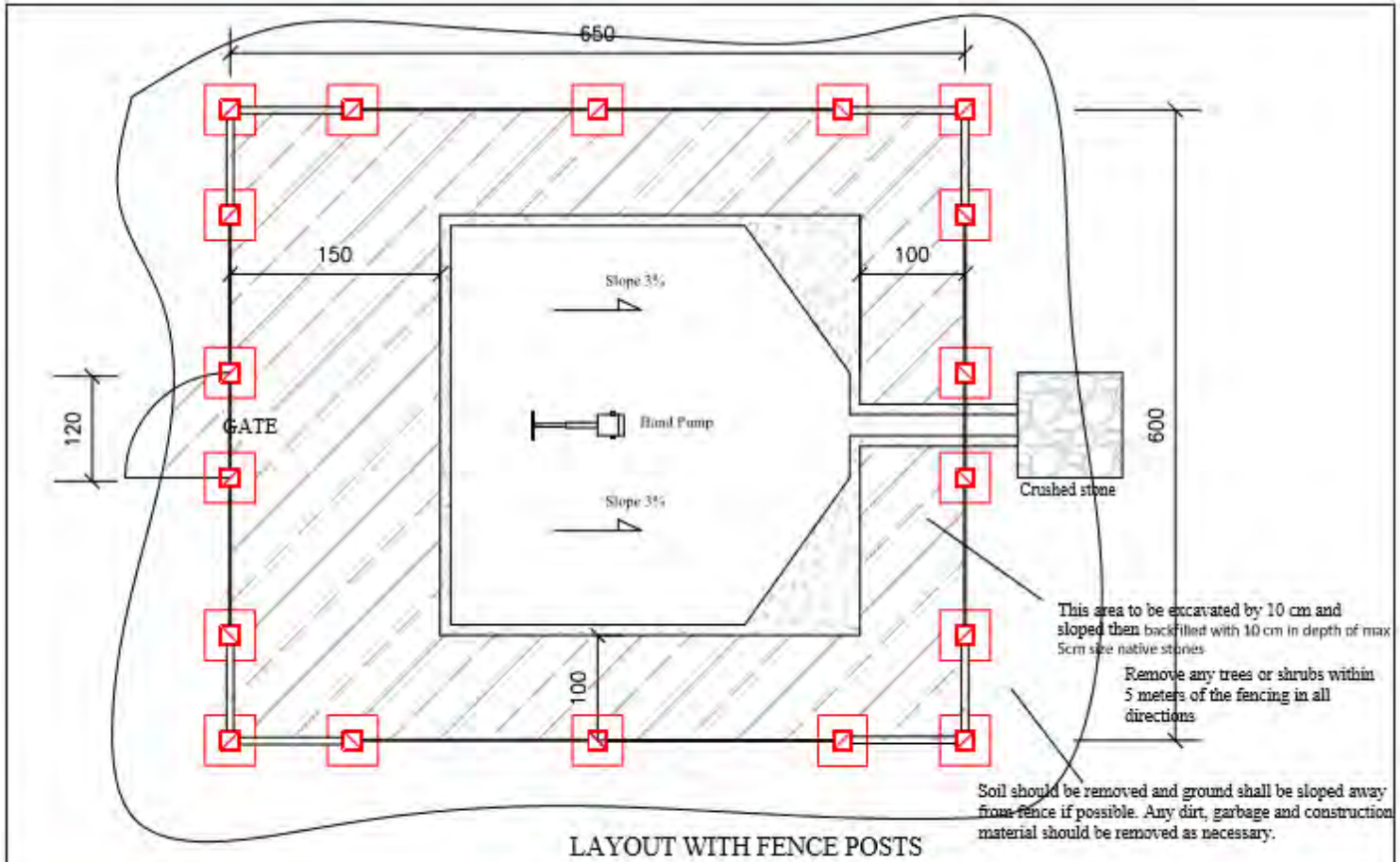
REINFORCEMENT
Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

FORMWORK
The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface
The internal surface of the formwork must be clean and free from concrete scrap and dirt
The formwork should be levelled properly
Wood formwork used to form the top edge of the slab shall be cut straight and level
The formwork should be plumb and straight
A string line shall be used to ensure the formwork is straight and provides required slope
Before casting interior surfaces of the formwork should be moistened with water
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface
The mud slab that the concrete is being placed on must be debris, dirt and dust free
The formwork should be supported with braces properly and fixed with nails as needed.
The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads
The joints between the panels of the formwork should be adequately tight

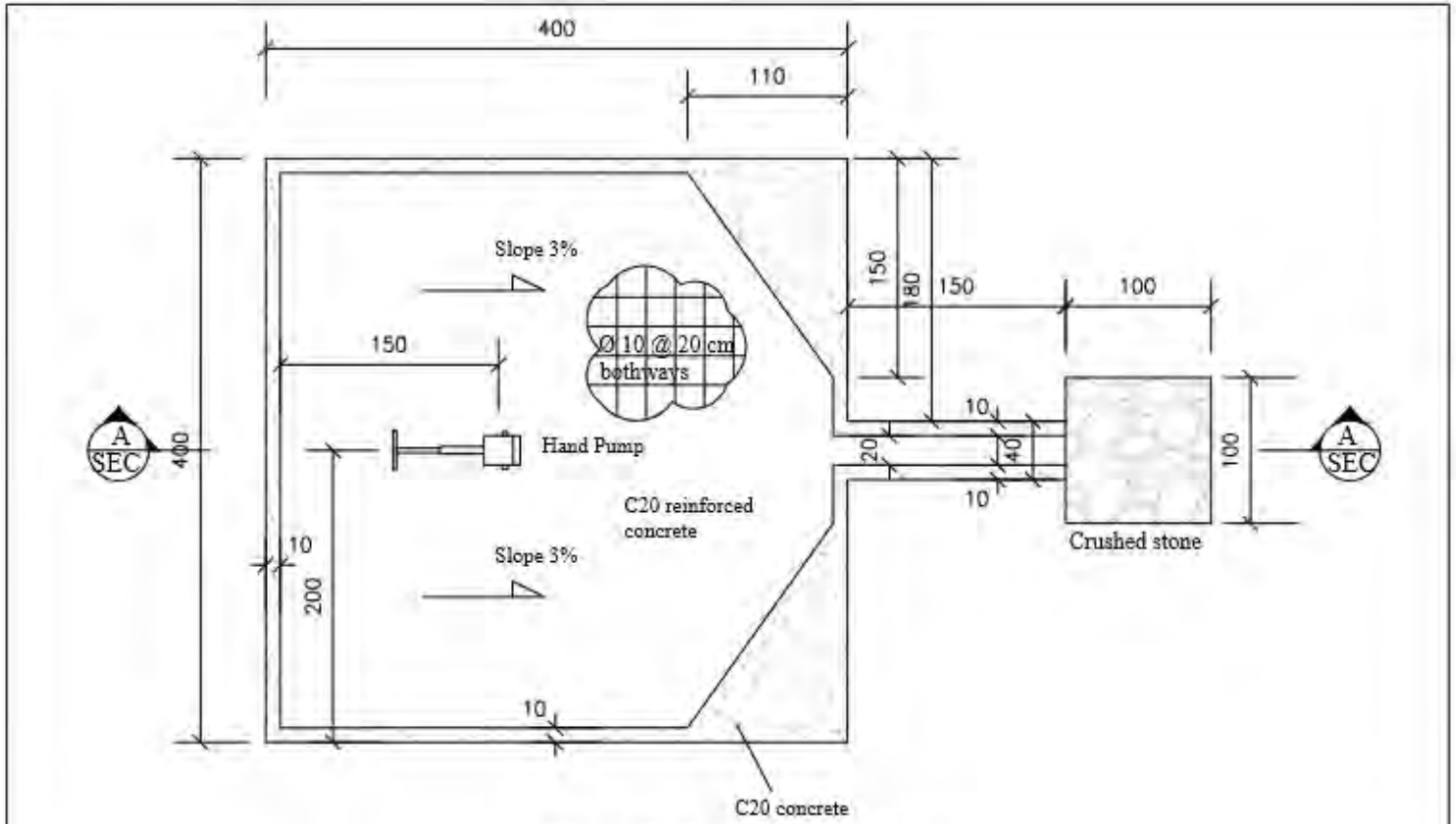
FORMWORK AND REINFORCEMENT DETAILS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 1-SPRING CAPPING	LOWLAND WASH ENGINEERS	MAY 2017	CM	4/4

TYPICAL DRAWING 2 – TYPICAL WELL HEAD APRON AND HAND PUMP

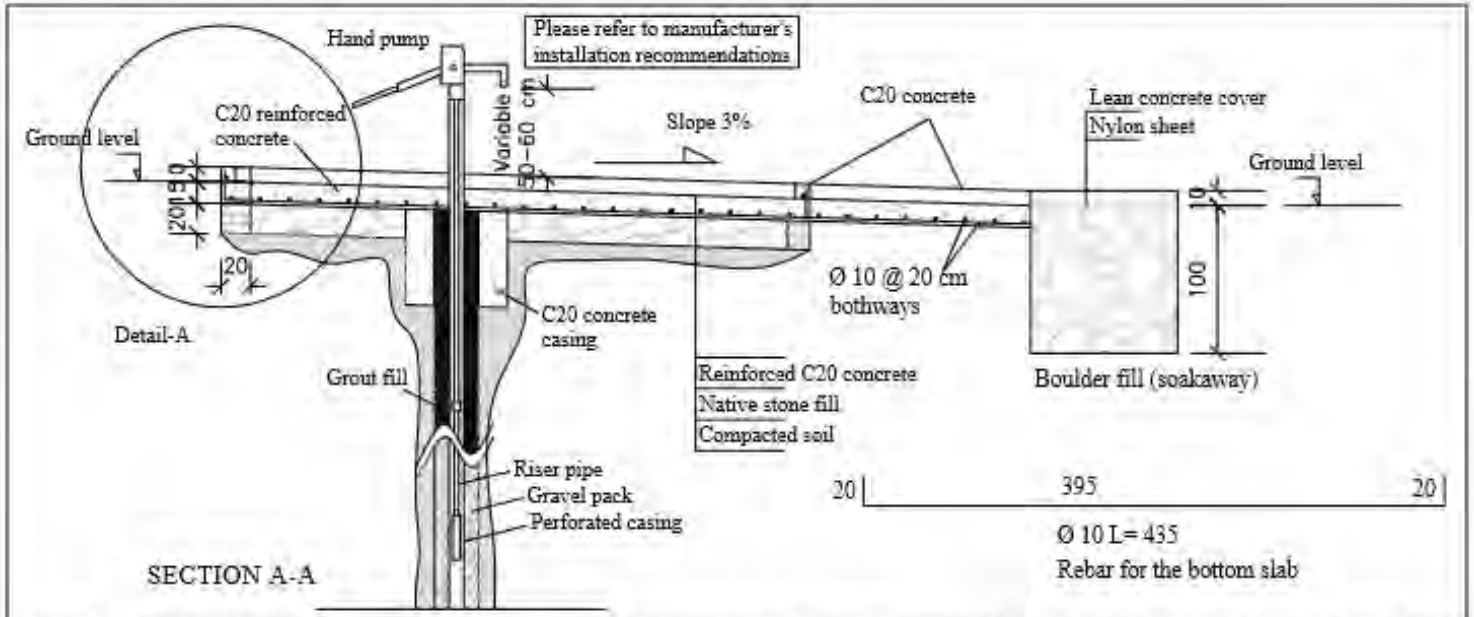


LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY:	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING-2 WELL HEAD APRON AND HAND PUMP	LOWLAND WASH ENGINEERS	JUNE 2017	CM	1/5



WELL HEAD AND APPRON PLAN

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-2 WELL HEAD APRON AND HAND PUMP	LOWLAND WASH ENGINEERS	JUNE 2017	CM	2/5



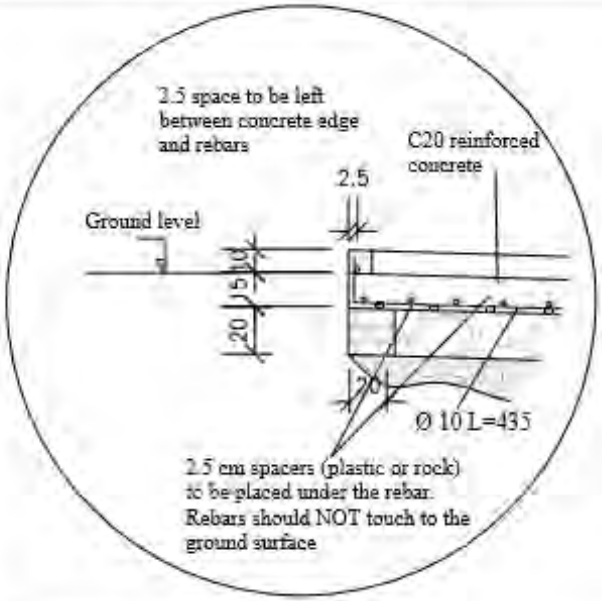
CONCRETE
Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

1 m3 C20 concrete batching amounts
Ratio 1:2:4
6 bags cement (300 kg cement)
0.25 m3 coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)
Max 180 lt water (W/C ratio 0.60)

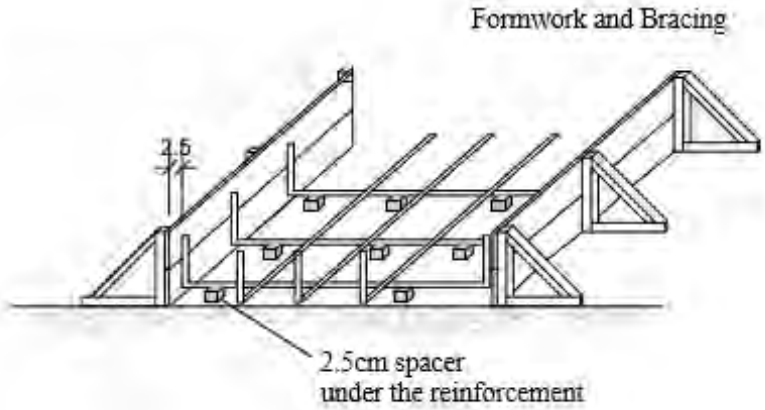
Standard Mixes for Ordinary Structural Concrete
per 50 kg bag of cement
1 bag cement (50 kg cement)
275 kg crushed stone (max dia 2 cm) and coarse sand
0.155 m3 concrete
Max 30 lt water (W/C ratio 0.60)

1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 30x30x20cm)
6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg/m3

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO.
	TYPICAL DRAWING-2 WELL HEAD APRON AND HAND PUMP	LOWLAND WASH ENGINEERS	JUNE 2017	CM	3/5



Detail-A



REINFORCEMENT
Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well.

FORMWORK
The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface
The internal surface of the formwork must be clean and free from concrete scrap and dirt
The formwork should be levelled properly
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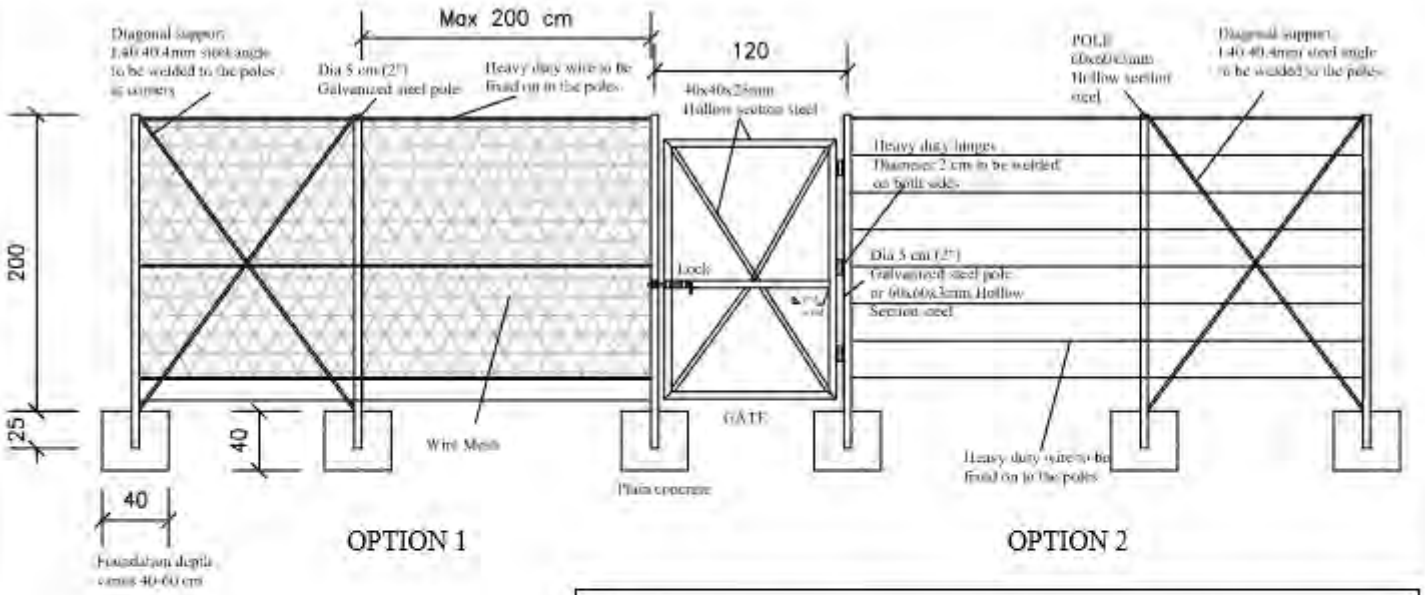
A string line shall be used to ensure the formwork is straight and provides required slope
Before casting interior surfaces of the formwork should be moistened with water
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface
The mud slab that the concrete is being placed on must be debris, dirt and dust free
The formwork should be supported with braces properly and fixed with nails as needed.
The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads
The joints between the panels of the formwork should be adequately tight

FORMWORK AND REINFORCEMENT DETAILS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-2 WELL HEAD APRON AND HAND PUMP	LOWLAND WASH ENGINEERS	JUNE 2017	CM	4/5

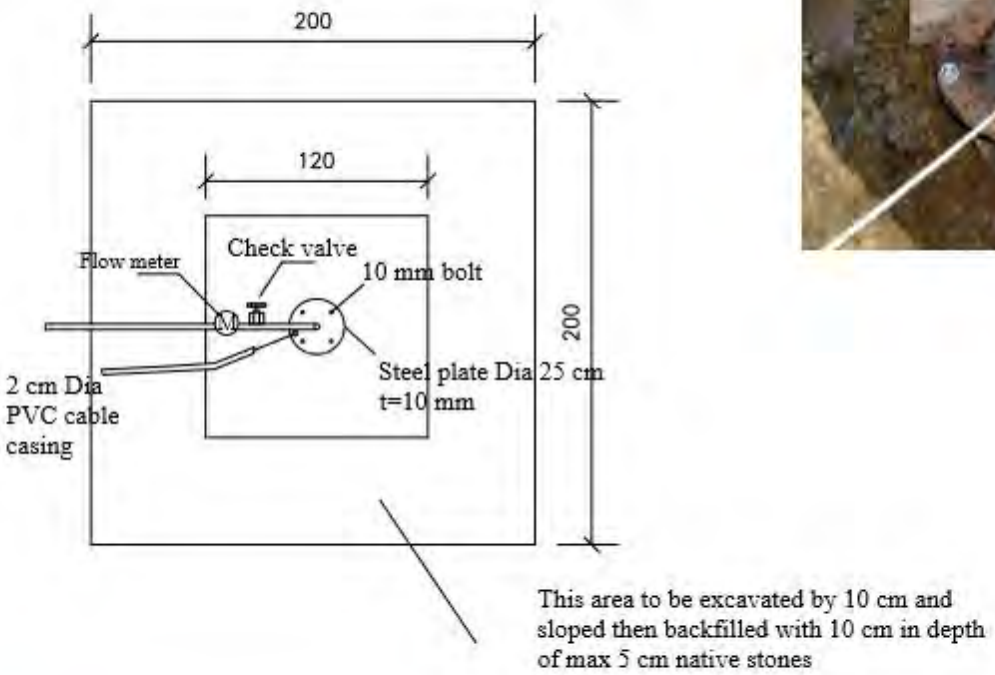


NOTES :
- CONCRETE FOUNDATION SHALL BE PLAIN CONCRETE 1:3:6
- GALVANIZED MESH SHALL BE DIPPED (MIN 300 gr/m2, EN1461), 2 mm IN DIAMETER AND 50*50mm PARTED, SPIRAL KNITTED
-BARBED WIRE (OPTION 2) IS ACCEPTABLE INSTEAD OF WIRE MESH (OPTION 1)
- POLES SHALL BE PAINTED WITH 2 COATS OF RED OXIDE (CORROSION PREVENT) AND OIL PAINT
- LOCK SHALL BE PROVIDED ON THE GATE
- HINGES SHALL BE DIA 2 cm AND HEAVY DUTY
-DIAGONAL SUPPORTS SHALL BE INSTALLED AT EACH CORNER

FENCE DETAILS

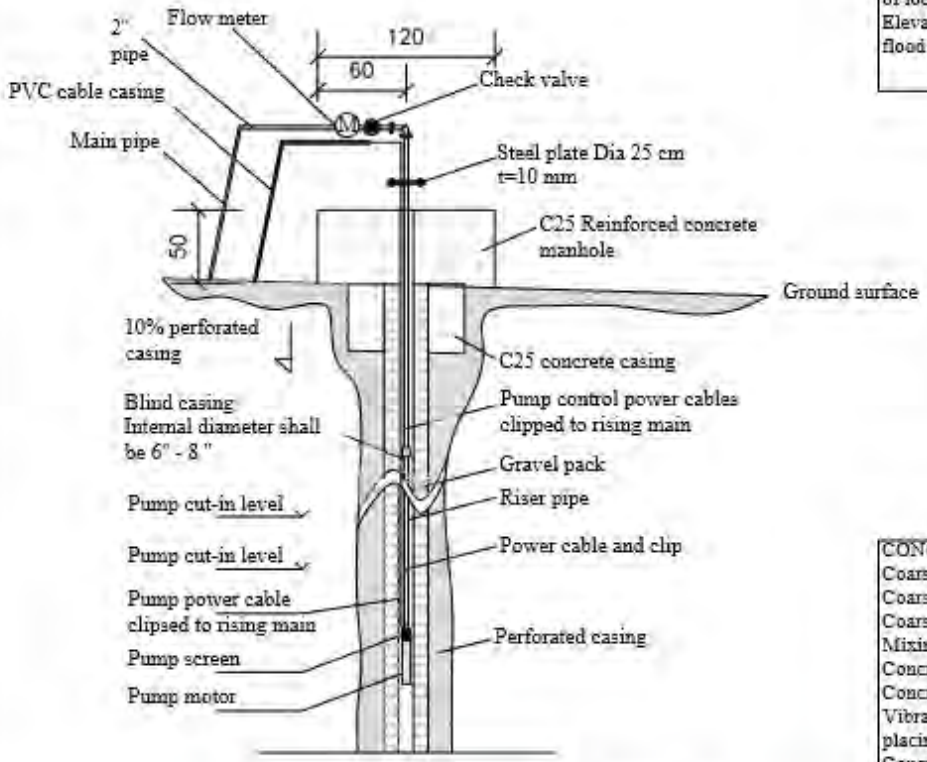
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO.
	TYPICAL DRAWING-2 WELL HEAD APRON AND HAND PUMP	LOWLAND WASH ENGINEERS	JUNE 2017	CM	5/5

TYPICAL DRAWING 3 - BOREHOLE WELL HEAD AND CASING ARRANGEMENT



WELL HEAD PLAN

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-3 BOREHOLE HEAD AND CASING ARRANGEMENT	LOWLAND WASH ENGINEERS	MAY 2017	CM	1/4

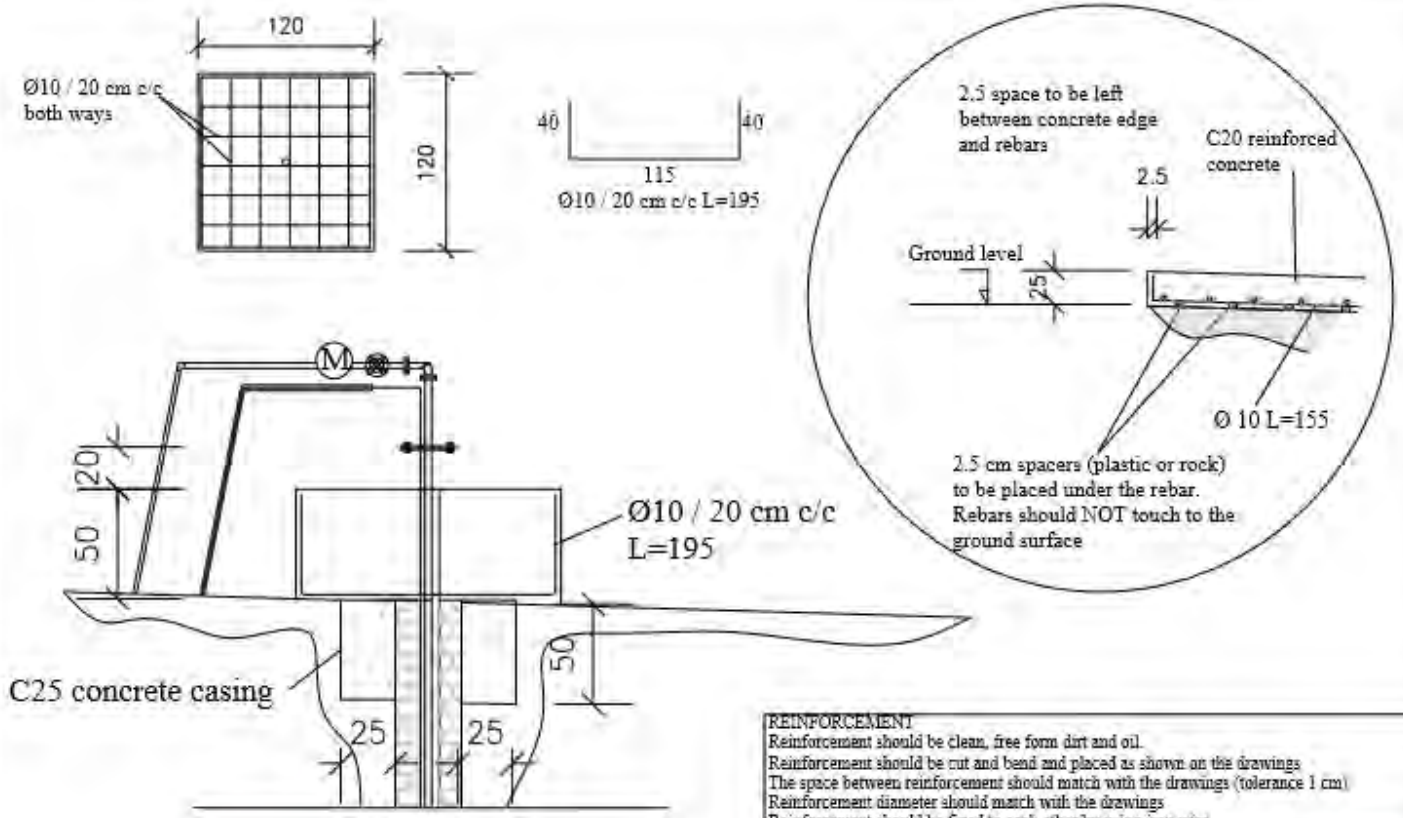


SECTION

NOTES
Pressure valve shall be installed upon request of local government.
Elevation of well head shall be arranged in order to allow flood protection.

CONCRETE
Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-3 BOREHOLE HEAD AND CASING ARRANGEMENT	LOWLAND WASH ENGINEERS	MAY 2017	CM	2/4

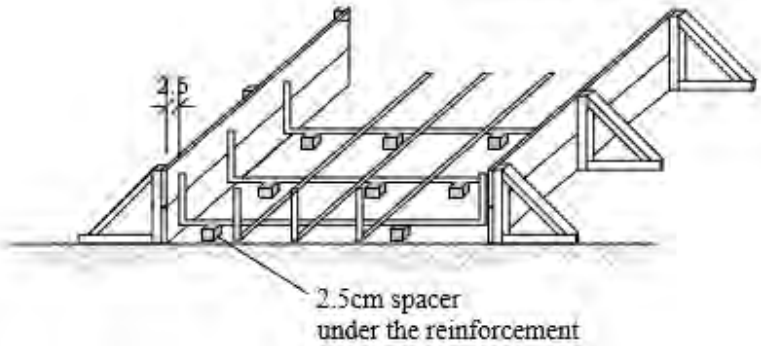


REINFORCEMENT DETAILS

REINFORCEMENT
Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-3 BOREHOLE HEAD AND CASING ARRANGEMENT	LOWLAND WASH ENGINEERS	MAY 2017	CM	3/4

Formwork and Bracing

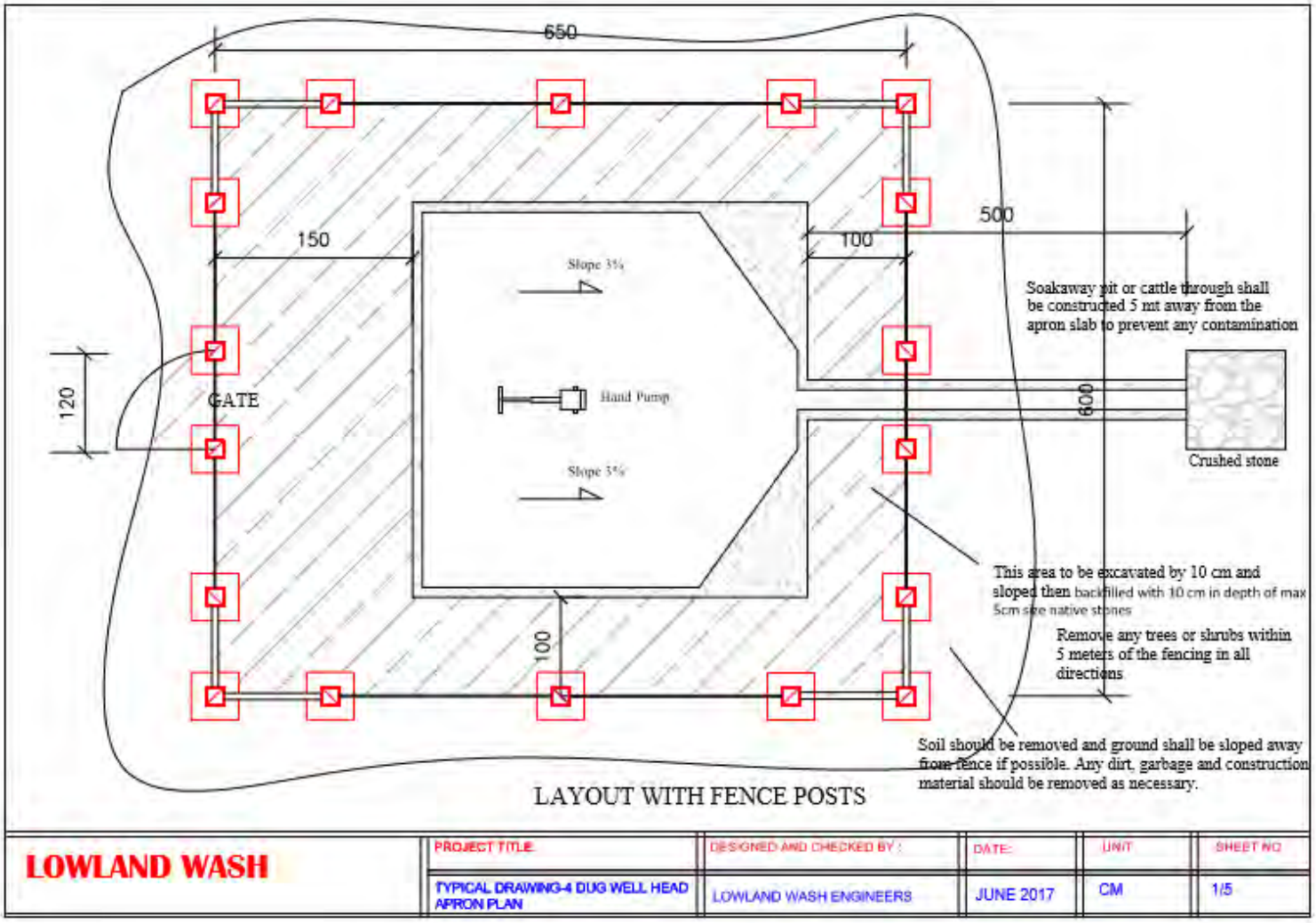


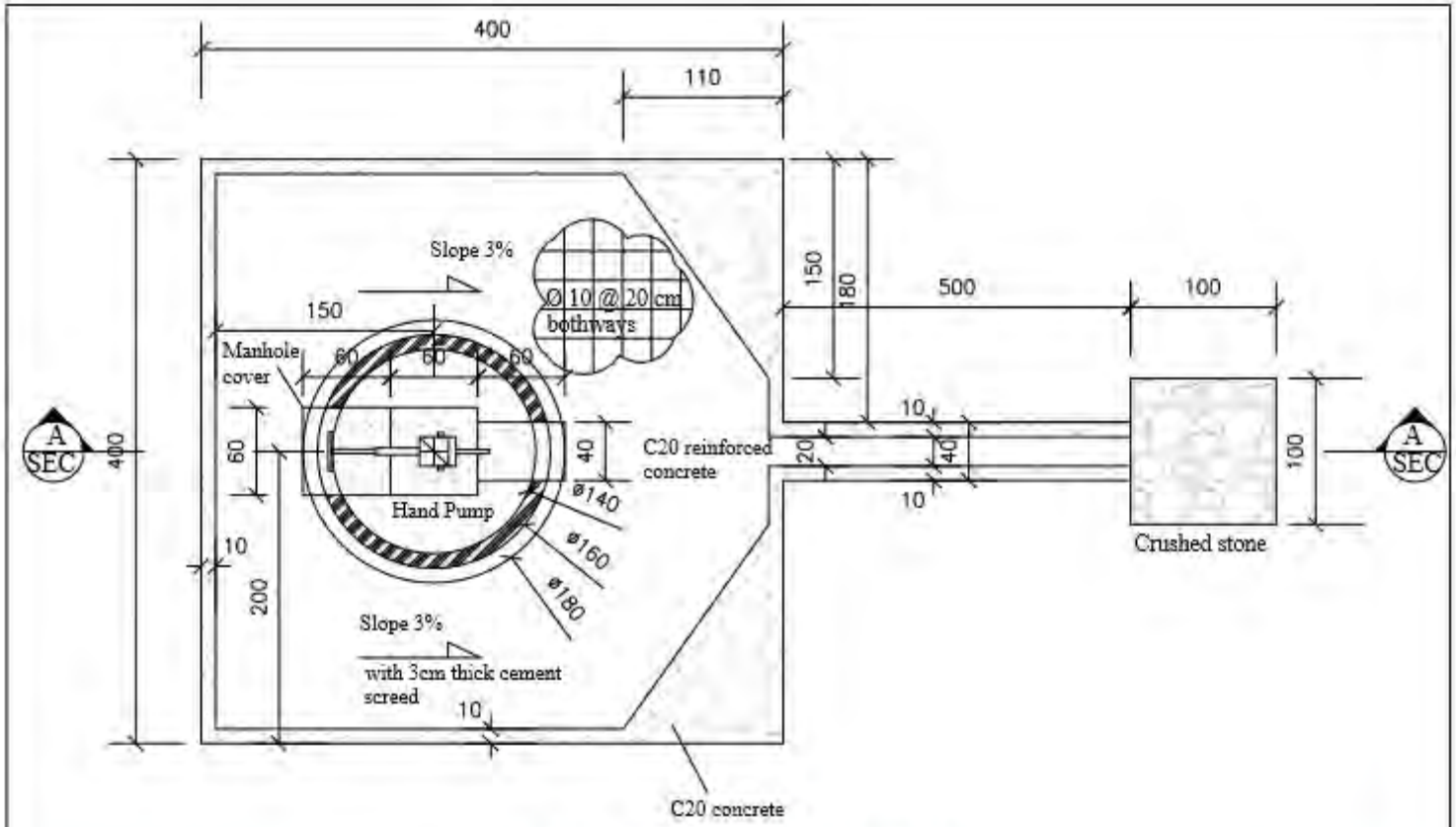
FORMWORK
The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface
The internal surface of the formwork must be clean and free from concrete scrap and dirt
The formwork should be levelled properly
Wood formwork used to form the top edge of the slab shall be cut straight and level
The formwork should be plumb and straight
A string line shall be used to ensure the formwork is straight and provides required slope
Before casting interior surfaces of the formwork should be moistened with water
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface
The mud slab that the concrete is being placed on must be debris, dirt and dust free
The formwork should be supported with braces properly and fixed with nails as needed.
The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads
The joints between the panels of the formwork should be adequately tight

FORMWORK AND REINFORCEMENT DETAILS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-3 BOREHOLE HEAD AND CASING ARRANGEMENT	LOWLAND WASH ENGINEERS	MAY 2017	CM	4/4

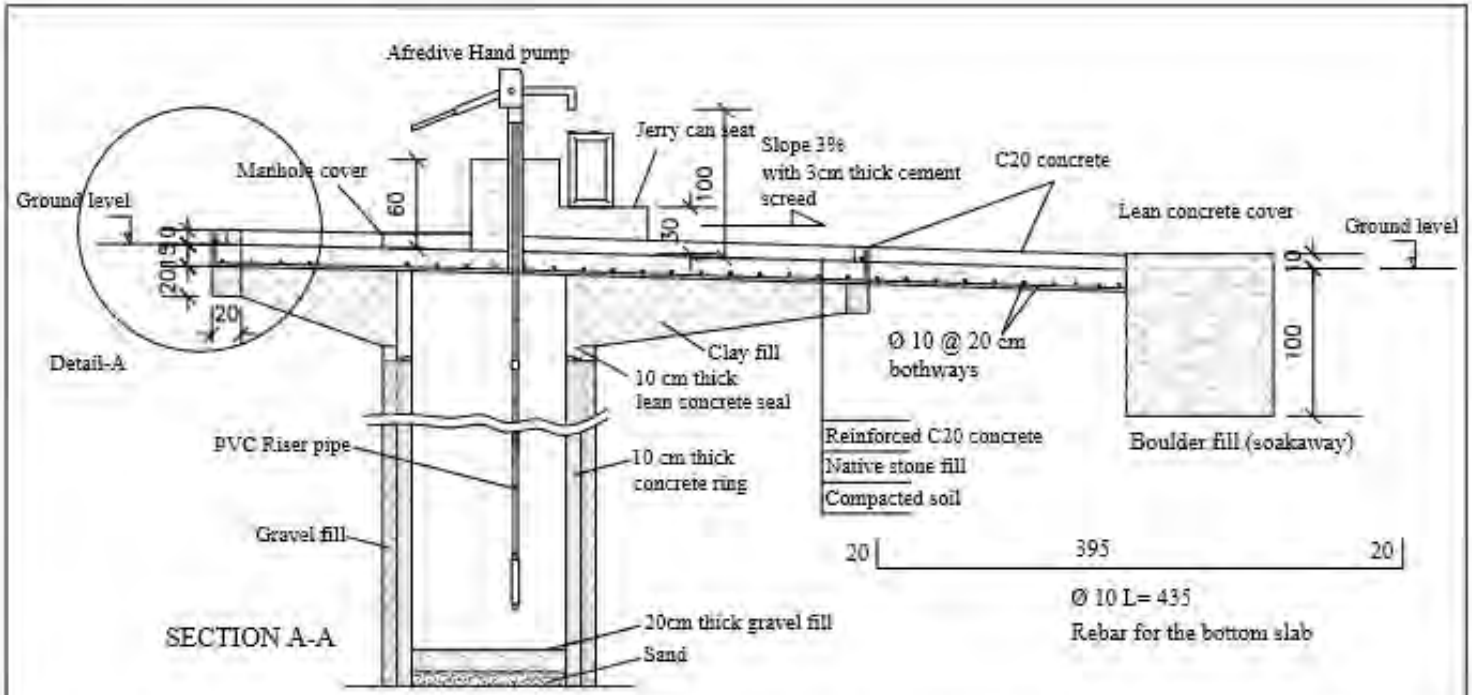
TYPICAL DRAWING 4 – DUG WELL HEAD AND APRON PLAN





WELL HEAD AND APPRON PLAN

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-4 DUG WELL HEAD APRON PLAN	LOWLAND WASH ENGINEERS	JUNE 2017	CM	2/5



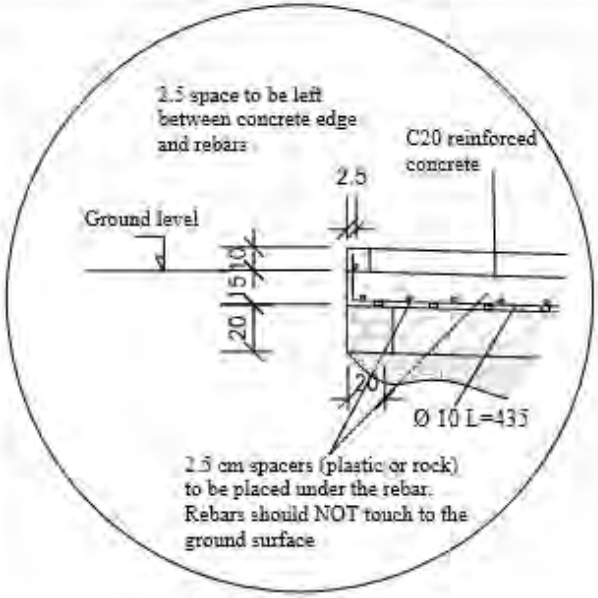
CONCRETE
Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

1 m3 C20 concrete batching amounts
Ratio 1:2:4
6 bags cement (300 kg cement)
0.25 m3 coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)
Max 180 lt water (W/C ratio 0.60)

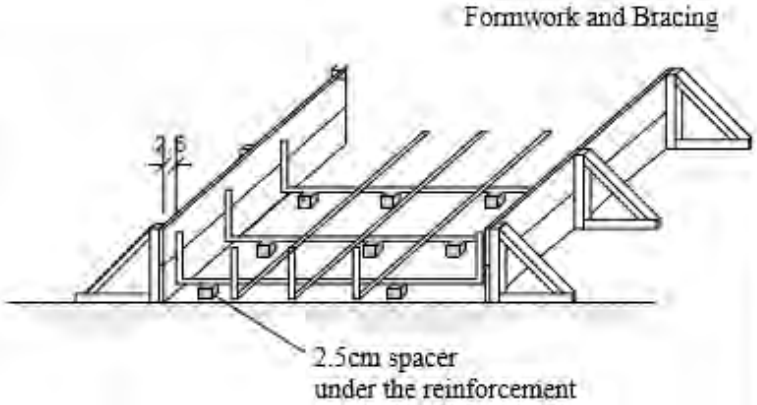
Standard Mixes for Ordinary Structural Concrete
per 50 kg bag of cement
1 bag cement (50 kg cement)
275 kg crushed stone (max dia 2 cm) and coarse sand
0.155 m3 concrete
Max 30 lt water (W/C ratio 0.60)

1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 30x50x20cm)
6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg/m3

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY:	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-4 FNSD WELL HEAD APRON PLAN	LOWLAND WASH ENGINEERS	JUNE 2017	CM	3/5



Detail-A

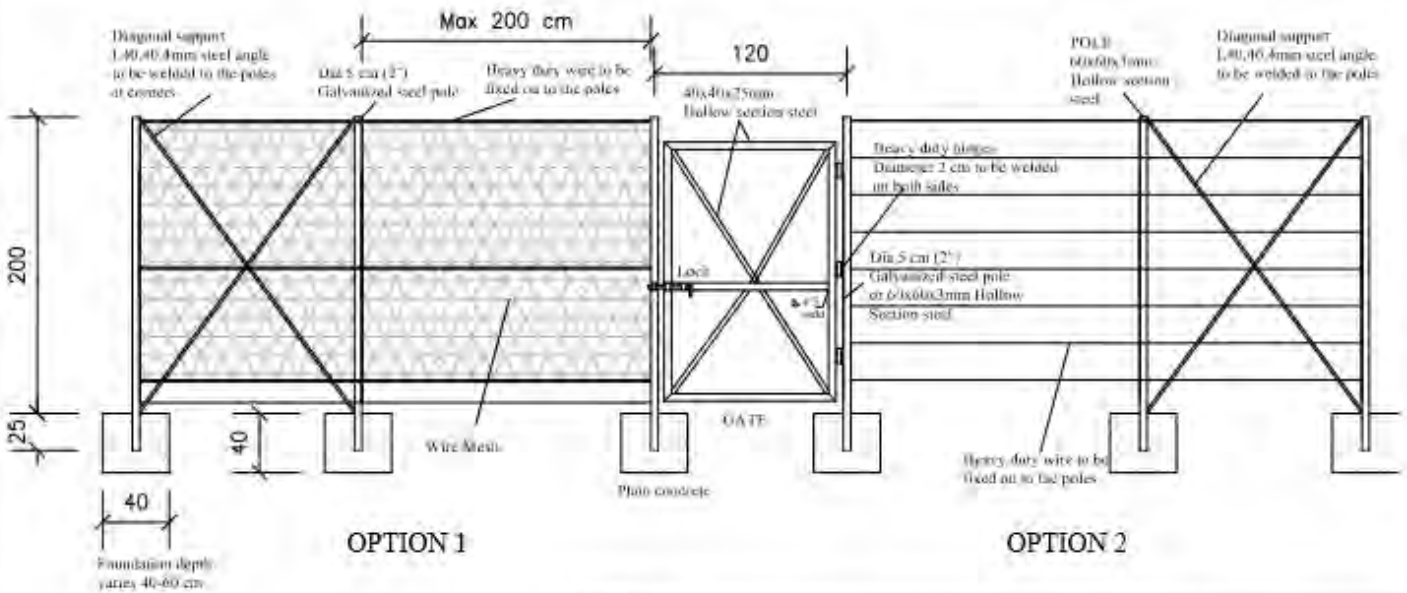


REINFORCEMENT
Reinforcement should be clean, free form dirt and oil
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

FORMWORK
The formwork shall be consructed so that there is no loss of fines or blemish of the concrete surface
The internal surface of the formwork must be clean and free from concrete scrap and dirt
The formwork should be levelled properly
Wood formwork used to form the top edge of the slab shall be cut straight and level
The formwork should be plumb and straight
A string line shall be used to ensure the formwork is straight and provides required slope
Before casting interior surfaces of the formwork should be moistened with water
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface
The mud slab that the concrete is being placed on must be debris, dirt and dust free
The formwork should be supported with braces properly and fixed with nails as needed
The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads
The joints between the panels of the formwork should be adequately tight

FORMWORK AND REINFORCEMENT DETAILS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	DRG	SHEET NO
	TYPICAL DRAWING-4 DUG WELL HEAD APRON PLAN	LOWLAND WASH ENGINEERS	JUNE 2017	OM	4/5

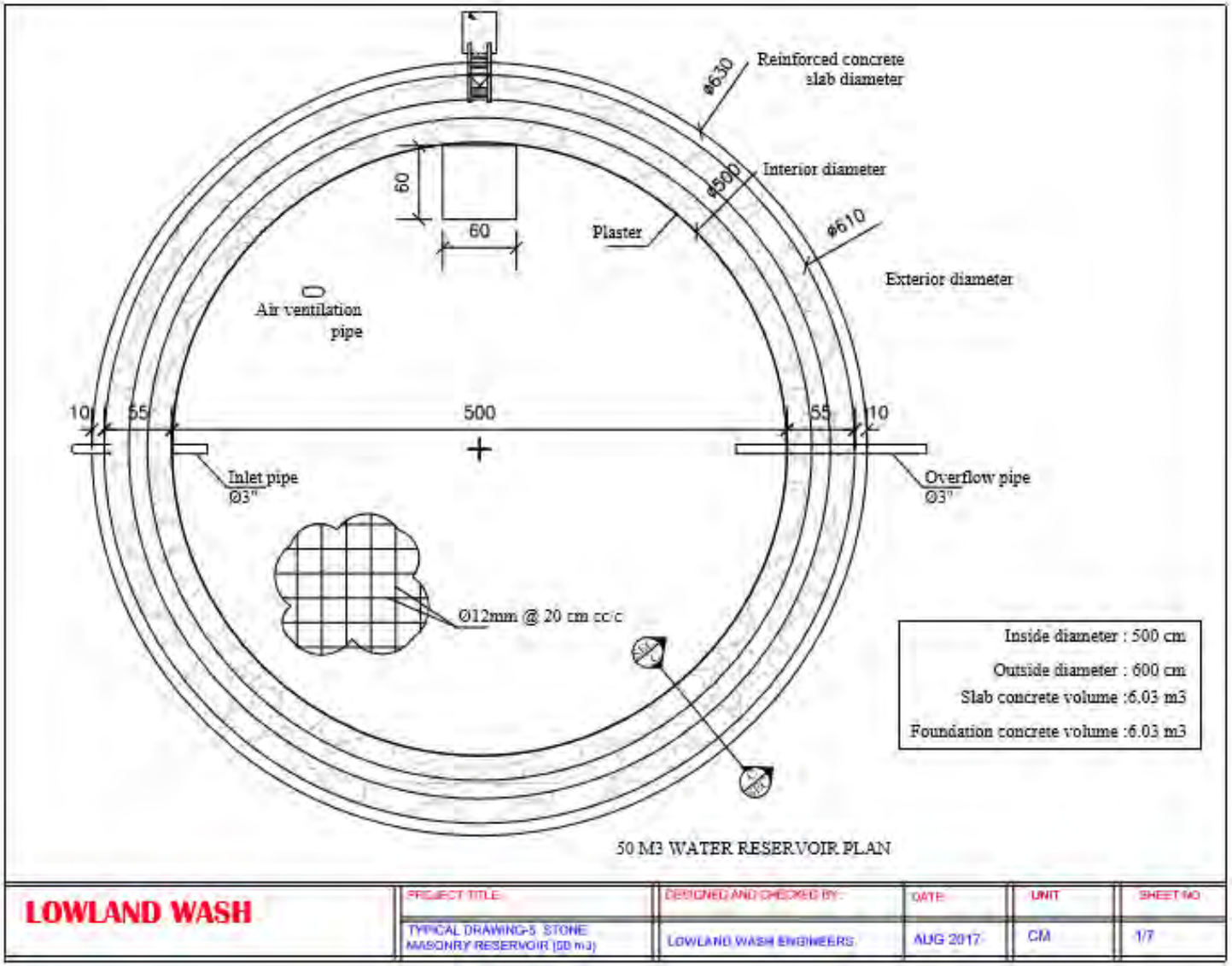


NOTES :
- CONCRETE FOUNDATION SHALL BE PLAIN CONCRETE 1:3:6
- GALVANIZED MESH SHALL BE DIPPED (MIN 300 gr/m2, EN1461), 2 mm IN DIAMETER AND 50*50mm PARTED, SPIRAL KNITTED
-BARBED WIRE (OPTION 2) IS ACCEPTABLE INSTEAD OF WIRE MESH (OPTION 1)
- POLES SHALL BE PAINTED WITH 2 COATS OF RED OXIDE (CORROSION PREVENT) AND OIL PAINT
- LOCK SHALL BE PROVIDED ON THE GATE
- HINGES SHALL BE DIA 2 cm AND HEAVY DUTY
-DIAGONAL SUPPORTS SHALL BE INSTALLED AT EACH CORNER

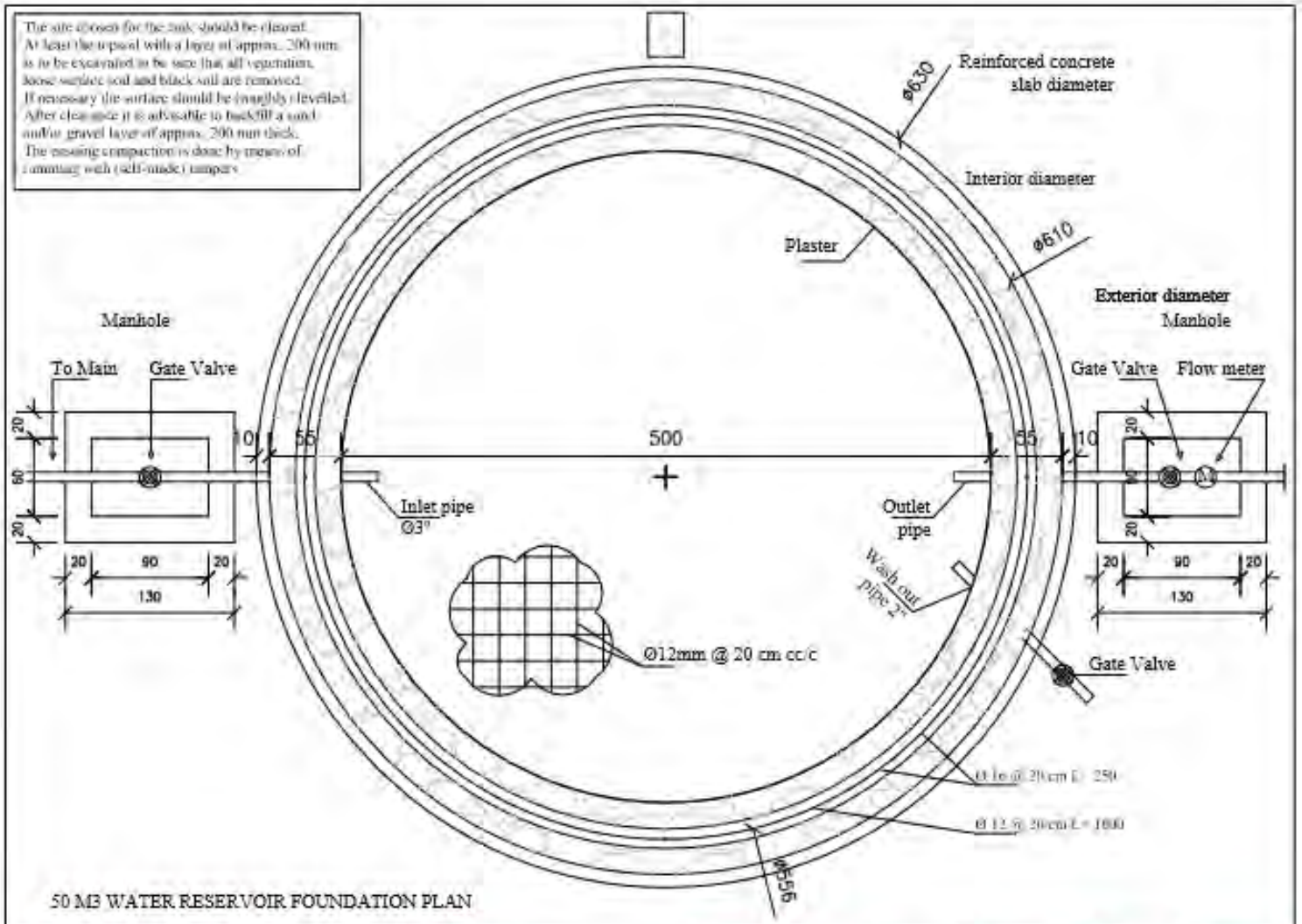
FENCE DETAILS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING-4 DUG WELL HEAD APRON PLAN	LOWLAND WASH ENGINEERS	JUNE 2017	CM	5/5

TYPICAL DRAWING 5 –STONE MASONRY RESERVOIR (50 M^3)

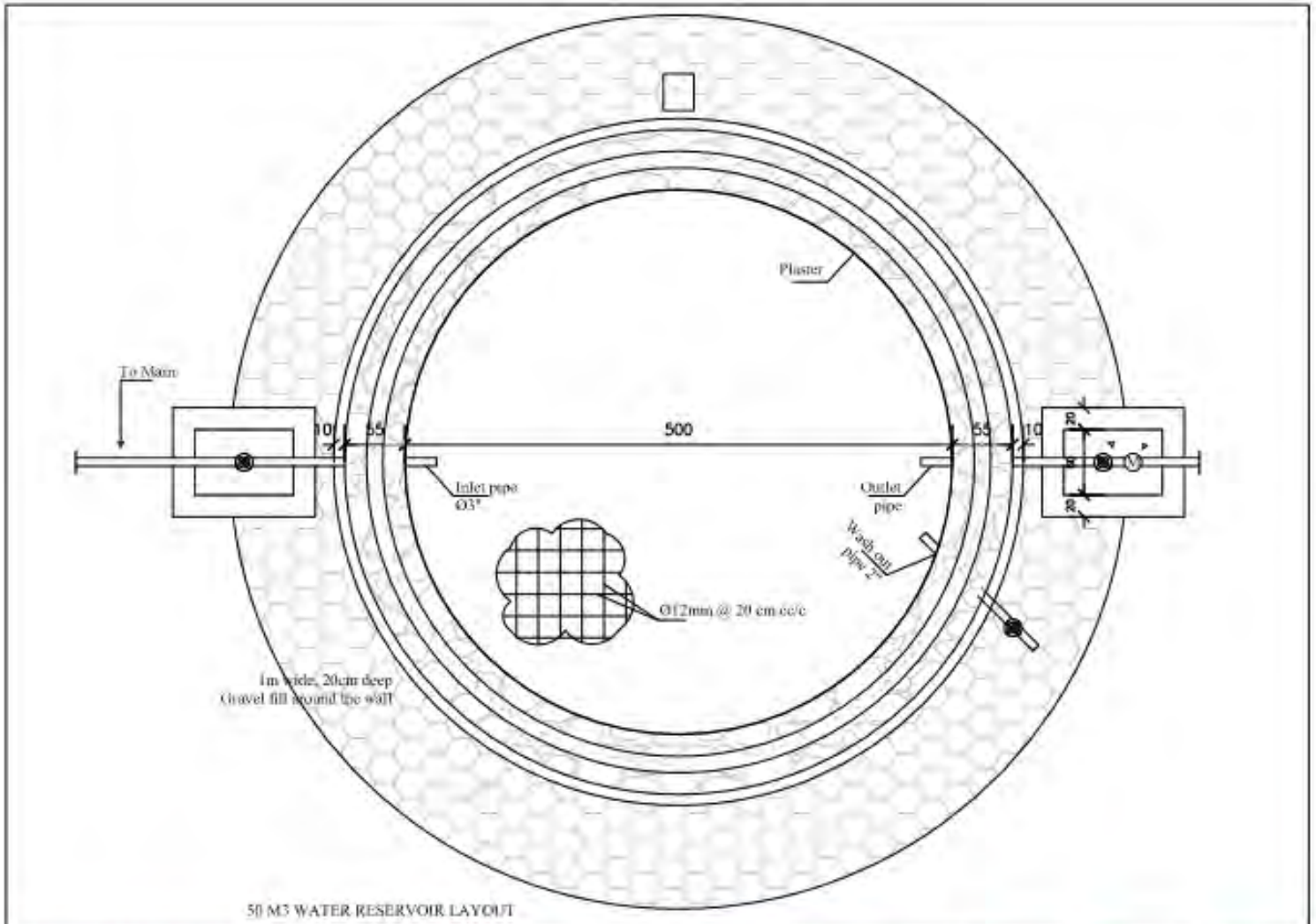


LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-5 STONE MASONRY RESERVOIR (50 m3)	LOWLAND WASH ENGINEERS	AUG 2017	CM	1/7



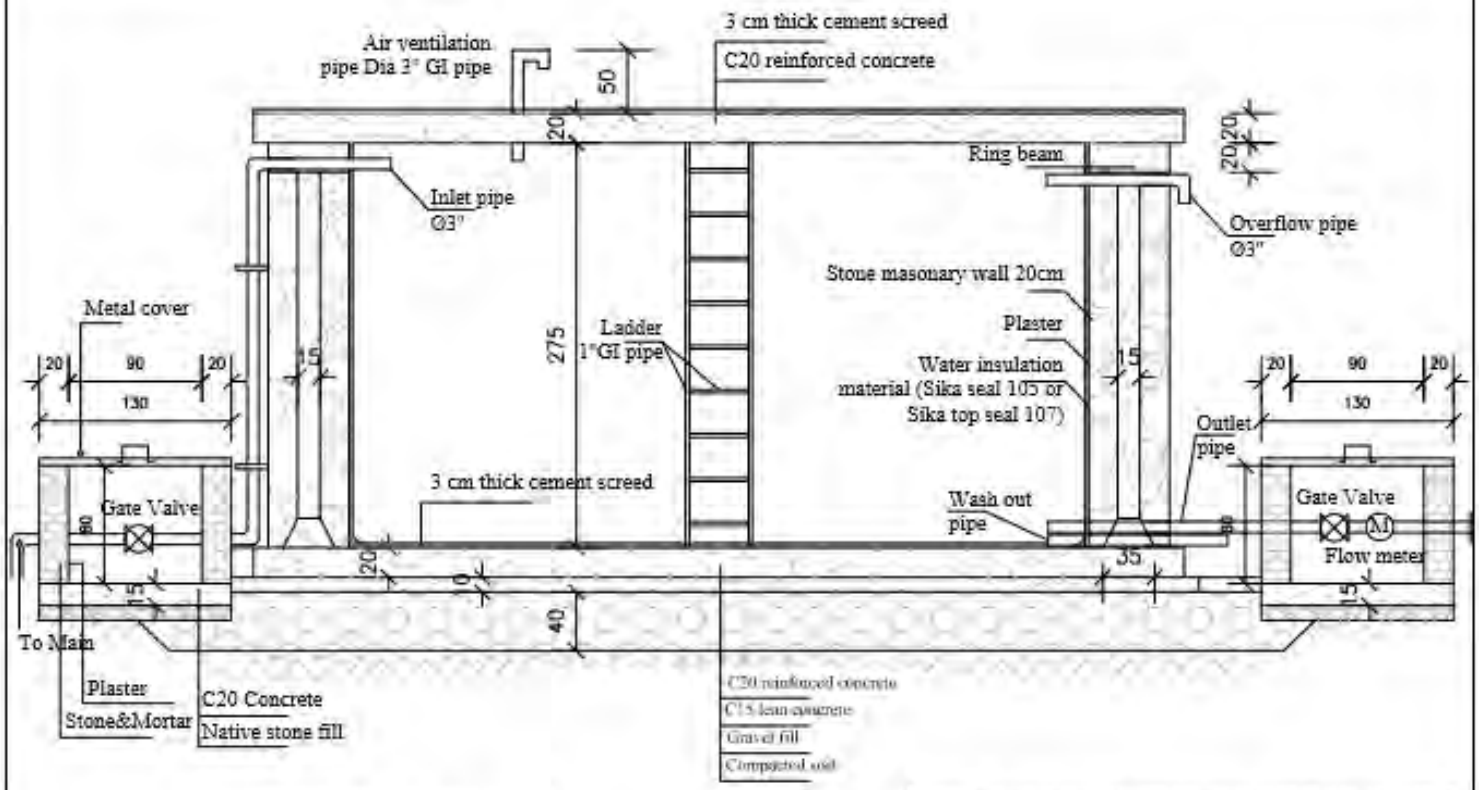
50 M3 WATER RESERVOIR FOUNDATION PLAN

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-5 STONE MASONRY RESERVOIR (50 m3)	LOWLAND WASH ENGINEERS	AUG 2017	CM	2/7



50 M3 WATER RESERVOIR LAYOUT

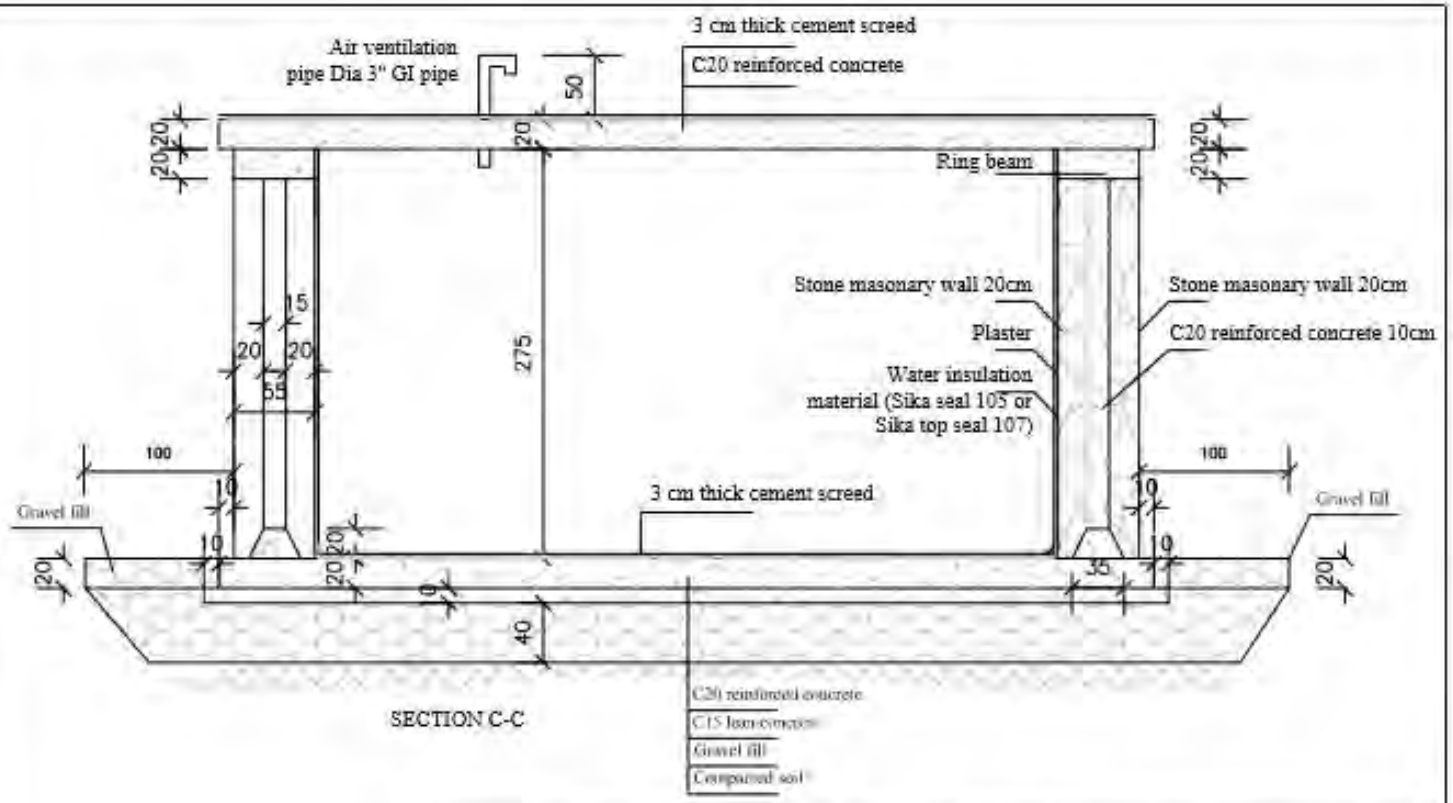
LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY:	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING-5 STONE MASONRY RESERVOIR (50 m3)	LOWLAND WASH ENGINEERS	AUG 2017	CM	3/7



CENTER SECTION INCLUDING
THE VALVE CHAMBERS

Note: The interior surface of the reservoir shall be covered with plaster. Over the plaster water sealing agent suitable for drinking water tanks shall be applied. Bitum based sealing product is not acceptable. Sika seal 105 or Sika top seal 107 shall be applied as permanufacturer's recommendations.

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-5 STONE MASONRY RESERVOIR (50 m3)	LOWLAND WASH ENGINEERS	AUG 2017	CM	4/7

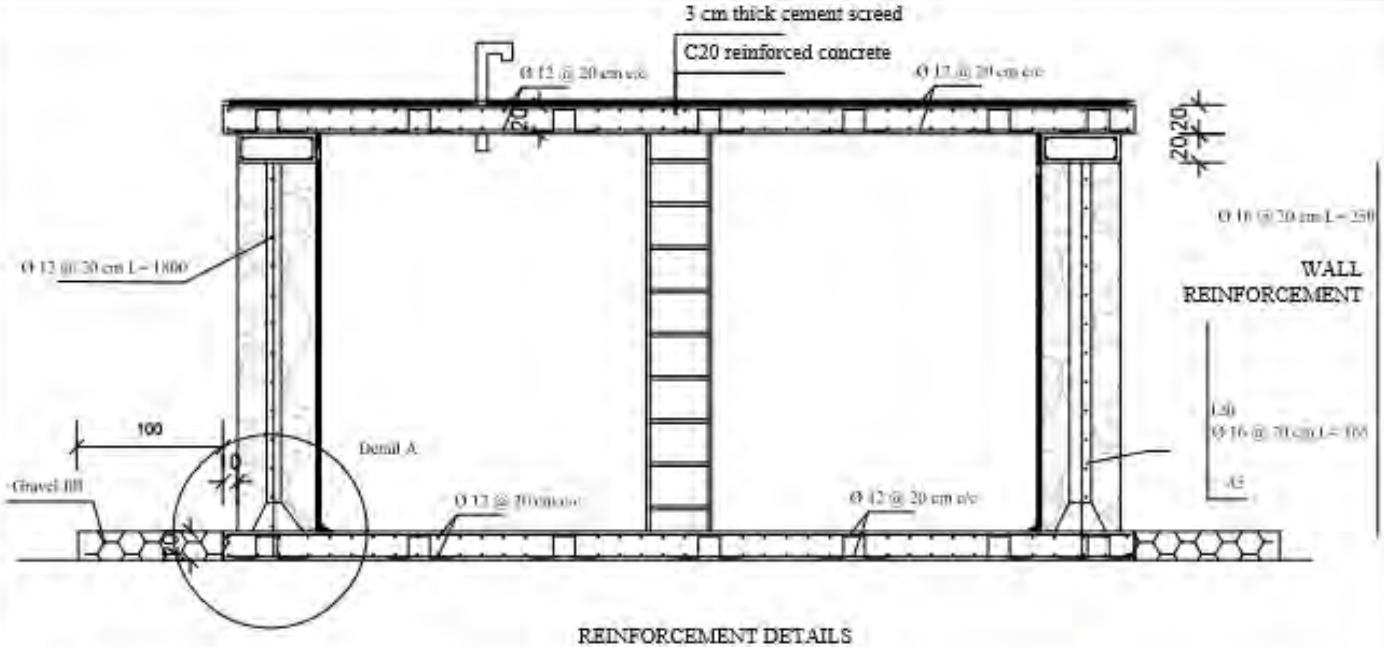


SECTION C-C

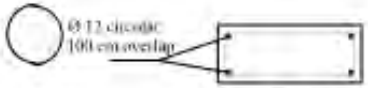
To ensure a more watertight construction it is advisable to scrape out the inner wall and slab joints and to apply an approximately 15 mm thick, rendering to the inner surfaces of the tank.
1 Part of cement to 5 parts of sand by volume batching.
Take special care of the joint between the tank slab and the tank wall. The joint should be cleaned and moistened before bricklaying of the tank wall starts.

The stones for the reservoir construction must be of good quality in order to obtain a watertight structure. Mortars for brickwork are a mixture of cement, sand and water, each ingredient having the correct proportion. For a maximum brickwork resistance to water pressure the following cement mortar mixes are advisable:
1 volume part of portland cement
2 volume parts of sand (fine aggregate)

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO.
	TYPICAL DRAWING-5 STONE MASONRY RESERVOIR (50 m3)	LOWLAND WASH ENGINEERS	AUG 2017	CM	5/7

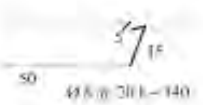


REINFORCEMENT DETAILS



20x55 cm

RING BEAM REINFORCEMENT



15

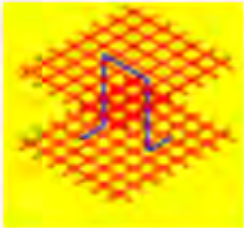
15

15

Ø 10 @ 60 cm o/c L = 75

stand to be placed in every 60 cm

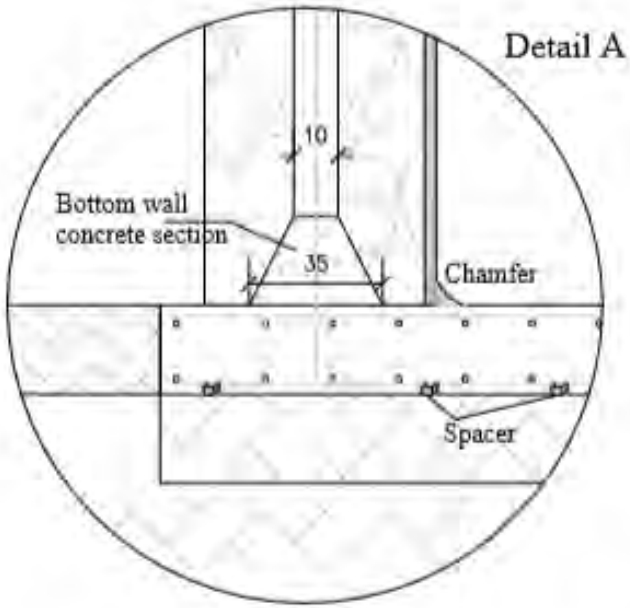
CONCRETE COVER IN THE SLAB SHOULD BE 2.5 cm.

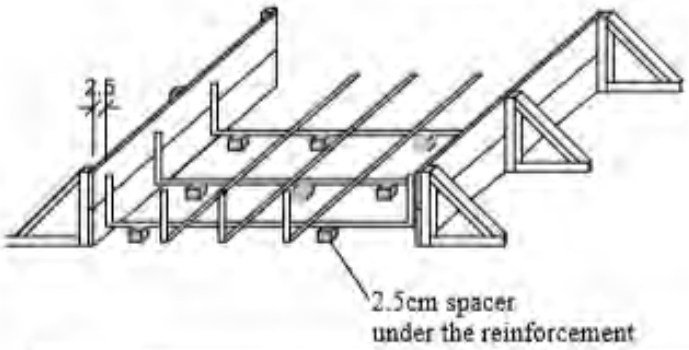


REINFORCEMENT

Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance ± cm)
Reinforcement diameter should match with the drawings
Reinforcement should by fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 6 STONE MASONRY RESERVOIR (50 m3)	LOWLAND WASH ENGINEERS	AUG 2017	CM	6/7





FORMWORK

The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface

The internal surface of the formwork must be clean and free from concrete scraps and dirt

The formwork should be levelled properly

Wood formwork used to form the top edge of the slab shall be cut straight and level

The formwork should be plumb and straight

A string line shall be used to ensure the formwork is straight and provides required slope

Before casting interior surfaces of the formwork should be moistened with water

While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface

The mud slab that the concrete is being placed on must be debris, dirt and dust free

The formwork should be supported with braces properly and fixed with nails as needed

The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads

The joints between the panels of the formworks should be adequately tight

CONCRETE

Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

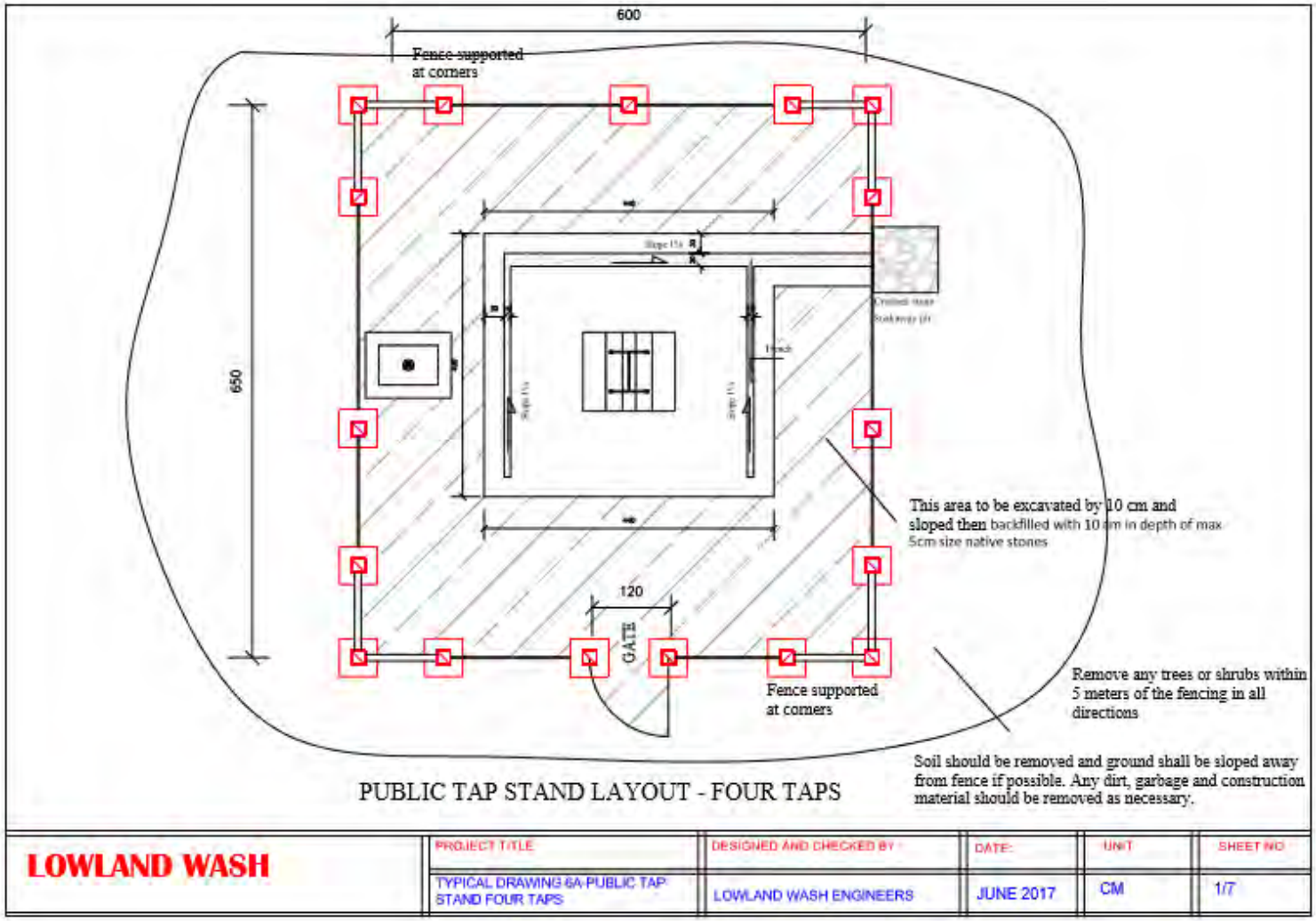
1 m3 C20 concrete batching amounts
Ratio 1:2:4
6 bags cement (300 kg cement)
0.25 m3 coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)
Max 180 lt water (W/C ratio 0.60)

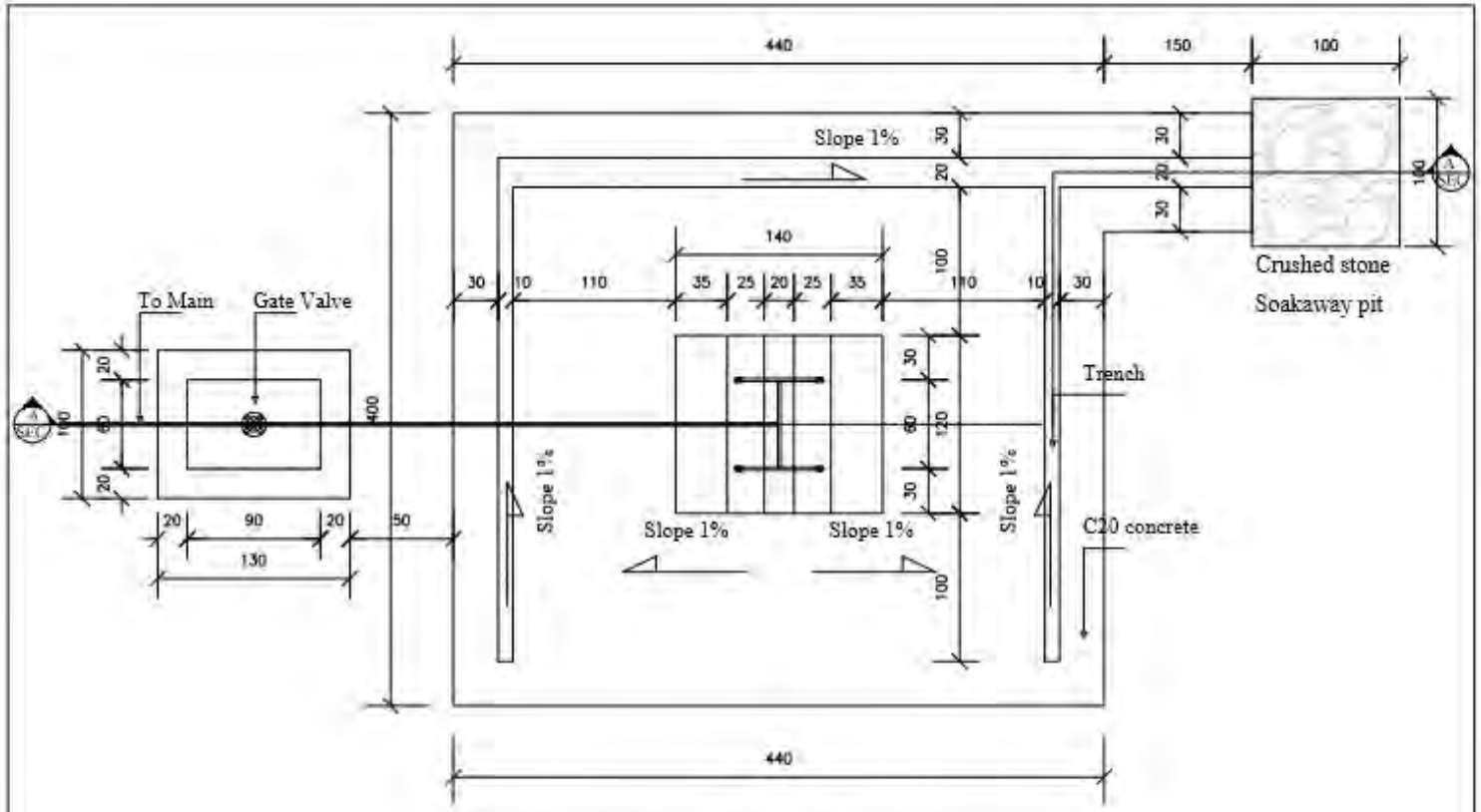
Standard Mixes for Ordinary Structural Concrete
per 50 kg bag of cement
1 bag cement (50 kg cement)
275 kg crushed stone (max dia 2 cm) and coarse sand
0.155 m3 concrete
Max 30 lt water (W/C ratio 0.60)

1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 50x30x20cm)
6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg/m3

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-5 STONE MASONRY RESERVOIR (50 m3)	LOWLAND WASH ENGINEERS	AUG 2017	CM	7/7

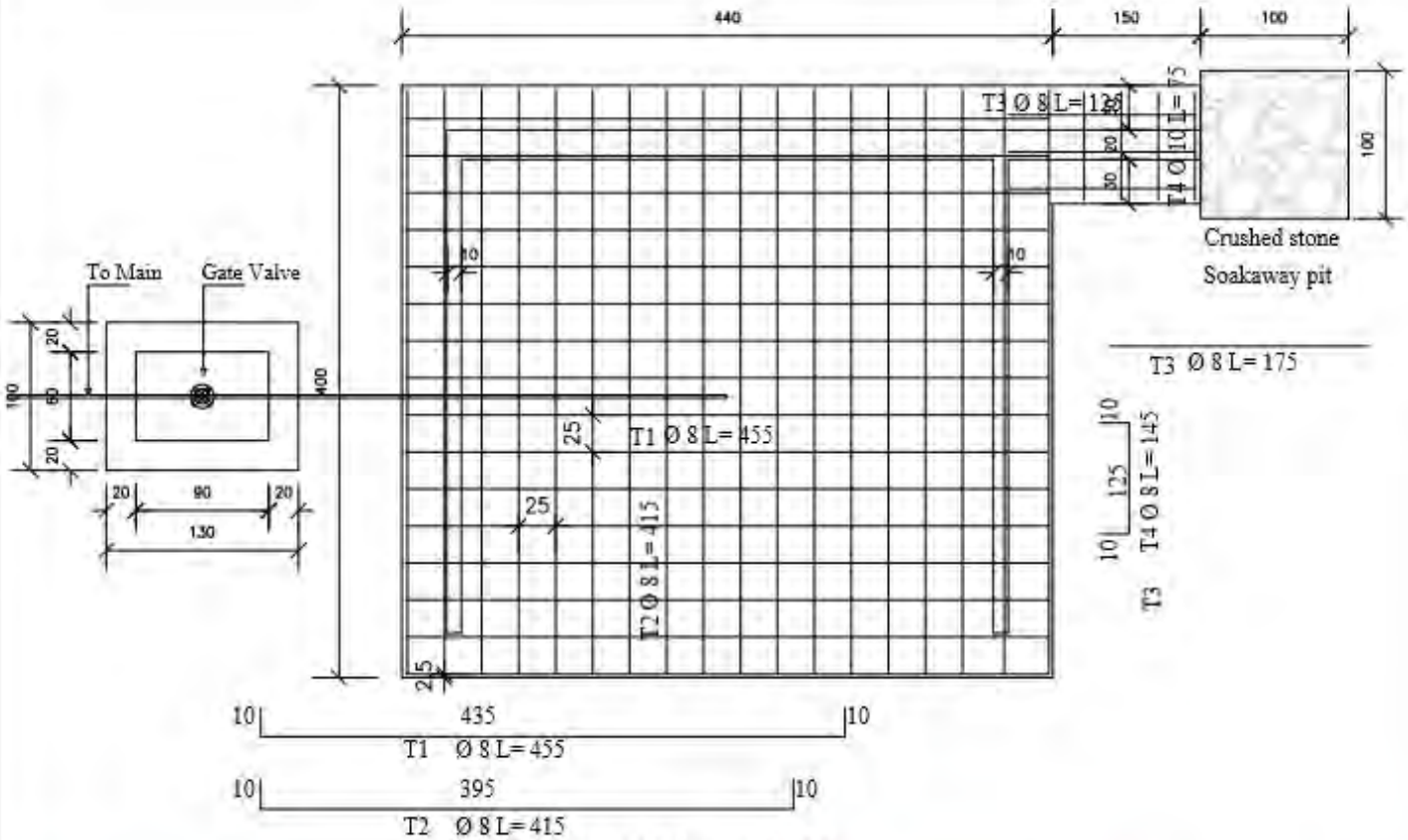
TYPICAL DRAWING 6A - PUBLIC TAPSTAND – FOUR TAPS





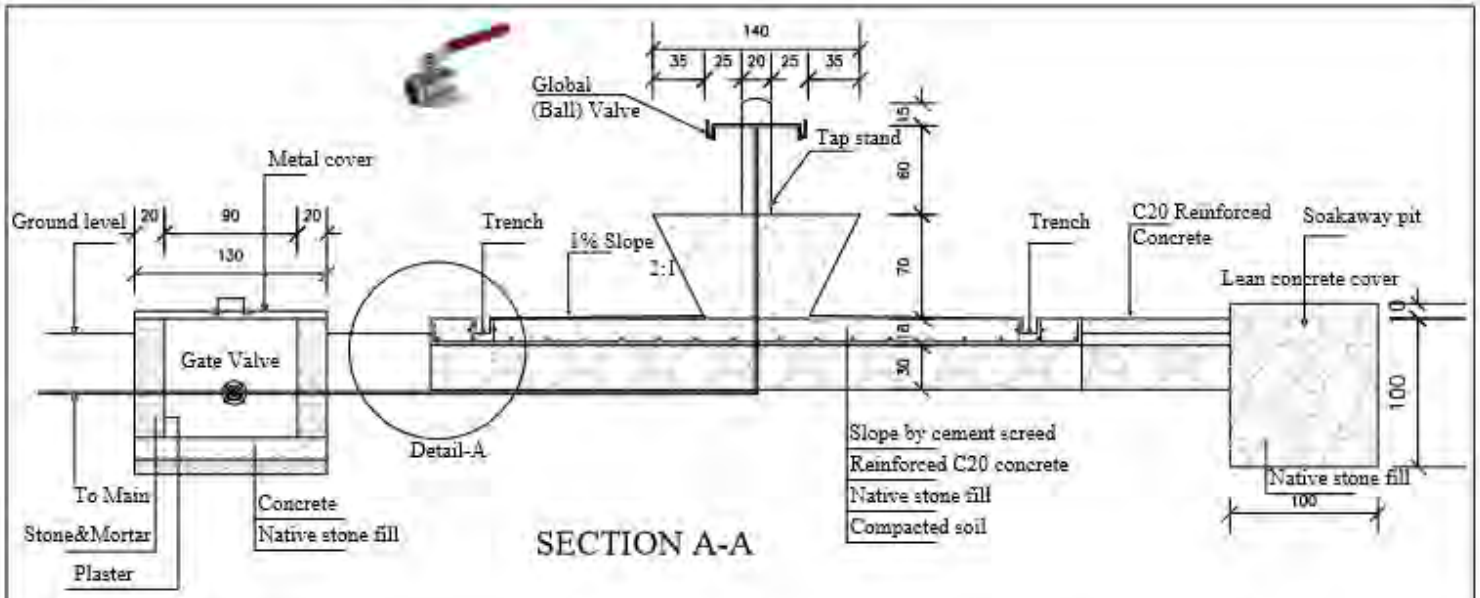
PUBLIC TAP STAND PLAN - FOUR TAPS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 6A-PUBLIC TAP STAND FOUR TAPS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	2/7



REINFORCEMENT DETAILS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 6A-PUBLIC TAP STAND FOUR TAPS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	3/7



CONCRETE
Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

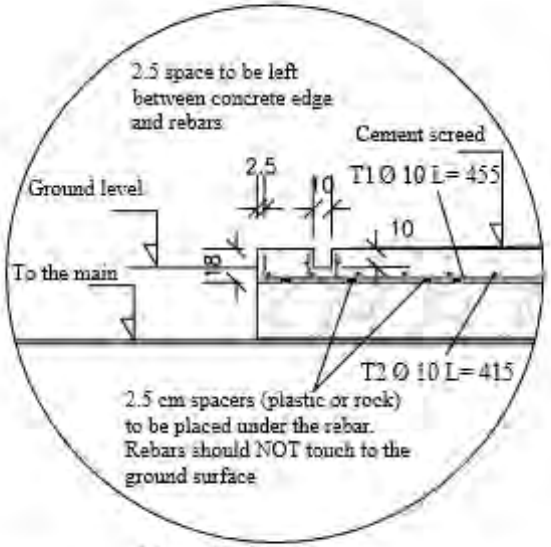
1 m3 C20 concrete batching amounts
Ratio 1:2:4
6 bags cement (300 kg cement)
0.25 m3 coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)
Max 180 lt water (W/C ratio 0.60)

Standard Mixes for Ordinary Structural Concrete
per 50 kg bag of cement
1 bag cement (50 kg cement)
275 kg crushed stone (max dia 2 cm) and coarse sand
0.155 m3 concrete
Max 30 lt water (W/C ratio 0.60)

1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 30x50x20cm)
6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg/m3

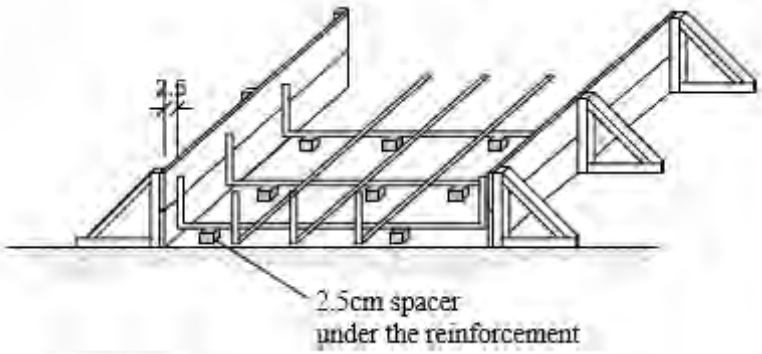
LOWLAND WASH

PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
TYPICAL DRAWING 6A-PUBLIC TAP STAND FOUR TAPS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	4/7



Detail-A

Formwork and Bracing



REINFORCEMENT

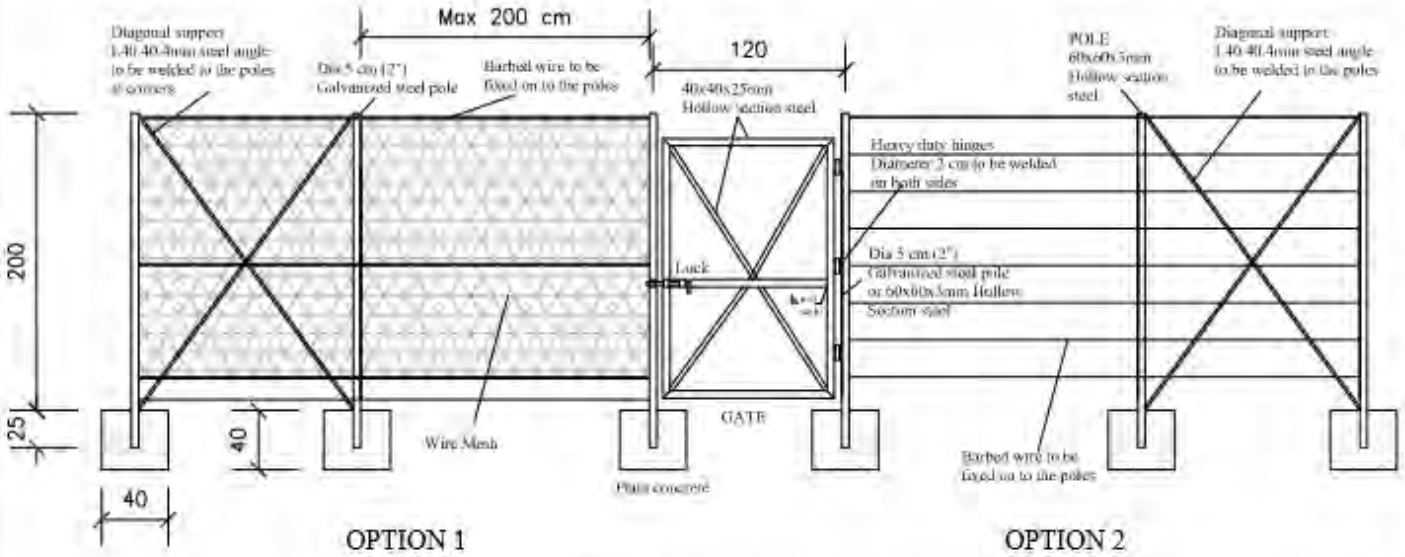
Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

FORMWORK

The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface
The internal surface of the formwork must be clean and free from concrete scrap and dirt
The formwork should be levelled properly
Wood formwork used to form the top edge of the slab shall be cut straight and level
The formwork should be plumb and straight
A string line shall be used to ensure the formwork is straight and provides required slope
Before casting interior surfaces of the formwork should be moistened with water
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface
The mud slab that the concrete is being placed on must be debris, dirt and dust free
The formwork should be supported with braces properly and fixed with nails as needed
The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads
The joints between the panels of the formwork should be adequately tight

FORMWORK AND REINFORCEMENT DETAILS

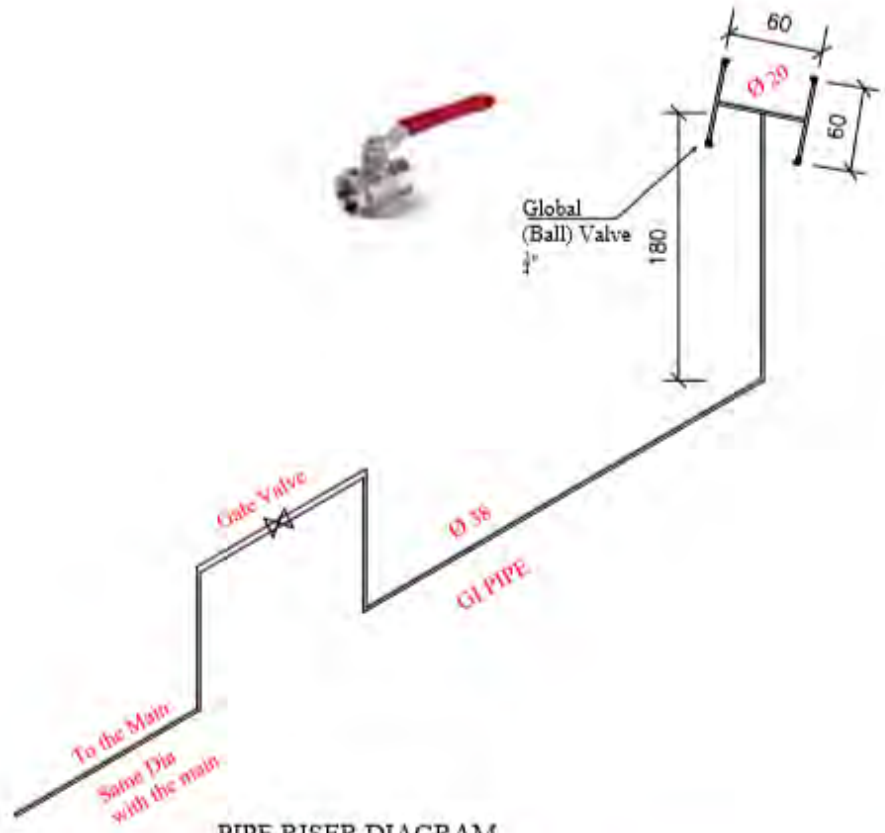
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 6A-PUBLIC TAP STAND, FOUR TAPS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	5/7



NOTES :
- CONCRETE FOUNDATION SHALL BE PLAIN CONCRETE 1:3:6
- GALVANIZED MESH SHALL BE DIPPED (MIN 300 gr/m2, EN1461), 2 mm IN DIAMETER AND 50*50mm PARTED, SPIRAL KNITTED
-BARBED WIRE (OPTION 2) IS ACCEPTABLE INSTEAD OF WIRE MESH (OPTION 1)
- POLES SHALL BE PAINTED WITH 2 COATS OF RED OXIDE (CORROSION PREVENT) AND OIL PAINT
- LOCK SHALL BE PROVIDED ON THE GATE
- HINGES SHALL BE DIA 2 cm AND HEAVY DUTY
-DIAGONAL SUPPORTS SHALL BE INSTALLED AT EACH CORNER

FENCE DETAILS

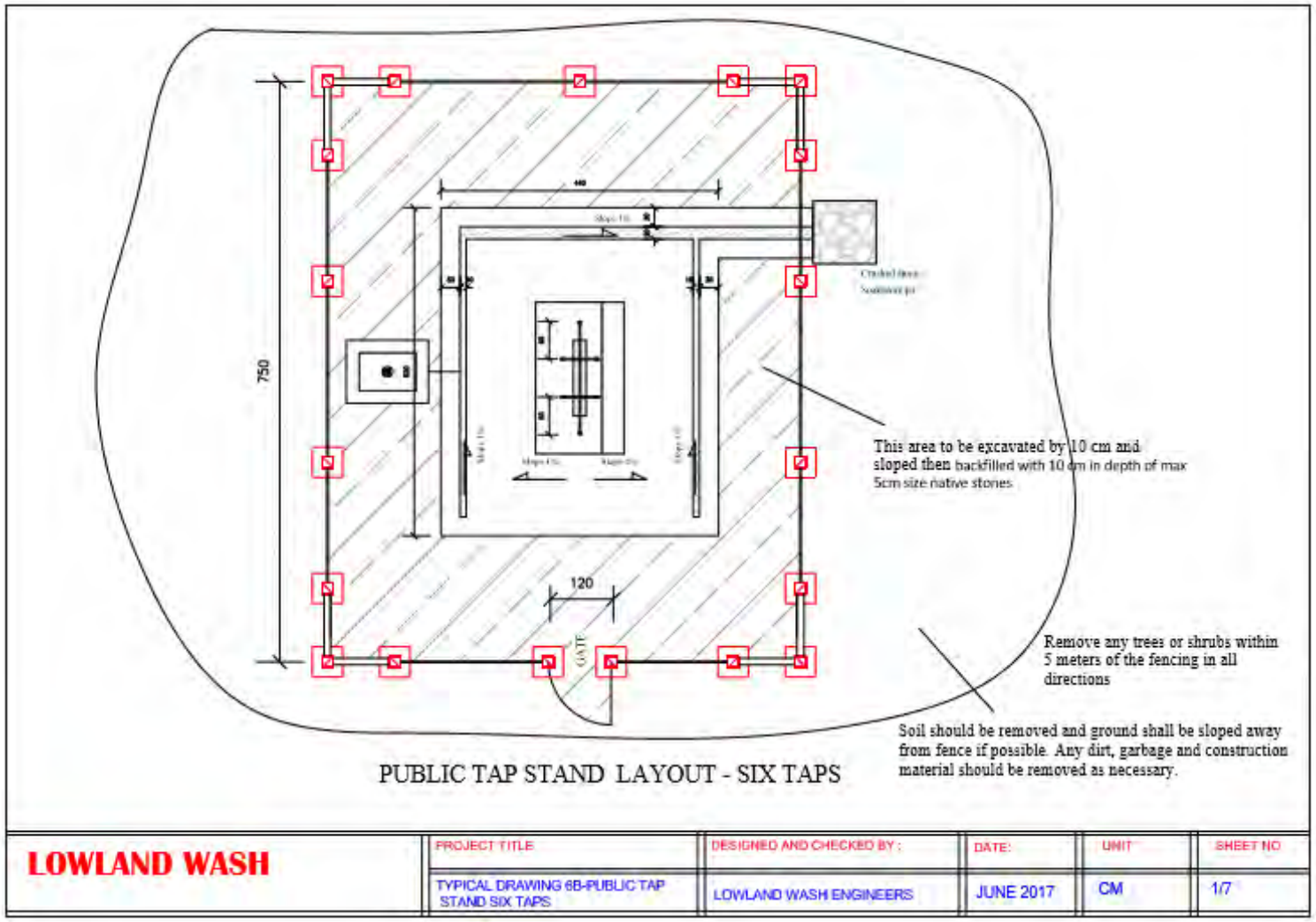
LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY:	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 6A-PUBLIC TAP STAND FOUR TAPS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	6/7



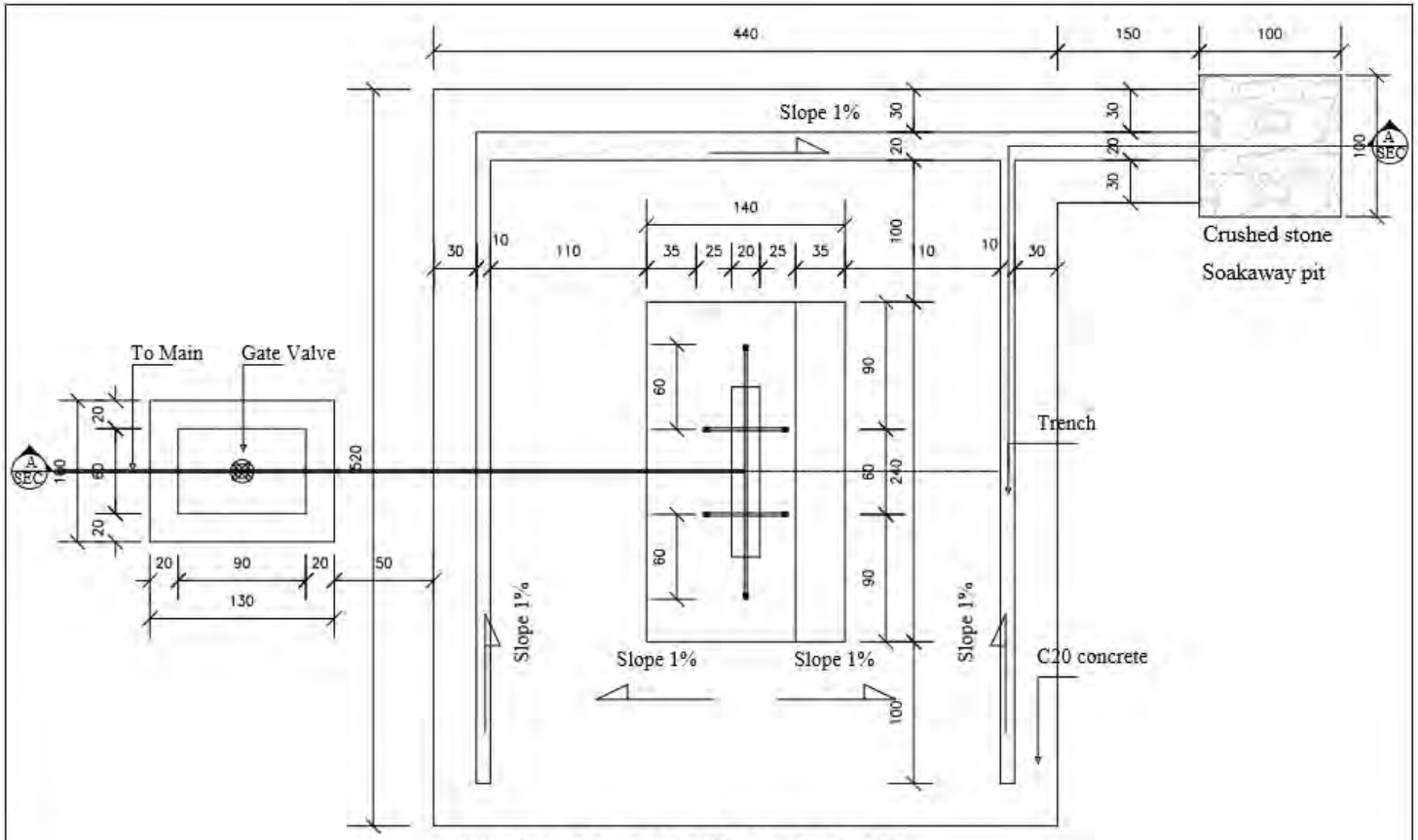
PIPE RISER DIAGRAM

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 6A-PUBLIC TAP STAND FOUR TAPS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	7/7

TYPICAL DRAWING 6B - PUBLIC TAPSTAND – SIX TAPS

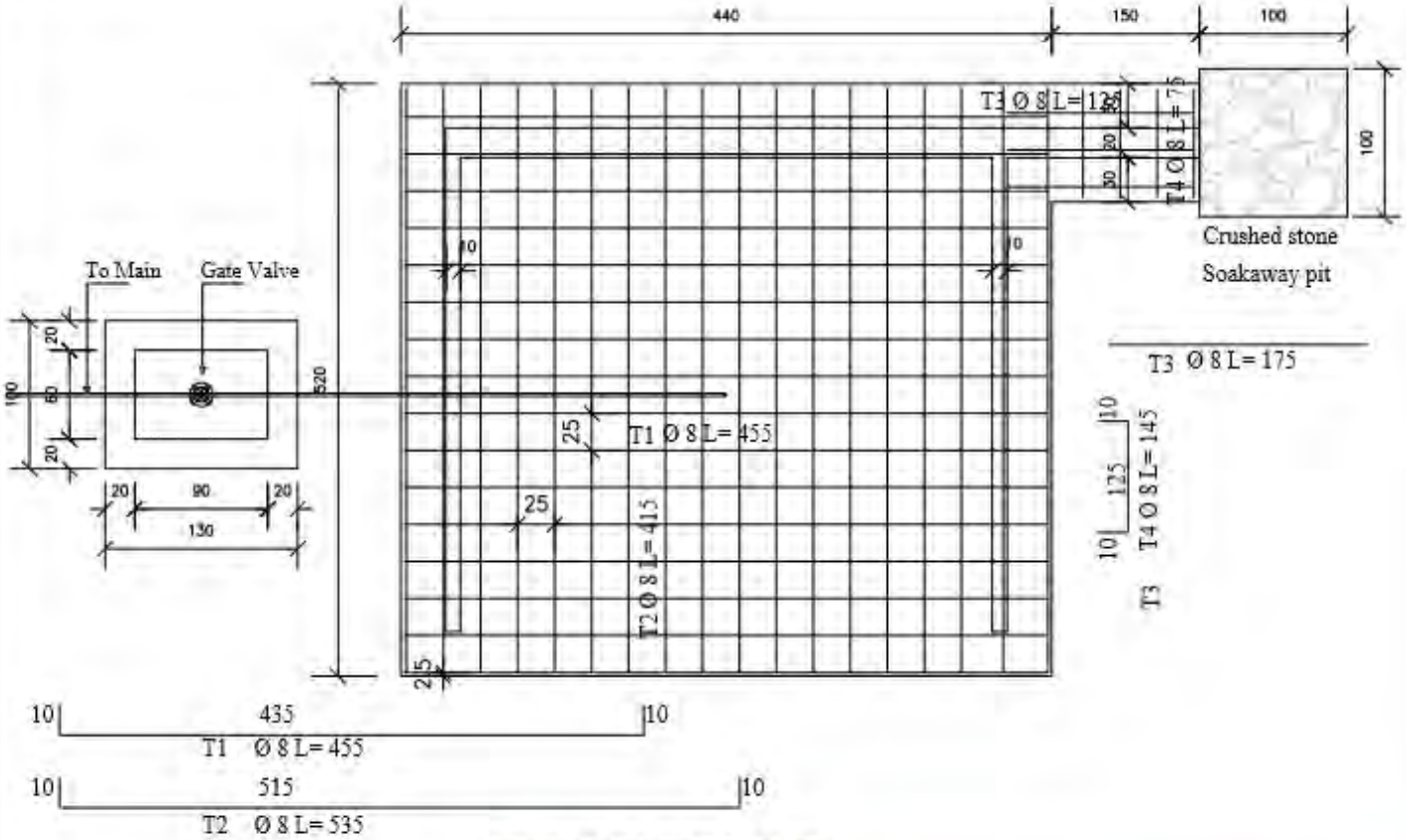


LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 6B-PUBLIC TAP STAND SIX TAPS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	1/7



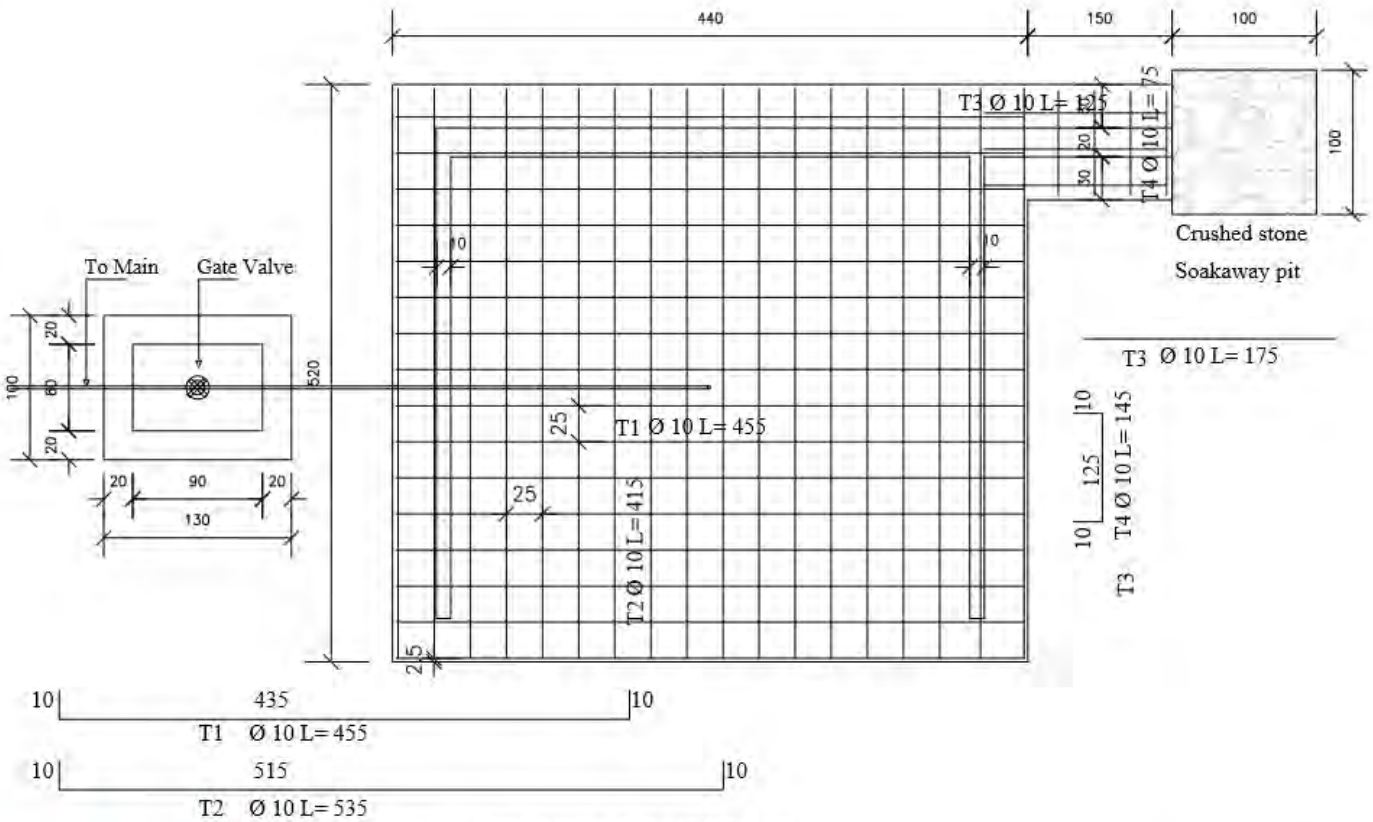
PUBLIC TAP STAND PLAN - SIX TAPS

LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY:	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 6B-PUBLIC TAP STAND SIX TAPS	LOWLAND WASH ENGINEERS	APRIL 2017	CM	2/7



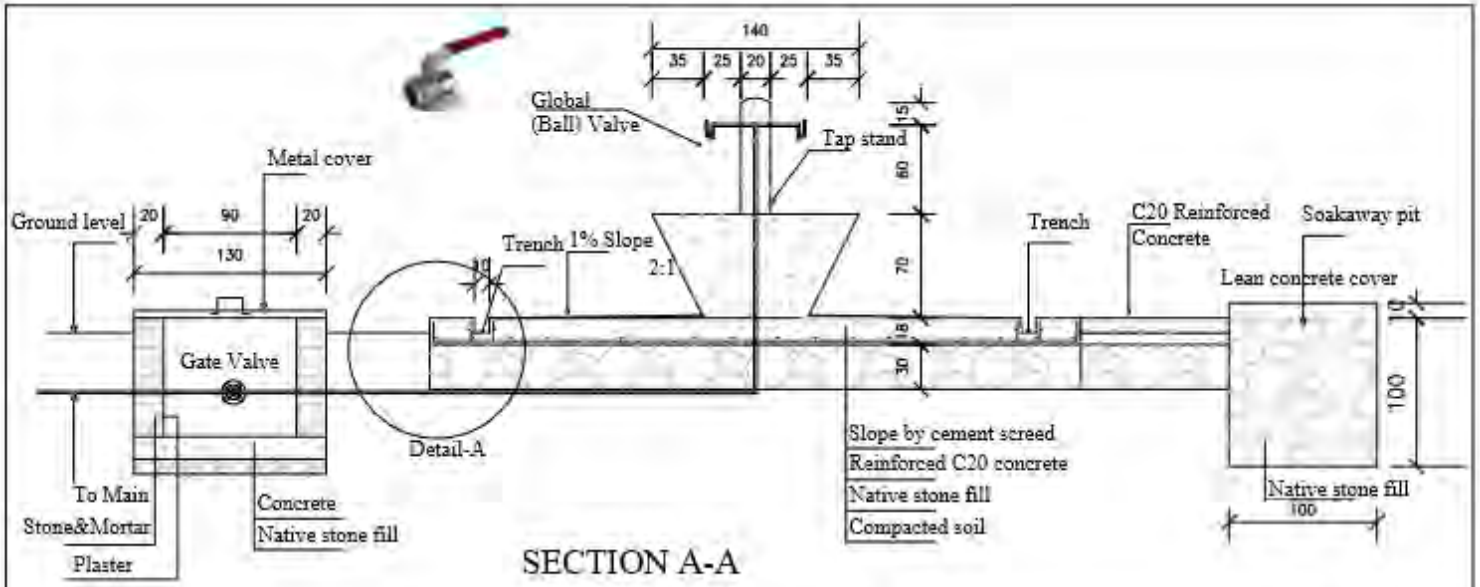
REINFORCEMENT DETAILS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 69-PUBLIC TAP STAND SIX TAPS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	3/7



REINFORCEMENT DETAILS

LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 6B-PUBLIC TAP STAND SIX TAPS	LOWLAND WASH ENGINEERS	APRIL 2017	CM	3/7



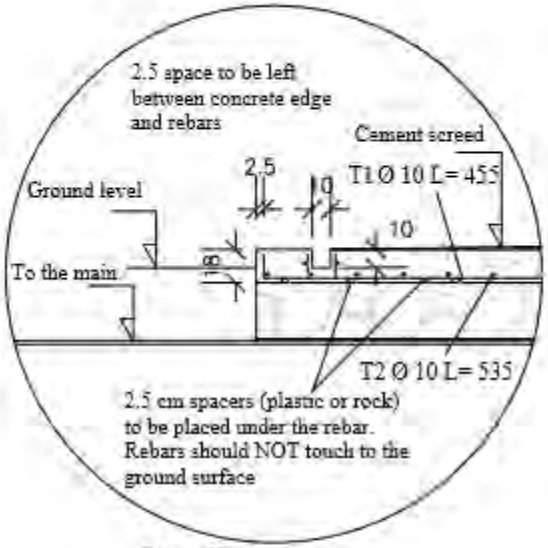
CONCRETE
Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

1 m3 C20 concrete batching amounts Ratio 1:2:4	Standard Mixes for Ordinary Structural Concrete per 50 kg bag of cement
6 bags cement (300 kg cement) 0.25 m3 coarse sand 0.50 m3 crushed stone (aggregate Dia 2cm) Max 180 lt water (W/C ratio 0.60)	1 bag cement (50 kg cement) 275 kg crushed stone (max dia 2 cm) and coarse sand 0.155 m3 concrete Max 30 lt water (W/C ratio 0.60)

1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 30x30x20cm)
6 bags cement (300 kg cement) 5 buckets coarse sand 10 buckets crushed stone (max Dia 2cm) Max 180 lt water (W/C ratio 0.60) Coarse sand and crushed stone density: 2200 kg/m3

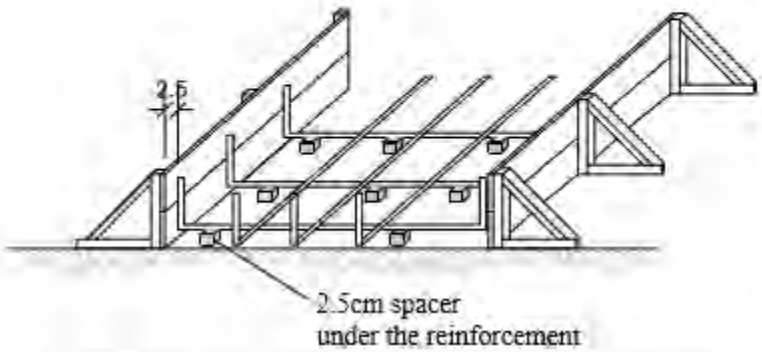
LOWLAND WASH

PROJECT TITLE	DESIGNED AND CHECKED BY:	DATE:	UNIT	SHEET NO
TYPICAL DRAWING 68-PUBLIC TAP STAND SIX TAPS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	4/7



Detail-A

Formwork and Bracing



REINFORCEMENT

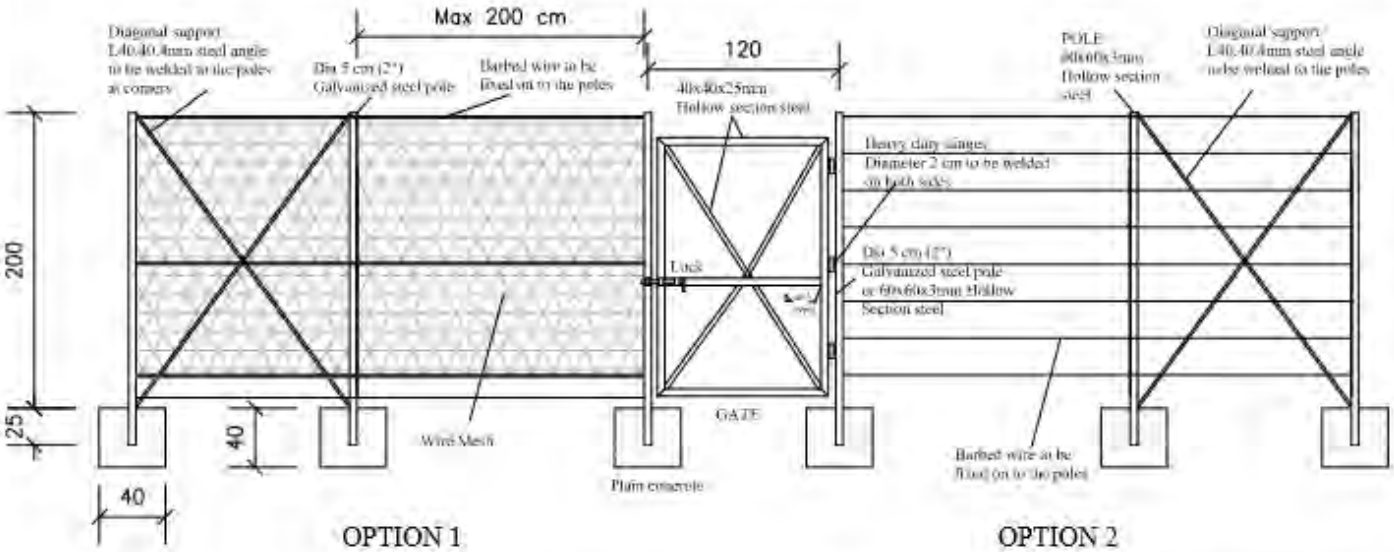
Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

FORMWORK

The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface
The internal surface of the formwork must be clean and free from concrete scrap and dirt
The formwork should be levelled properly
Wood formwork used to form the top edge of the slab shall be cut straight and level
The formwork should be plumb and straight
A string line shall be used to ensure the formwork is straight and provides required slope
Before casting interior surfaces of the formwork should be moistened with water
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface
The mud slab that the concrete is being placed on must be debris, dirt and dust free
The formwork should be supported with braces properly and fixed with nails as needed
The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads
The joints between the panels of the formwork should be adequately tight

FORMWORK AND REINFORCEMENT DETAILS

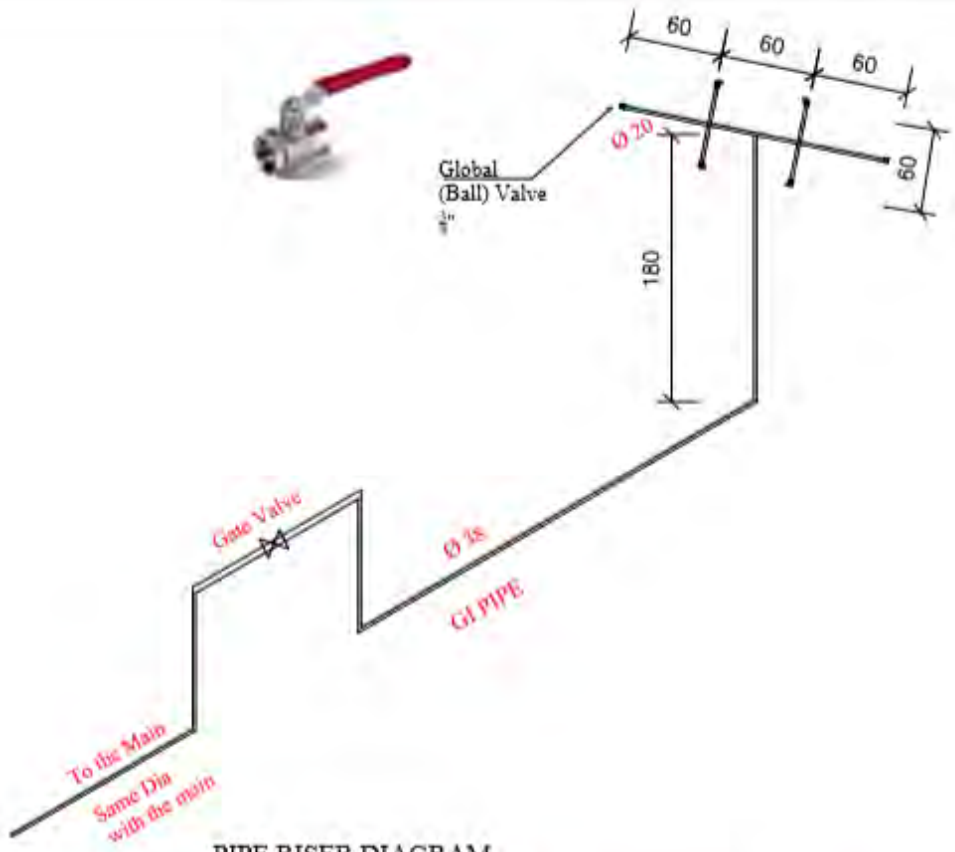
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 60-PUBLIC TAP STAND SIX TAPS	LOWLAND WASH ENGINEER'S	JUNE 2017	CM	5/7



FENCE DETAILS

NOTES :
- CONCRETE FOUNDATION SHALL BE PLAIN CONCRETE 1:3:6
- GALVANIZED MESH SHALL BE DIPPED (MIN 300 gr/m2, EN1461), 2 mm IN DIAMETER AND 50*50mm PARTED, SPIRAL KNITTED
-BARBED WIRE (OPTION 2) IS ACCEPTABLE INSTEAD OF WIRE MESH (OPTION 1)
- POLES SHALL BE PAINTED WITH 2 COATS OF RED OXIDE (CORROSION PREVENT) AND OIL PAINT
- LOCK SHALL BE PROVIDED ON THE GATE
- HINGES SHALL BE DIA 2 cm AND HEAVY DUTY
-DIAGONAL SUPPORTS SHALL BE INSTALLED AT EACH CORNER

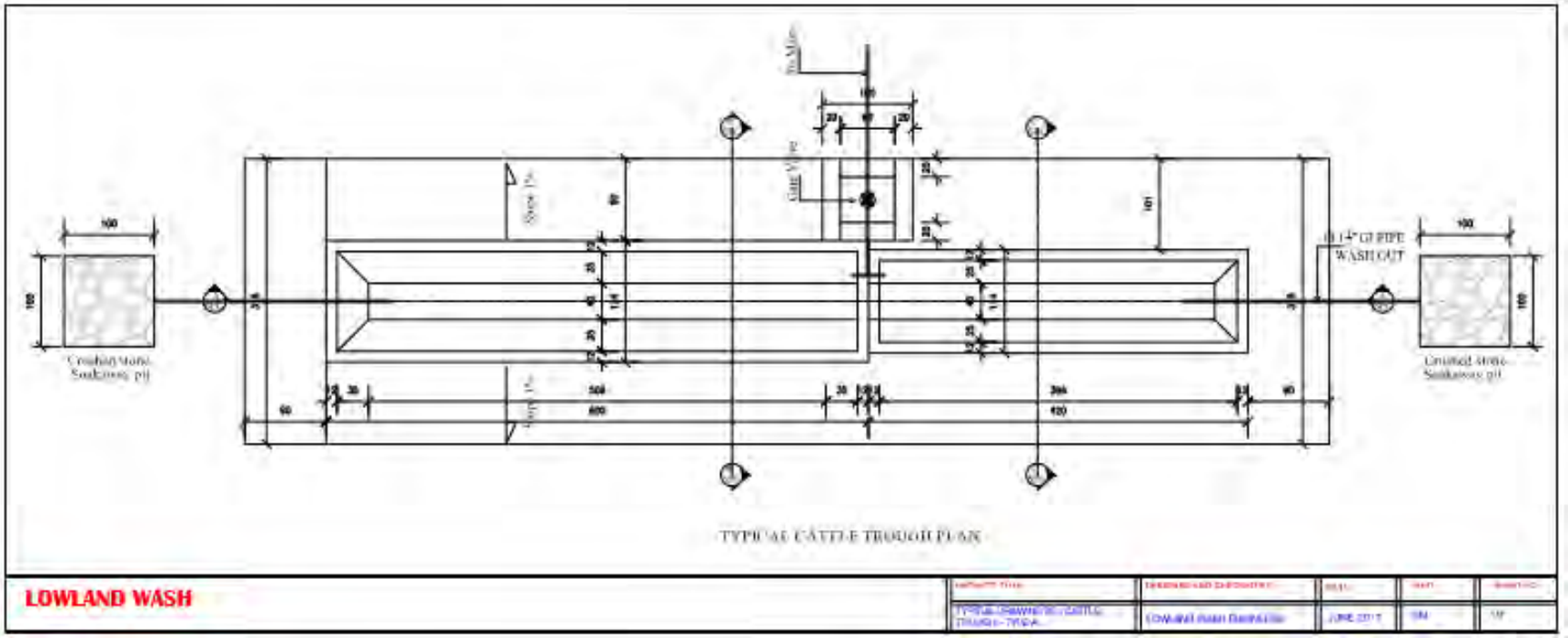
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 6B PUBLIC TAP STAND SIX TAPS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	6/7



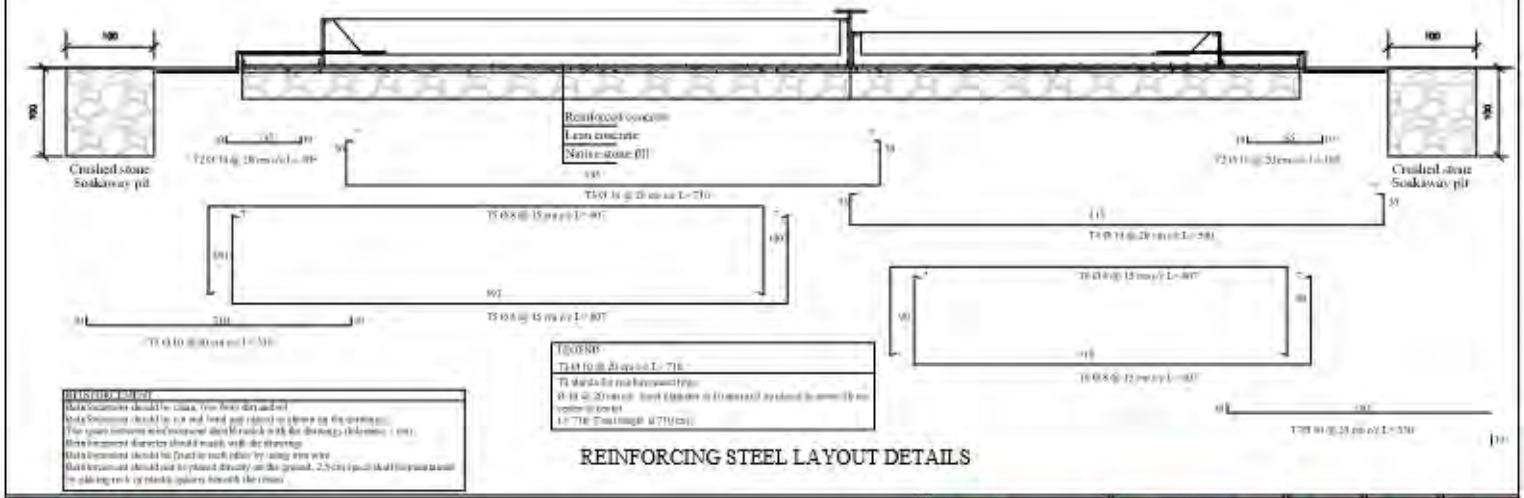
PIPE RISER DIAGRAM

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 6B-PUBLIC TAP STAND SIX TAPS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	7/7

TYPICAL DRAWING 7B – CATTLE TROUGH – TYPE A



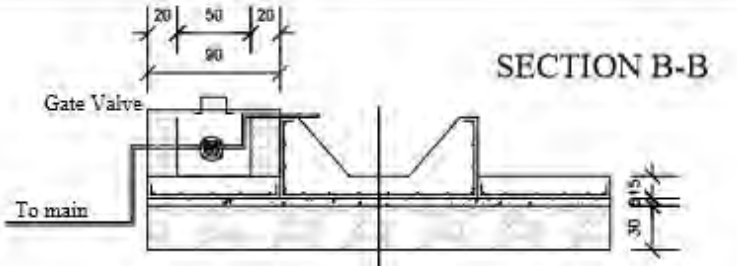
SECTION A-A



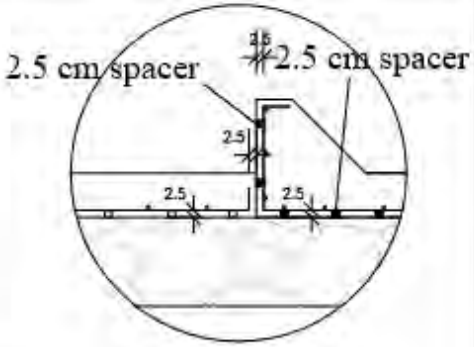
REINFORCING STEEL LAYOUT DETAILS

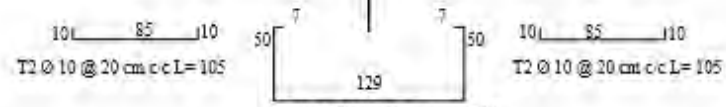
LOWLAND WASH

PROJECT TITLE	DESIGNED AND ENGINEERED BY	DATE	SCALE	SHEET NO
TYPICAL DRAWING 08 - CATTLE TROUGH - TYPE A	LOWLAND WASH ENGINEERS	JUNE 2017	CM	2/7



SECTION B-B

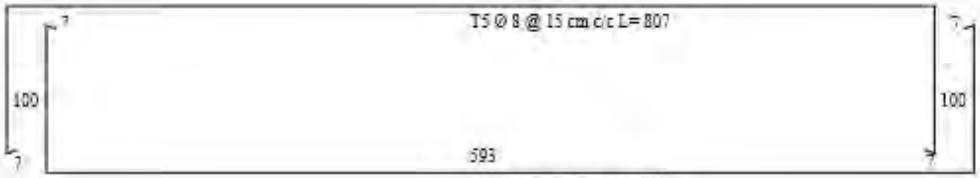




T2 Ø 10 @ 20 cm c/c L= 105

T2 Ø 10 @ 20 cm c/c L= 105

T1 Ø 10 @ 20 cm c/c L= 243



T5 Ø 8 @ 15 cm c/c L= 807

T5 Ø 8 @ 15 cm c/c L= 807

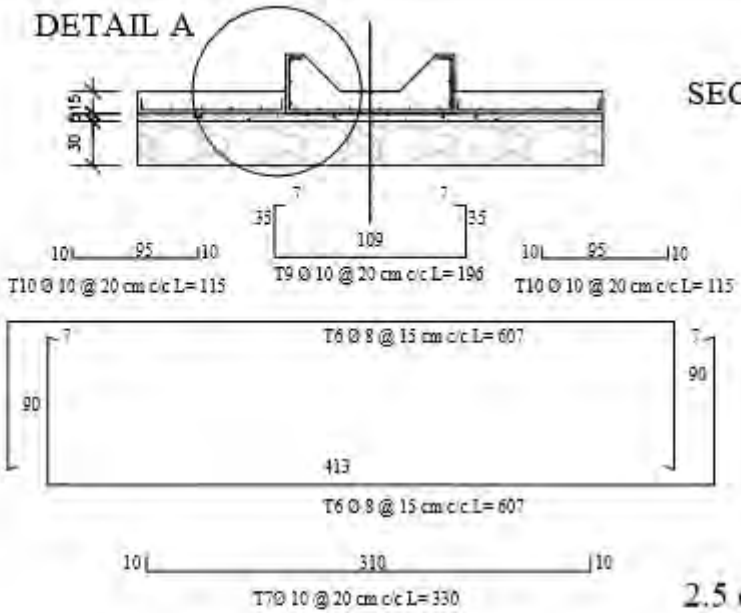
T8 Ø 10 @ 20 cm c/c L= 615

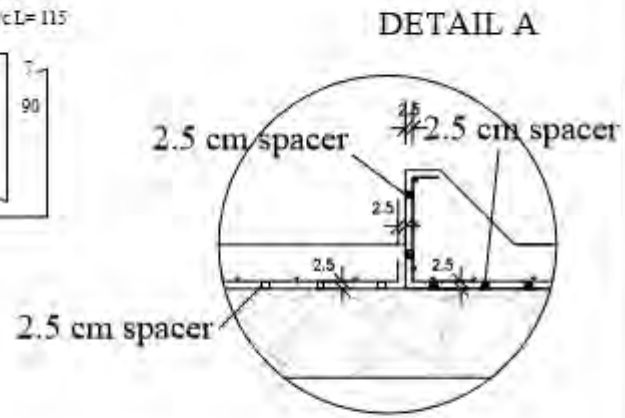
REINFORCEMENT

Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

REINFORCING STEEL LAYOUT DETAILS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 7B - CATTLE TROUGH - TYPE A	LOWLAND WASH ENGINEERS	JUNE 2017	CM	3/7

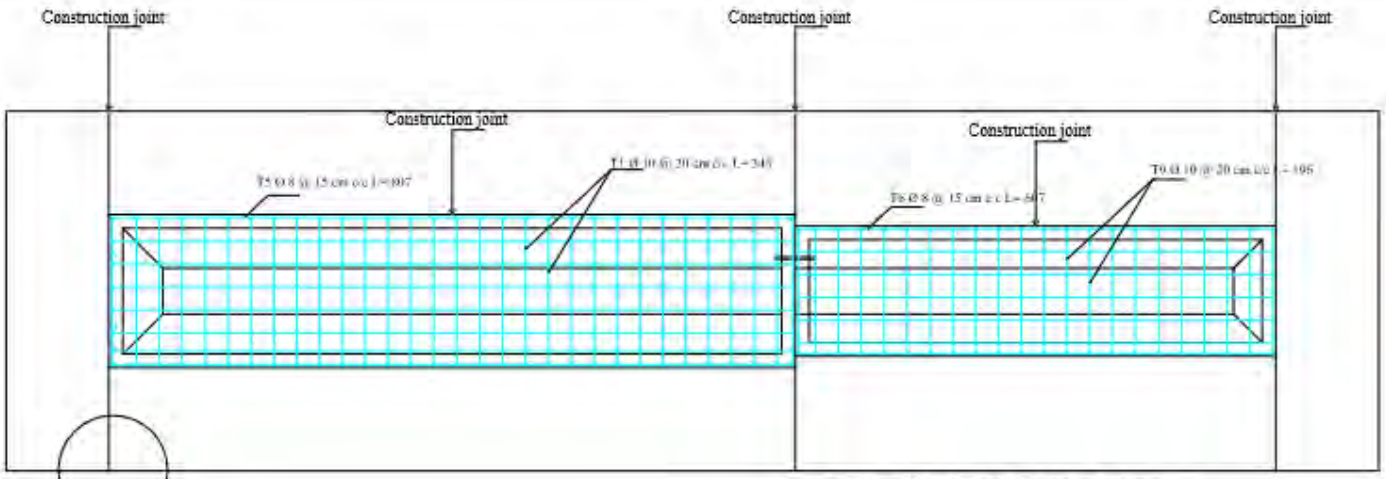


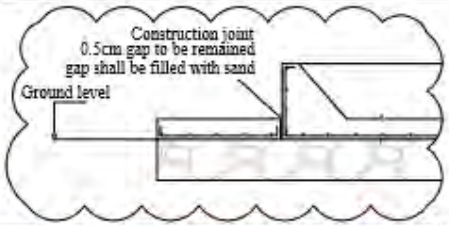


REINFORCEMENT
Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

REINFORCING STEEL LAYOUT DETAILS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 7B - CATTLE TROUGH - TYPE A	LOWLAND WASH ENGINEERS	JUNE 2017	CM	4/7

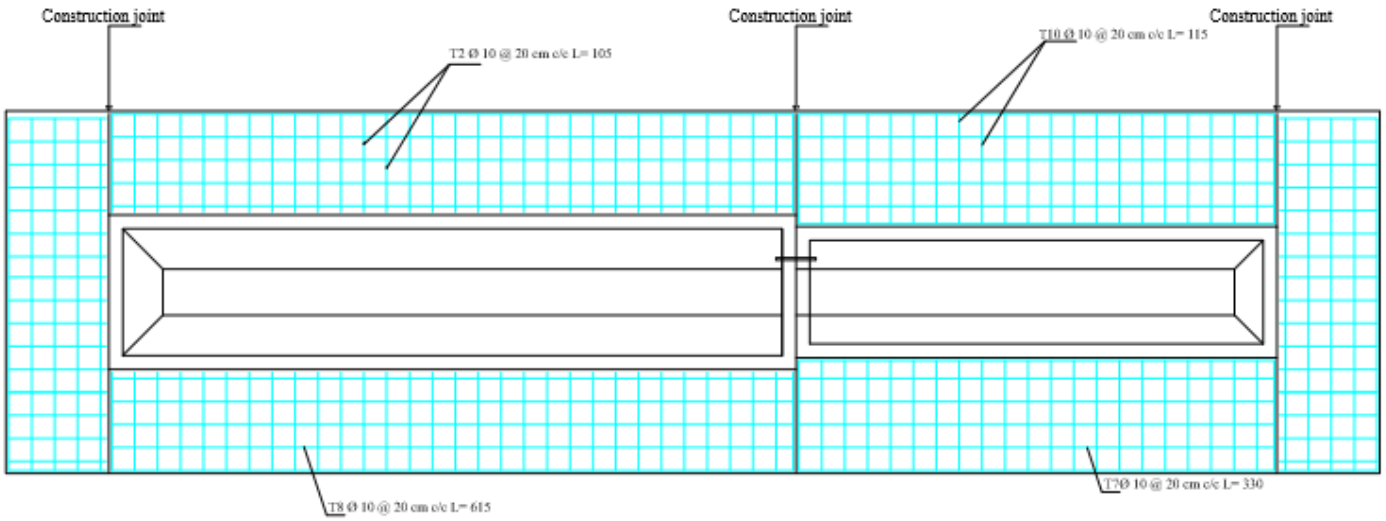




TROUGH REINFORCEMENT LAYOUT

DETAIL B

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 75 - CATTLE TROUGH - TYPE A	LOWLAND WASH ENGINEERS	JUNE 2017	CM	5/7

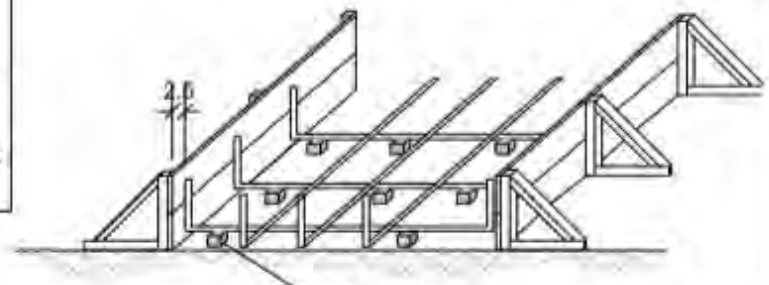


SLAB REINFORCEMENT LAYOUT

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 7B - CATTLE TROUGH - TYPE A	LOWLAND WASH ENGINEERS	JUNE 2017	CM	6/7

FORMWORK
The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface
The internal surface of the formwork must be clean and free from concrete scrap and dirt
The formwork should be levelled properly
Wood formwork used to form the top edge of the slab shall be cut straight and level
The formwork should be plumb and straight
A string line shall be used to ensure the formwork is straight and provides required slope
Before casting interior surfaces of the formwork should be moistened with water
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface
The mud slab that the concrete is being placed on must be debris, dirt and dust free
The formwork should be supported with braces properly and fixed with nails as needed
The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads
The joints between the panels of the formwork should be adequately tight

Formwork and Bracing



Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

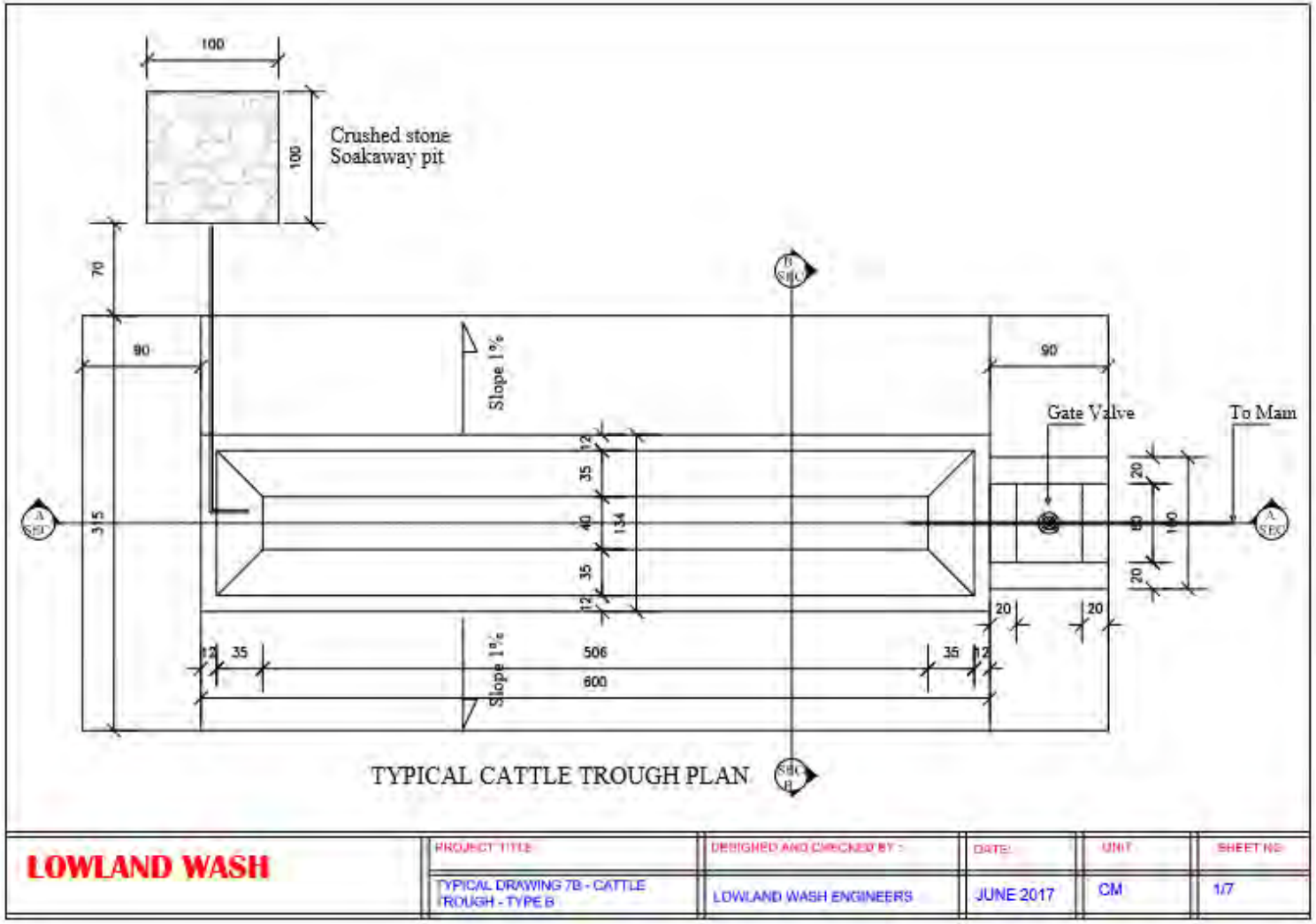
CONCRETE
Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

1 m3 C20 concrete batching amounts	Standard Mixes for Ordinary Structural Concrete per 50 kg bag of cement
Ratio 1:2:4	1 bag cement (50 kg cement)
6 bags cement (300 kg cement)	275 kg crushed stone (max dia 2 cm) and coarse sand
0.25 m3 coarse sand	0.155 m3 concrete
0.50 m3 crushed stone (aggregate Dia 2cm)	Max 30 lt water (W/C ratio 0.60)
Max 180 lt water (W/C ratio 0.60)	

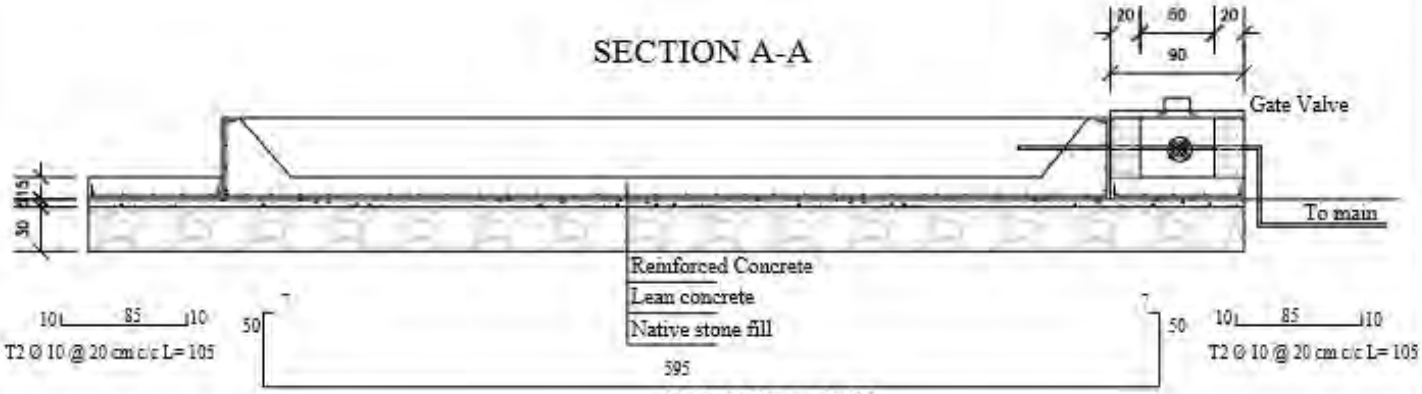
1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 30x30x20cm)
6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg/m3

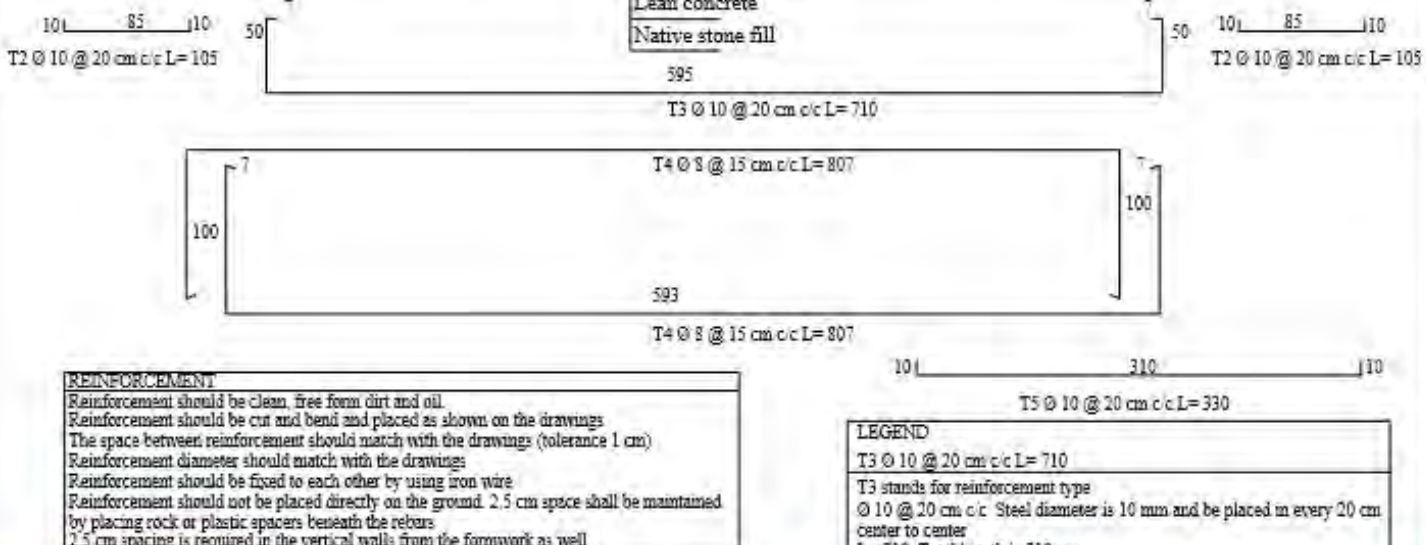
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 78 - CATTLE TROUGH - TYPE A	LOWLAND WASH ENGINEERS	JUNE 2017	CM	7/7

TYPICAL DRAWING 7B – CATTLE TROUGH – TYPE B



SECTION A-A

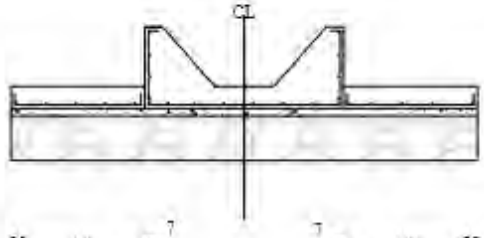




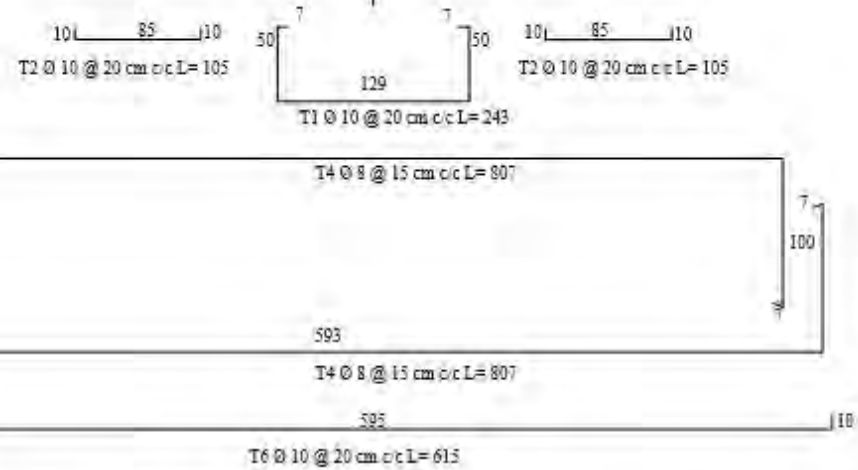
REINFORCEMENT
Reinforcement should be clean, free form dirt and oil. Reinforcement should be cut and bend and placed as shown on the drawings The space between reinforcement should match with the drawings (tolerance 1 cm) Reinforcement diameter should match with the drawings Reinforcement should be fixed to each other by using iron wire Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars 2.5 cm spacing is required in the vertical walls from the formwork as well

LEGEND
T3 Ø 10 @ 20 cm c/c L= 710
T3 stands for reinforcement type Ø 10 @ 20 cm c/c Steel diameter is 10 mm and be placed in every 20 cm center to center L= 710 Total length is 710 cm

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 7B - CATTLE TROUGH - TYPE B	LOWLAND WASH ENGINEERS	JUNE 2017	CM	2/7



SECTION B-B



REINFORCEMENT

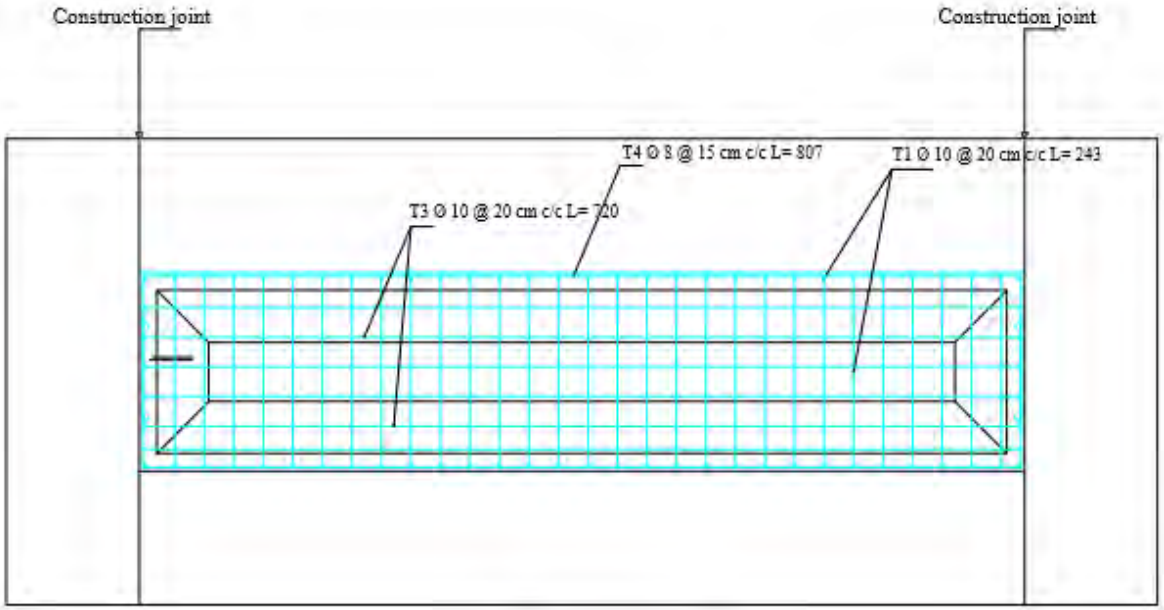
Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

LEGEND

T3 Ø 10 @ 20 cm c/c L= 710

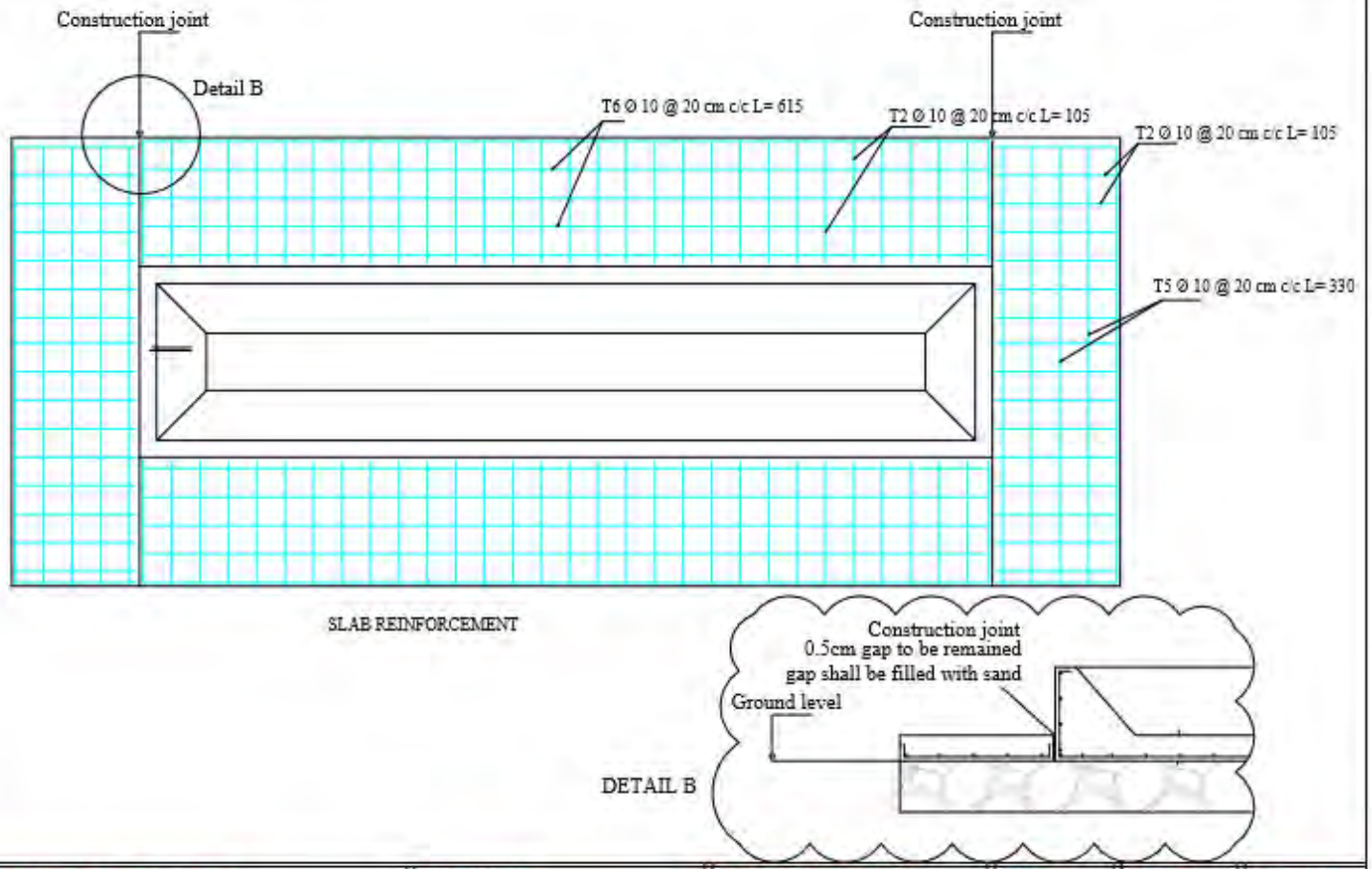
T3 stands for reinforcement type
Ø 10 @ 20 cm c/c Steel diameter is 10 mm and be placed in every 20 cm center to center
L= 710 Total length is 710 cm

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 7B - CATTLE TROUGH - TYPE B	LOWLAND WASH ENGINEERS	JUNE 2017	CM	3/7



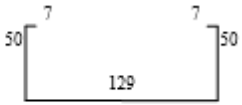
TROUGH REINFORCEMENT

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 7B - CATTLE TROUGH - TYPE B	LOWLAND WASH ENGINEERS	JUNE 2017	CM	4/7



LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 7B - CATTLE TROUGH - TYPE B	LOWLAND WASH ENGINEERS	JUNE 2017	CM	5/7

REINFORCEMENT LIST

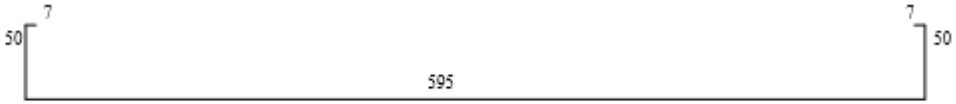


T1 Ø 10 @ 20 cm c/c L= 243

T1	31 PIECES

T2 Ø 10 @ 20 cm c/c L= 105

T2	96 PIECES

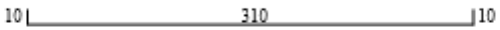


T3 Ø 10 @ 20 cm c/c L= 710

T3	8 PIECES

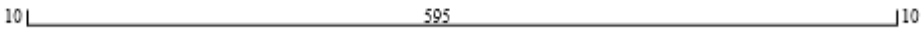
T4 Ø 8 @ 15 cm c/c L= 807

T4	8 PIECES



T5 Ø 10 @ 20 cm c/c L= 330

T5	10 PIECES



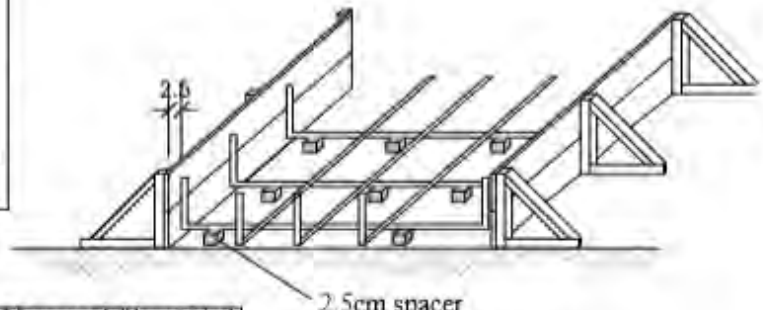
T6 Ø 10 @ 20 cm c/c L= 615

T6	10 PIECES

LOWLAND WASH	PROJECT TITLE.	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 7B - CATTLE TROUGH - TYPE B	LOWLAND WASH ENGINEERS	JUNE 2017	CM	6/7

FORMWORK
The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface
The internal surface of the formwork must be clean and free from concrete scrap and dirt
The formwork should be levelled properly
Wood formwork used to form the top edge of the slab shall be cut straight and level
The formwork should be plumb and straight
A string line shall be used to ensure the formwork is straight and provides required slope
Before casting interior surfaces of the formwork should be moistened with water
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface
The mud slab that the concrete is being placed on must be debris, dirt and dust free
The formwork should be supported with braces properly and fixed with nails as needed
The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads
The joints between the panels of the formwork should be adequately tight

Formwork and Bracing



Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

CONCRETE
Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

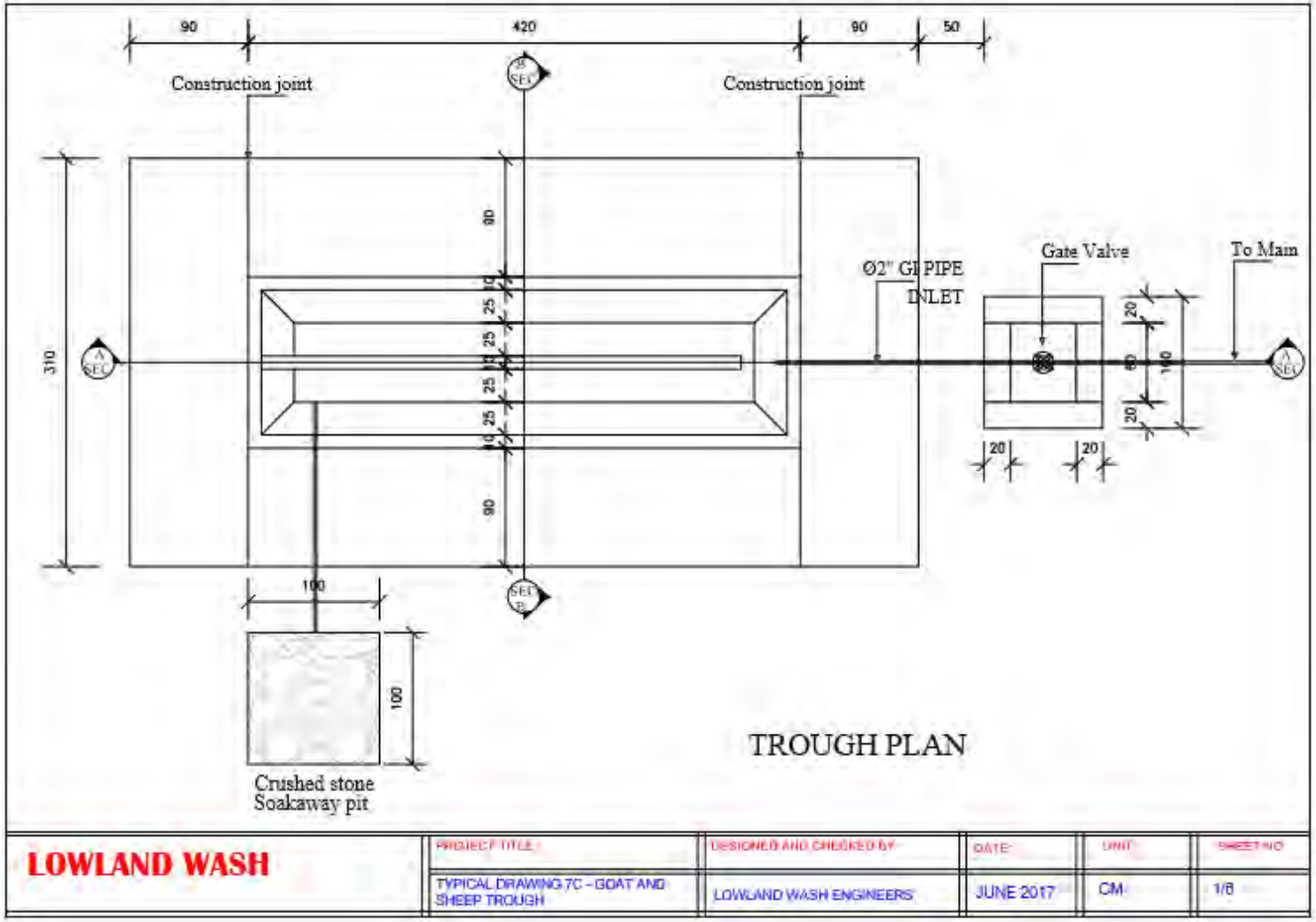
1 m3 C20 concrete batching amounts
Ratio 1:2:4
6 bags cement (300 kg cement)
0.25 m3 coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)
Max 180 lt water (W/C ratio 0.60)

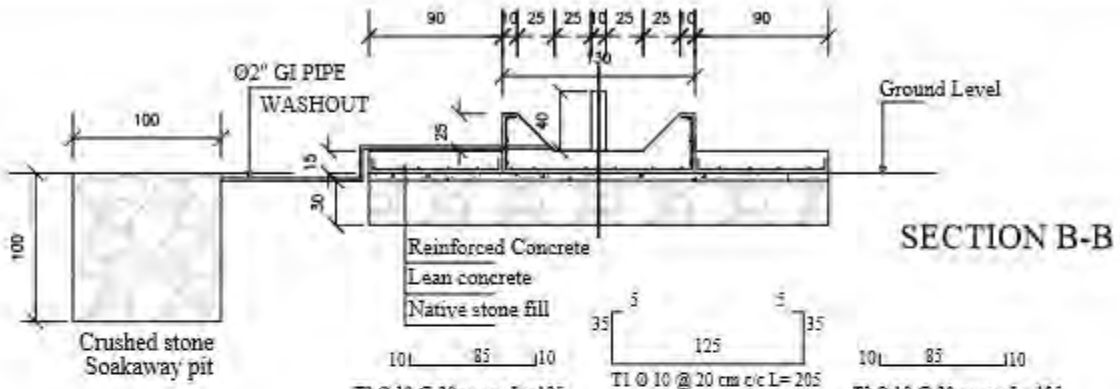
Standard Mixes for Ordinary Structural Concrete
per 50 kg bag of cement
1 bag cement (50 kg cement)
275 kg crushed stone (max dia 2 cm) and coarse sand
0.155 m3 concrete
Max 50 lt water (W/C ratio 0.60)

1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 30x30x20cm)
6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg/m3

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO.
	TYPICAL DRAWING 7B - CATTLE TROUGH - TYPE B	LOWLAND WASH ENGINEERS	JUNE 2017	CM	7/7

TYPICAL DRAWING 7C – GOAT AND SHEEP TROUGH





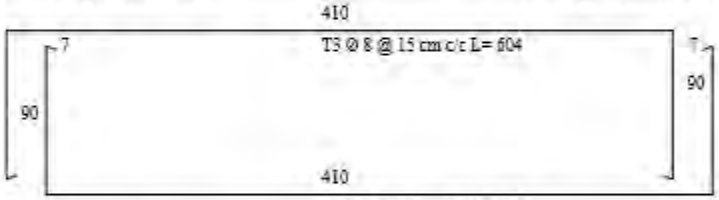
10 85 10

T2 Ø 10 @ 20 cm c/c L= 105

T1 Ø 10 @ 20 cm c/c L= 205

10 85 10

T2 Ø 10 @ 20 cm c/c L= 105



T3 Ø 8 @ 15 cm c/c L= 604

T3 Ø 8 @ 15 cm c/c L= 604

10 305 10

T4Ø 10 @ 20 cm c/c L= 325

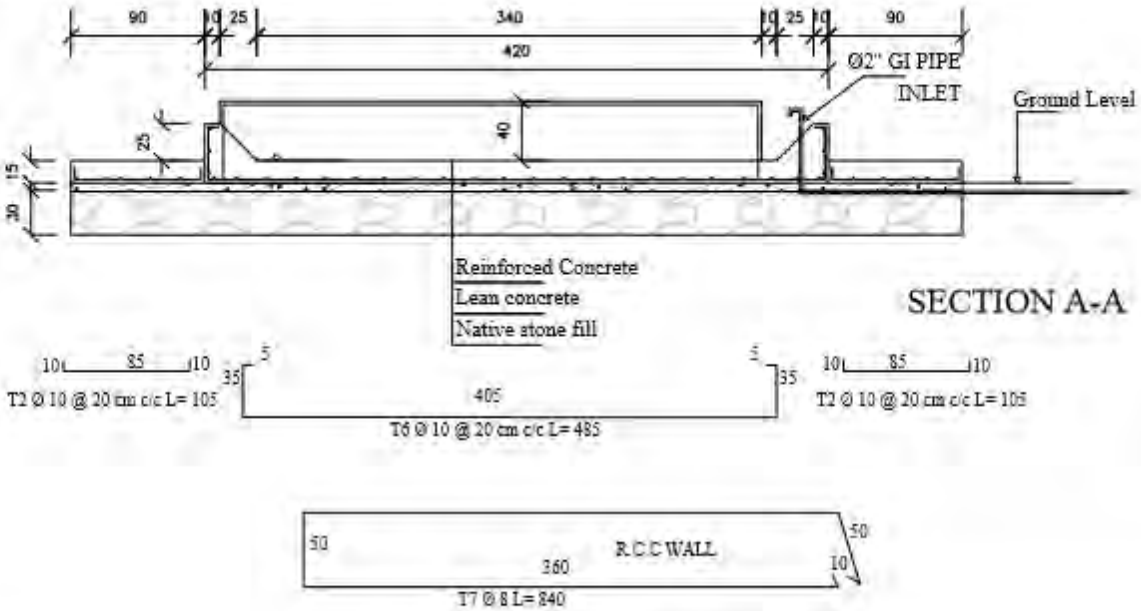
10 415 10

T5Ø 10 @ 20 cm c/c L= 435

REINFORCEMENT

Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings.
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 7C : GOAT AND SHEEP TROUGH	LOWLAND WASH ENGINEERS	JUNE 2017	CM	2/6



REINFORCEMENT

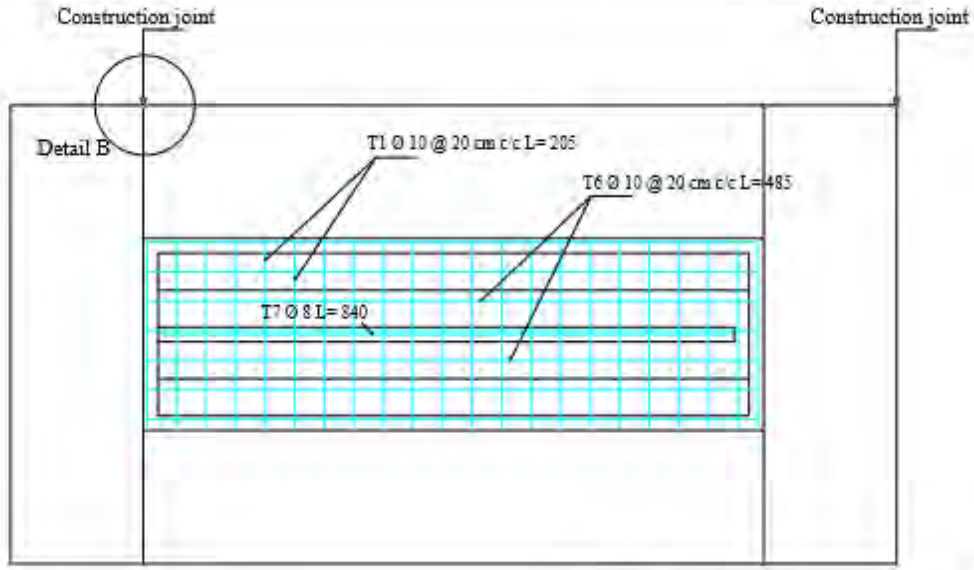
Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

LEGEND

T3 Ø 10 @ 20 cm c/c L= 710

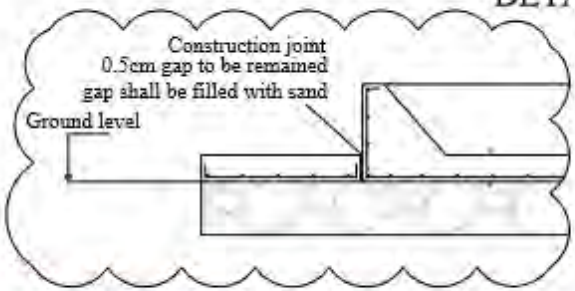
T3 stands for reinforcement type
Ø 10 @ 20 cm c/c Steel diameter is 10 mm and be placed in every 20 cm center to center
L= 710 Total length is 710 cm

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 7C - GOAT AND SHEEP TROUGH	LOWLAND WASH ENGINEERS	JUNE 2017	CM	3/6



TROUGH REINFORCEMENT

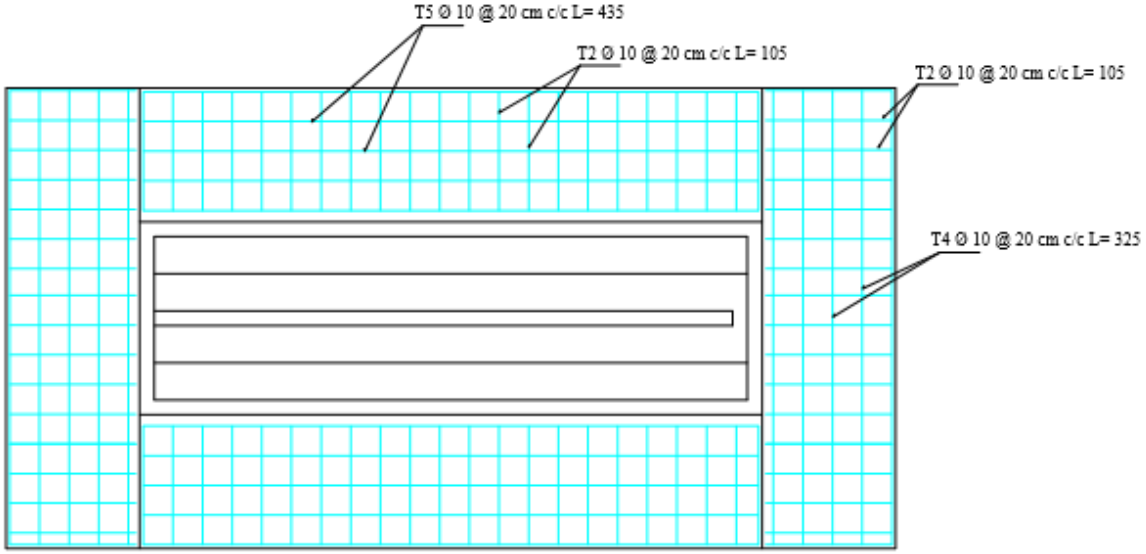
DETAIL B



REINFORCEMENT

Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formawork as well

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 7C - GOAT AND SHEEP TROUGH	LOWLAND WASH ENGINEERS	JUNE 2017	CM	4/6



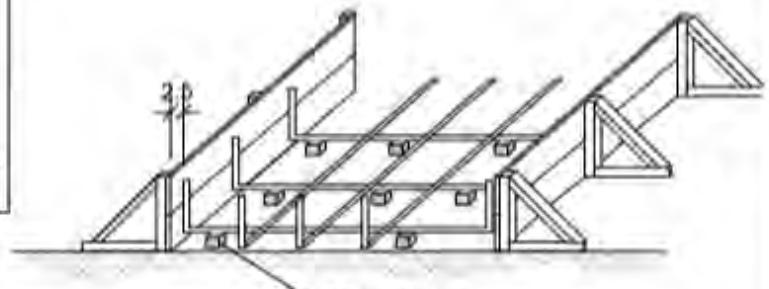
SLAB REINFORCEMENT

REINFORCEMENT
Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

LOWLAND WASH	PROJECT TITLE.	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 7C - GOAT AND SHEEP TROUGH	LOWLAND WASH ENGINEERS	JUNE 2017	CM	5/6

FORMWORK
The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface
The internal surface of the formwork must be clean and free from concrete scrap and dirt
The formwork should be levelled properly
Wood formwork used to form the top edge of the slab shall be cut straight and level
The formwork should be plumb and straight
A string line shall be used to ensure the formwork is straight and provides required slope
Before casting interior surfaces of the formwork should be moistened with water
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface
The mud slab that the concrete is being placed on must be debris, dirt and dust free
The formwork should be supported with braces properly and fixed with nails as needed
The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads
The joints between the panels of the formwork should be adequately tight

Formwork and Bracing



Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

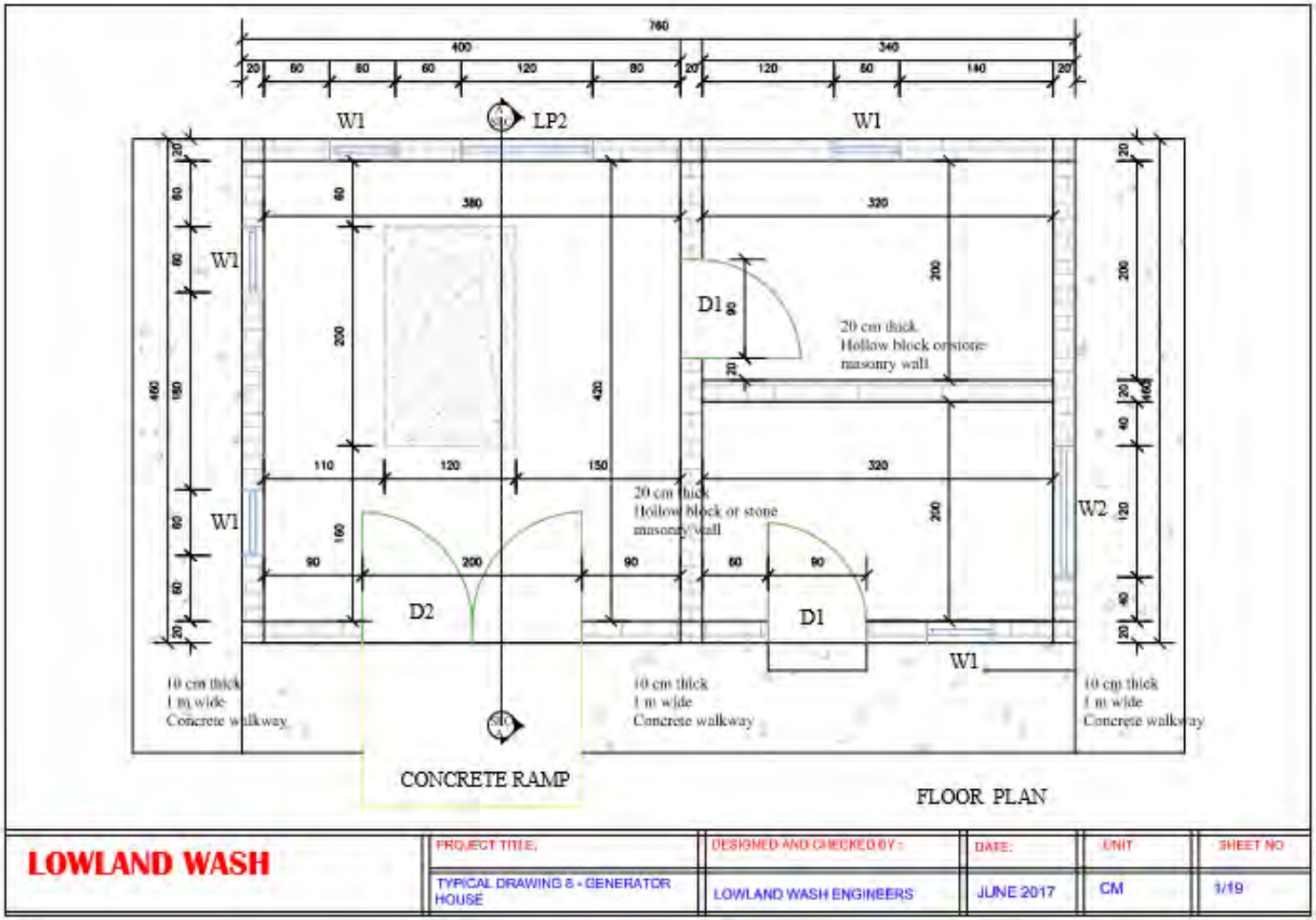
CONCRETE
Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

1 m3 C20 concrete batching amounts	Standard Mixes for Ordinary Structural Concrete
Ratio 1:2:4	per 50 kg bag of cement
6 bags cement (300 kg cement)	1 bag cement (50 kg cement)
0.25 m3 coarse sand	275 kg crushed stone (max dia 2 cm) and coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)	0.155 m3 concrete
Max 180 lt water (W/C ratio 0.60)	Max 30 lt water (W/C ratio 0.60)

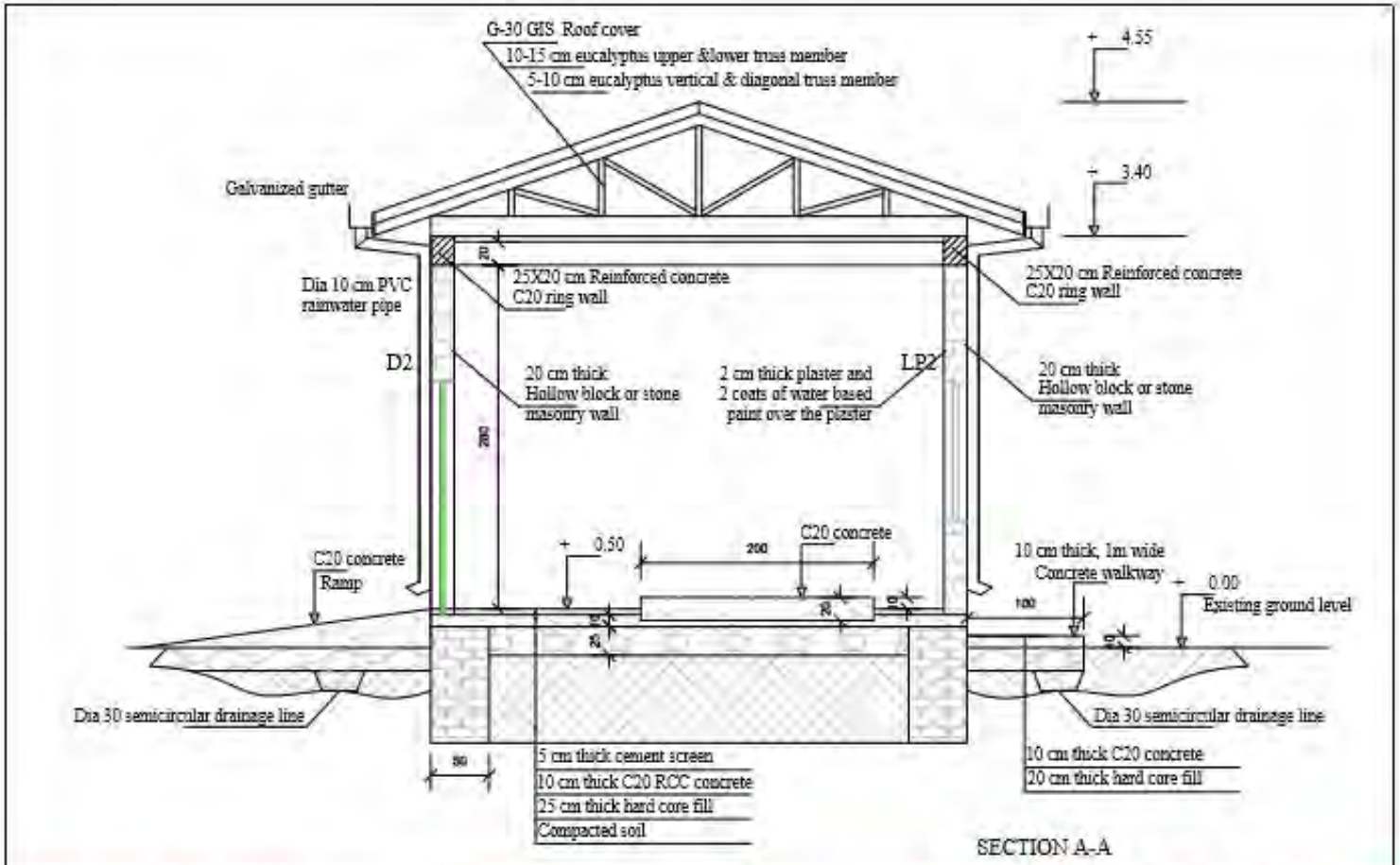
1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 30x30x20cm)
6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg/m3

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 7C - GOAT AND SHEEP TROUGH	LOWLAND WASH ENGINEERS	JUNE 2017	CM	6/8

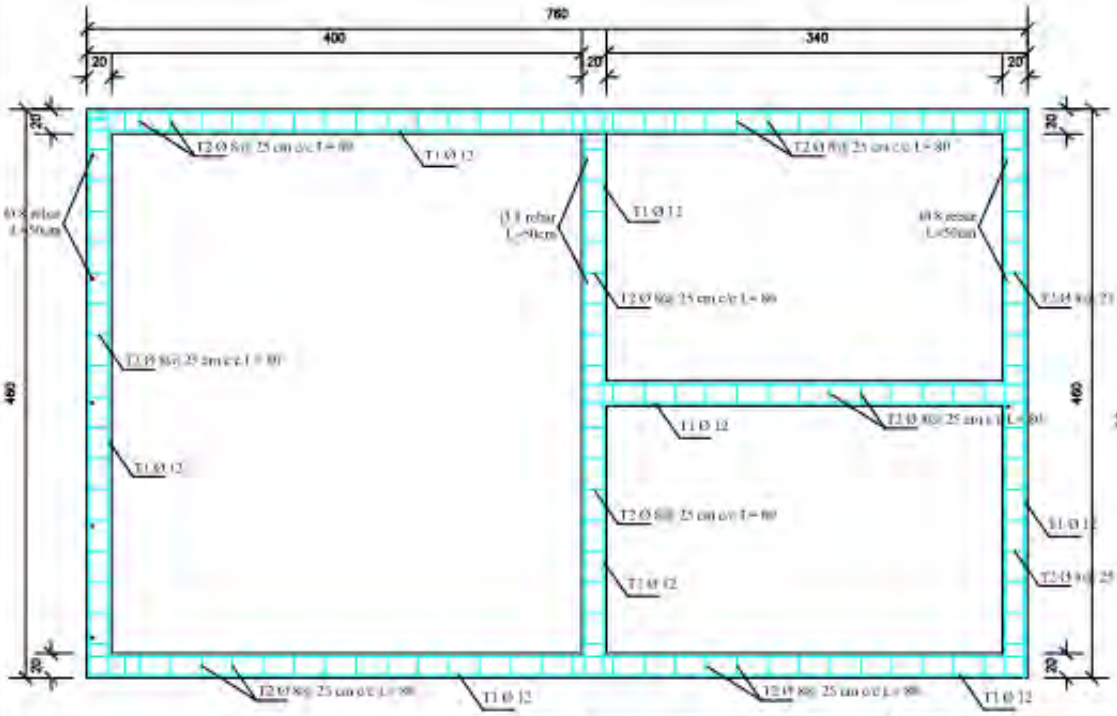
TYPICAL DRAWING 8 – GENERATOR HOUSE

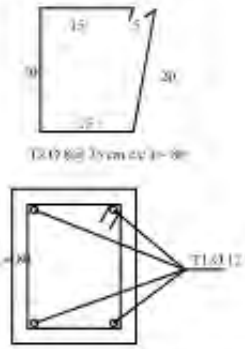


LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 8 - GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	1/19



LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 8 : GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	2/12





SECTION OF THE RING WALL

REINFORCED CONCRETE (C20) RING WALL ON TOP OF THE WALLS

T1 Ø 8 MD

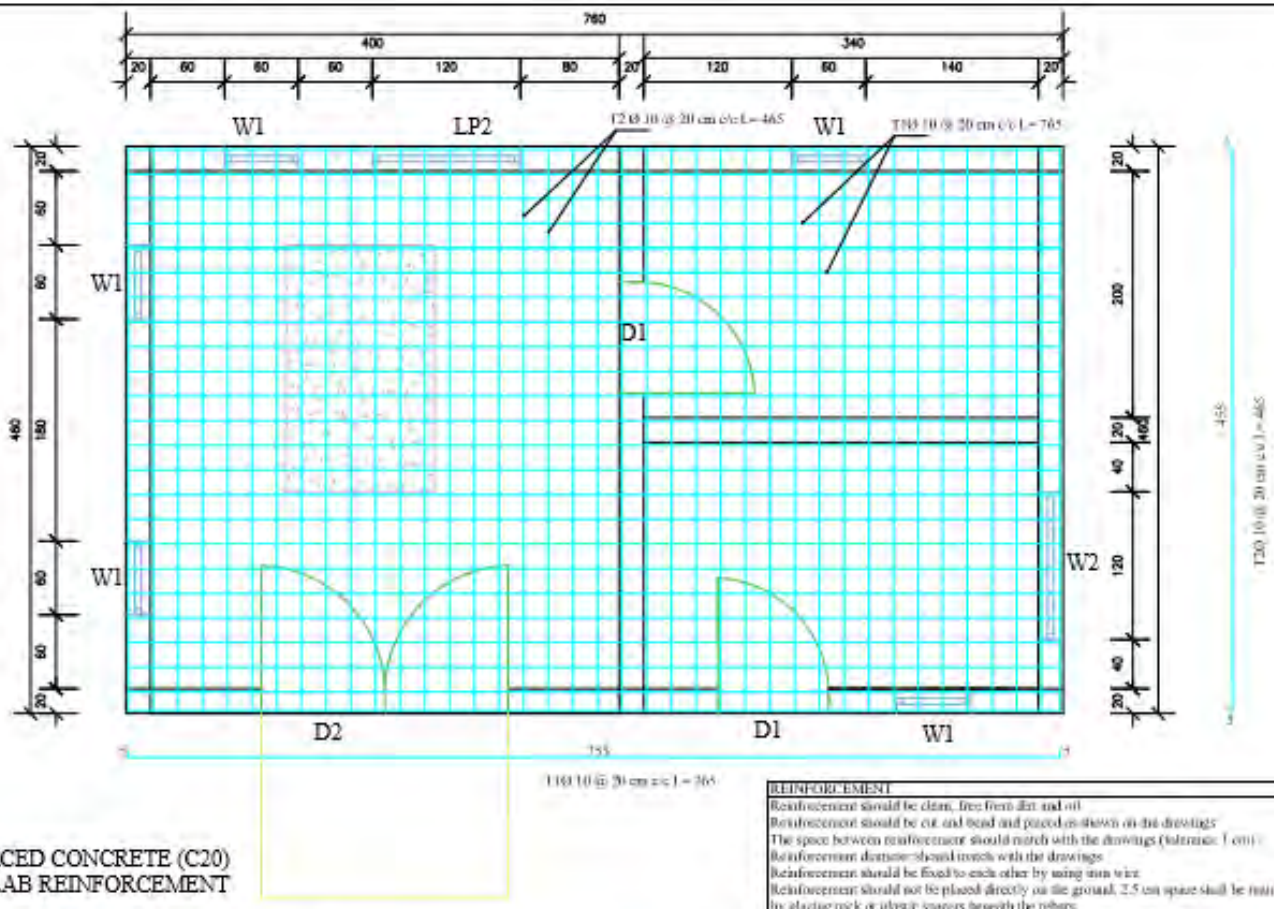
T2 Ø 8 @ 25 cm c/c L=80

T2 stands for reinforcement type
Ø 8 @ 25 cm c/c Steel diameter is 8 mm and be placed in each 25 cm center to center
L=80 Total reinforcement length is 80 cm

REINFORCEMENT

Reinforcement should be clean, free from dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings.
The space between reinforcement should match with the drawings (tolerance 1 cm).
Reinforcement diameter should match with the drawings.
Reinforcement should be fixed to each other by using iron wire.
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars.
2.5 cm spacing is required in the vertical walls from the formwork as well.

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 8 - GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	3/19

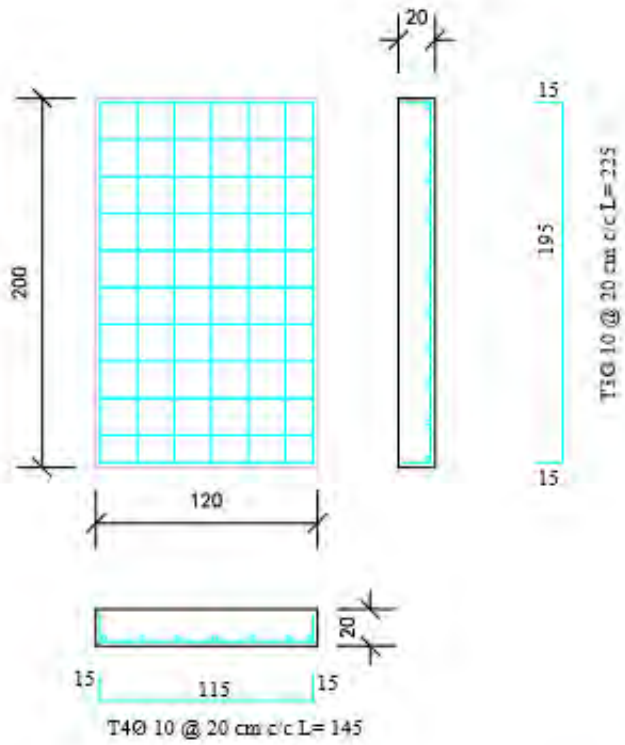


REINFORCED CONCRETE (C20)
SLAB REINFORCEMENT

REINFORCEMENT

Reinforcement should be clean, free from dirt and oil
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance: 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 8 - GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	4/19



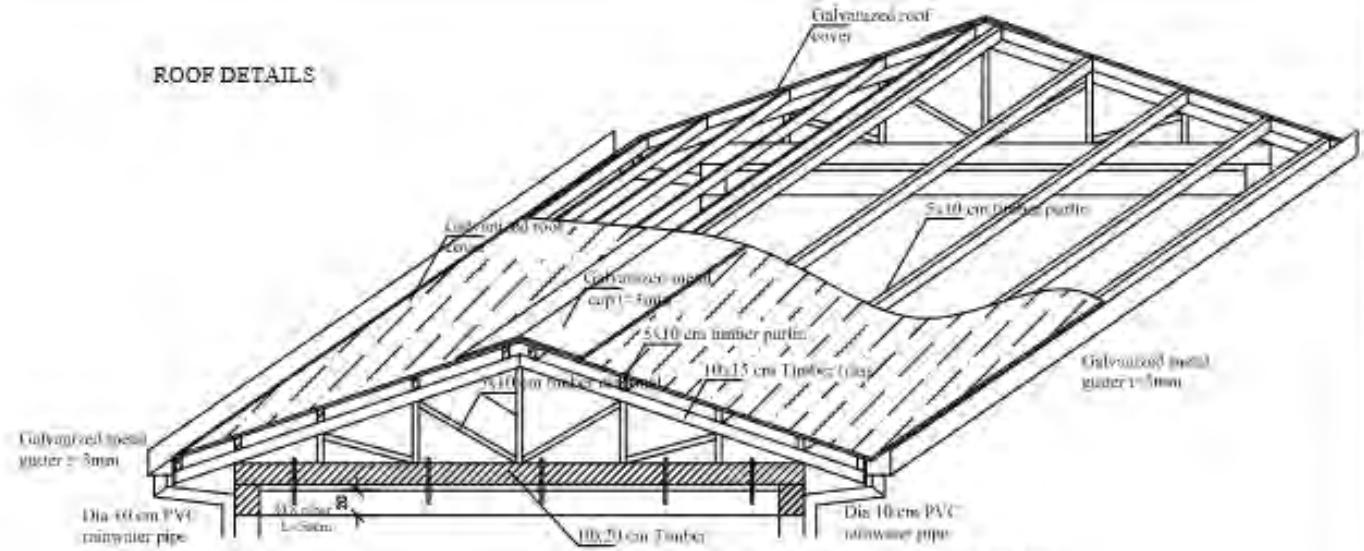
REINFORCED CONCRETE (C20)
GENERATOR PAD REINFORCEMENT

REINFORCEMENT

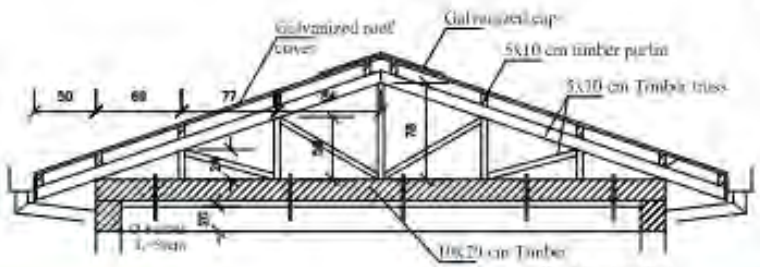
Reinforcement should be clean, free from dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shd be maintained by placing rock or plastic spacers beneath the mesh
2.5 cm spacing is required in the vertical walls from the formwork as well

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO.
	TYPICAL DRAWING 8 – GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	5/19

ROOF DETAILS



3D View of the Roof Truss and roof Cover



Roof truss section

ROOF TRUSS AND COVER

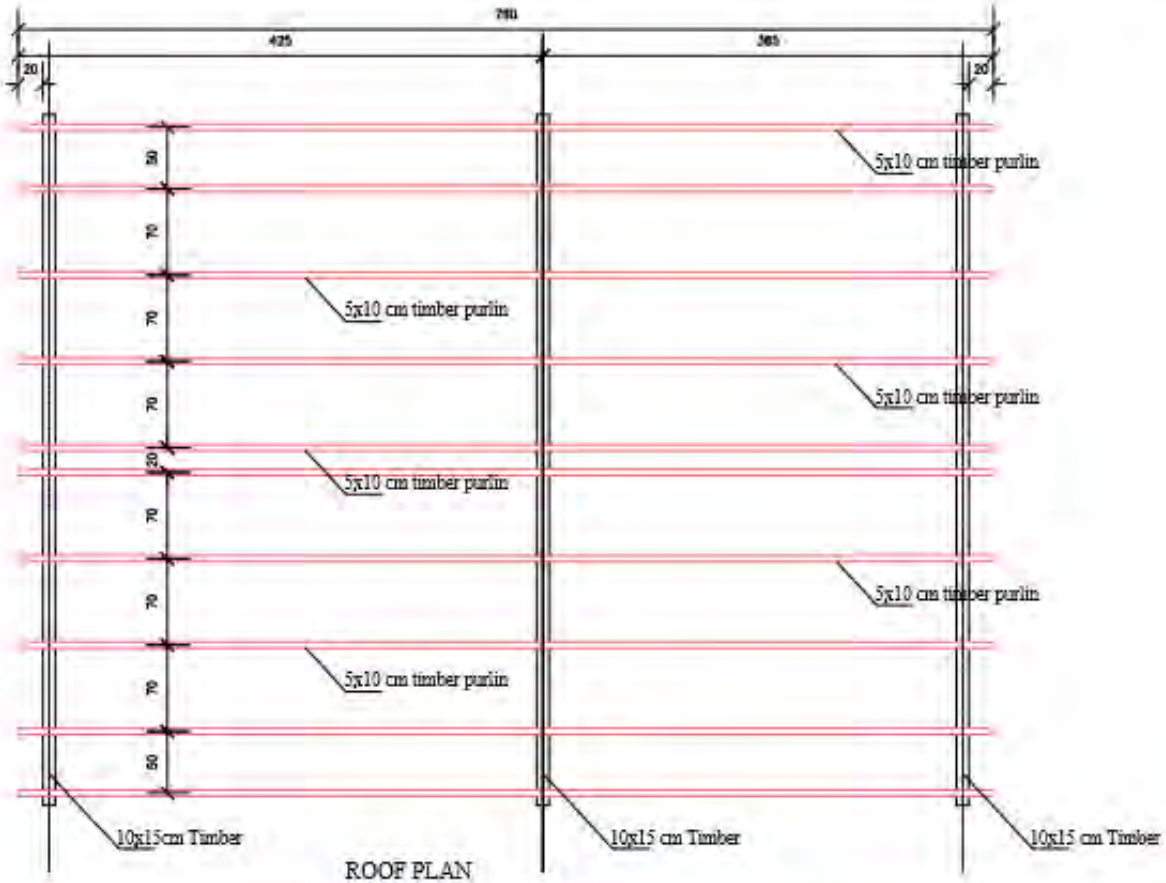
Roof truss shall be formed by using 10x20cm timber beams, 5x10cm timber truss and 5x10 cm timber purlins on top. All timber elements shall be joined by using nails, structurally sound.

0.50 mm thick galvanized trapezoidal metal sheet (corrugated) shall be installed over roof timber purlins. Metal sheets shall be fixed to the purlins by using galvanized nails. Screws shall be used on the gutter to prevent leaking.

Galvanized metal cap shall be placed on top of the under.

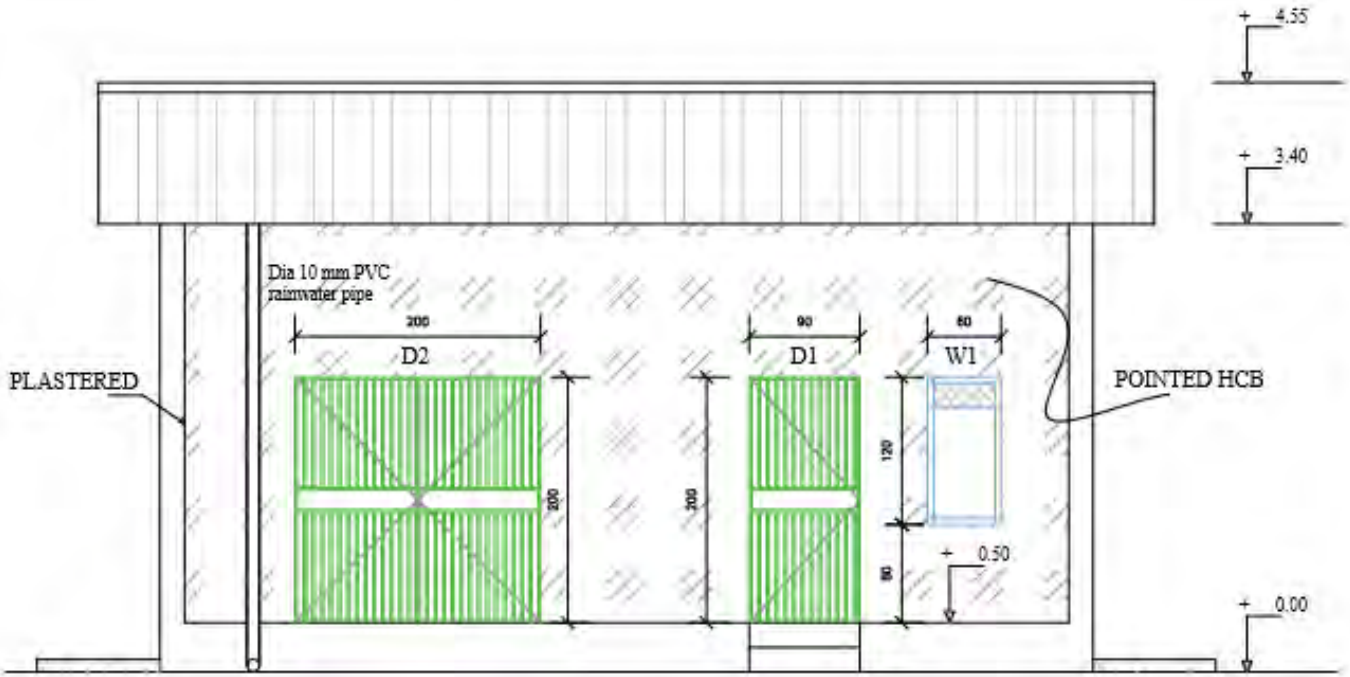
Wooden roof truss shall be placed over reinforced concrete ring wall and rest on the other which are reinforced, double ring wall in every 1m.

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 6 = GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	6/10



ROOF PLAN

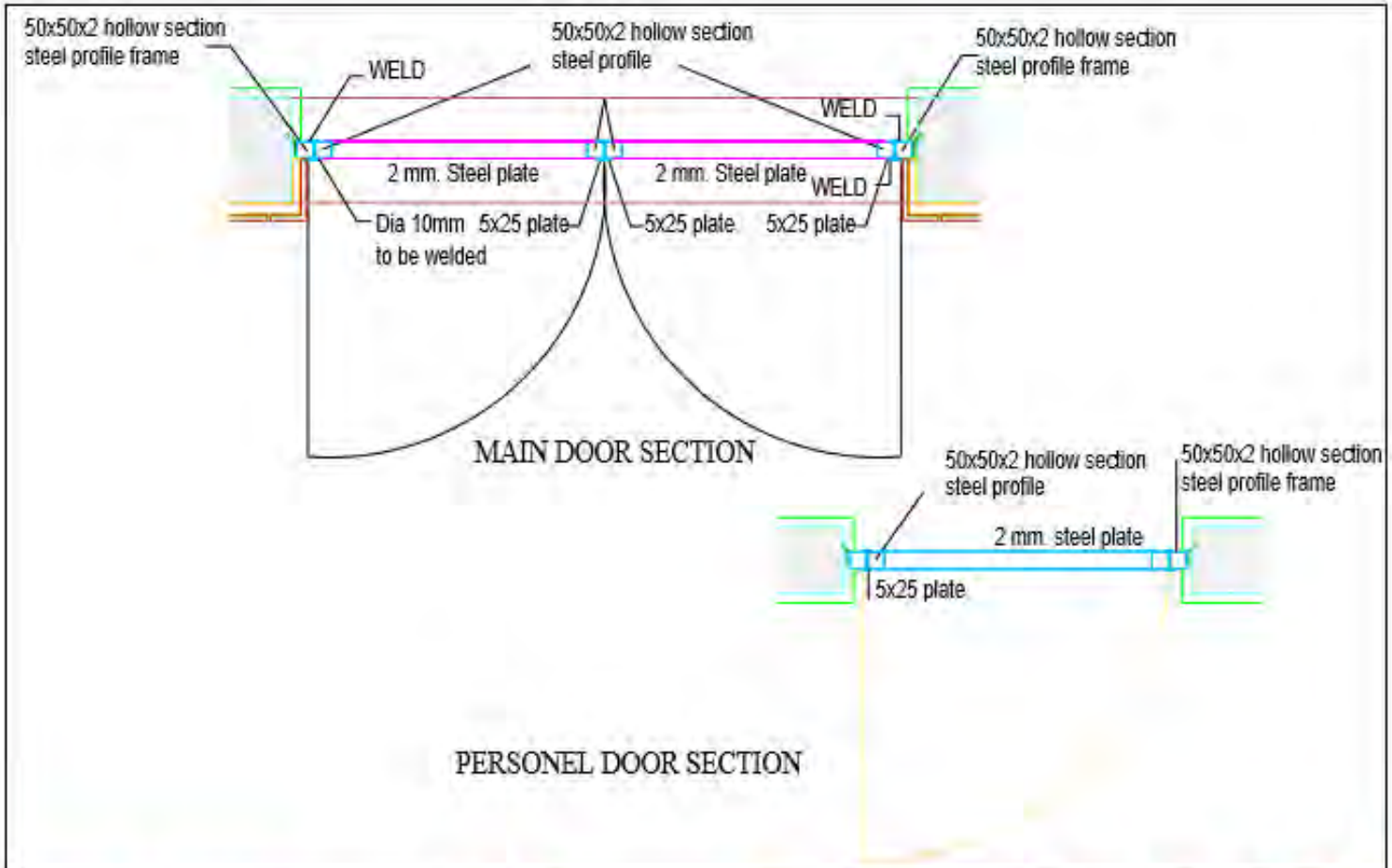
LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO:
	TYPICAL DRAWING 8 - GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	7/18



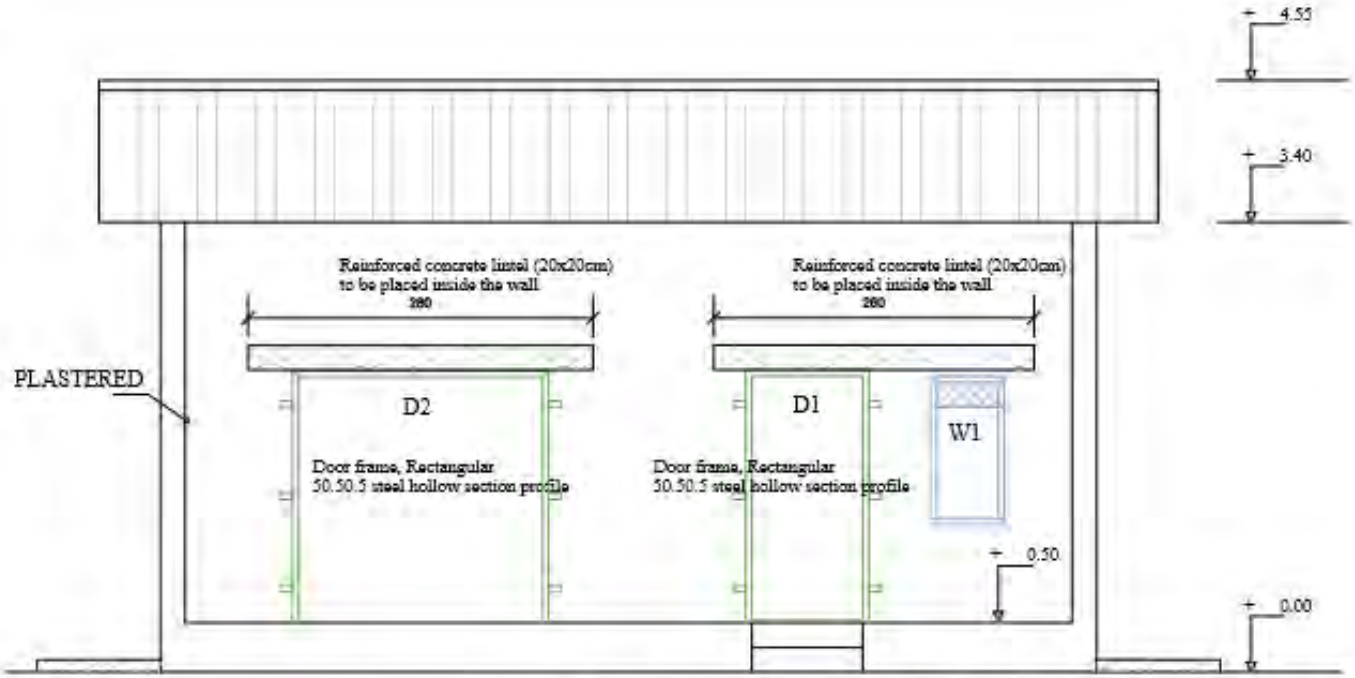
DOOR AND WINDOW LEGEND			
CODE	SIZE (mm)	NO	DEFINITION
D1	200X90	2	Steel frame & 3 mm thick steel door
D2	200x200	1	Steel frame & 3 mm thick steel door
W1	120x60	1	Seko profile, steel frame & 3 mm thick steel
W2	120x120	1	Seko profile, steel frame & 3 mm thick steel
LP1	80x40	3	Steel frame & 3 mm thick steel louvers with internal insect screen
LP2	120x120	1	Steel frame & 3 mm thick steel louvers with internal insect screen

FRONT ELEVATION

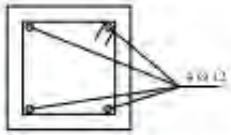
LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 8 - GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	8/19



LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY:	DATE:	UNIT	SHEET NO.
	TYPICAL DRAWING 6 - GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	6/16



STEEL DOOR FRAMES AND LINTEL INSTALLATION

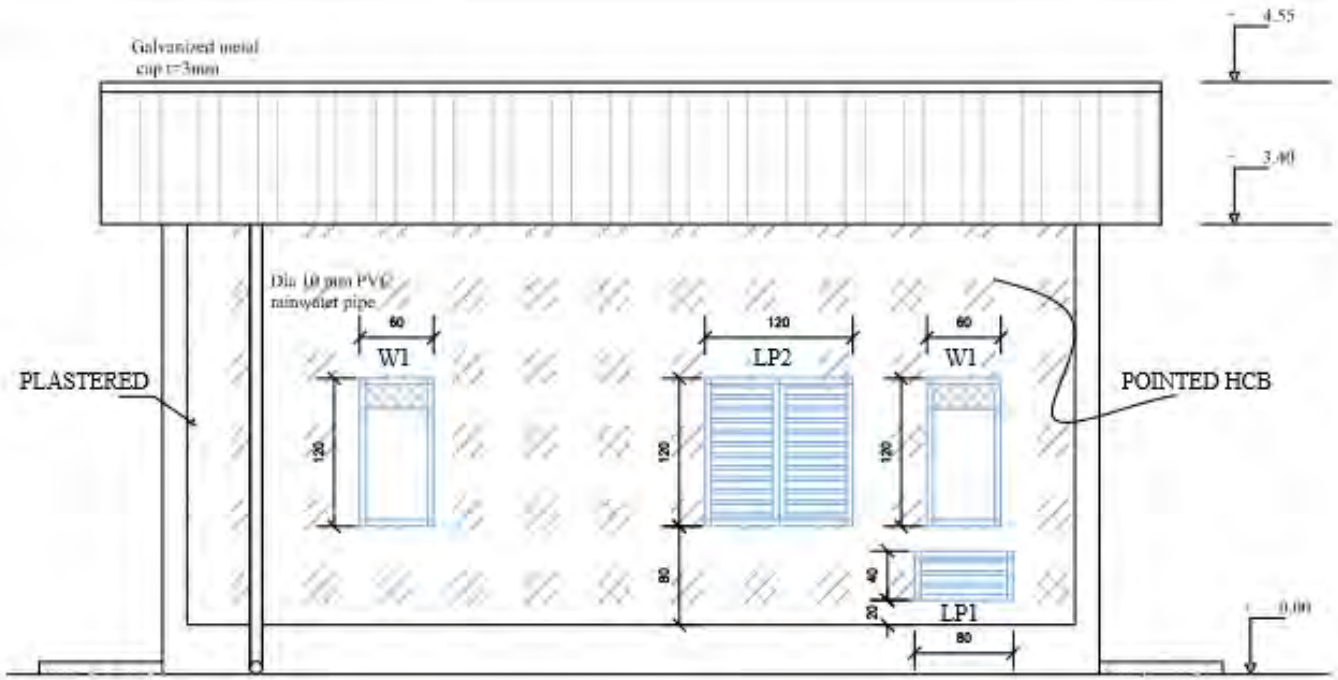


LINTEL BEAM REINFORCEMENT

DOOR AND WINDOW LEGEND

CODE	SIZE (mm)	NO	DESCRIPTION
D1	280X90	2	Steel frame & 3 mm thick steel door
D2	280x200	1	Steel frame & 3 mm thick steel door
W1	170x60	5	Steel profile, steel frame & 3 mm thick steel
W2	120x120	1	Steel profile, steel frame & 3 mm thick steel
LF1	80x40	5	Ventilation window, Steel frame & 3 mm thick steel louvers with internal insect screen
LF2	120x120	1	Ventilation window, Steel frame & 3 mm thick steel louvers with internal insect screen

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 8 – GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	10/19

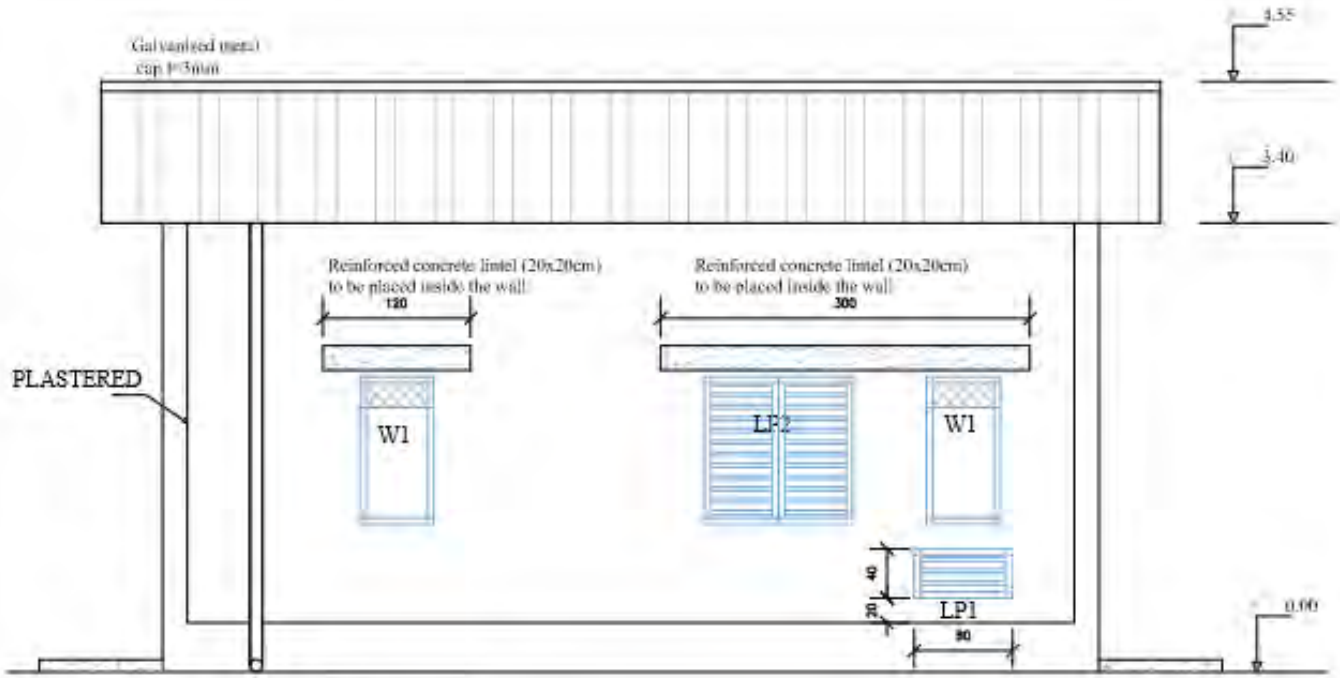


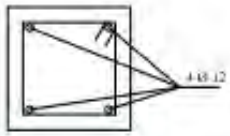
REAR ELEVATION

DOOR AND WINDOW LEGEND

CODE	SIZE (mm)	NO	DEFINITION
D1	700X300	2	Steel frame & 3 mm thick steel door
D2	200x200	1	Steel frame & 3 mm thick steel door
W1	120x60	5	Sabo profile, steel frame & 3 mm thick steel
W2	120x120	1	Sabo profile, steel frame & 3 mm thick steel
LP1	80x40	1	Ventilation louvers, Steel frame & 3 mm thick steel louvers with internal insect screen
LP2	120x120	1	Ventilation louvers, Steel frame & 3 mm thick steel louvers with internal insect screen

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 8 - GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	11/19

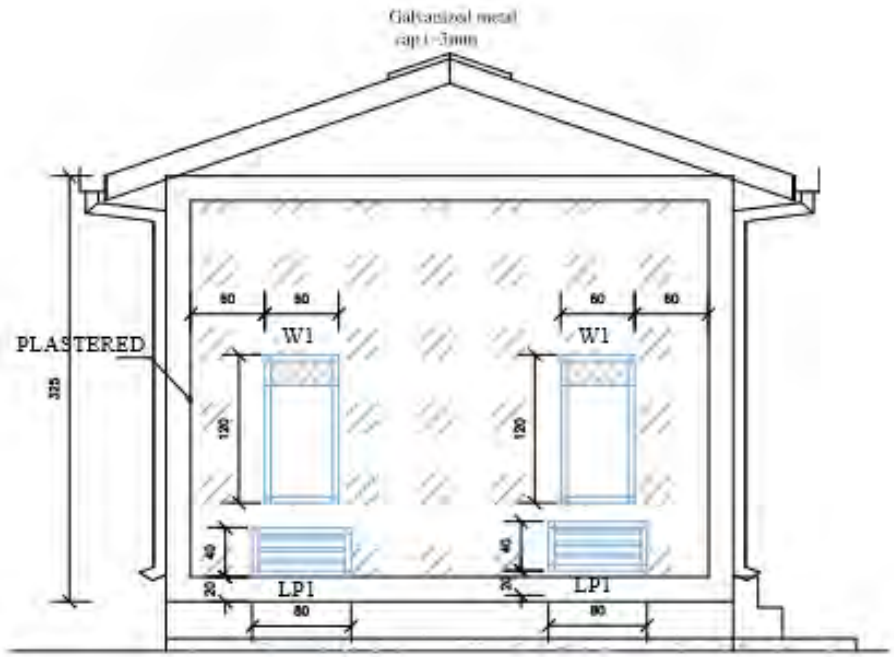




LINTEL BEAM REINFORCEMENT

LINTEL INSTALLATION FOR WINDOWS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 8 - GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	12/19

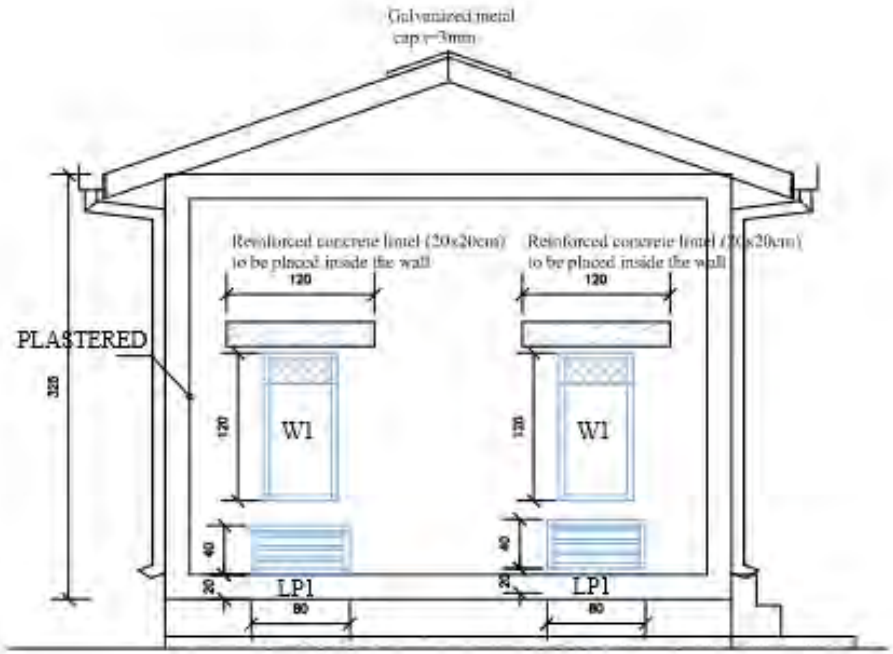


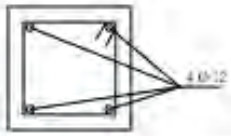
LEFT ELEVATION

DOOR AND WINDOW LEGEND

CODE	SIZE (mm)	NO	DEFINITION
D1	200X90	2	Steel frame & 3 mm thick steel door
D2	200x200	1	Steel frame & 3 mm thick steel door
W1	120x60	5	Sebo profile, steel frame & 3 mm thick steel
W2	120x120	1	Sebo profile, steel frame & 3 mm thick steel
LP1	80x40	4	Ventilation louvers, Steel frame & 3 mm thick steel louvers with internal insect screen
LP2	120x120	1	Ventilation louvers, Steel frame & 3 mm thick steel louvers with internal insect screen

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 8 - GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	13/19

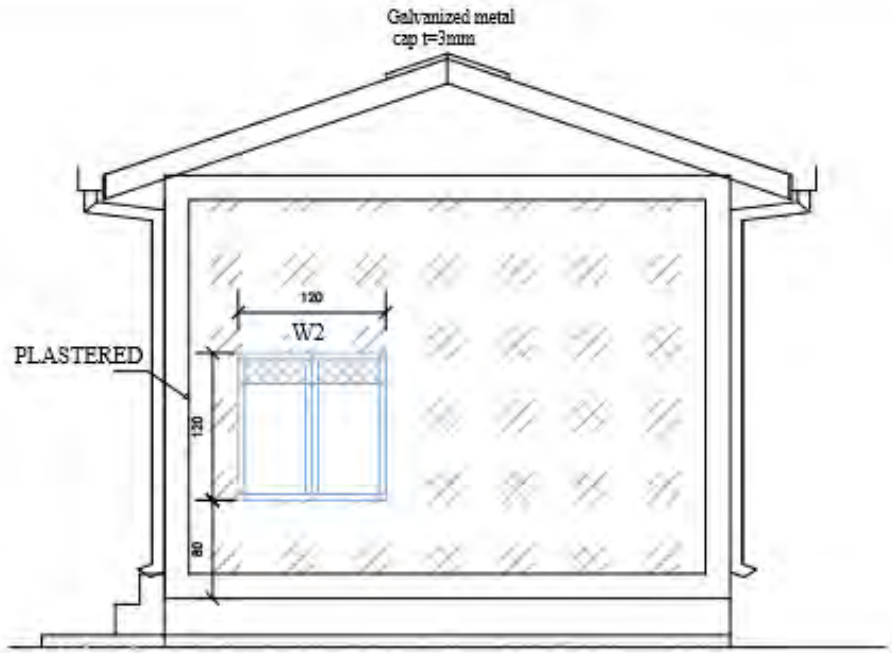




LINTEL BEAM REINFORCEMENT

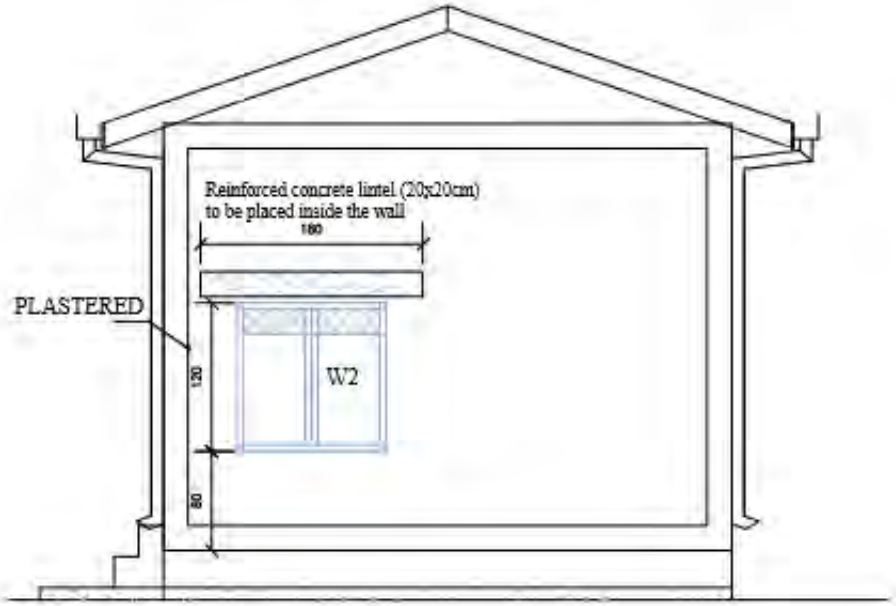
LINTEL INSTALLATION FOR WINDOWS

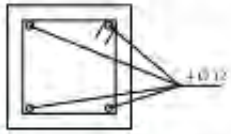
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO.
	TYPICAL DRAWING 8 - GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	14/19



RIGHT ELEVATION

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO.
	TYPICAL DRAWING 8 - GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	15/19

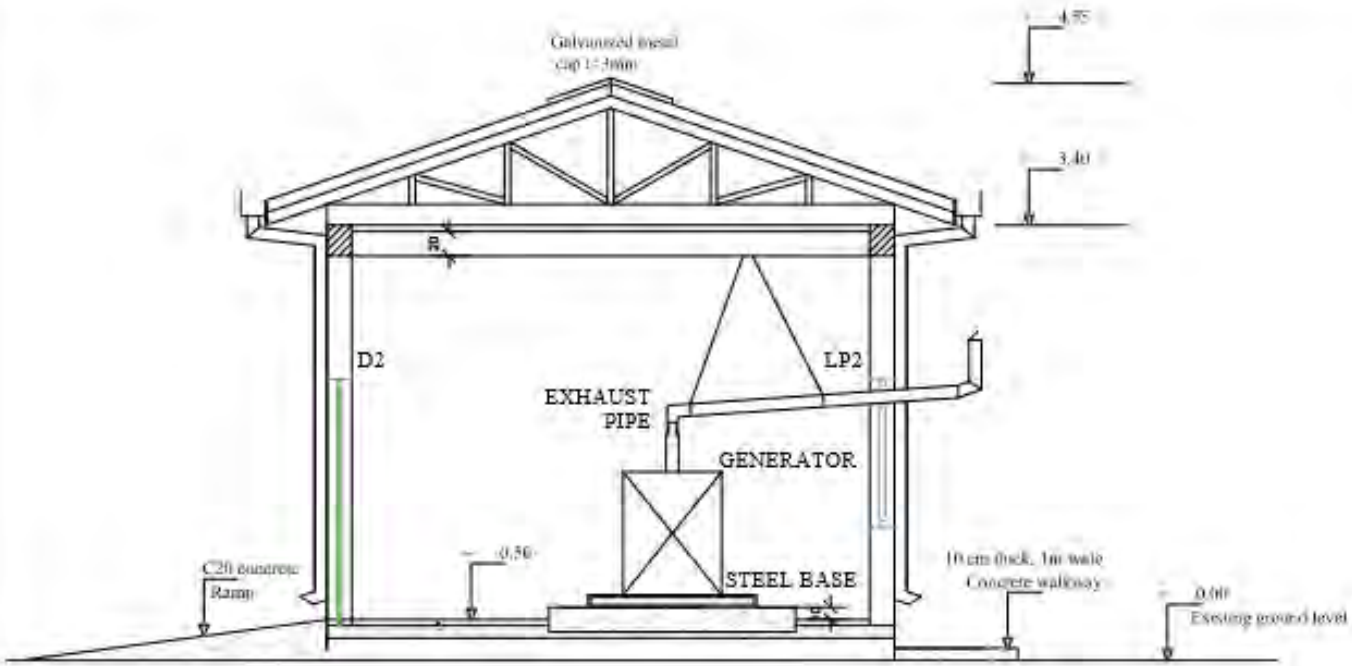




LINTEL BEAM REINFORCEMENT

LINTEL INSTALLATION FOR WINDOWS

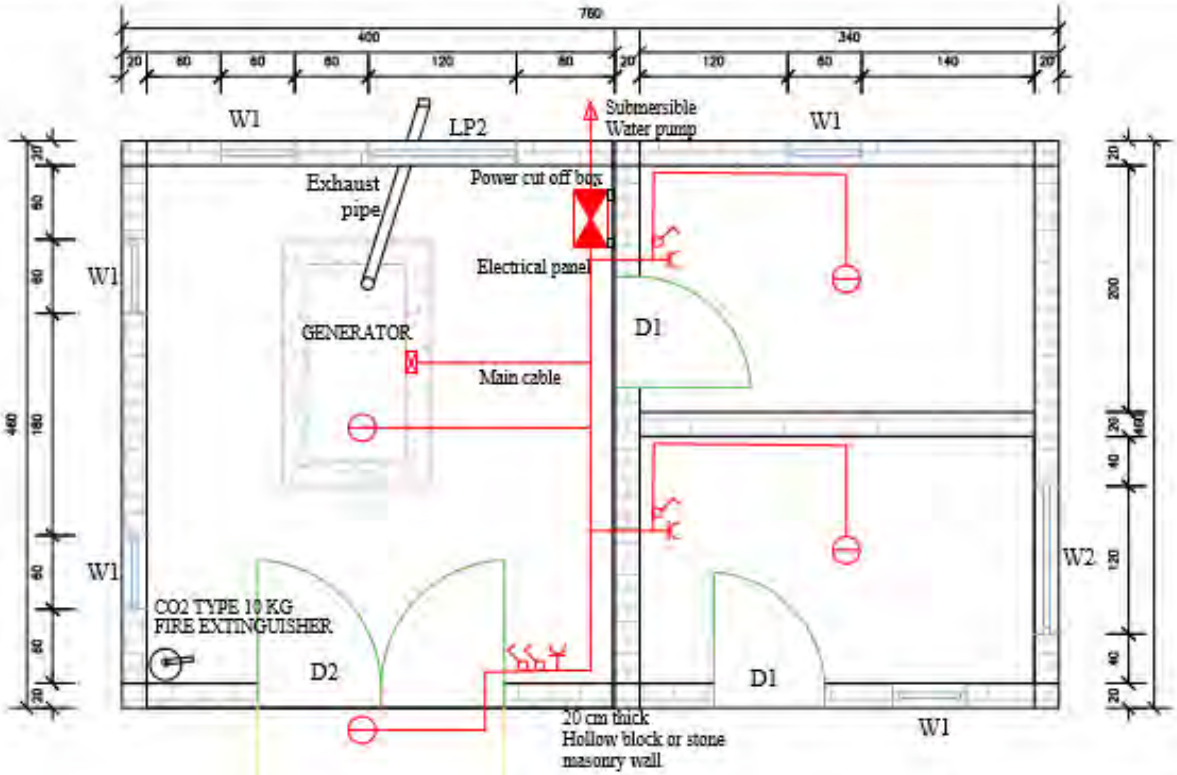
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 5 – GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	16/19



GENERAL:

Generator should be placed onto the steel base over the concrete footing
Vibration isolators shall be placed between steel base and generator
Exhaust pipe to be extended through out the window using proper extension galvanized pipe hoed to the ceiling

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 6 - GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	17/10



Electrical symbols
Switch
Lamp switch
100 watt lamp

GENERATOR CONTROL PANEL

Control panel shall be installed vertically on a steel frame mounted on to the wall.
Electrical control panel must be installed independent of the generator and vertically aligned (cannot be flat)
CO2 type 10 kg fire extinguisher shall be provided

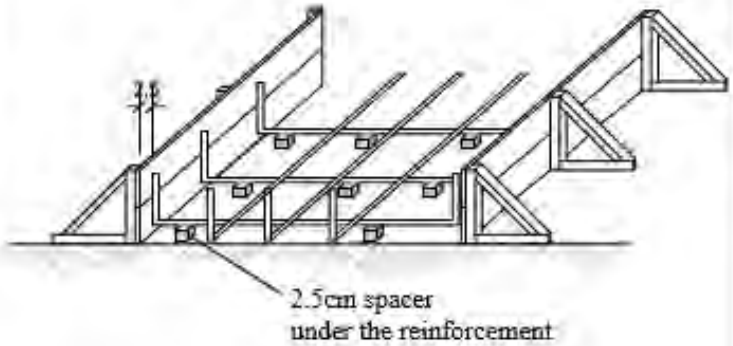
ELECTRICAL PLAN

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 6 - GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	18/19

FORMWORK

The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface
The internal surface of the formwork must be clean and free from concrete crap and dirt
The formwork should be levelled properly
The formwork should be plumb and straight
Before casting interior surfaces of the formwork should be moistened with water
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface
The formwork should be supported with braces properly and fixed with nails as needed.
The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads
The joints between the panels of the formwork should be adequately tight

Formwork and Bracing



CONCRETE

Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

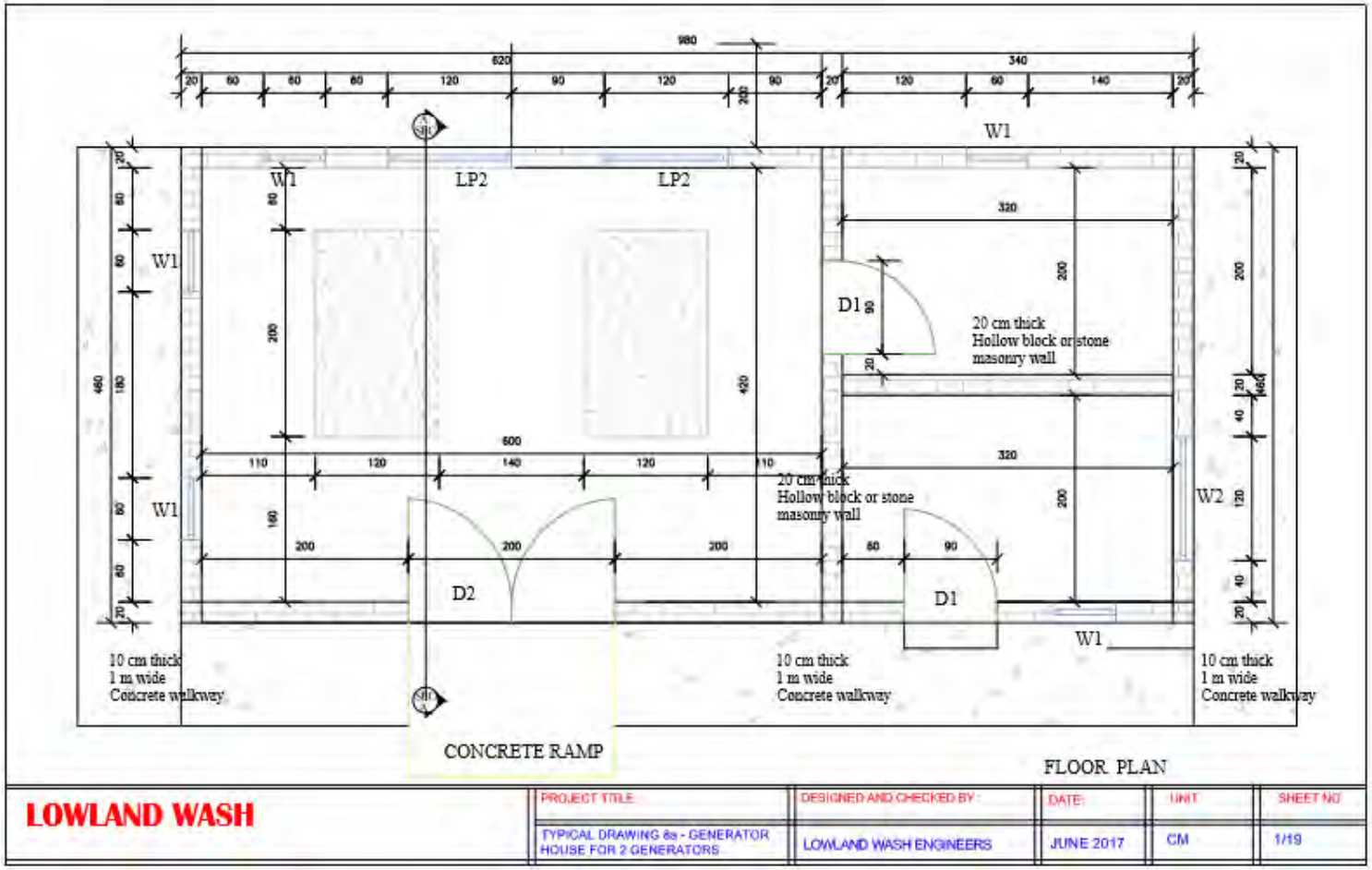
1 m3 C20 concrete batching amounts	Standard Mixes for Ordinary Structural Concrete
Ratio 1:2:4	per 50 kg bag of cement
6 bags cement (300 kg cement)	1 bag cement (50 kg cement)
0.25 m3 coarse sand	275 kg crushed stone (max dia 2 cm) and coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)	0.155 m3 concrete
Max 180 lt water (W/C ratio 0.60)	Max 30 lt water (W/C ratio 0.60)

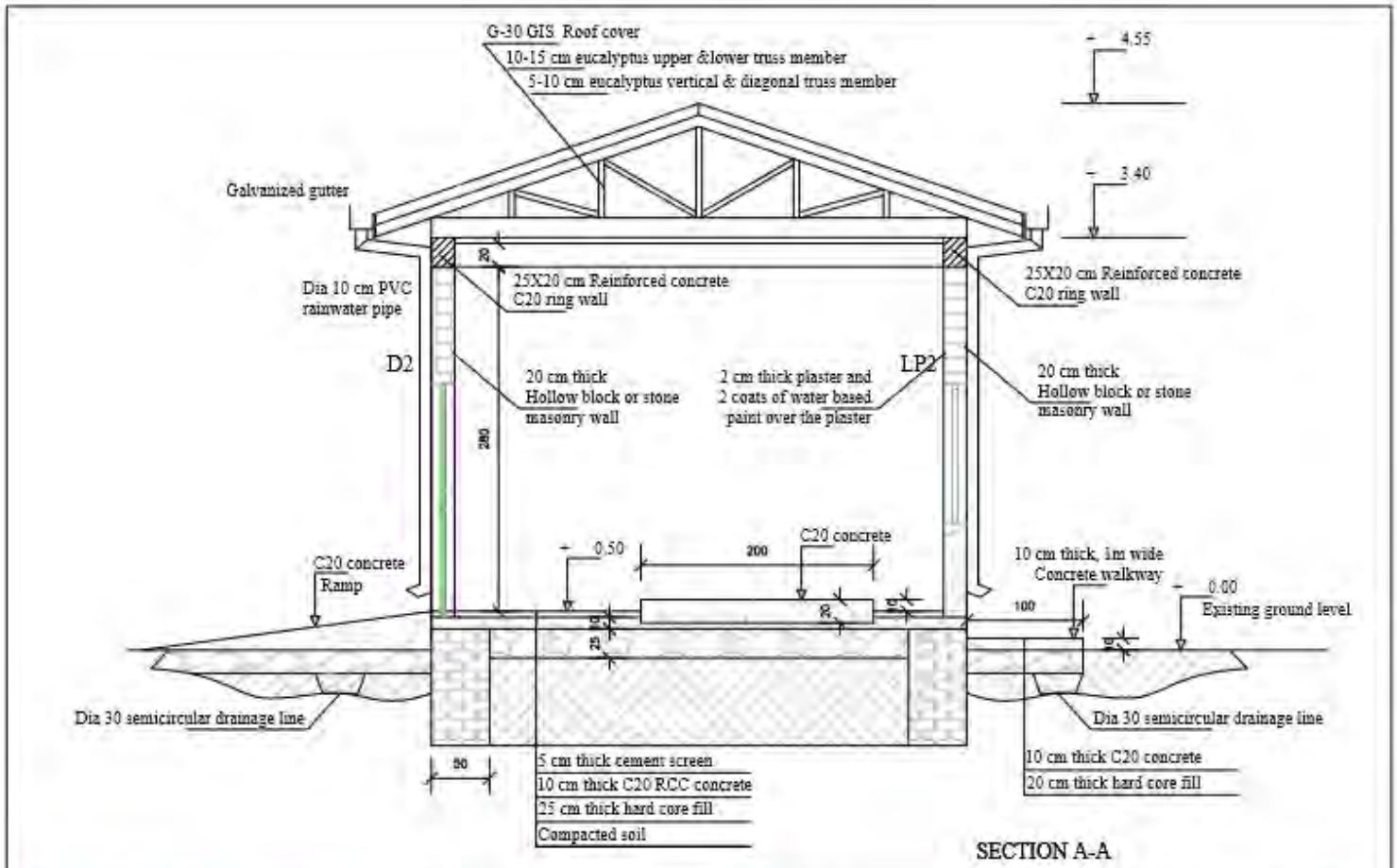
1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 30x30x20cm)

6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg/m3

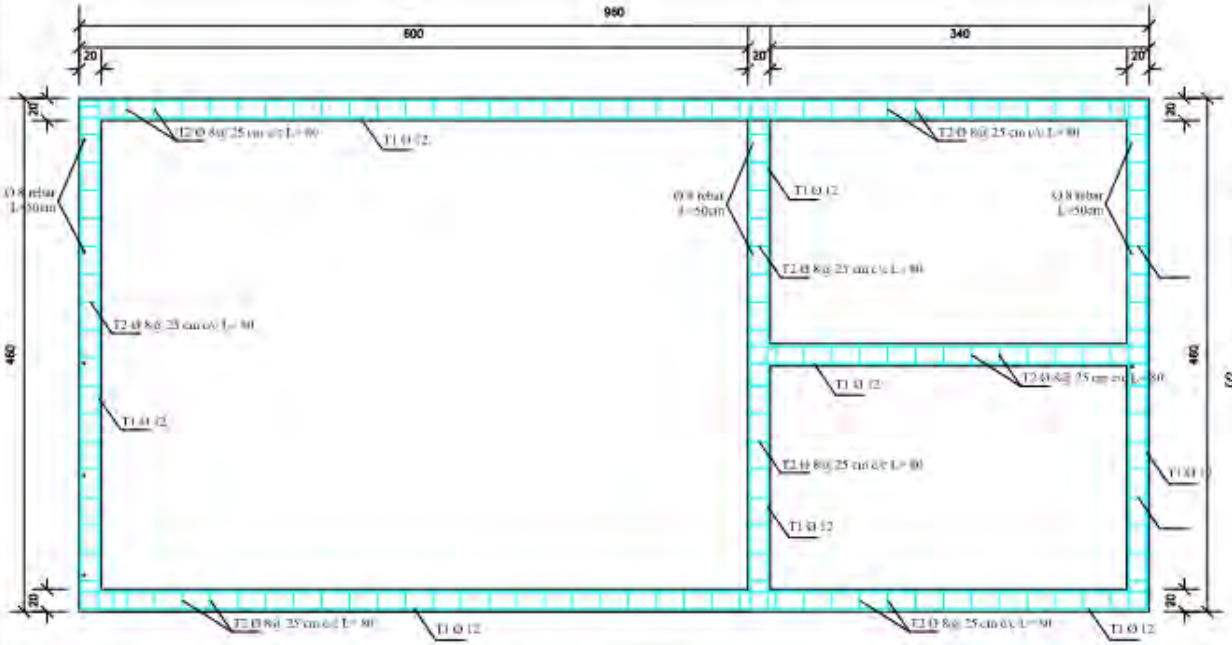
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CONSTRUCTED BY	DATE	DWG	SHEET NO
	TYPICAL DRAWING 6 – GENERATOR HOUSE	LOWLAND WASH ENGINEERS	JUNE 2017	CM	18/19

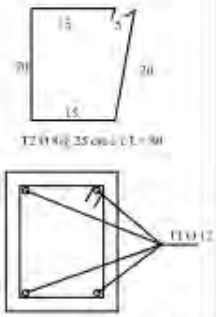
TYPICAL DRAWING 8 – GENERATOR HOUSE FOR 2 GENERATORS





LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO.
	TYPICAL DRAWING 8a - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	2/19





SECTION OF THE RING WALL

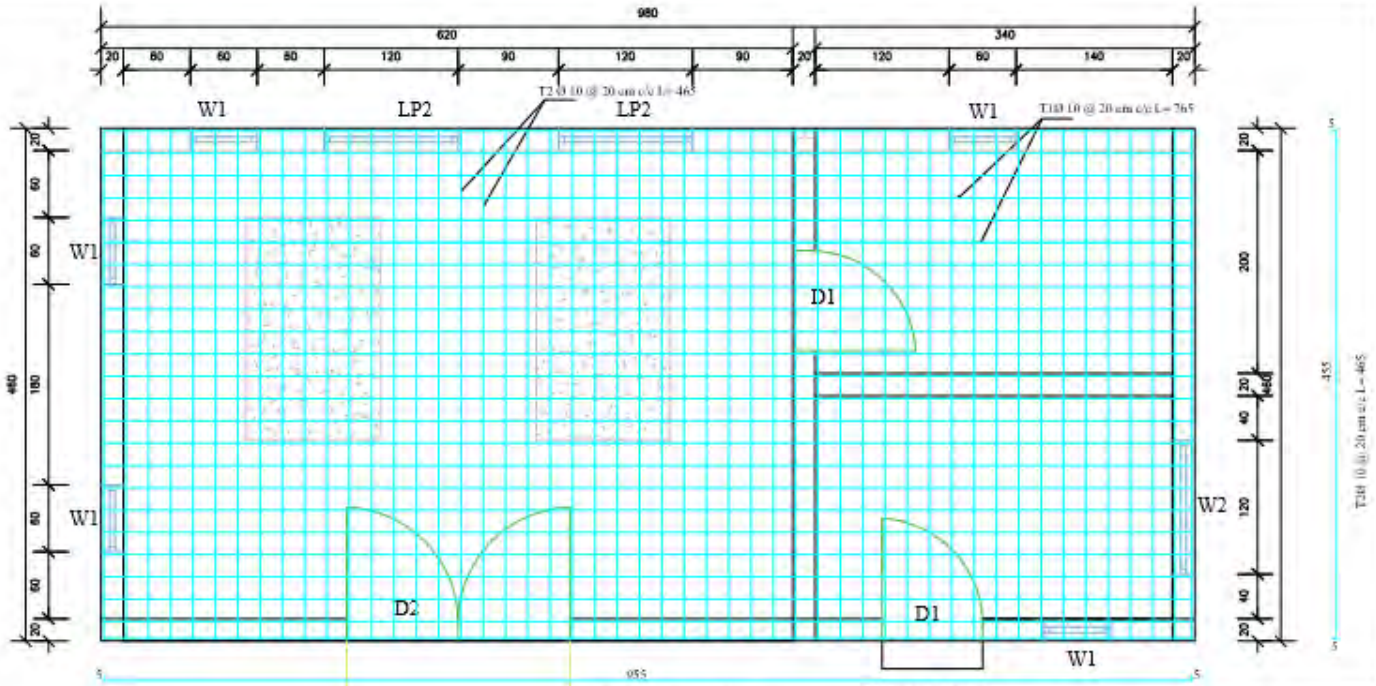
REINFORCED CONCRETE (C20) RING WALL ON TOP OF THE WALLS

LEGEND
T2 Ø 8 @ 25 cm o/c L= 80
T2 stands for reinforcement type Ø 8 @ 25 cm o/c. Steel diameter is 8 mm and be placed in each 25 cm centers to center L= 80 /Total reinforcement length is 80 cm .

REINFORCEMENT

Reinforcement should be clean, free from dirt and oil.
Reinforcement should be cut and bend and placed as drawn on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm).
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well.

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 8a - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	3/19



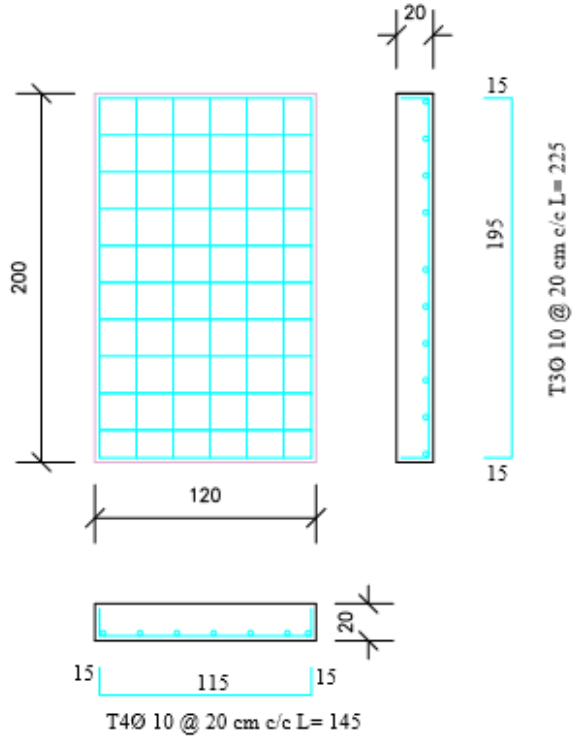
REINFORCED CONCRETE (C20)
SLAB REINFORCEMENT

CONCRETE RAMP

REINFORCEMENT

Reinforcement should be clean, free form dirt and oil
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1.cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

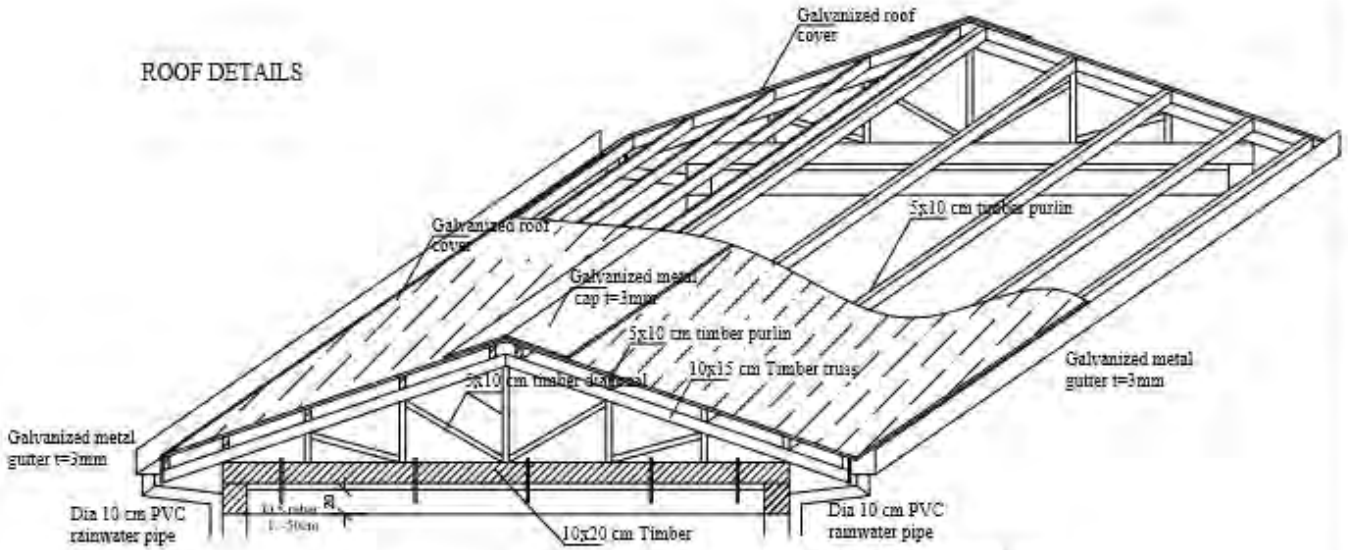
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING #s - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	4/19



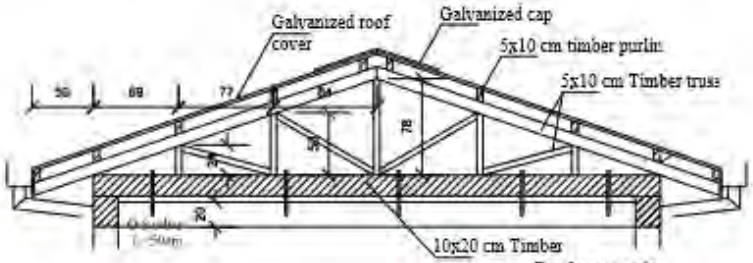
REINFORCED CONCRETE (C20)
GENERATOR PAD REINFORCEMENT

LOWLAND WASH	PROJECT TITLE.	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 8a - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	5/19

ROOF DETAILS



3D View of the Roof Truss and roof cover



Roof truss section

ROOF TRUSS AND COVER

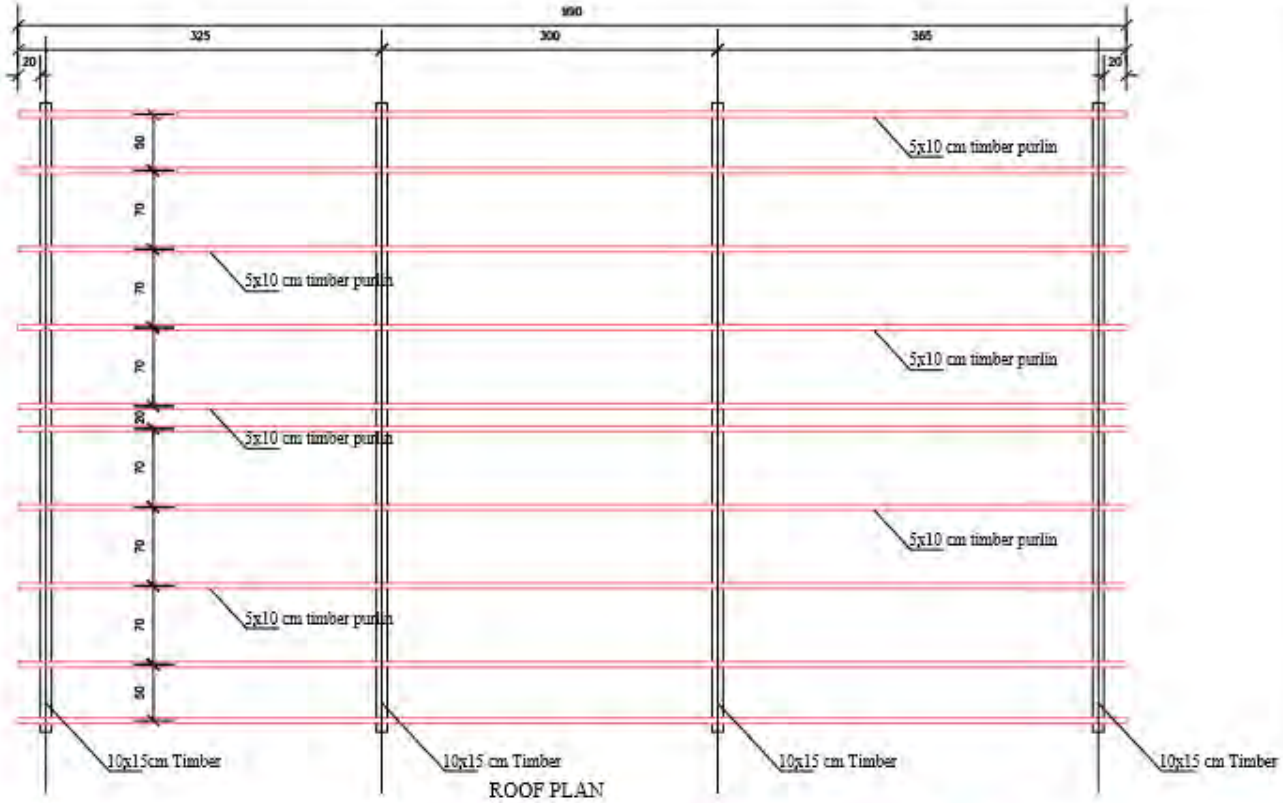
Roof truss shall be formed by using 10x20cm timber beams, 5x10cm timber truss and 5x10 cm timber purlins on top. All timber elements shall be joined by using nails structurally sound.

0.55 mm thick galvanized trapezoidal metal sheet (corrugated) shall be installed over roof timber purlins. Metal sheet shall be fixed to the purlins by using galvanized screws. Screws shall be with rubber gasket to prevent leaking.

Galvanized metal cap shall be placed on top (50 cm wide)

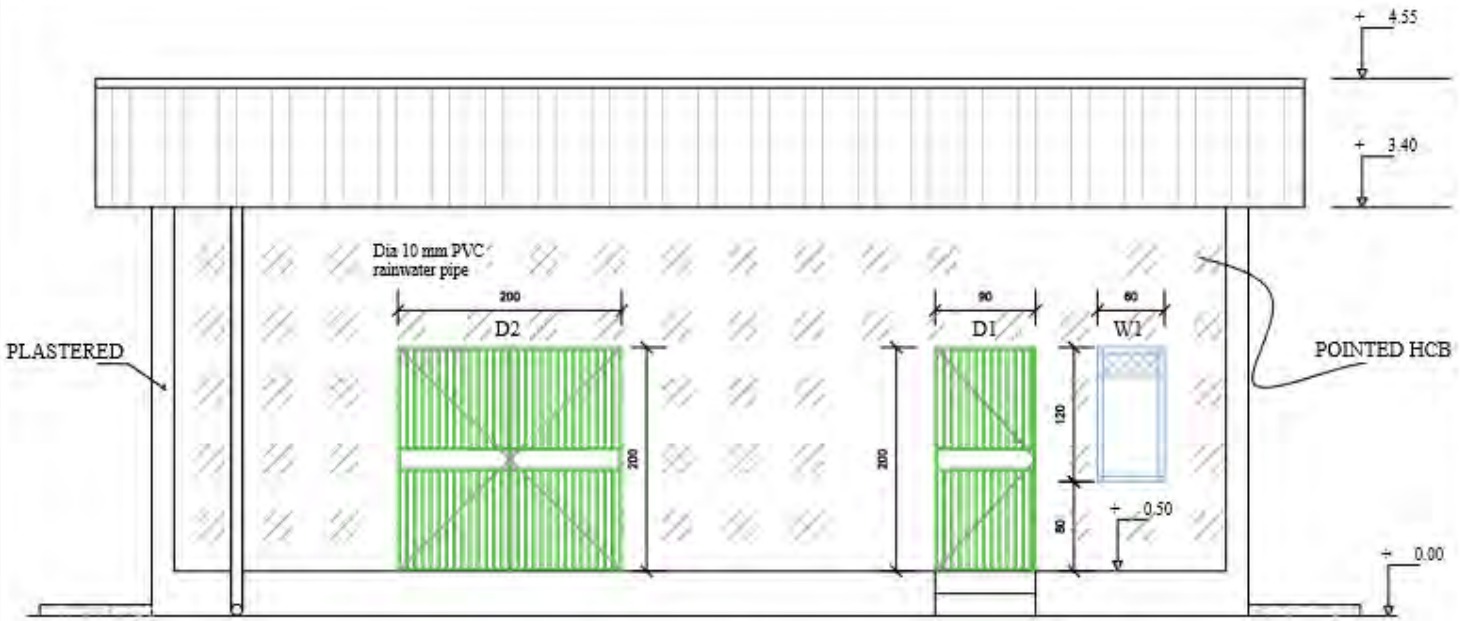
Wooden roof truss shall be placed over reinforced concrete ring wall and tied to 4-T16 rebar which were installed inside ring wall in every 1m

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 5a – GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	8/19



ROOF PLAN

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING IIa - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	7/19

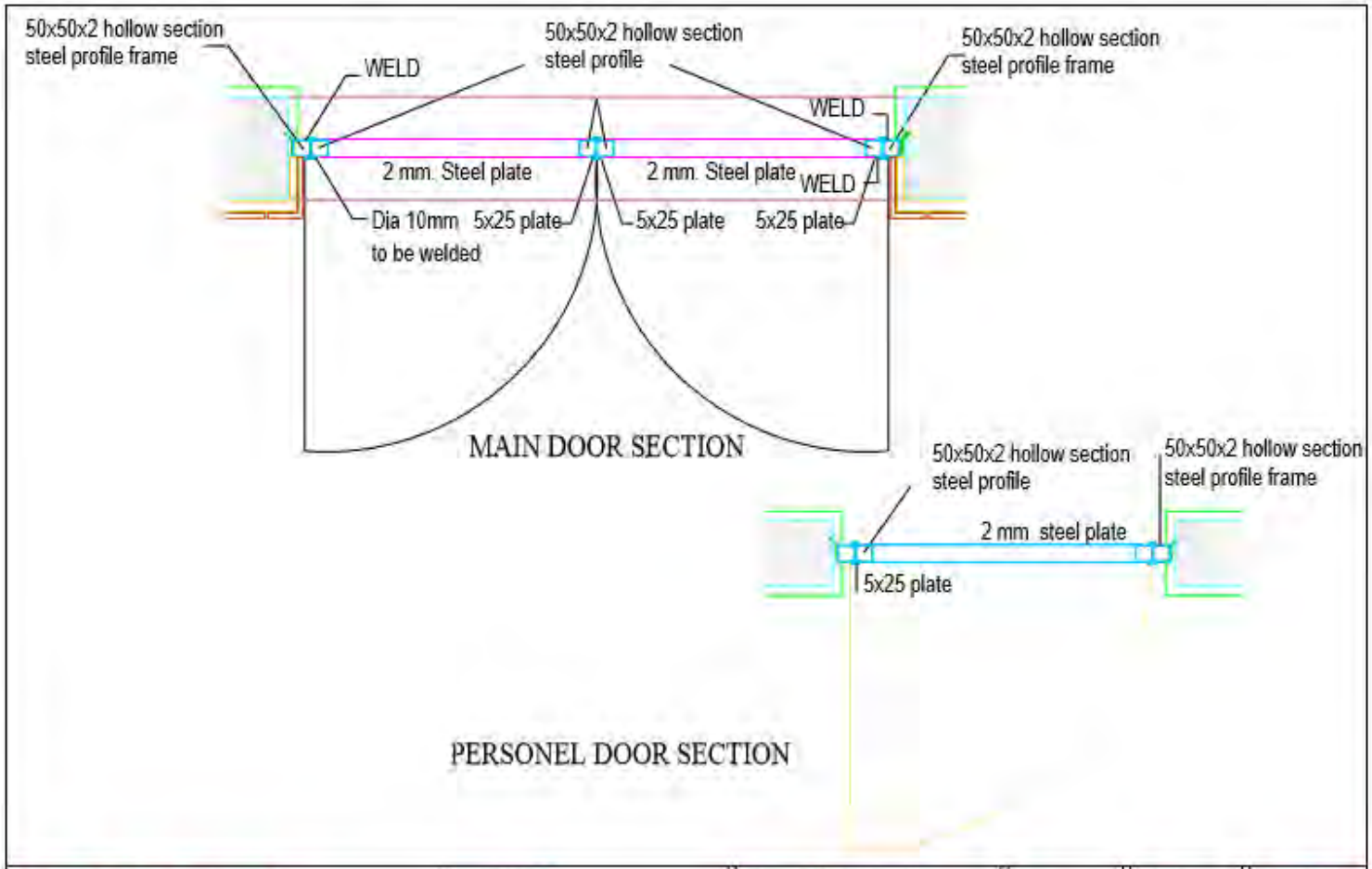


DOOR AND WINDOW LEGEND			
CODE	SIZE (mm)	NO	DEFINITION
D1	200X90	2	Steel frame & 3 mm thick steel door
D2	200X200	1	Steel frame & 3 mm thick steel door
W1	120x60	5	Seko profile, steel frame & 3 mm thick steel
W2	120x120	1	Seko profile, steel frame & 3 mm thick steel
LP1	80x40	3	Steel frame & 3 mm thick steel louvers with internal insect screen
LP2	120x120	1	Steel frame & 3 mm thick steel louvers with internal insect screen

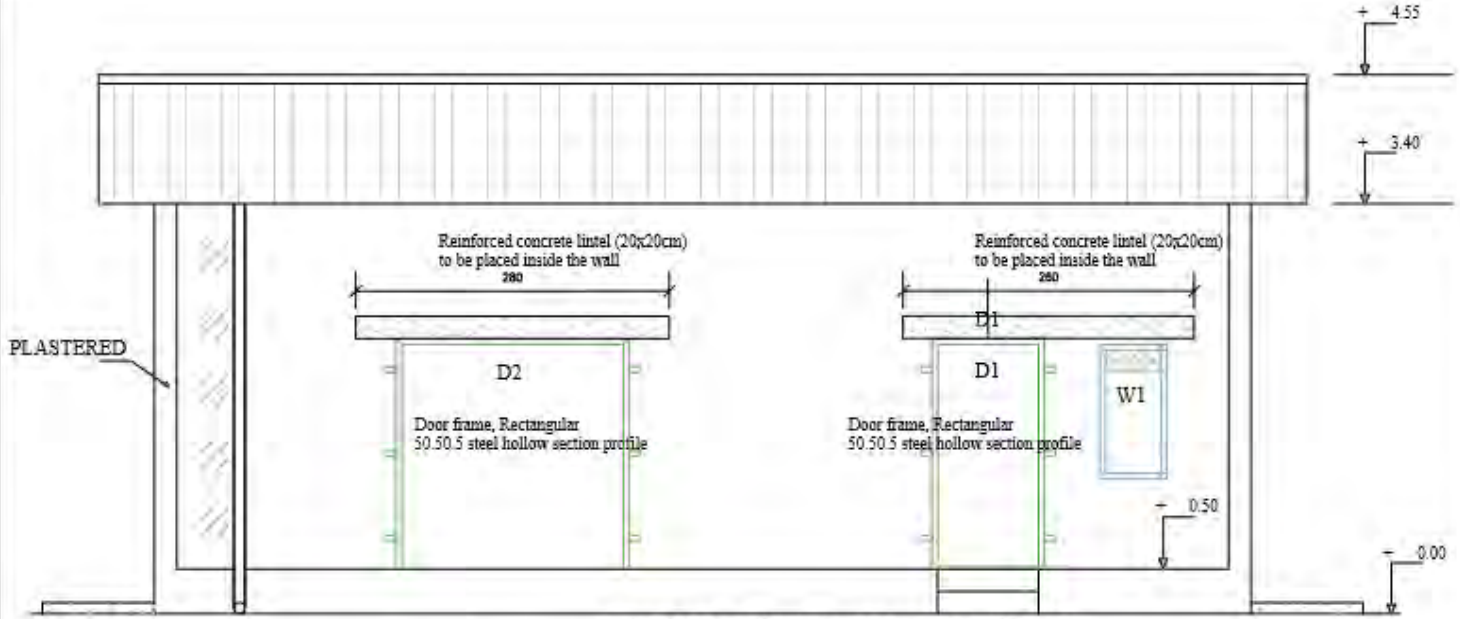
FRONT ELEVATION

LOWLAND WASH

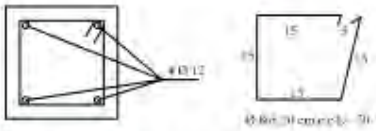
PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
TYPICAL DRAWING 8a - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	8/19



LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 8a - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	9/19



STEEL DOOR FRAMES AND LINTEL INSTALLATION

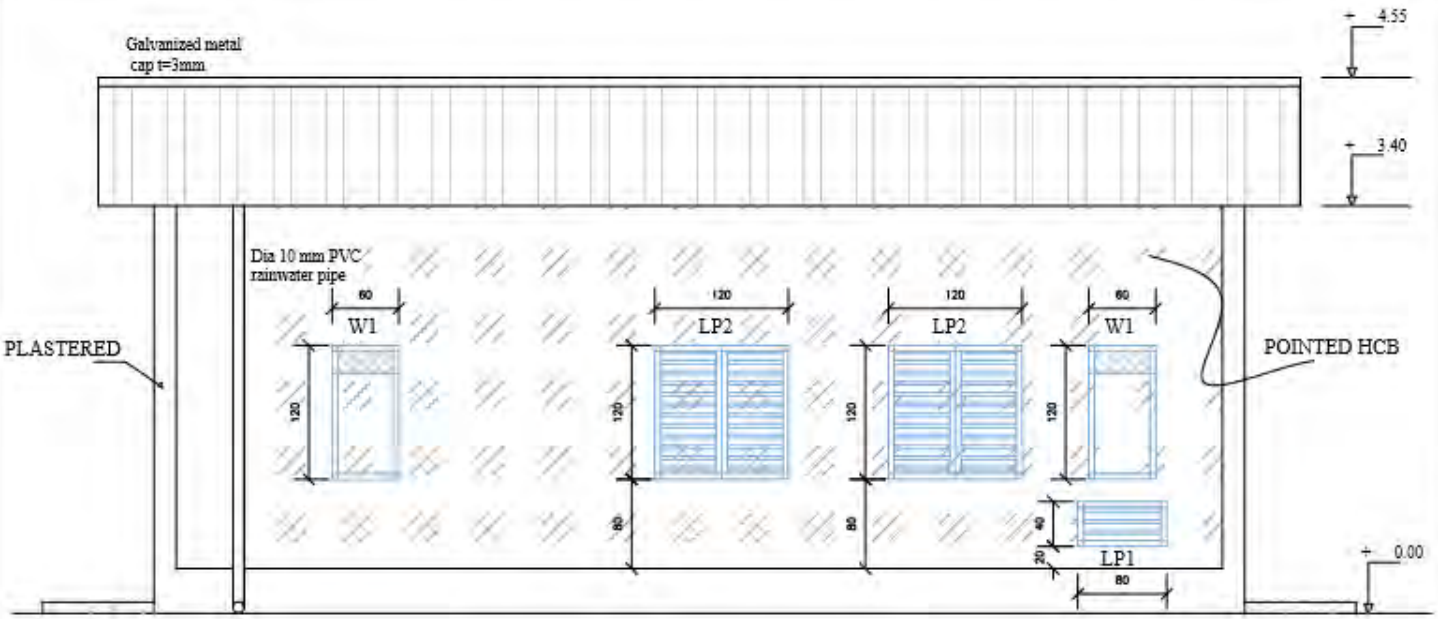


LINTEL BEAM REINFORCEMENT

DOOR AND WINDOW LEGEND

CODE	SIZE (mm)	NO	DEFINITION
D1	300/90	2	Steel frame & 3 mm thick steel door
D2	200x200	1	Steel frame & 3 mm thick steel door
W1	120x60	5	Selo profile steel frame & 3 mm thick steel
W2	120x120	1	Selo profile steel frame & 3 mm thick steel
LW1	80x40	2	Ventilation window, Steel frame & 3 mm thick steel louvers with internal insect screen
LW2	120x120	1	Ventilation window, Steel frame & 3 mm thick steel louvers with internal insect screen

LOWLAND WASH	PROJECT TITLE.	DESIGNED AND CHECKED BY .	DATE	UNIT	SHEET NO
	TYPICAL DRAWING IIa - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	1/0/19

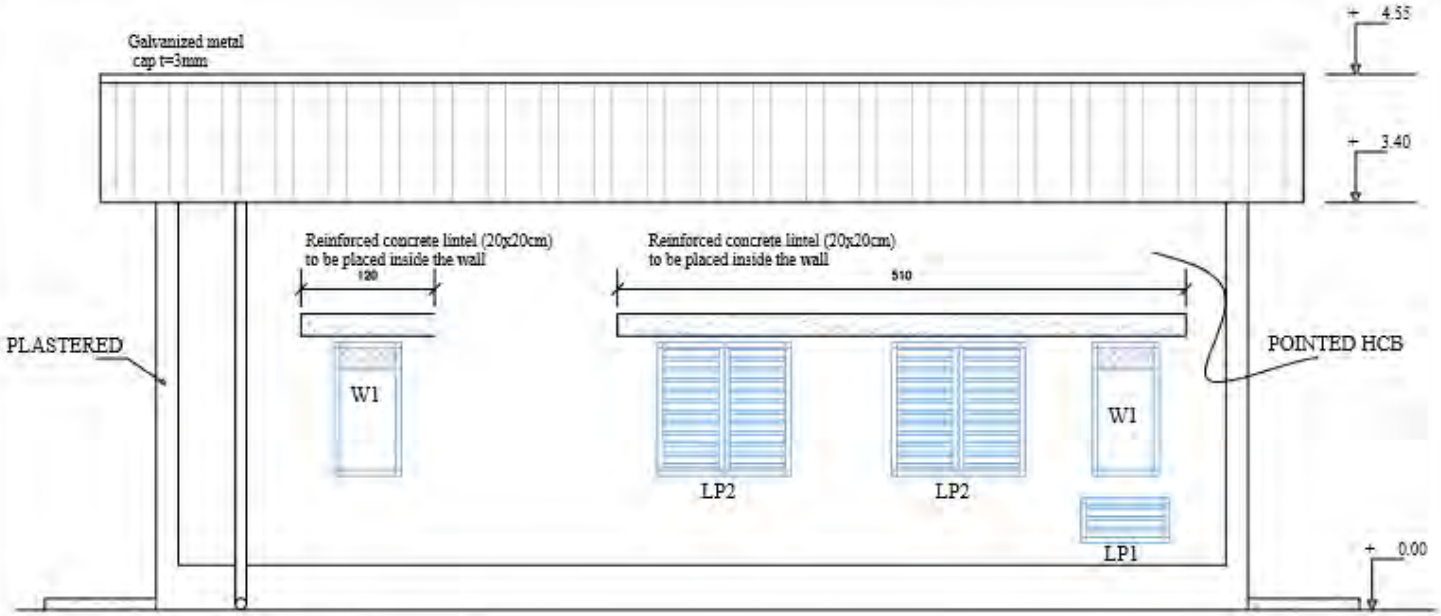


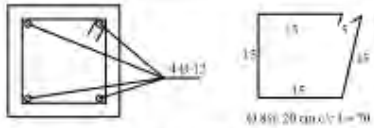
REAR ELEVATION

DOOR AND WINDOW LEGEND

CODE	SIZE (mm)	NO	DEFINITION
D1	900X90	2	Steel frame & 3 mm thick steel door
D2	800x200	1	Steel frame & 3 mm thick steel door
W1	120x60	5	Seko profile, steel frame & 3 mm thick steel
W2	120x120	1	Seko profile, steel frame & 3 mm thick steel
LP1	80x40	2	Ventilation louvers, Steel frame & 3 mm thick steel louvers with internal insect screen
LP2	120x120	1	Ventilation louvers, Steel frame & 3 mm thick steel louvers with internal insect screen

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 8a - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	11/19

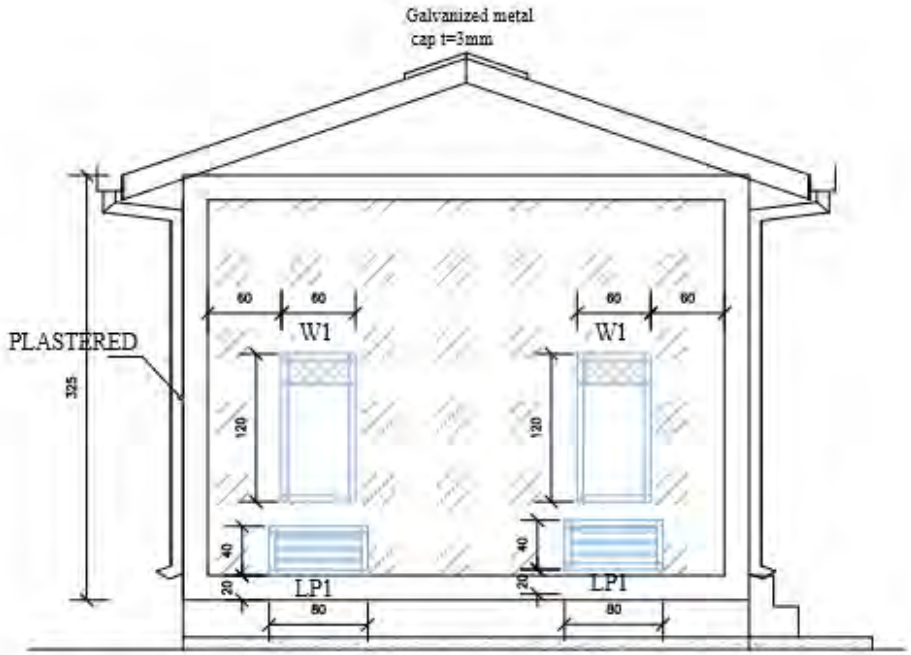




LINTEL BEAM REINFORCEMENT

LINTEL INSTALLATION FOR WINDOWS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 8a - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	12/19

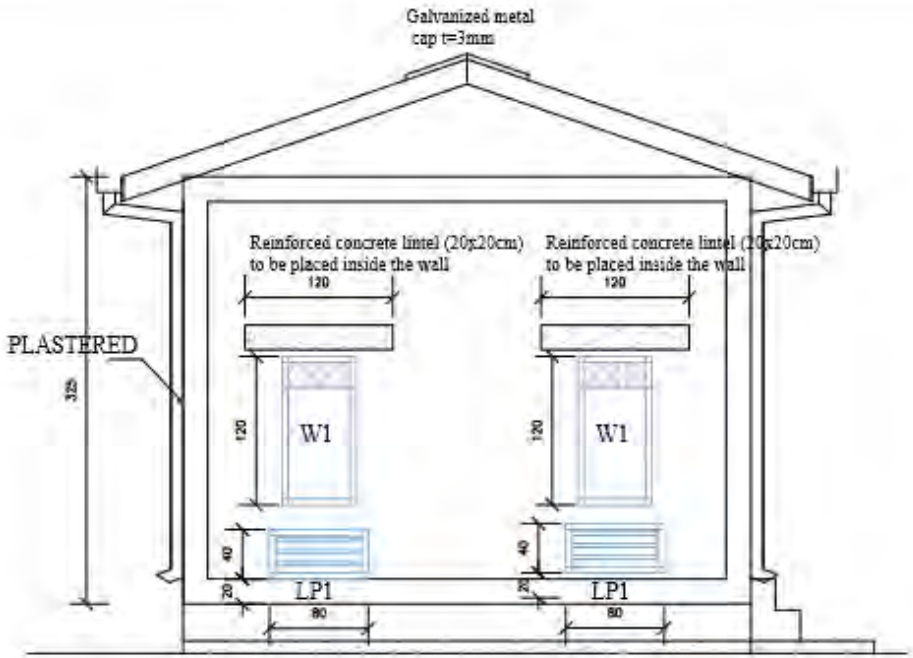


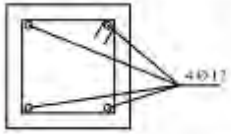
LEFT ELEVATION

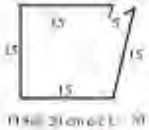
DOOR AND WINDOW LEGEND

CODE	SIZE (mm)	NO	DEFINITION
D1	200X90	2	Steel frame & 3 mm thick steel door
D2	200x200	1	Steel frame & 3 mm thick steel door
W1	120x60	5	Seko profile, steel frame & 3 mm thick steel
W2	120x120	1	Seko profile, steel frame & 3 mm thick steel
LP1	80x40	3	Ventilation louvers, Steel frame & 3 mm thick steel louvers with internal insect screen
LP2	120x120	1	Ventilation louvers, Steel frame & 3 mm thick steel louvers with internal insect screen

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 8a - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	13/19



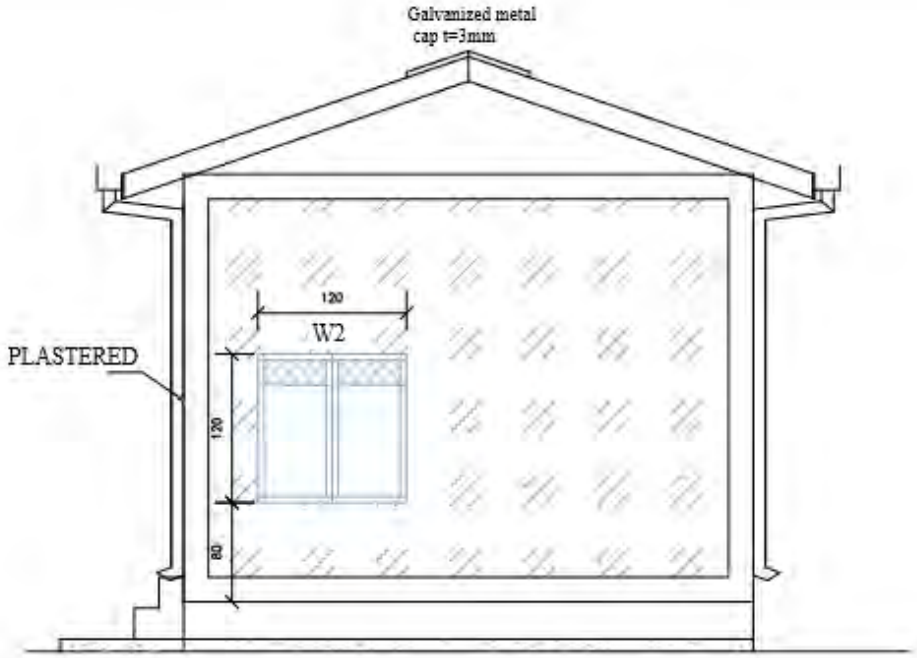




LINTEL BEAM REINFORCEMENT

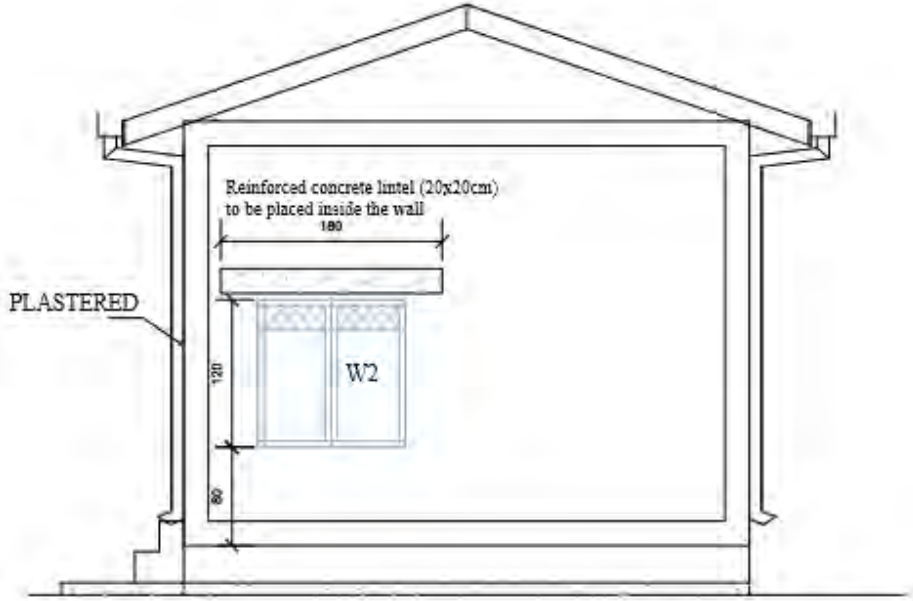
LINTEL INSTALLATION FOR WINDOWS

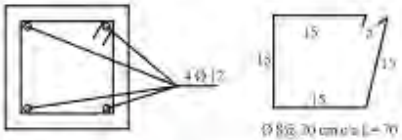
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO.
	TYPICAL DRAWING 8a - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	14/19



RIGHT ELEVATION

LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY:	DATE:	UNIT	SHEET NO.
	TYPICAL DRAWING 8a - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	15/19

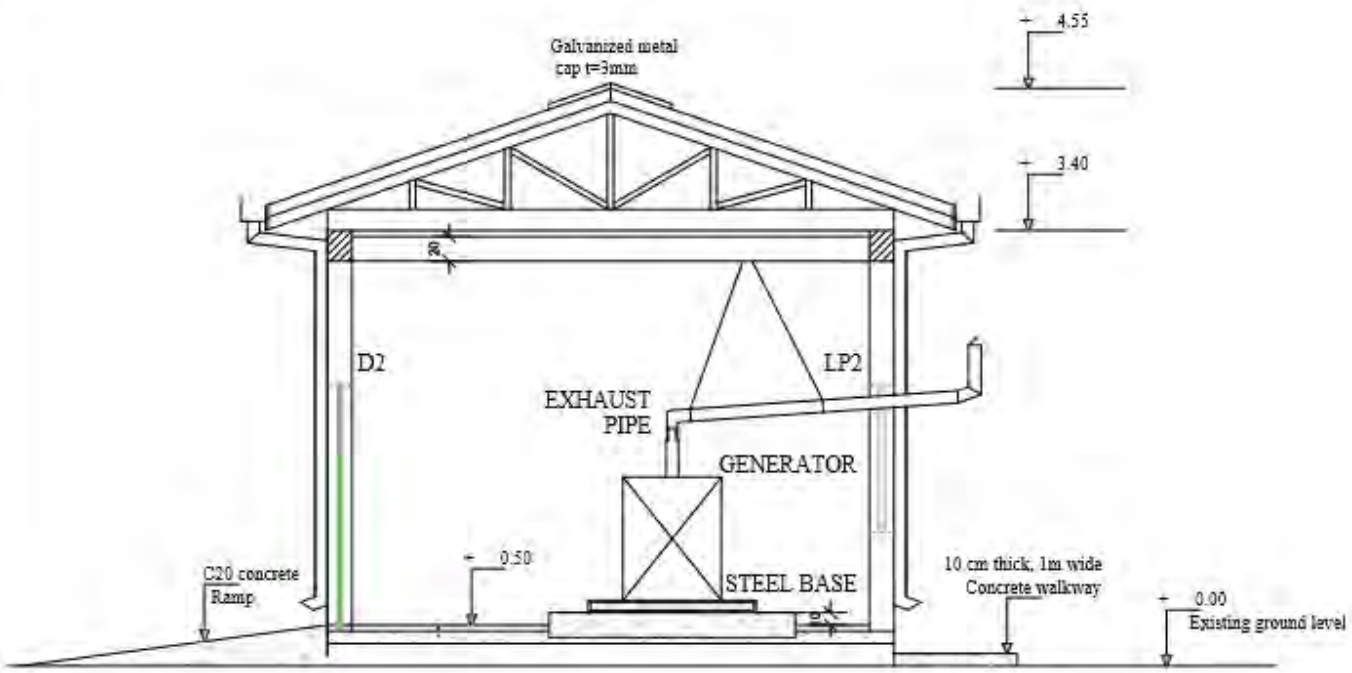




LINTEL BEAM REINFORCEMENT

LINTEL INSTALLATION FOR WINDOWS

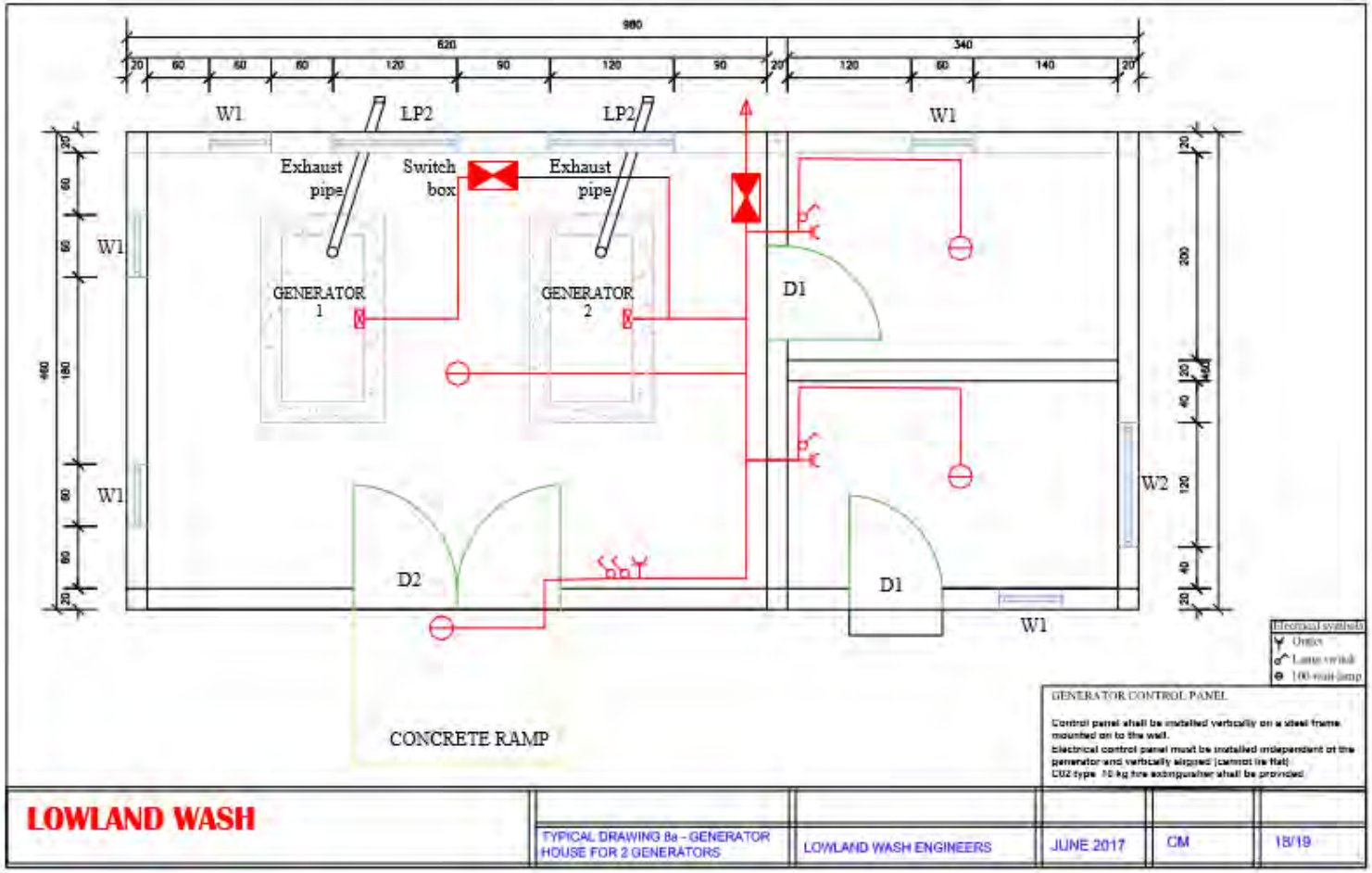
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING 8a - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	16/19



GENERATOR

Generator should be placed onto the steel base over the concrete footing
Vibration isolators shall be placed between steel base and generator
Exhaust pipe to be extended through out the window using proper extension galvanized pipe fixed to the ceiling

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 8e - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	17/19



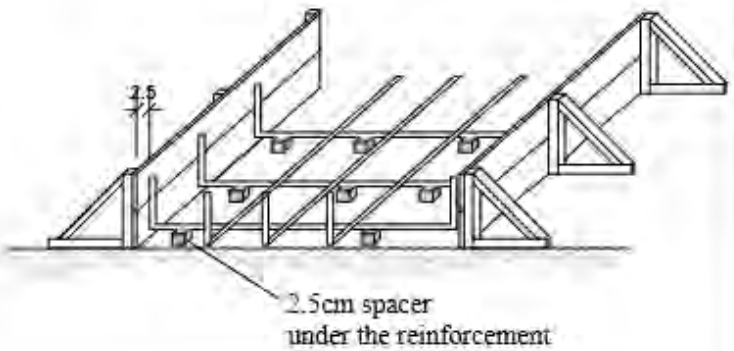
LOWLAND WASH

TYPICAL DRAWING 8a - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	18/19

FORMWORK

The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface
The internal surface of the formwork must be clean and free from concrete crap and dirt
The formwork should be levelled properly
The formwork should be plumb and straight
Before casting interior surfaces of the formwork should be moistened with water
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface
The formwork should be supported with braces properly and fixed with nails as needed
The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads
The joints between the panels of the formwork should be adequately tight

Formwork and Bracing



CONCRETE

Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

1 m3 C20 concrete batching amounts	Standard Mixes for Ordinary Structural Concrete per 50 kg bag of cement
Ratio 1:2:4	1 bag cement (50 kg cement)
6 bags cement (300 kg cement)	275 kg crushed stone (max dia 2 cm) and coarse sand
0.25 m3 coarse sand	0.155 m3 concrete
0.50 m3 crushed stone (aggregate Dia 2cm)	Max 30 lt water (W/C ratio 0.60)
Max 180 lt water (W/C ratio 0.60)	

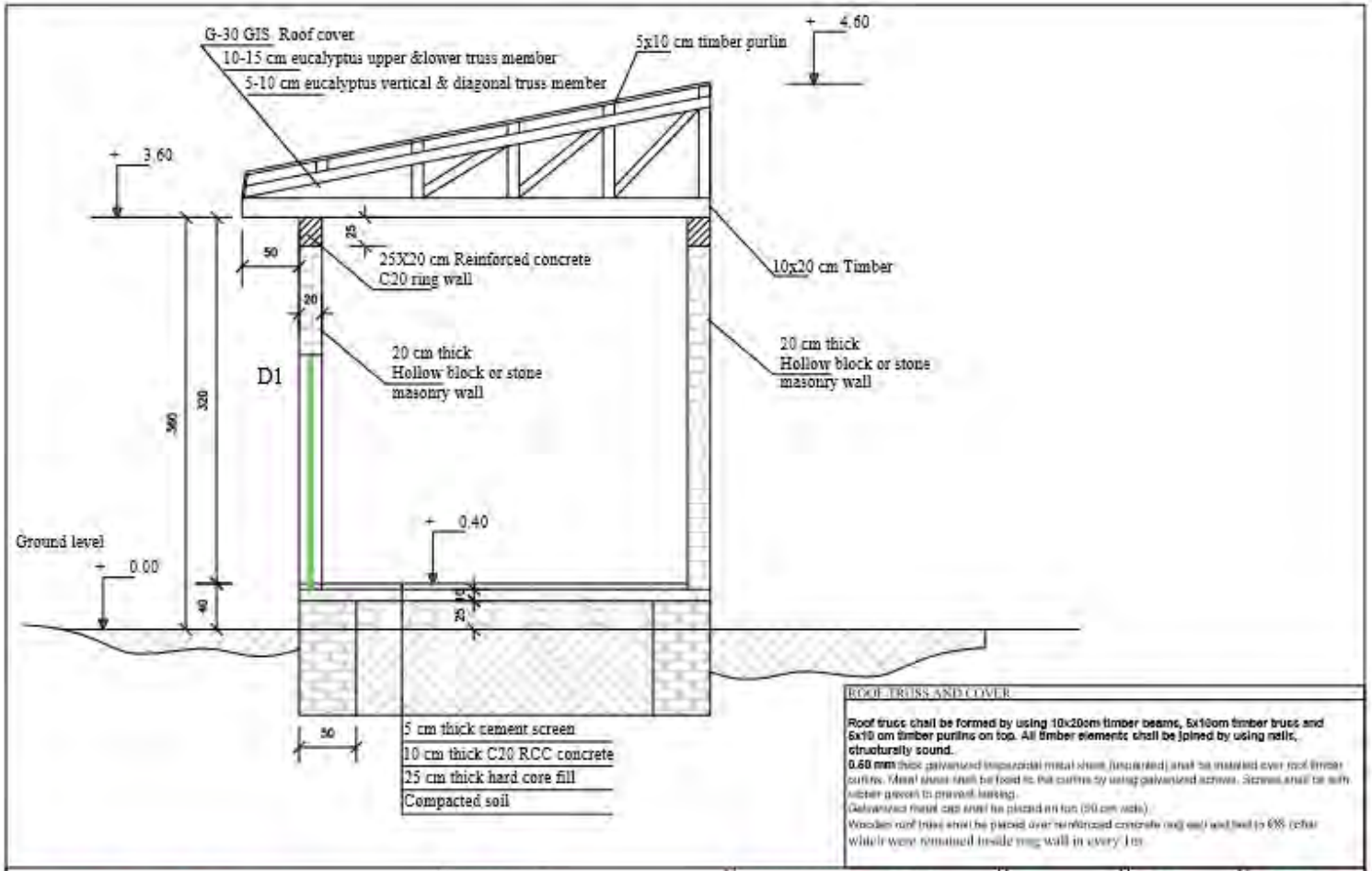
1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 30x50x20cm)

6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg/m3

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	SCALE	SHEET NO
	TYPICAL DRAWING 8a - GENERATOR HOUSE FOR 2 GENERATORS	LOWLAND WASH ENGINEERS	JUNE 2017	CM	19/19

TYPICAL DRAWING-9 GUARD HOUSE FOR BOOSTER STATION

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING BOOSTER STATION GUARD HOUSE	LOWLAND WASH ENGINEERS	OCT 2017	CM	1/8



ROOF TRUSS AND COVER

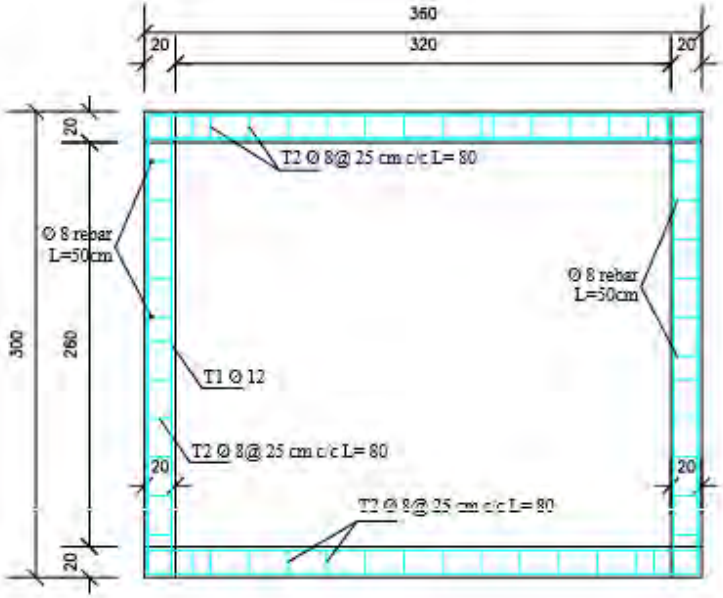
Roof truss shall be formed by using 10x20cm timber beams, 5x10cm timber truss and 5x10 cm timber purlins on top. All timber elements shall be joined by using nails, structurally sound.

0.60 mm thick galvanized trapezoidal metal sheet (uncoated) shall be installed over roof timber purlins. Metal sheet shall be fixed to the purlins by using galvanized screws. Screws shall be with rubber gasket to prevent leaking.

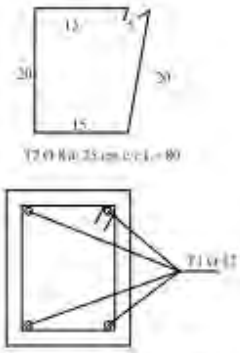
Galvanized metal cap shall be placed on top (50 cm wide).

Wooden roof trusses shall be placed over reinforced concrete ring wall and tied to 6Ø8 rebar which were remained inside ring wall in every 1 m.

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING BOOSTER STATION GUARD HOUSE	LOWLAND WASH ENGINEERS	OCT 2017	CM	2/6



REINFORCED CONCRETE (C20) RING WALL ON TOP OF THE WALLS



SECTION OF THE RING WALL

LEGEND

T2 Ø 8 @ 25 cm c/c L = 80

T2 stands for reinforcement type

Ø 8 @ 25 cm c/c Steel diameter is 8 mm and be placed in each 25 cm center to center

L=80 Total reinforcement length is 80 cm

REINFORCEMENT

Reinforcement should be clean, free form dirt and oil.

Reinforcement should be cut and bend and placed as shown on the drawings

The space between reinforcement should match with the drawings (tolerance 1 cm)

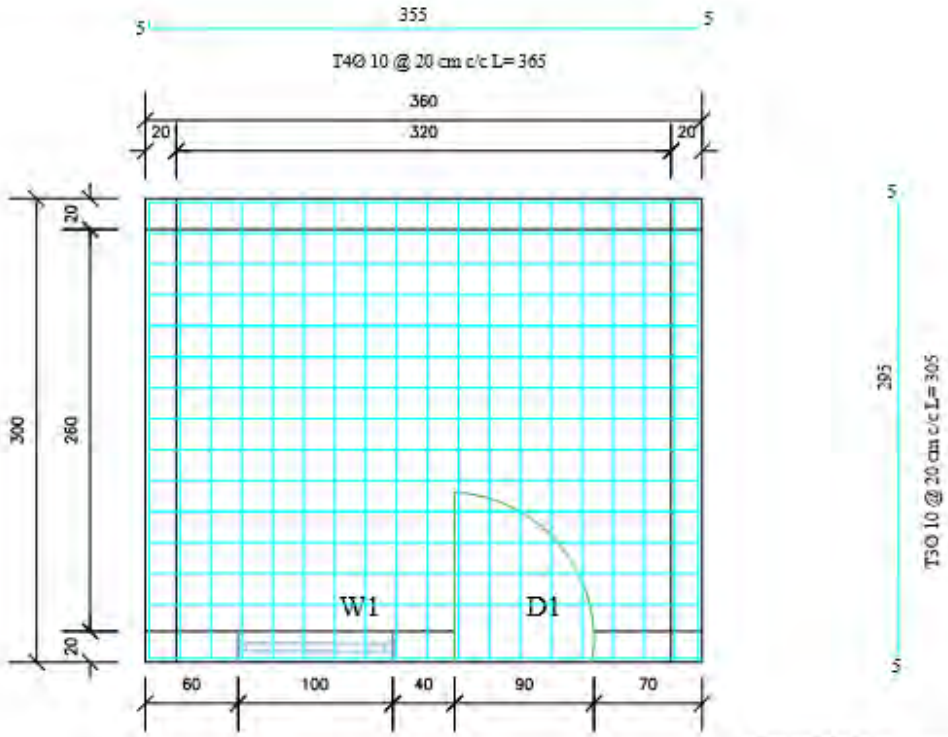
Reinforcement diameter should match with the drawings

Reinforcement should be fixed to each other by using iron wire

Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars

2.5 cm spacing is required in the vertical walls from the formwork as well

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING BOOSTER STATION GUARD HOUSE	LOWLAND WASH ENGINEERS	OCT 2017	CM	3/6

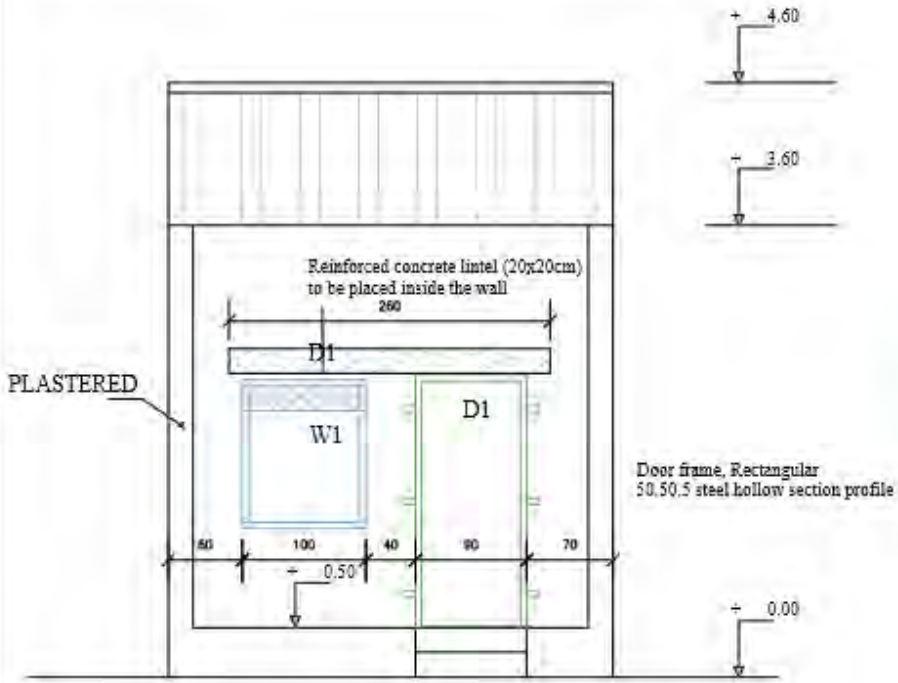


REINFORCED CONCRETE (C20)
SLAB REINFORCEMENT

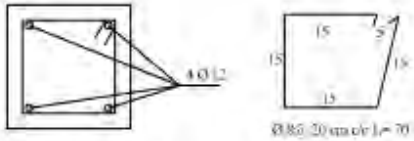
REINFORCEMENT

Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings.
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

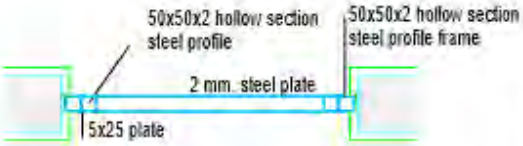
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING BOOSTER STATION GUARD HOUSE	LOWLAND WASH ENGINEERS	OCT 2017	CM	4/6



STEEL DOOR FRAMES AND LINTEL INSTALLATION



LINTEL BEAM REINFORCEMENT



DOOR SECTION

DOOR AND WINDOW LEGEND

CODE	SIZE (mm)	NO.	DEFINITION
D1	280x200	1	Steel frame & 5 mm thick steel door
W1	100x100	1	Soko profile steel frame & 5 mm thick steel

LOWLAND WASH	TYPICAL DRAWING BOOSTER STATION GUARD HOUSE	LOWLAND WASH ENGINEERS	OCT 2017	CM	5/6

FORMWORK

The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface

The internal surface of the formwork must be clean and free from concrete crap and dirt

The formwork should be levelled properly

The formwork should be plumb and straight

Before casting interior surfaces of the formwork should be moistened with water

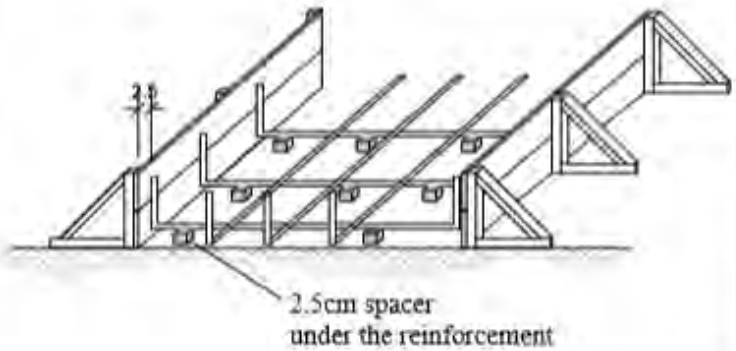
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface

The formwork should be supported with braces properly and fixed with nails as needed.

The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads

The joints between the panels of the formwork should be adequately tight

Formwork and Bracing



CONCRETE

Coarse sand shall be clean and free from dirt and clay

Coarse aggregate size shall be max dia 2 cm

Coarse aggregate shall be mixture of 0-1 and 0-2 size

Mixing water shall be clean

Concrete shall be mixed on steel plate or on clean surface

Concrete shall be placed within 30 min after mixing completed

Vibrator or steel bars shall be used to compact concrete during placing

Concrete surface shall be levelled using trowel

Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

1 m3 C20 concrete batching amounts	Standard Mixes for Ordinary Structural Concrete
Ratio 1:2:4	per 50 kg bag of cement
6 bags cement (300 kg cement)	1 bag cement (50 kg cement)
0.25 m3 coarse sand	275 kg crushed stone (max dia 2 cm) and coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)	0.155 m3 concrete
Max 180 lt water (W/C ratio 0.60)	Max 30 lt water (W/C ratio 0.60)

1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 30x30x20cm)

6 bags cement (300 kg cement)

5 buckets coarse sand

10 buckets crushed stone (max Dia 2cm)

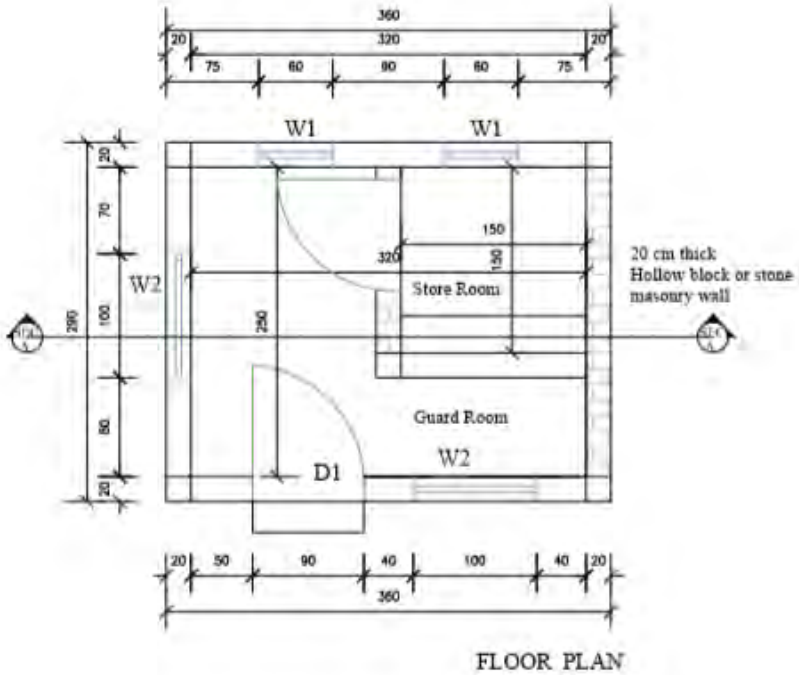
Max 180 lt water (W/C ratio 0.60)

Coarse sand and crushed stone density: 2200 kg/m3

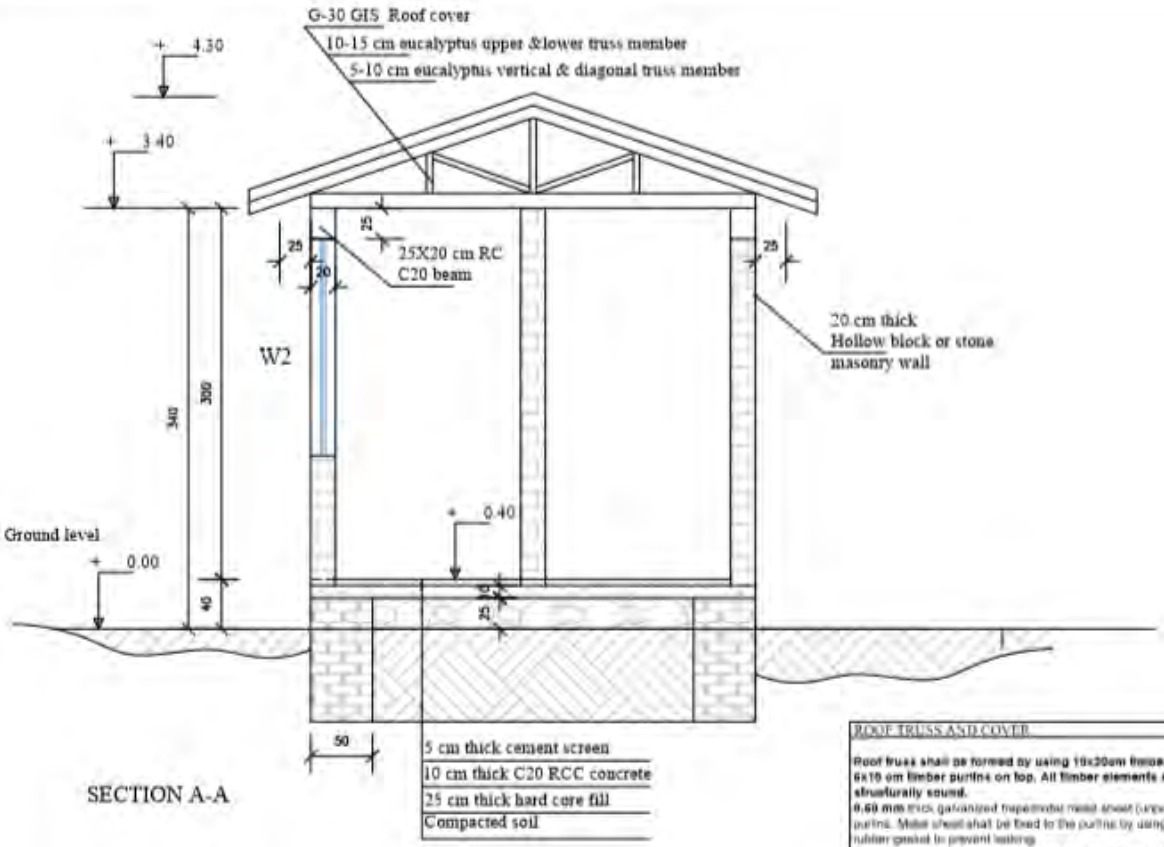
LOWLAND WASH

PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
TYPICAL DRAWING BOOSTER STATION GUARD HOUSE	LOWLAND WASH ENGINEERS	OCT 2017	CM	6/6

TYPICAL DRAWING 10 GUARD HOUSE FOR THE SOLAR POWER SYSTEM



LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 10 - GUARD HOUSE FOR SOLAR POWER SYSTEM	LOWLAND WASH ENGINEERS	DEC. 2017	CM	1/8



ROOF TRUSS AND COVER

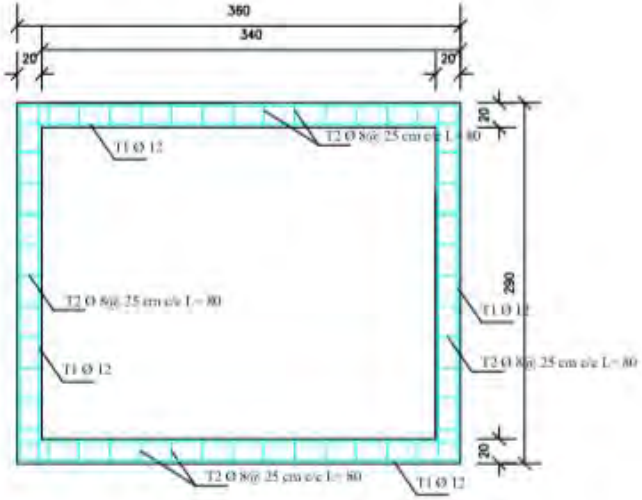
Roof truss shall be formed by using 10x20cm timber beams, 5x10cm timber truss and 6x10 cm timber purlins on top. All timber elements shall be joined by using nails, structurally sound.

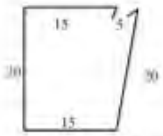
0.60 mm thick galvanized trapezoidal metal sheet (unpainted) shall be installed over roof timber purlins. Metal sheet shall be fixed to the purlins by using galvanized screws. Screws shall be with rubber gasket to prevent leaking.

Galvanized metal cap shall be placed on top (50 cm wide).

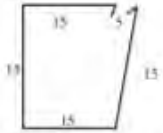
Wooden roof truss shall be placed over reinforced concrete ring wall and tied to Ø8 rebar which were remained inside ring wall in every 1m

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 10 - GUARD HOUSE FOR SOLAR POWER SYSTEM	LOWLAND WASH ENGINEERS	DEC 2017	CM	2/8

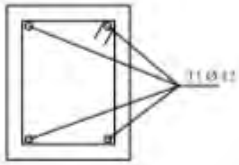




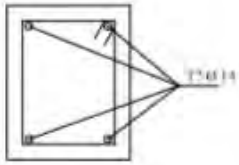
T2 Ø 8@ 25 cm c/c L= 80



T6 Ø 8@ 25 cm c/c L= 70



SECTION OF THE BEAM



SECTION OF THE COLUMN

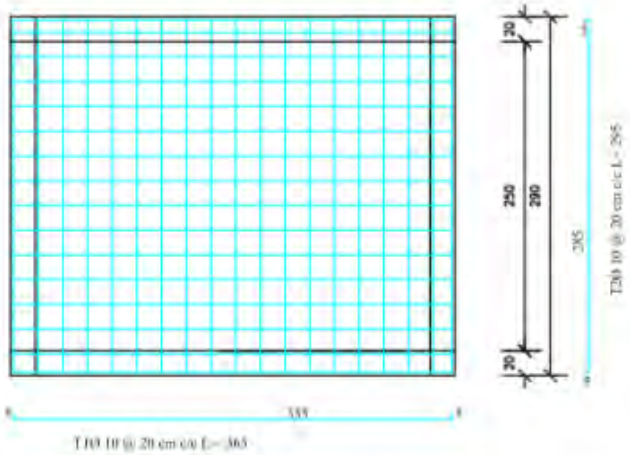
REINFORCED CONCRETE (C20) BEAM
ON TOP OF THE WALLS

LEGEND
T2 Ø 8 @ 25 cm c/c L= 80
T2 stands for reinforcement type Ø 8 @ 25 cm c/c Steel diameter is 8 mm and be placed to each 25 cm center to center L= 80 Total reinforcement length is 80 cm

REINFORCEMENT

Reinforcement should be clean, free from dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock -or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 10 - GUARD HOUSE FOR SOLAR POWER SYSTEM	LOWLAND WASH ENGINEERS	DEC 2017	CM	3/6



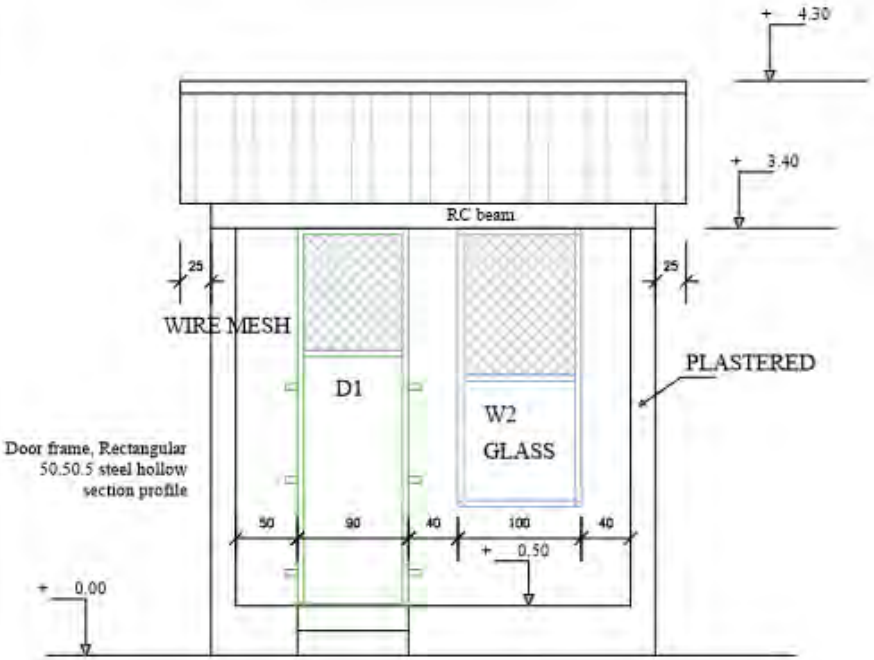
BOTTOM SLAB

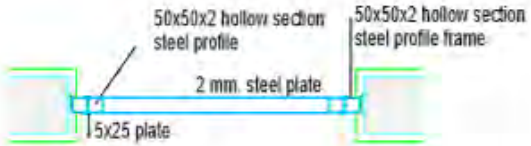
REINFORCED CONCRETE (C20)
BOTTOM SLAB REINFORCEMENT

REINFORCEMENT

Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm).
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained, by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well.

LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO.
	TYPICAL DRAWING 10 - GUARD HOUSE FOR SOLAR POWER SYSTEM	LOWLAND WASH ENGINEERS	DEC 2017	CM	4/6





DOOR SECTION

STEEL DOOR FRAMES AND LINTEL INSTALLATION

DOOR AND WINDOW LEGEND

CODE	SIZE (mm)	NO	DEFINITION
D1	200X90	2	Steel frame & 3 mm thick steel door
W1	60x60	2	Seko profile, steel frame & 3 mm thick steel
W2	100x100	2	Seko profile, steel frame & 3 mm thick steel

LOWLAND WASH	PROJECT TITLE:				
	TYPICAL DRAWING 10 - GUARD HOUSE FOR SOLAR POWER SYSTEM	LOWLAND WASH ENGINEERS	DEC 2017	CM	5/6

FORMWORK

The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface

The internal surface of the formwork must be clean and free from concrete crap and dirt

The formwork should be levelled properly

The formwork should be plumb and straight

Before casting interior surfaces of the formwork should be moistened with water

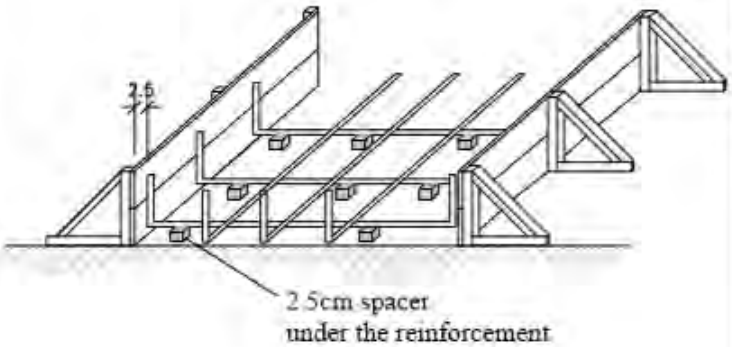
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface

The formwork should be supported with braces properly and fixed with nails as needed.

The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads

The joints between the panels of the formwork should be adequately tight

Formwork and Bracing



CONCRETE

Coarse sand shall be clean and free from dirt and clay

Coarse aggregate size shall be max dia 2 cm

Coarse aggregate shall be mixture of 0-1 and 0-2 size

Mixing water shall be clean

Concrete shall be mixed on steel plate or on clean surface

Concrete shall be placed within 30 min after mixing completed

Vibrator or steel bars shall be used to compact concrete during placing

Concrete surface shall be levelled using trowel

Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

1 m3 C20 concrete batching amounts	Standard Mixes for Ordinary Structural Concrete:
Ratio 1:2:4	per 50 kg bag of cement
6 bags cement (300 kg cement)	1 bag cement (50 kg cement)
0.25 m3 coarse sand	275 kg crushed stone (max dia 2 cm) and coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)	0.155 m3 concrete
Max 180 lt water (W/C ratio 0.60)	Max 30 lt water (W/C ratio 0.60)

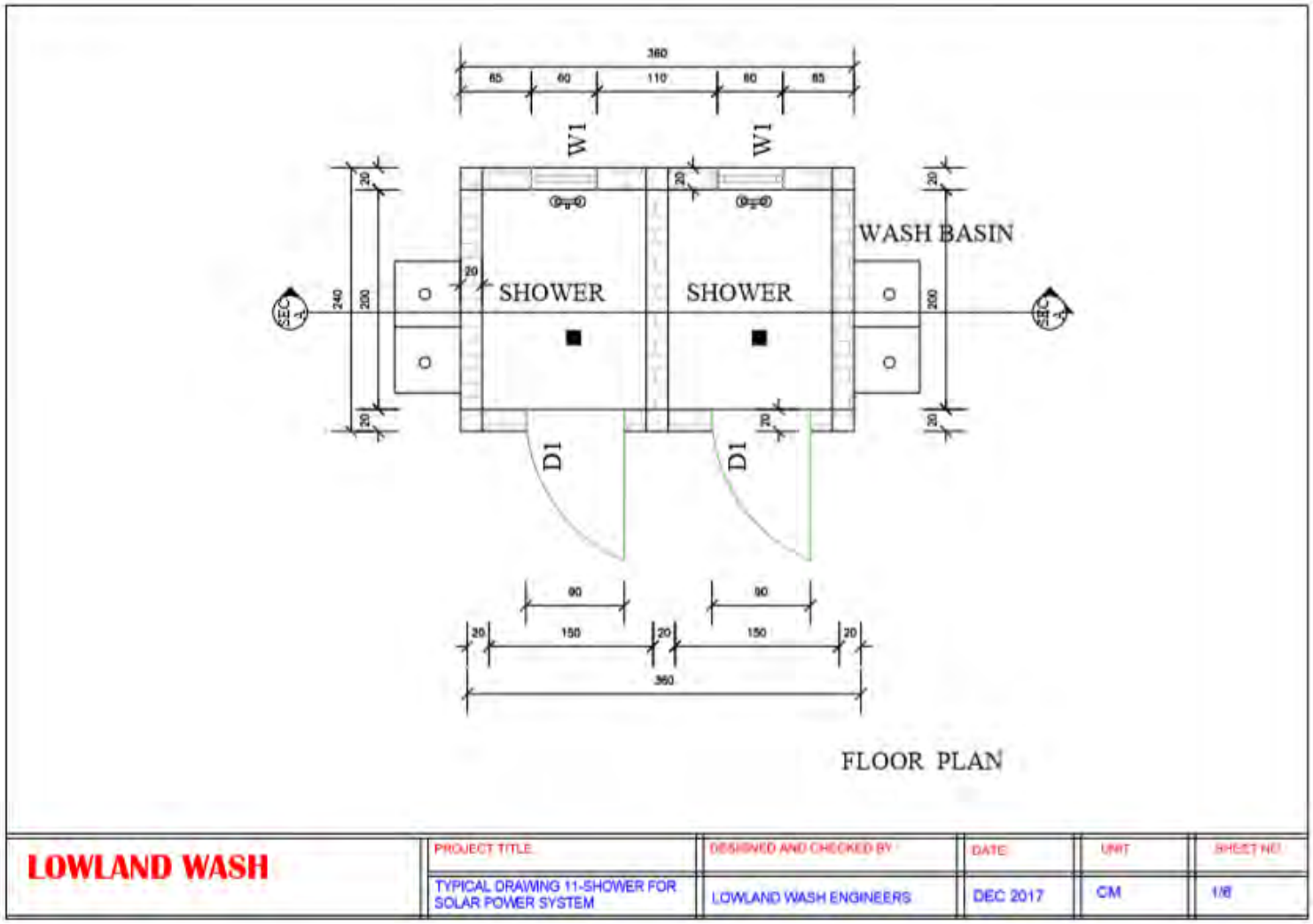
1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 30x30x20cm)

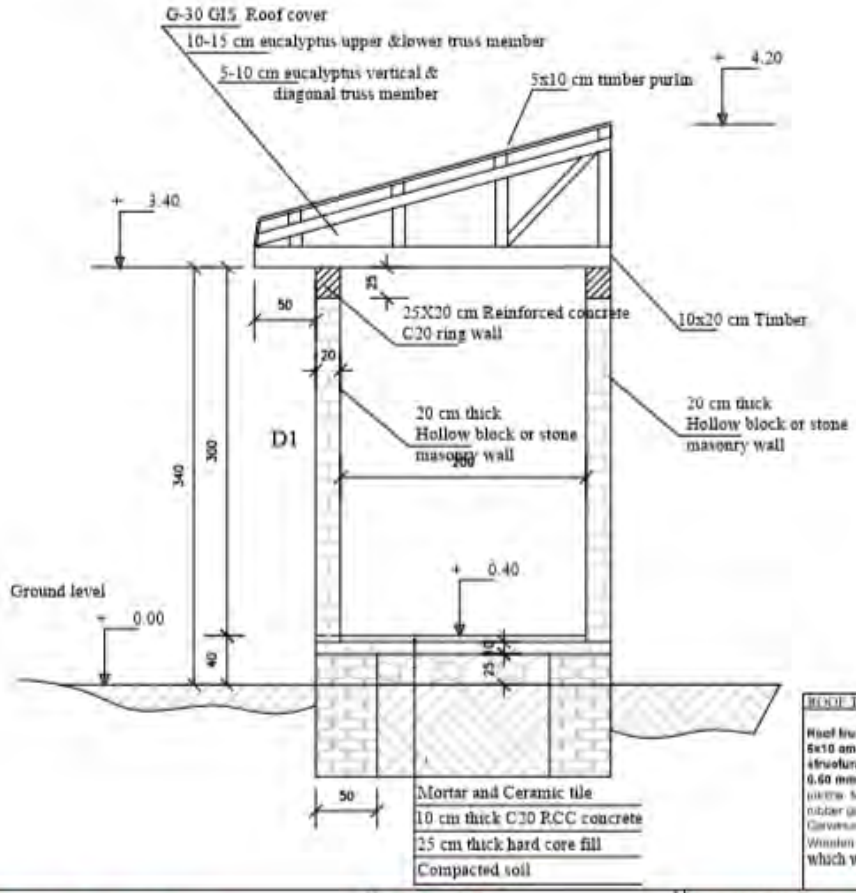
6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg/m3

LOWLAND WASH

PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
TYPICAL DRAWING 10 - GUARD HOUSE FOR SOLAR POWER SYSTEM	LOWLAND WASH ENGINEERS	DEC 2017	CM	6/6

TYPICAL DRAWING 11 SHOWER FOR THE SOLAR POWER SYSTEM





ROOF TRUSS AND COVER

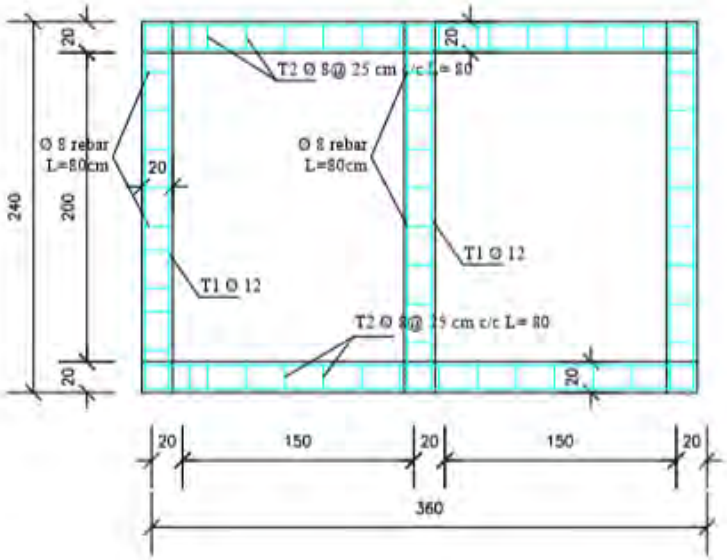
Roof truss shall be formed by using 10x20cm timber beams, 5x10cm timber truss and 5x10 cm timber purlins on top. All timber elements shall be joined by using nails, structurally sound.

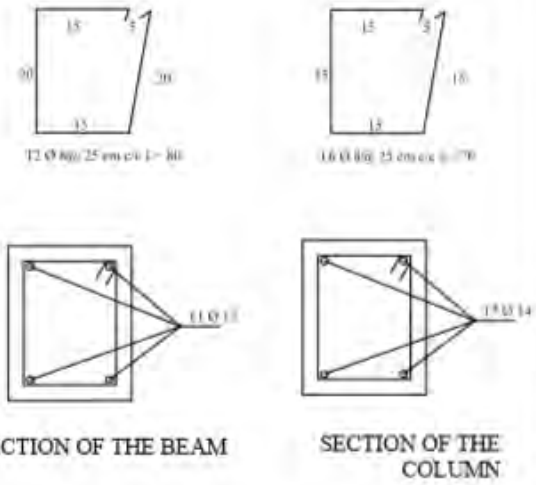
0.60 mm thick galvanized trapezoidal metal sheet (uncoated) shall be installed over roof timber purlins. Metal sheet shall be fixed to the purlins by using galvanized screws. Screws shall be with rubber gasket to prevent leaking.

Galvanized metal ties shall be placed on top (50 cm wide).

Wooden roof truss shall be placed over reinforced concrete ring wall and tied to Ø8 rebar which were remained inside ring wall in every 1m

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING 11-SHOWER FOR SOLAR POWER SYSTEM	LOWLAND WASH ENGINEERS	DEC 2017	CM	2/6





REINFORCED CONCRETE (C20) RING WALL ON TOP OF THE WALLS AND COLUMNS

LEGEND

T2 Ø 8 @ 25 cm c/c L = 80

T2 stands for reinforcement type

Ø 8 @ 25 cm c/c Steel diameter is 8 mm and be placed in every 25 cm center to center

L= 80 Total reinforcement length is 80 cm

REINFORCEMENT

Reinforcement should be clean, free form dirt and oil.

Reinforcement should be cut and bend and placed as shown on the drawings

The space between reinforcement should match with the drawings tolerance 1 mm

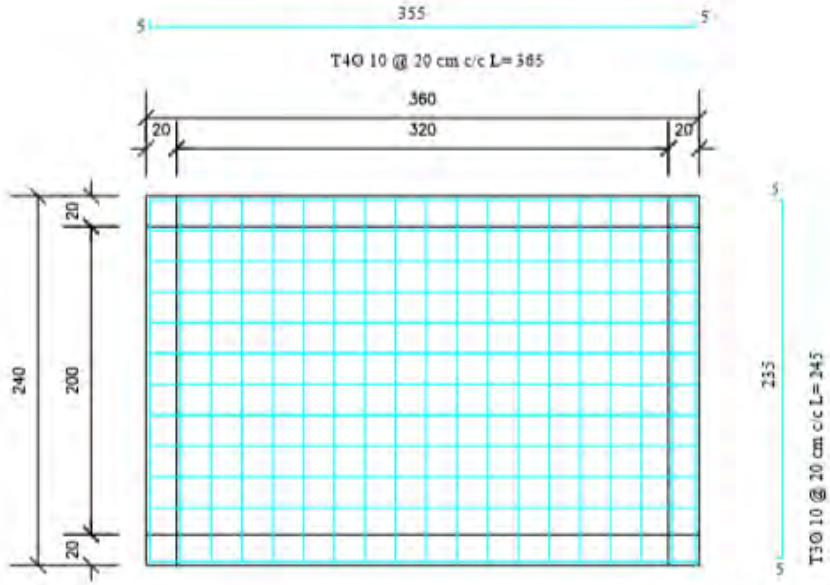
Reinforcement diameter should match with the drawings

Reinforcement should be fixed to each other by using iron wire

Reinforcement should not be placed directly on the ground. 2.5 cm space need be maintained by placing rock or plastic spacers beneath the rebars

2.5 cm spacing is required in the vertical walls from the formwork as well

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING BOOSTER STATION GUARD HOUSE	LOWLAND WASH ENGINEERS	DEC 2017	CM	3/8

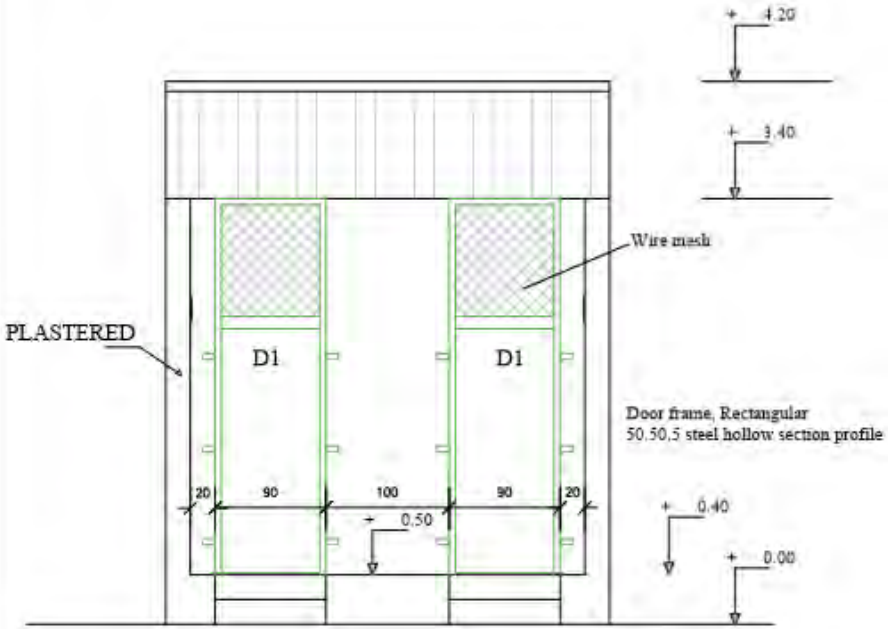


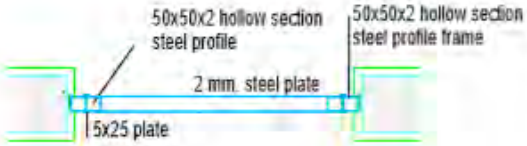
REINFORCED CONCRETE (C20)
SLAB REINFORCEMENT

REINFORCEMENT

Reinforcement should be clean, free from dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 7.5 cm space should be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required on the vertical walls from the formwork as well

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING BOOSTER STATION GUARD HOUSE	LOWLAND WASH ENGINEERS	DEC 2017	CM	4/6





DOOR SECTION

STEEL DOOR FRAMES AND LINTEL INSTALLATION

DOOR AND WINDOW LEGEND

CODE	SIZE (mm)	NO	DEFINITION
D1	200x90	2	Steel frame & 3 mm thick steel door
W1	160x60	2	Sdw profile, steel frame & 3 mm thick steel

LOWLAND WASH	TYPICAL DRAWING BOOSTER STATION GUARD HOUSE	LOWLAND WASH ENGINEERS	DEC 2017	CM	5/6

FORMWORK

The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface

The internal surface of the formwork must be clean and free from concrete crap and dirt

The formwork should be levelled properly

The formwork should be plumb and straight

Before casting interior surfaces of the formwork should be moistened with water

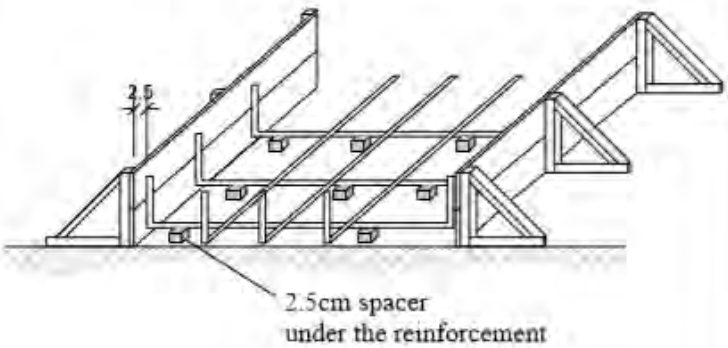
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface

The formwork should be supported with braces properly and fixed with nails as needed.

The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads

The joints between the panels of the formwork should be adequately tight

Formwork and Bracing



CONCRETE

Coarse sand shall be clean and free from dirt and clay

Coarse aggregate size shall be max dia 2 cm

Coarse aggregate shall be mixture of 0-1 and 0-2 size

Mixing water shall be clean

Concrete shall be mixed on steel plate or on clean surface

Concrete shall be placed within 30 min after mixing completed

Vibrator or steel bars shall be used to compact concrete during placing.

Concrete surface shall be levelled using trowel

Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

1 m3 C20 concrete batching amounts	Standard Mixes for Ordinary Structural Concrete
Ratio 1:2:4	per 50 kg bag of cement
6 bags cement (300 kg cement)	1 bag cement (50 kg cement)
0.25 m3 coarse sand	275 kg crushed stone (max dia 2 cm) and coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)	0.155 m3 concrete
Max 180 lt water (W/C ratio 0.60)	Max 30 lt water (W/C ratio 0.60)

1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.05 m3 - 30x30x20cm)

6 bags cement (300 kg cement)

5 buckets coarse sand

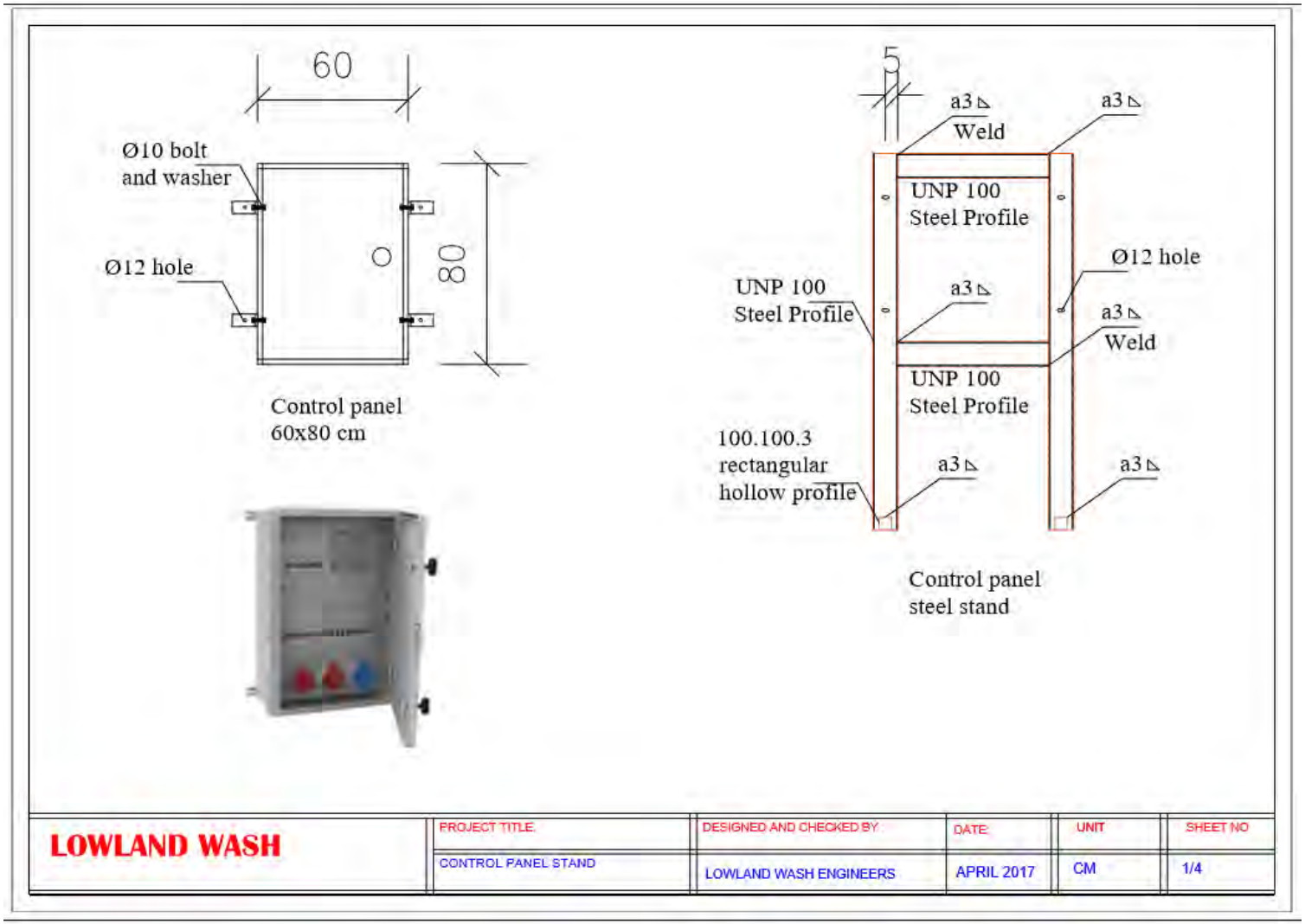
10 buckets crushed stone (max Dia 2cm)

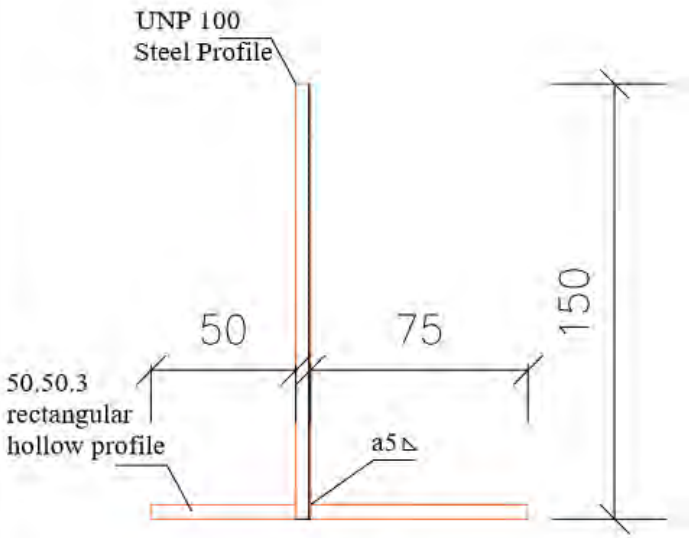
Max 180 lt water (W/C ratio 0.60)

Coarse sand and crushed stone density: 2200 kg/m3

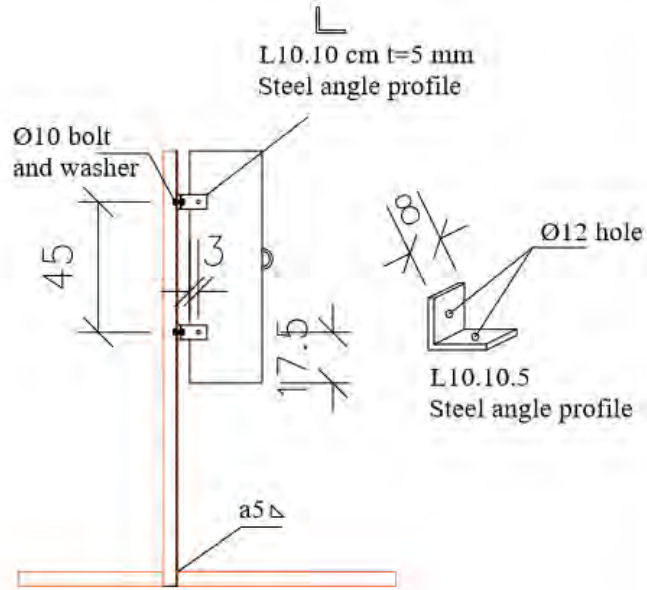
LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING BOOSTER STATION GUARD HOUSE	LOWLAND WASH ENGINEERS	DEC 2017	CM	6/6

TYPICAL DRAWING GENERATOR CONTROL PANEL STEEL STAND BOLTED TYPE



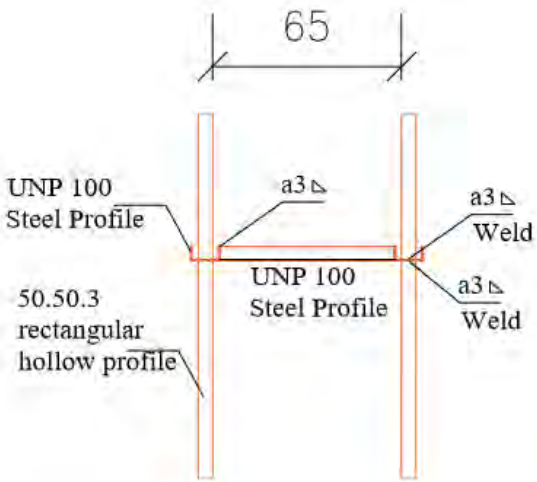


Control panel
steel stand section

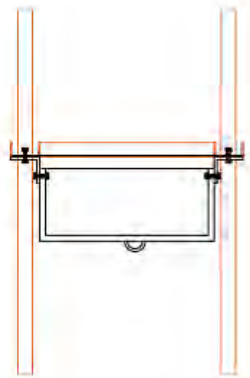


Control panel
steel stand side view with panel
mounted on it

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	CONTROL PANEL STAND	LOWLAND WASH ENGINEERS	APRIL 2017	CM	2/4

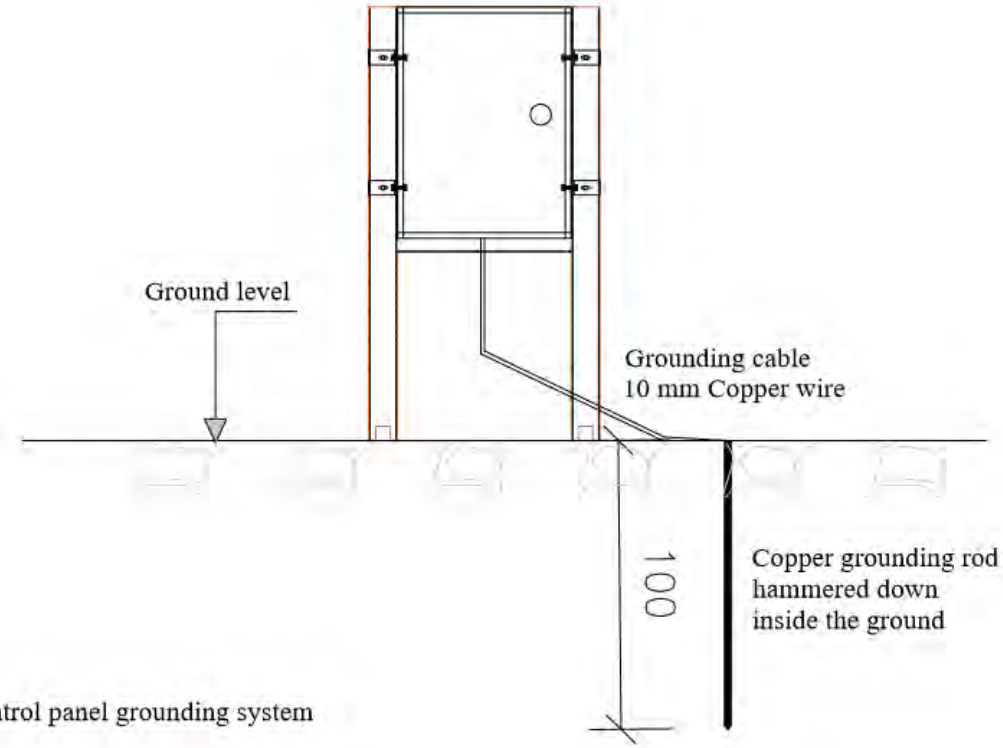


Control panel
steel panel top view



Control panel
steel panel top view with panel
mounted on it

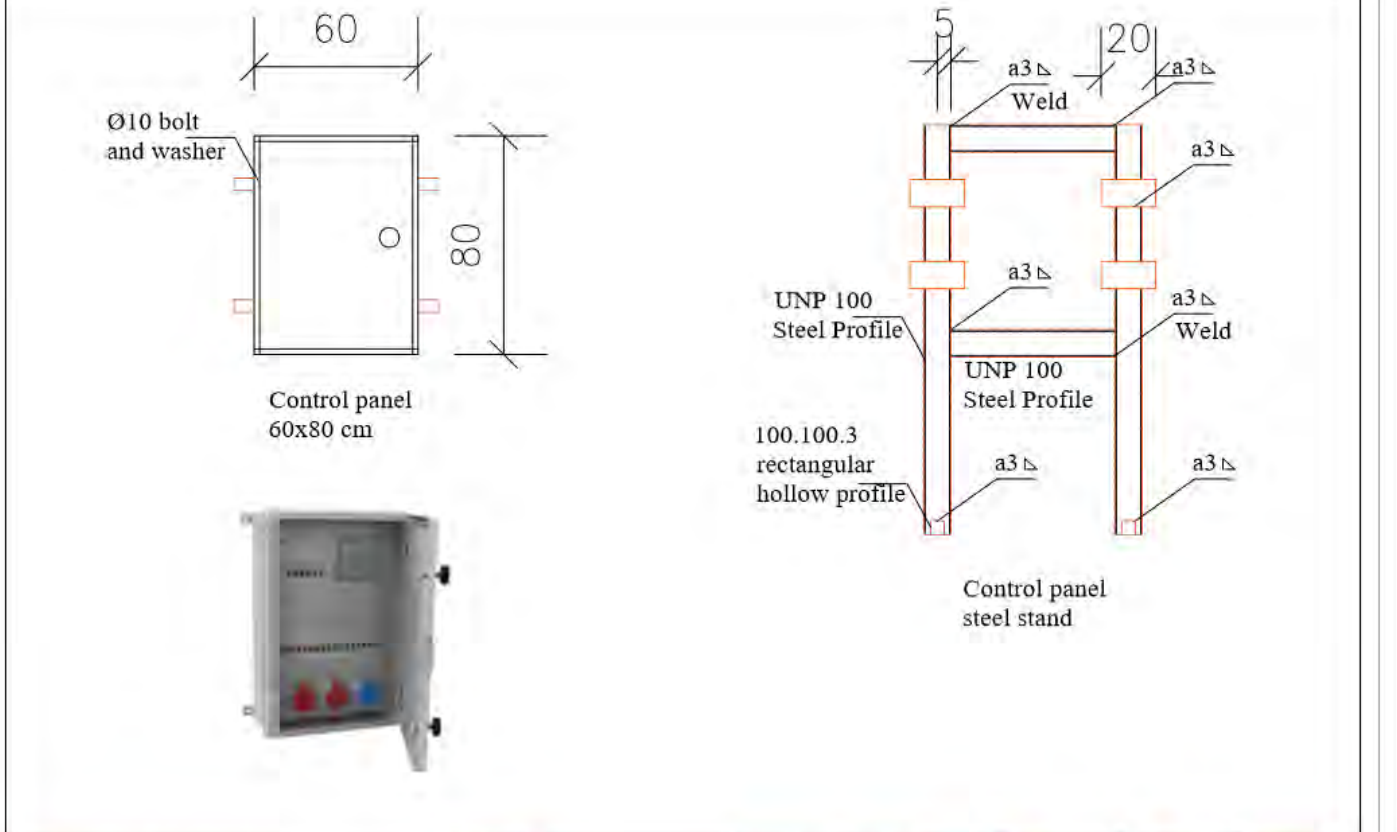
LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY:	DATE:	UNIT	SHEET NO.
	CONTROL PANEL STAND	LOWLAND WASH ENGINEERS	APRIL 2017	CM	3/4



Control panel grounding system

LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	CONTROL PANEL STAND	LOWLAND WASH ENGINEERS	APRIL 2017	CM	4/4

TYPICAL DRAWING GENERATOR CONTROL PANEL STEEL STAND HANGING TYPE



LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
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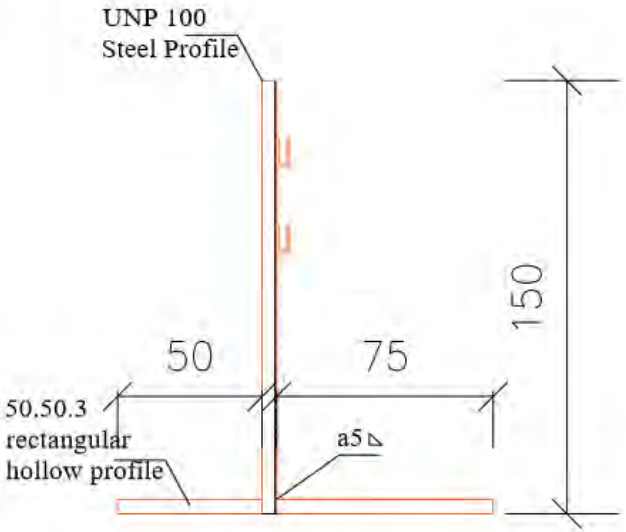
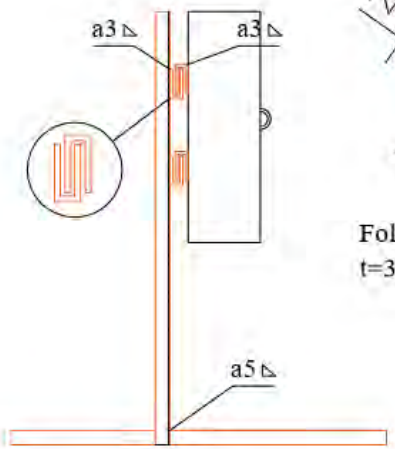
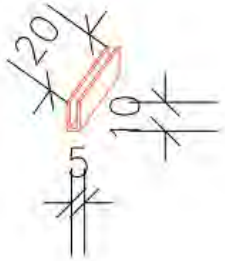


Control panel
steel stand section

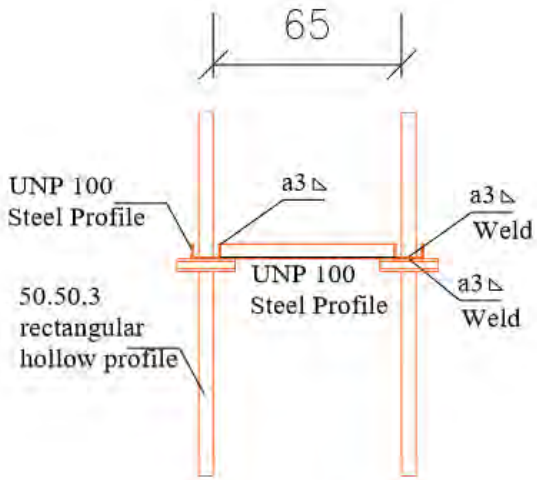


Control panel
steel stand side view with panel
mounted on it

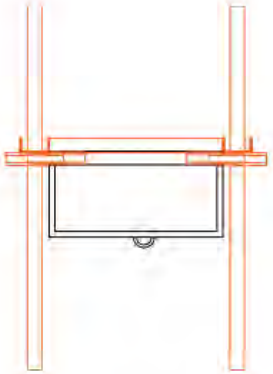


Folded U profile
t=3mm

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY:	DATE	UNIT	SHEET NO
	CONTROL PANEL STAND	LOWLAND WASH ENGINEERS	APRIL 2017	CM	2/4

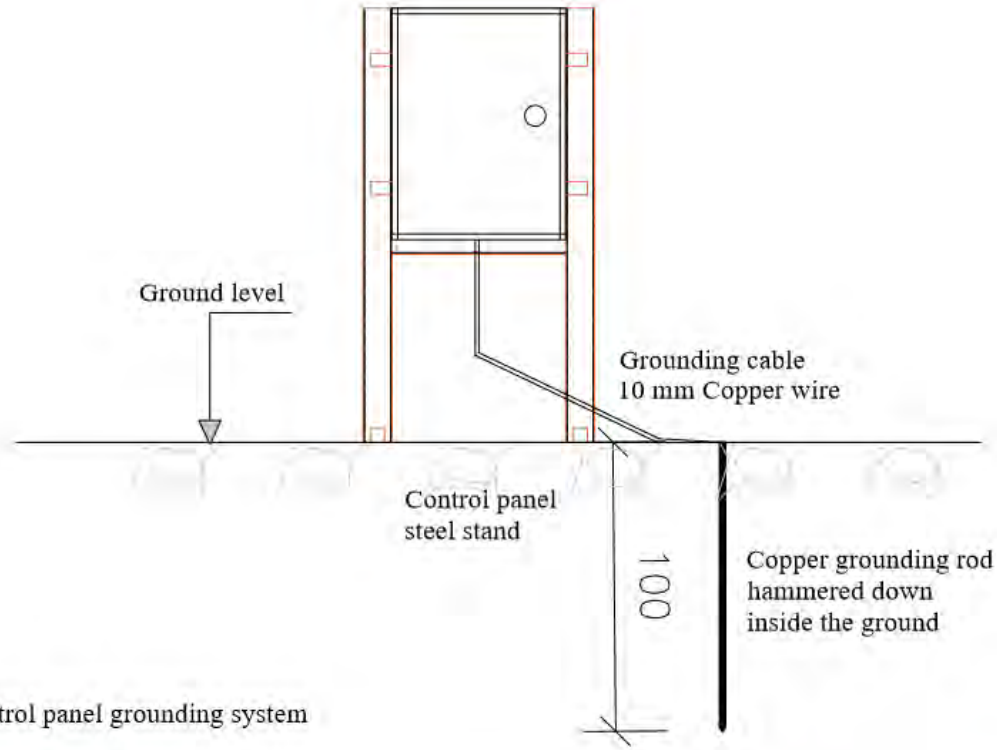


Control panel
steel panel top view



Control panel
steel panel top view with panel
mounted on it

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	CONTROL PANEL STAND	LOWLAND WASH ENGINEERS	APRIL 2017	CM	3/4



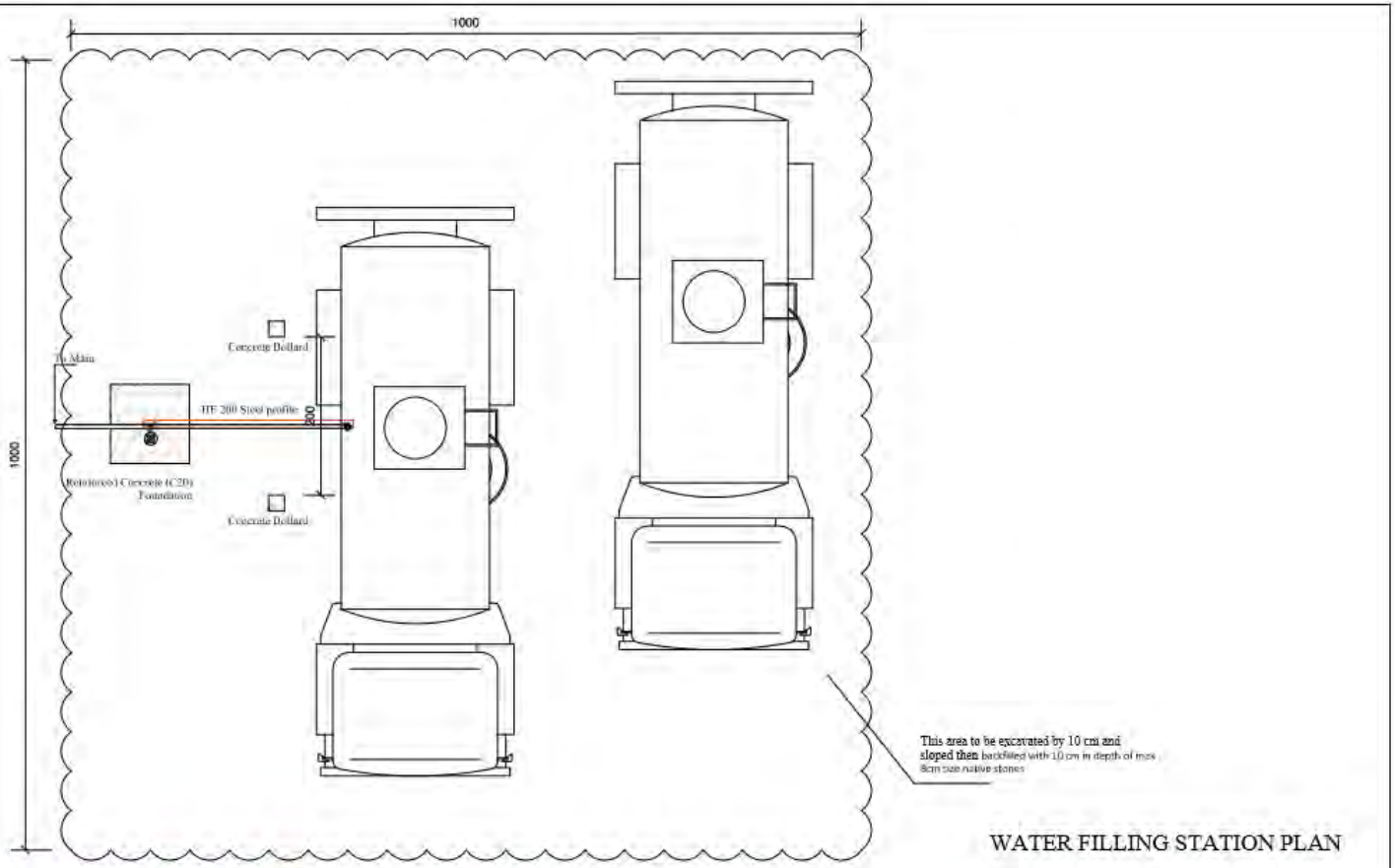
Control panel grounding system

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	CONTROL PANEL STAND	LOWLAND WASH ENGINEERS	APRIL 2017	CM	4/4

TYPICAL DRAWING – WATER FILLING STATION FOR WATER TANKERS

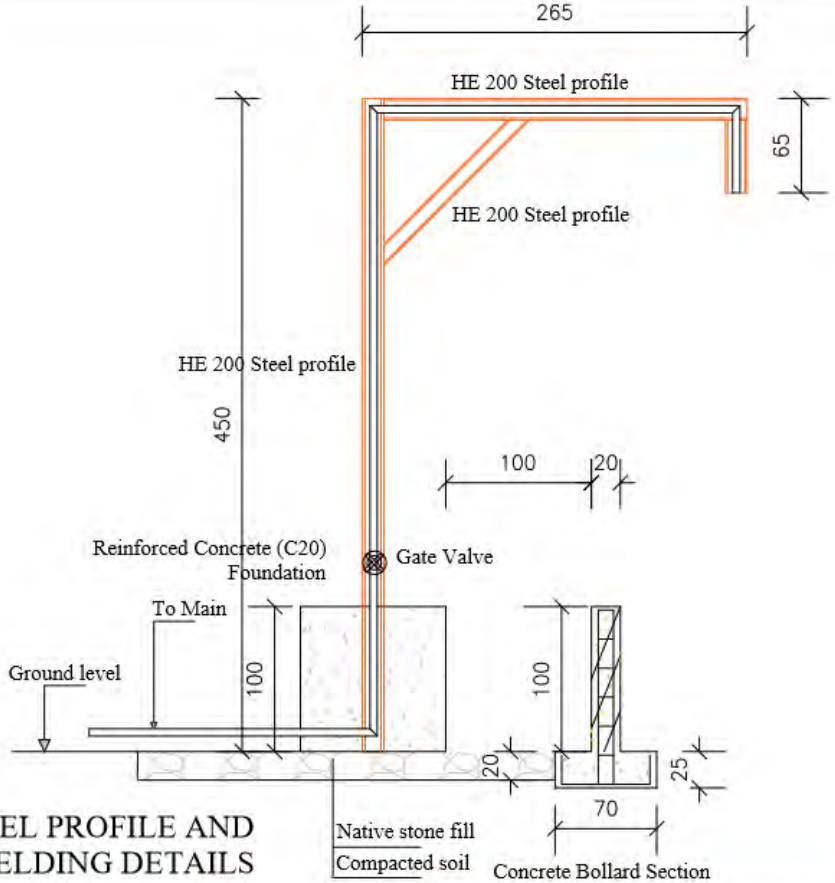
WATER FILLING STATION

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	TYPICAL DRAWING WATER FILLING STATION FOR WATER TANKERS	LOWLAND WASH ENGINEERS	APRIL 2017	CM	1/7

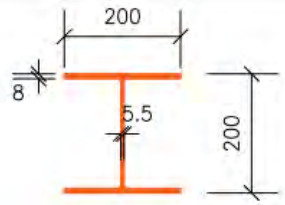


WATER FILLING STATION PLAN

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	TYPICAL DRAWING WATER FILLING STATION FOR WATER TANKERS	LOWLAND WASH ENGINEERS	APRIL 2017	CM	2/7



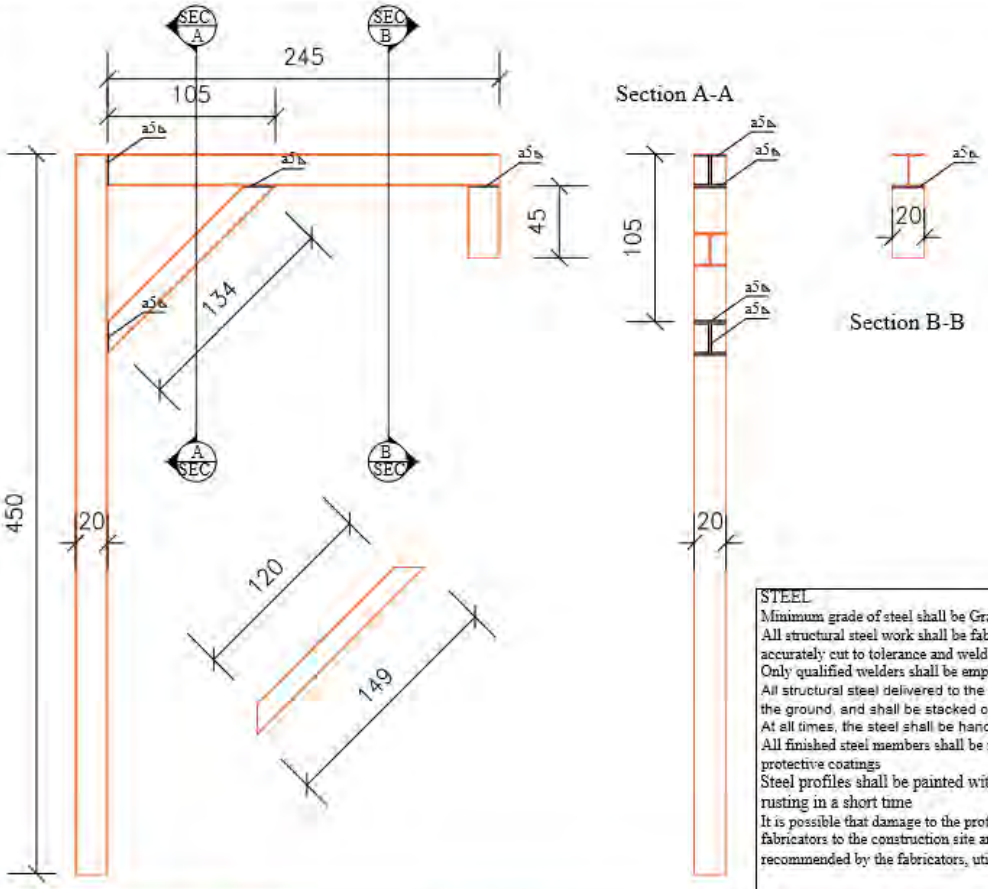
STEEL PROFILE AND WELDING DETAILS



HE 200 Steel profile section

a5 ◺ t=5 mm weld

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	TYPICAL DRAWING WATER FILLING STATION FOR WATER TANKERS	LOWLAND WASH ENGINEERS	APRIL 2017	CM	3/7



Section B-B

STEEL

Minimum grade of steel shall be Grade 43 to BS4360

All structural steel work shall be fabricated in accordance with the shop drawings. The steel shall be accurately cut to tolerance and welded as shown in the drawings

Only qualified welders shall be employed for such work

All structural steel delivered to the site shall be properly stored in a secure location, kept clear off the ground, and shall be stacked only if adequate intermediate timber supports are available.

At all times, the steel shall be handled with appropriate lifting equipment

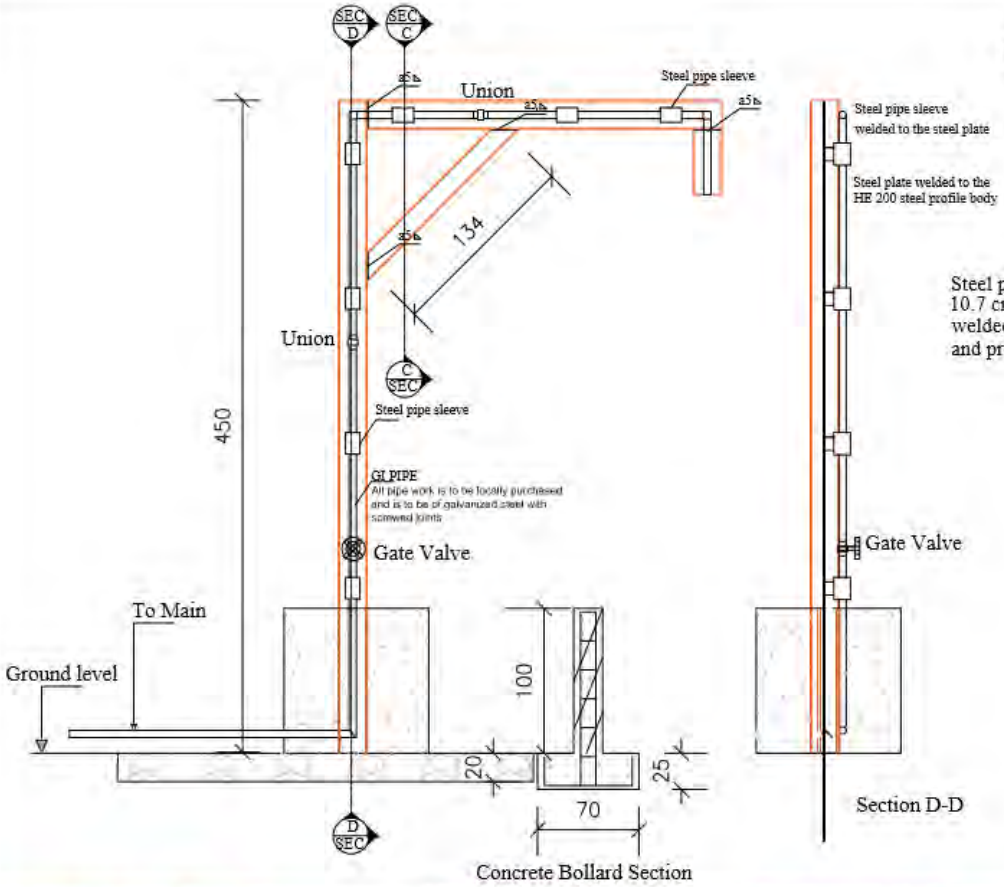
All finished steel members shall be free of grease, impurities and free of burrs before receiving the protective coatings

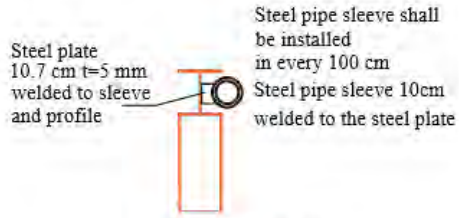
Steel profiles shall be painted with 2 coats of red oxide and 2 coats of oil paint to prevent rusting in a short time

It is possible that damage to the protective paint system can occur during the transportation from the fabricators to the construction site and/or during erection. All damages shall be repaired in the manner recommended by the fabricators, utilising the same protective coatings.

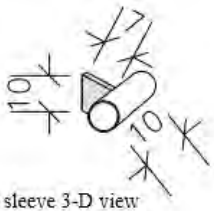
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING WATER FILLING STATION FOR WATER TANKERS	LOWLAND WASH ENGINEERS	APRIL 2017	CM	4/7

PIPE SLEEVE CONNECTION DETAILS





Section C-C

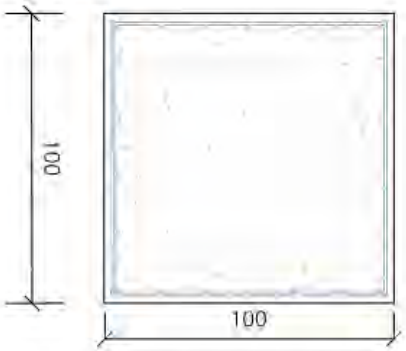


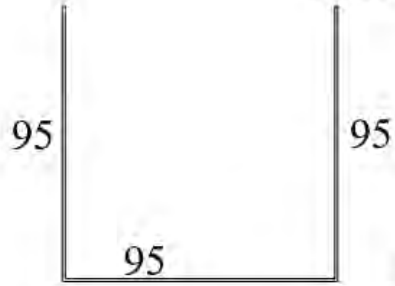
Pipe sleeve 3-D view

Steel pipe sleeve's interior diameter shall be 5 mm wider than the exterior diameter of the GI pipe

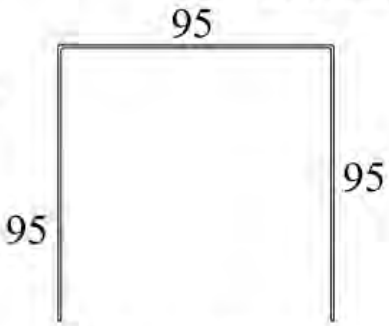
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING WATER FILLING STATION FOR WATER TANKERS	LOWLAND WASH ENGINEERS	APRIL 2017	CM	5/7

FOUNDATION REINFORCEMENT DETAILS





Ø 10 / 15 cm c/c
L= 285

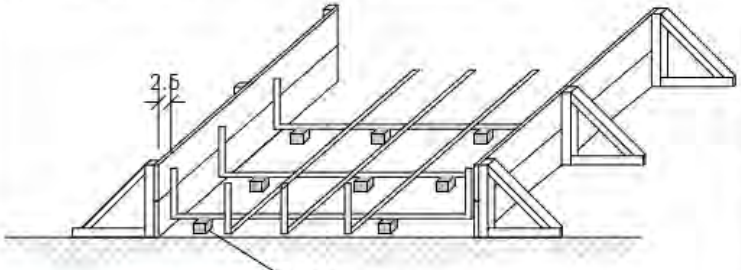


Ø 10 / 15 cm c/c
L= 285

REINFORCEMENT

Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

Formwork and Bracing

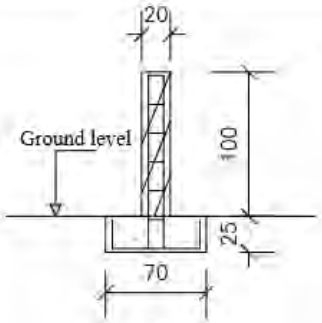


2.5cm spacer
under the reinforcement

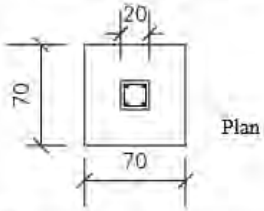
FORMWORK

The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface
The internal surface of the formwork must be clean and free from concrete scrap and dirt
The formwork should be levelled properly
Wood formwork used to form the top edge of the slab shall be cut straight and level
The formwork should be plumb and straight
A string line shall be used to ensure the formwork is straight and provides required slope
Before casting interior surfaces of the formwork should be moistened with water
While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork interior surface
The mud slab that the concrete is being placed on must be debris, dirt and dust free
The formwork should be supported with braces properly and fixed with nails as needed.
The formwork shall not be removed before the structure has gained enough strength (at least 1 day later) and safely carry all the possible loads
The joints between the panels of the formwork should be adequately tight

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO.
	TYPICAL DRAWING WATER FILLING STATION FOR WATER TANKERS	LOWLAND WASH ENGINEERS	APRIL 2017	CM	6/7

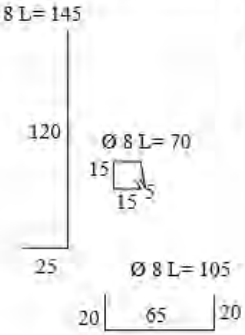


Concrete Bollard Section



Plan

Concrete Bollard Reinforcement



REINFORCEMENT
Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

CONCRETE BOLLARD REINFORCEMENT DETAILS

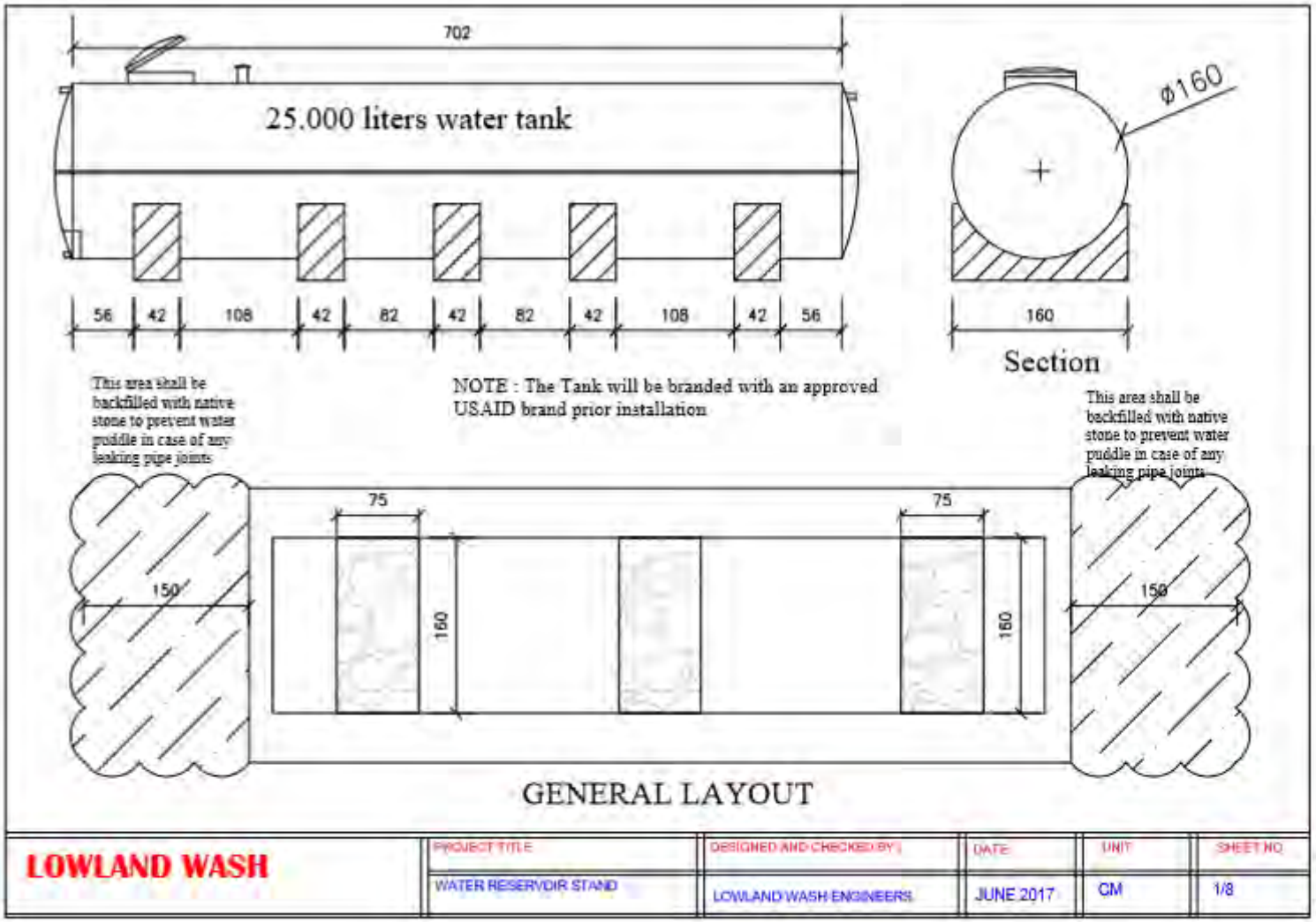
CONCRETE
Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

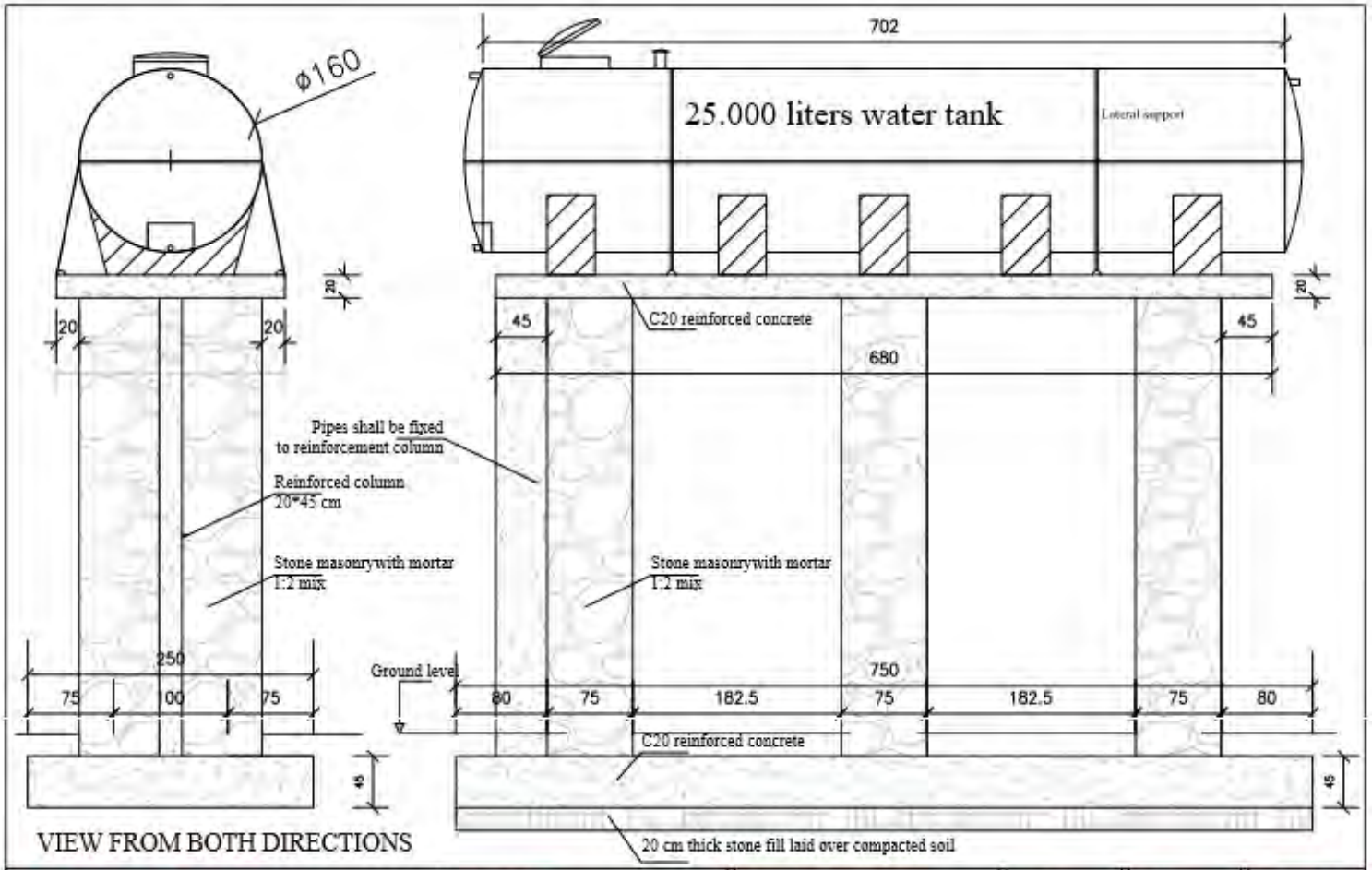
1 m3 C20 concrete batching amounts	Standard Mixes for Ordinary Structural Concrete
Ratio 1:2:4	per 50 kg bag of cement
6 bags cement (300 kg cement)	1 bag cement (50 kg cement)
0.25 m3 coarse sand	275 kg crushed stone (max dia 2 cm) and coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)	0.155 m3 concrete
Max 180 lt water (W/C ratio 0.60)	Max 30 lt water (W/C ratio 0.60)

1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 30x50x20cm)
6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg/m3

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO.
	TYPICAL DRAWING WATER FILLING STATION FOR WATER TANKERS	LOWLAND WASH ENGINEERS	APRIL 2017	CM	7/7

TYPICAL DRAWING – WATER RESERVOIR MASONRY STAND-25 m3





VIEW FROM BOTH DIRECTIONS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	JUNE 2017	CM	2/8

C20 reinforced concrete slab plan

Slab reinforcement

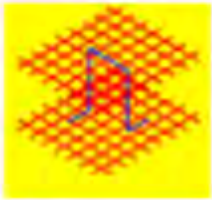
LEGEND

T3 Ø 14 @ 15 cm c/c L= 705

T3 stands for reinforcement type

Ø 14 @ 15 cm c/c Steel diameter is 14 mm and be placed in each 15 cm center to center

L= 705 Total reinforcement length = 705 cm



15

15

15

T2 Ø 10 @ 60 cm c/c L= 75

to be placed in every 60 cm

CONCRETE COVER IN THE SLAB SHOULD BE 2.5 cm

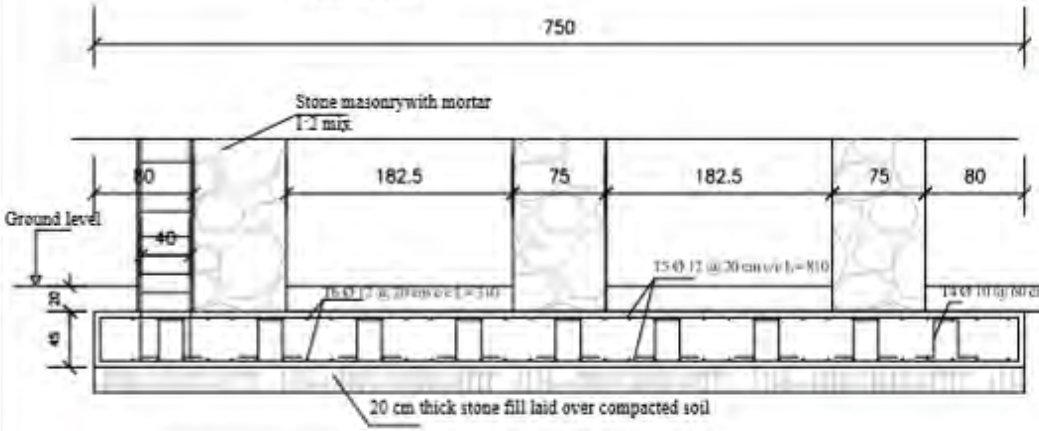
REINFORCEMENT

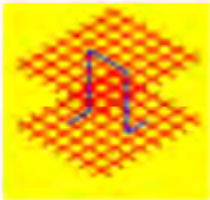
Reinforcement should be clean, free from dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

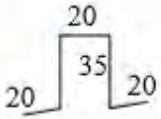
SLAB PLAN AND REINFORCEMENT

LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY	DATE:	UNIT	SHEET NO
	WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	JUNE 2017	CM	3/8

Foundation Plan







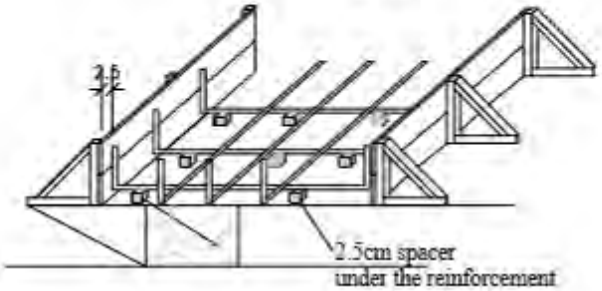
14 Ø 12 @ 60cm c/c L= 130
to be placed in every 60 cm

CONCRETE COVER IN THE FOUNDATION SHOULD BE 5 cm

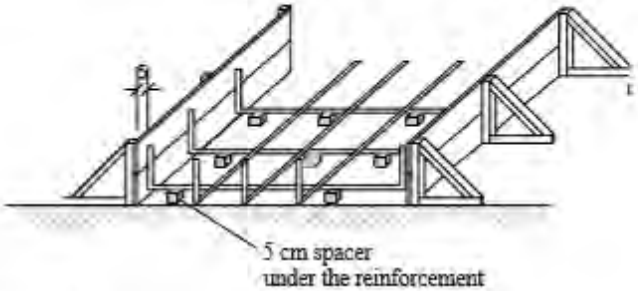
FOUNDATION PLAN AND REINFORCEMENT

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	JUNE 2017	CM	4/8

SLAB Formwork and Bracing



FOUNDATION Formwork and Bracing



FORMWORK

[illegible]

CONCRETE

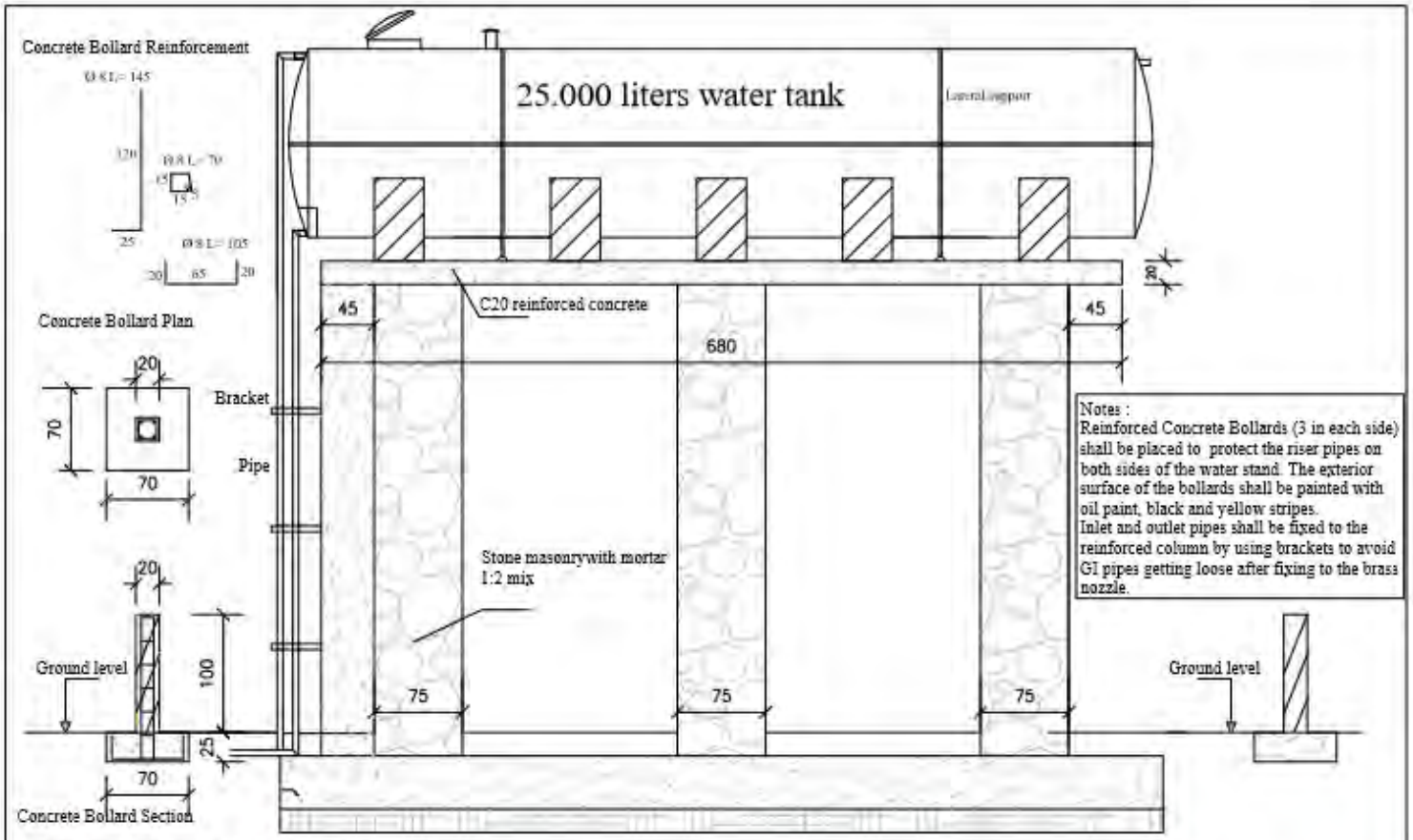
Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

1 m3 C20 concrete batching amounts	Standard Mixes for Ordinary Structural Concrete
Ratio 1:2:4	per 50 kg bag of cement
6 bags cement (300 kg cement)	1 bag cement (50 kg cement)
0.25 m3 coarse sand	275 kg crushed stone (max dia 2 cm) and coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)	0.155 m3 concrete
Max 180 lt water (W/C ratio 0.60)	Max 30 lt water (W/C ratio 0.60)

1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.01 m3 - 50x30x20cm)

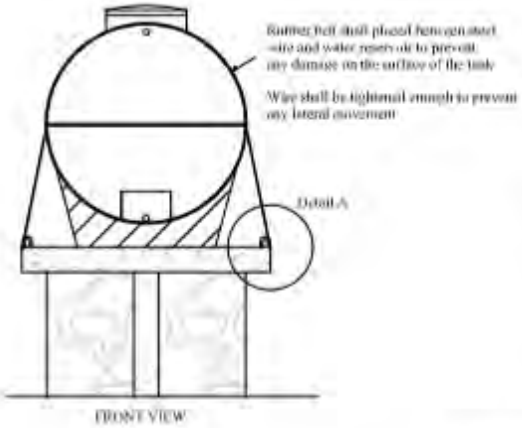
6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg m3

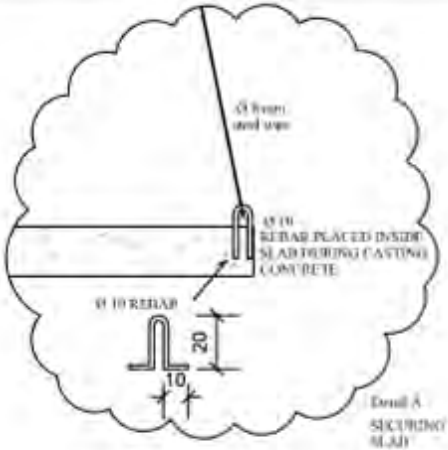
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	JUNE 2017	CM	5/8

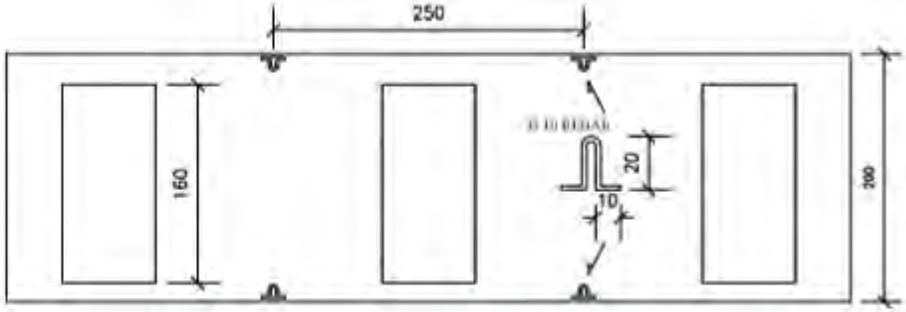


PROTECTIVE BOLLARD DETAILS

LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	JUNE 2017	CM	6/8

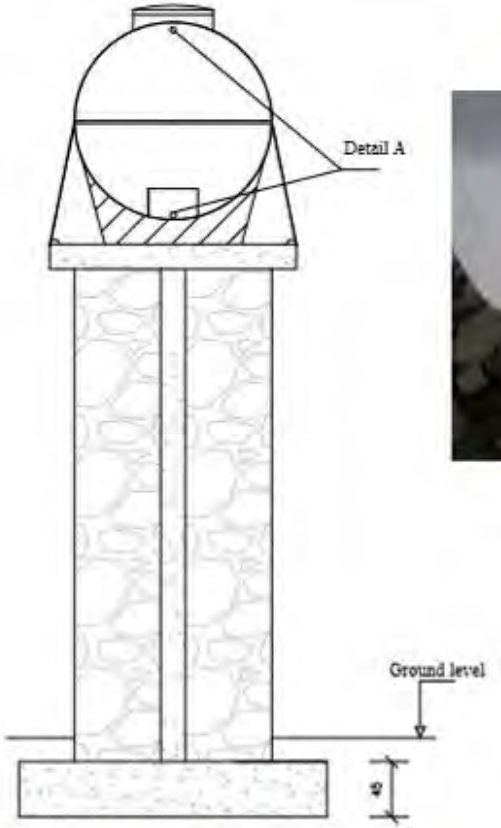


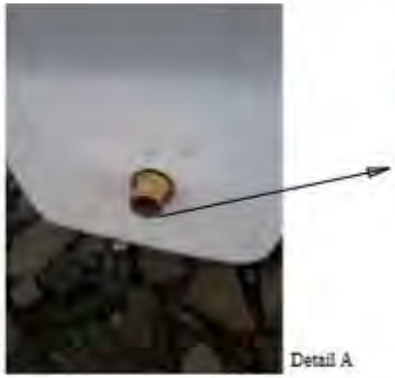




C20 reinforced concrete slab plan

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	JUNE 2017	CM	7/8





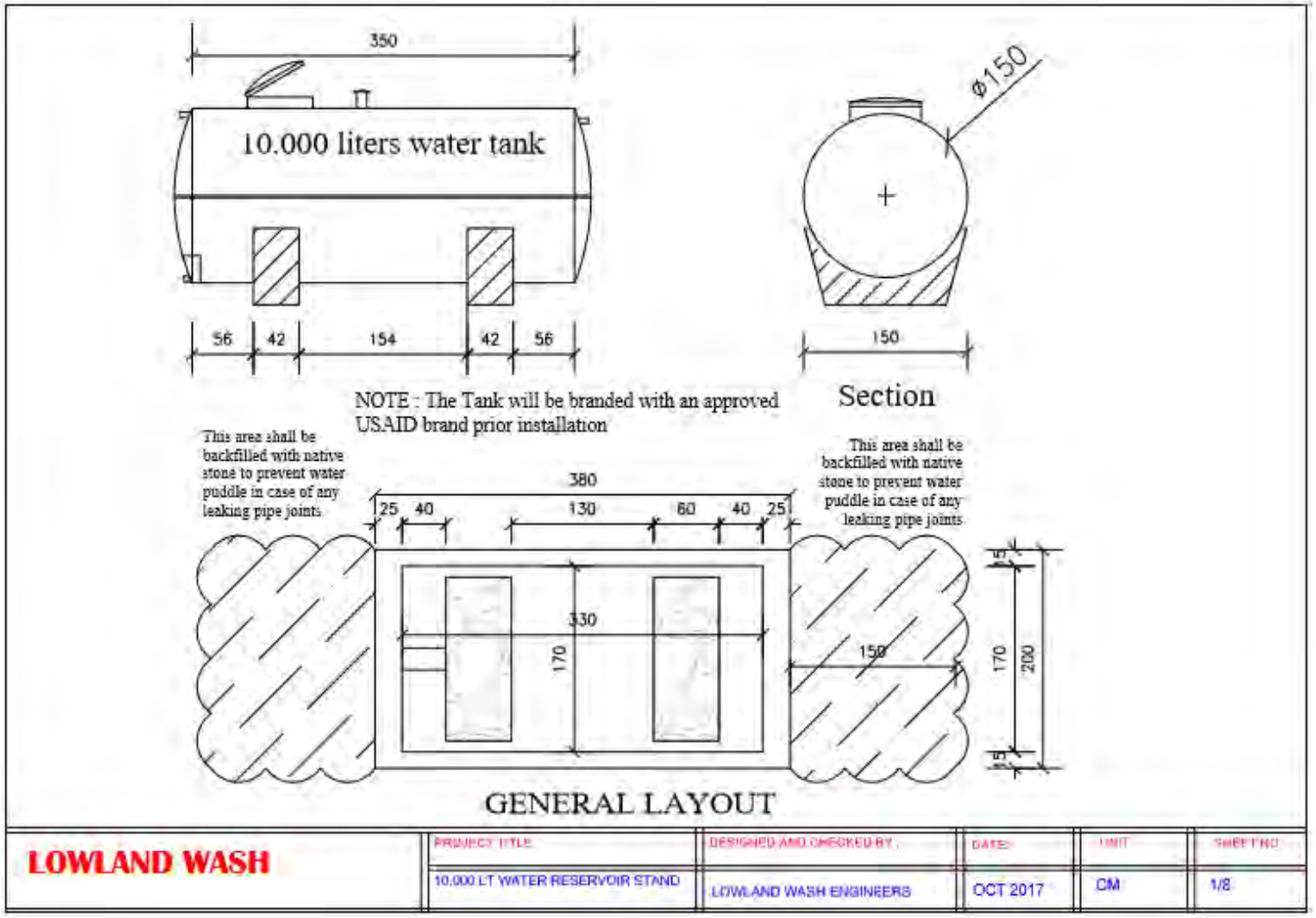
Detail A

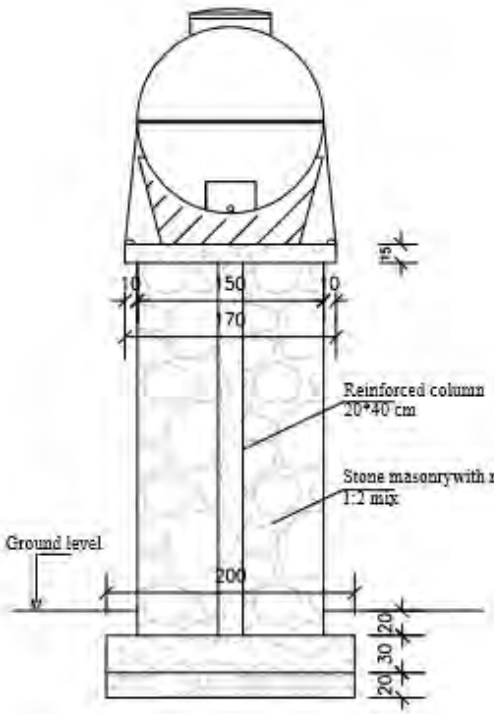
Brass Nozzle

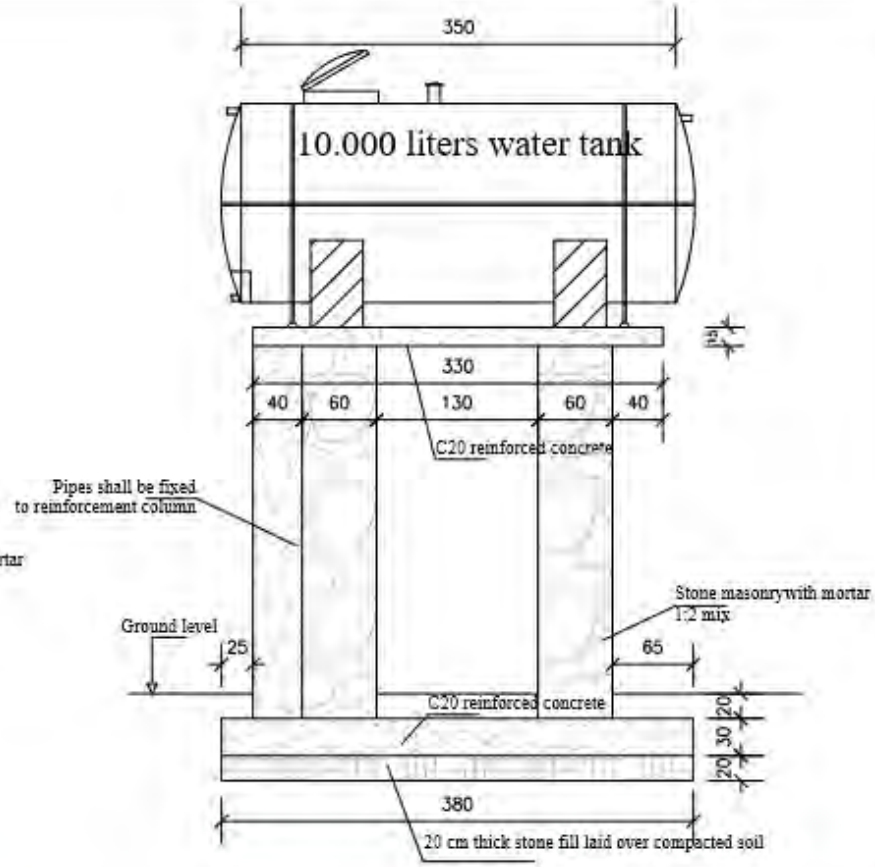
Notes :
The fiberglass tank shall be provided with brass nozzles for pipe connection at inlet, outlet and overflow points by the manufacturer. After fixing the pipes, connection at outlet shall be tested by filling water. If any leakage observed at nozzle joint, water shall be discharge and joint shall be sealed from the inside of the tank by using sealing agent recommended by the manufacturer.
For such repairs portable steel ladder shall be manufactured and kept near the reservoir.

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	JUNE 2017	CM	8/8

TYPICAL DRAWING – WATER RESERVOIR MASONRY STAND-10 m3

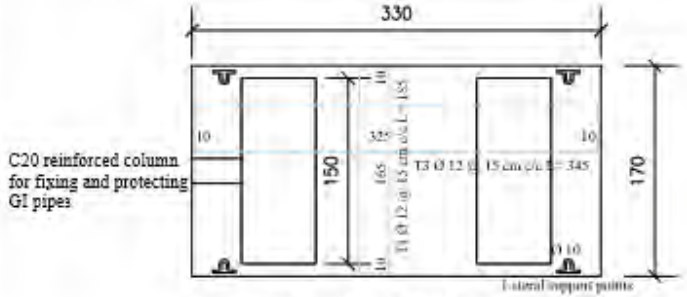




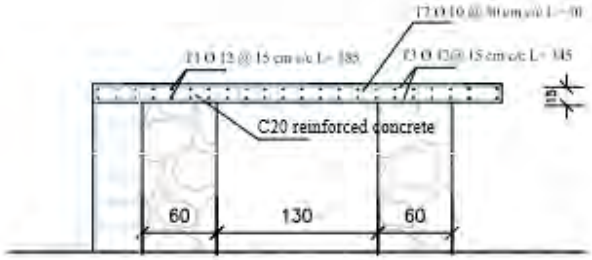


VIEW FROM BOTH DIRECTIONS

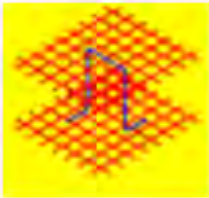
LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO.
	10.000 LT WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	OCT 2017	CM	2/8



C20 reinforced concrete slab plan



Slab reinforcement



10

10

10

T2 Ø 10 @ 50 cm c/c L= 50

to be placed in every 50 cm

CONCRETE COVER IN THE SLAB
SHOULD BE 2.5 cm

REINFORCEMENT

Reinforcement should be clean, free form dirt and oil.
Reinforcement should be cut and bend and placed as shown on the drawings
The space between reinforcement should match with the drawings (tolerance 1 cm)
Reinforcement diameter should match with the drawings
Reinforcement should be fixed to each other by using iron wire
Reinforcement should not be placed directly on the ground. 2.5 cm space shall be maintained by placing rock or plastic spacers beneath the rebars
2.5 cm spacing is required in the vertical walls from the formwork as well

LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	10,000 LT WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	OCT 2017	CM	3/8

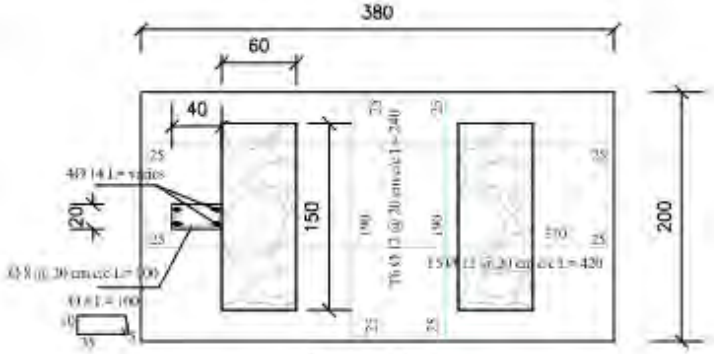
LEGEND

T3 Ø 14 @ 15 cm o/c L= 705

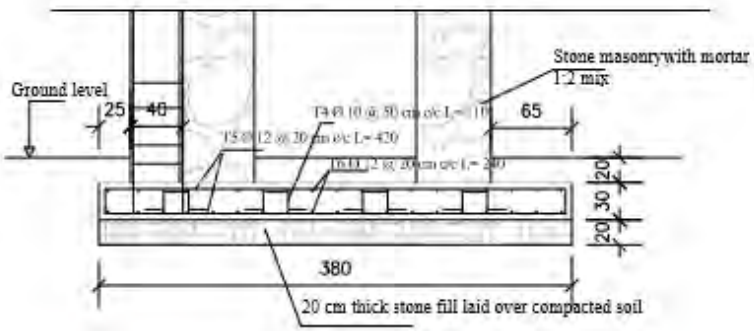
T3 stands for reinforcement type

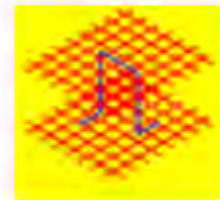
Ø 14 @ 15 cm o/c Steel diameter is 14 mm and be placed in each 15 cm center to center

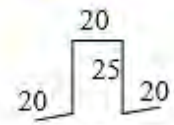
L= 705 Total reinforcement length is 705 cm



Foundation Plan







T4 Ø 12 @ 50cm o/c L= 110

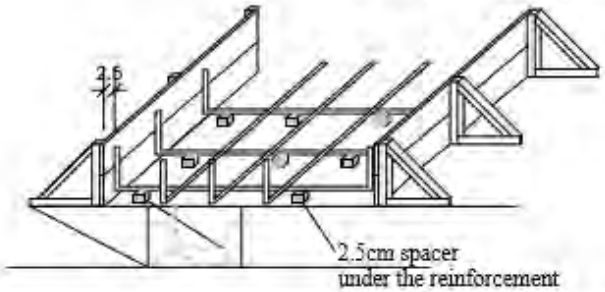
to be placed in every 50 cm

CONCRETE COVER IN THE FOUNDATION SHOULD BE 5 cm

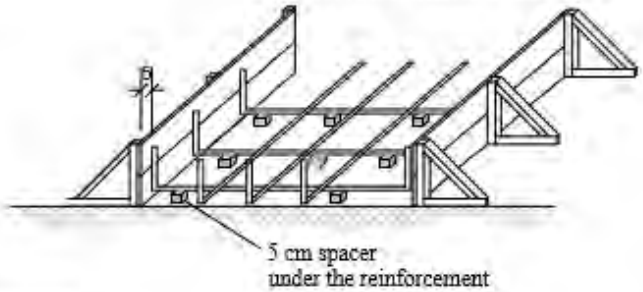
FOUNDATION PLAN AND REINFORCEMENT

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	10:000 LT WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	OCT 2017	CM	4/8

SLAB Formwork and Bracing



FOUNDATION Formwork and Bracing



FORMWORK

The formwork shall be constructed so that there is no loss of fines of cement at the concrete surface

The internal surfaces of the formwork must be clean and free from cement scrap and dirt

The formwork should be levelled properly

When formwork joins the [illegible] edge of the concrete be [illegible] tight and true

The formwork should be plumb and straight

A string line shall be used to ensure the formwork is straight and possesses uniform shape

Before casting internal surfaces of the formwork should be moistened with water

While placing reinforcement, there should be 2.5 cm space remained between the rebars and formwork inner surface

The end slab that the concrete is being placed on must be firmly set and grid free

The formwork should be supported with bracing properly and fixed with nails or screws

The formwork shall not be removed before the concrete has gained enough strength (at least 1 day [illegible]) and safety cases of the possible loads

The joints between the panel of the formwork should be adequately tight

CONCRETE

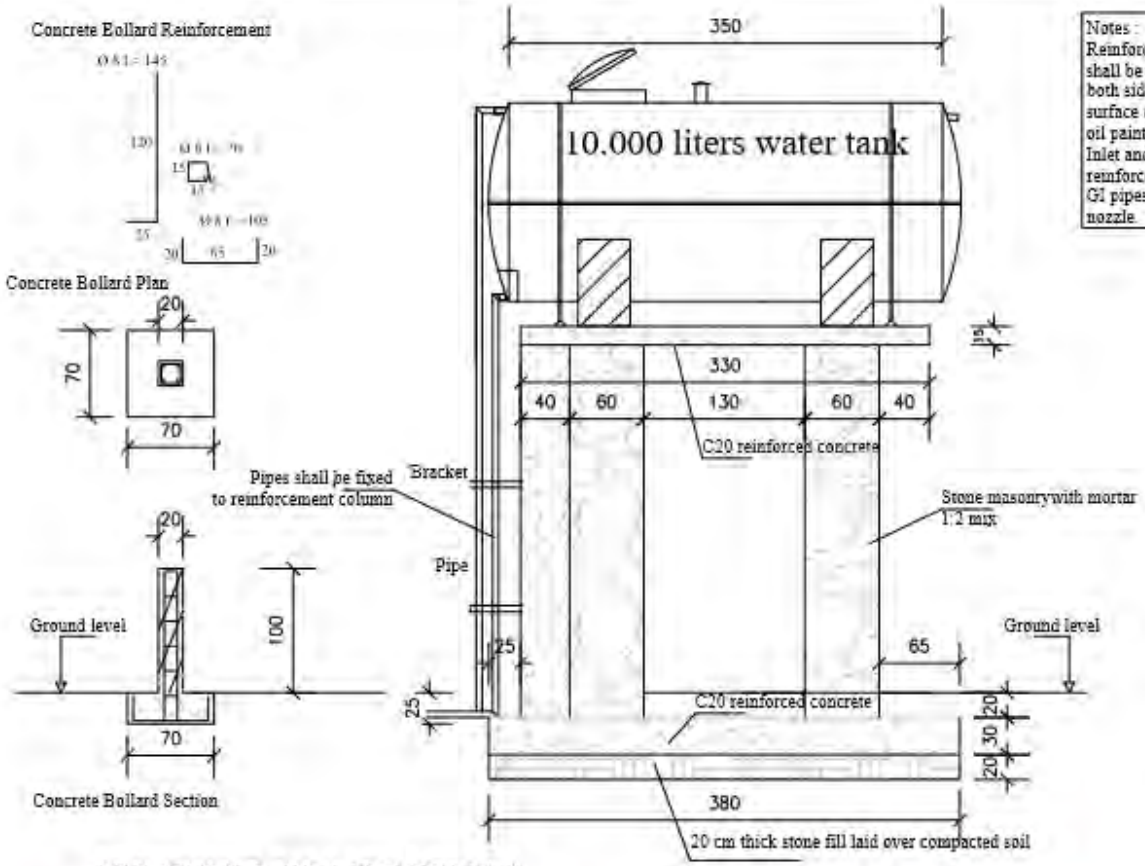
Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

1 m3 C20 concrete batching amounts	Standard Mixes for Ordinary Structural Concrete
Ratio 1:2:4	per 50 kg bag of cement
6 bags cement (300 kg cement)	1 bag cement (50 kg cement)
0.25 m3 coarse sand	275 kg crushed stone (max dia 2 cm) and coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)	0.155 m3 concrete
Max 180 lt water (W/C ratio 0.60)	Max 30 lt water (W/C ratio 0.60)

1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 30x30x20cm)

6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg/m3

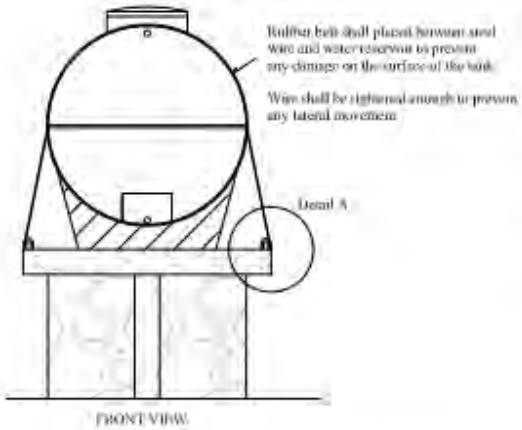
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	ANIT	SHEET NO
	10,000 LT WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	OCT 2017	CM	5/8

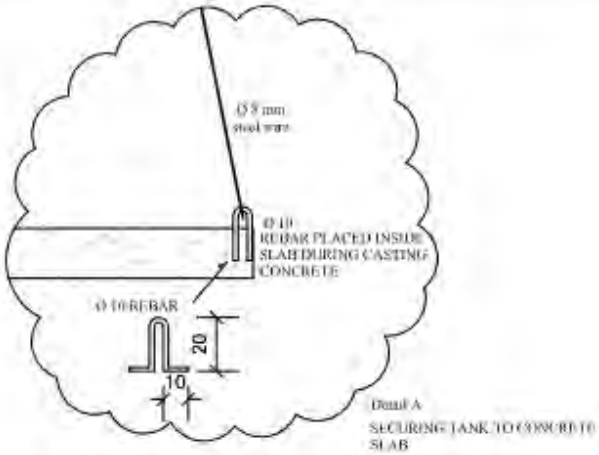


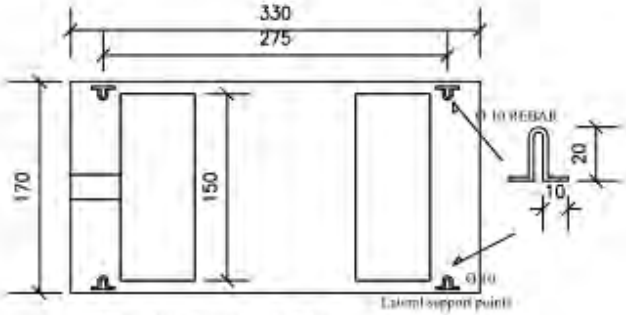
Notes :
Reinforced Concrete Bollards (3 in each side) shall be placed to protect the riser pipes on both sides of the water stand. The exterior surface of the bollards shall be painted with oil paint, black and yellow stripes.
Inlet and outlet pipes shall be fixed to the reinforced column by using brackets to avoid GI pipes getting loose after fixing to the brass nozzle.

PROTECTIVE BOLLARD DETAILS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	DRAWN	SHEET NO
	10.000 LT WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	OCT 2017	CM	6/8

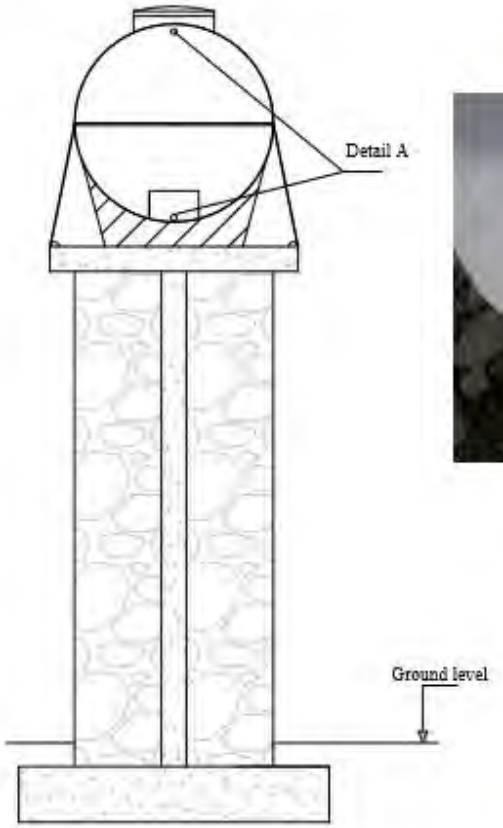


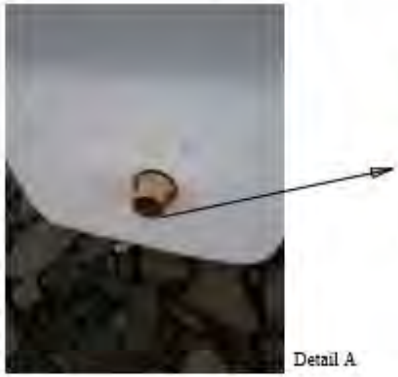




C20 reinforced concrete slab plan

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	10,000 LT WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	OCT 2017	CM	7/8





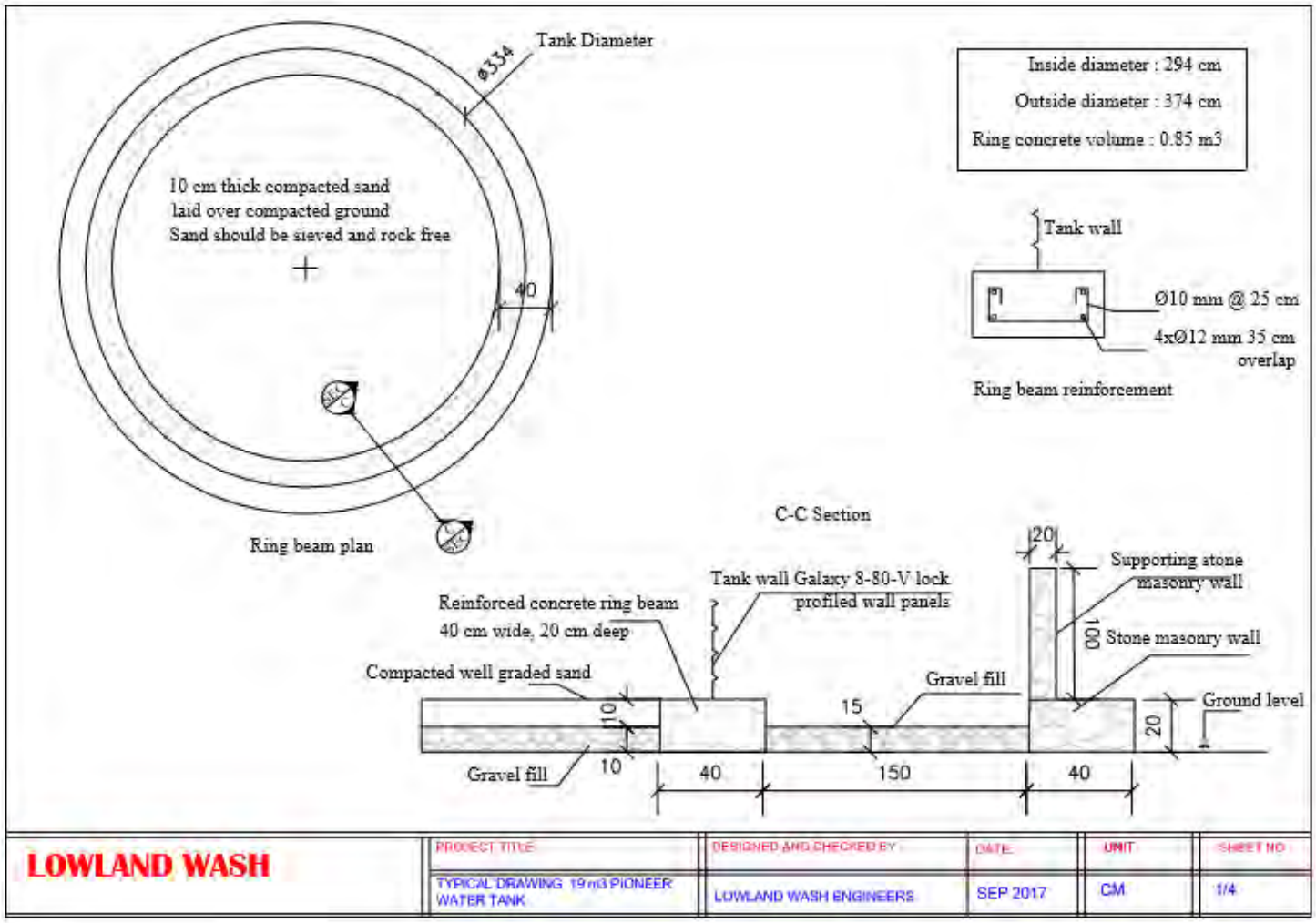
Detail A

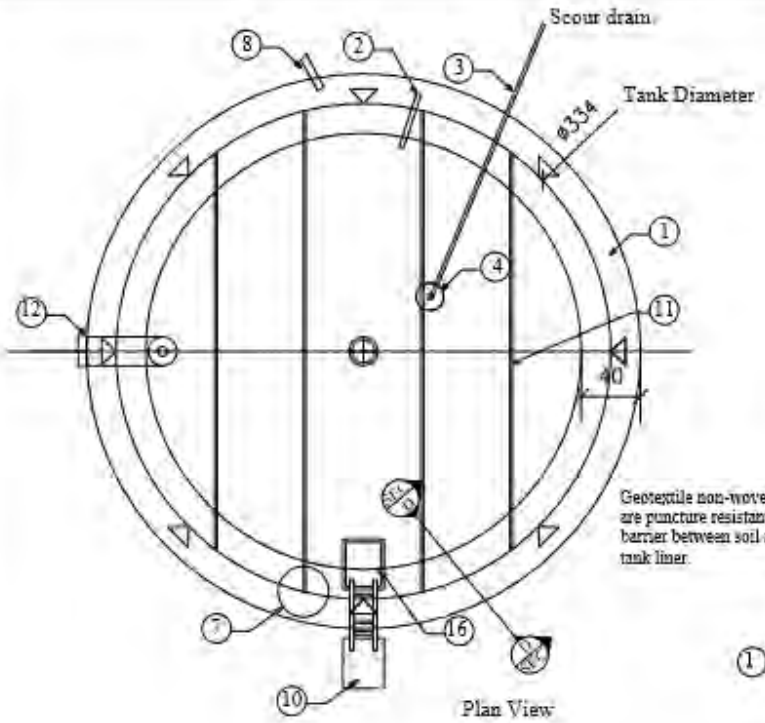
Brass Nozzle

Notes :
The fiberglass tank shall be provided with brass nozzles for pipe connection at inlet, outlet and overflow points by the manufacturer. After fixing the pipes, connection at outlet shall be tested by filling water. If any leakage observed at nozzle joint, water shall be discharge and joint shall be sealed from the inside of the tank by using sealing agent recommended by the manufacturer.
For such repairs portable steel ladder shall be manufactured and kept near the reservoir.

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	10.000 LT WATER RESERVOIR STAND	LOWLAND WASH ENGINEERS	OCT 2017	CM	8/8

TYPICAL DRAWING – WATER RESERVOIR MASONRY STAND



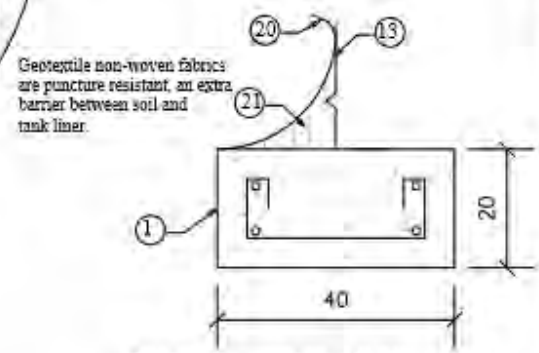


▽ Denotes wind girt location

Bolt size M 12

Bolts are Grade 8.8 High Strength steel bolts - AS1110, Galvanized AS1214
Roof sheeting, BMT 0.42 mm, G550
Liner material: Industratex or Aquaiiner
Liner thickness: 0.6 mm
Liner color: Green or Green/Black

Tank wall connection detail

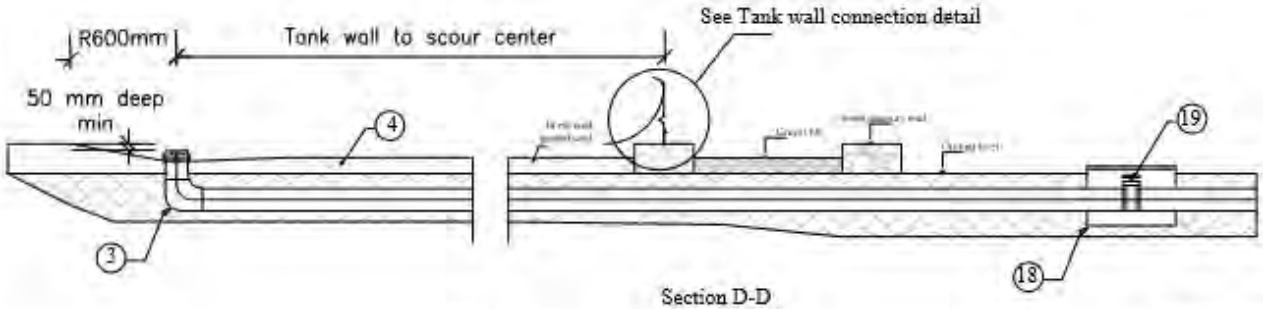


Tank liner (Industratex liner) to be used is a heavy duty homogeneous impervious membrane with an internal woven scrim to provide high-pressure resistance. Ring beam is not necessary.

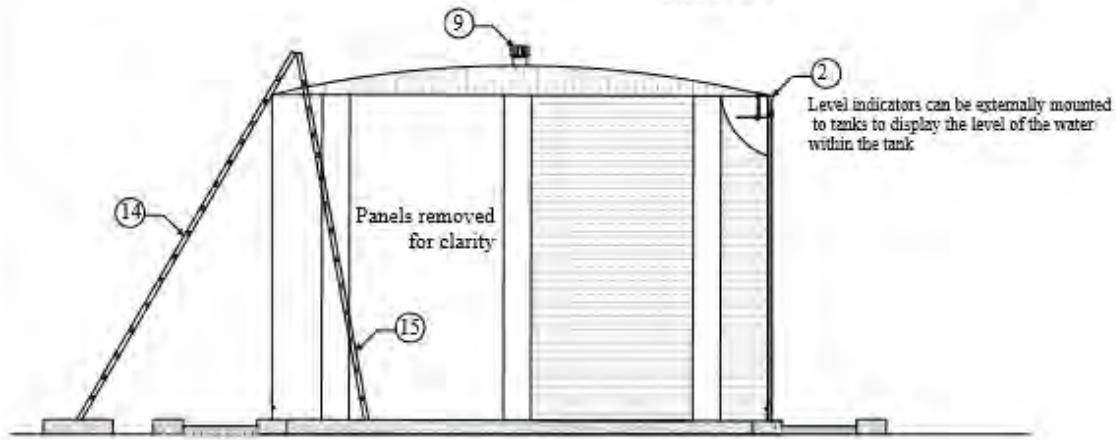
Item	Component description
21	Geotextile
20	Tank liner
19	Scour valve
18	Scour valve box
17	Dome roof sheets (galvanized)
16	Access hatch
15	Internal access ladder
14	External platform ladder
13	Tank wall panels
12	Overflow
11	Industry standard trusses
10	Concrete apron for ladder
9	Roof ventilators
8	Anti-corrosion anode tags
7	Truss foot
6	Inlet
5	Panel connection wind girts
4	Scour basin
3	Scour drain
2	Level indicator
1	Ring beam (is not necessary)

LOWLAND WASH

PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
TYPICAL DRAWING 19.0M PIONEER WATER TANK	LOWLAND WASH ENGINEERS	SEP 2017	CM	2/4



Section D-D

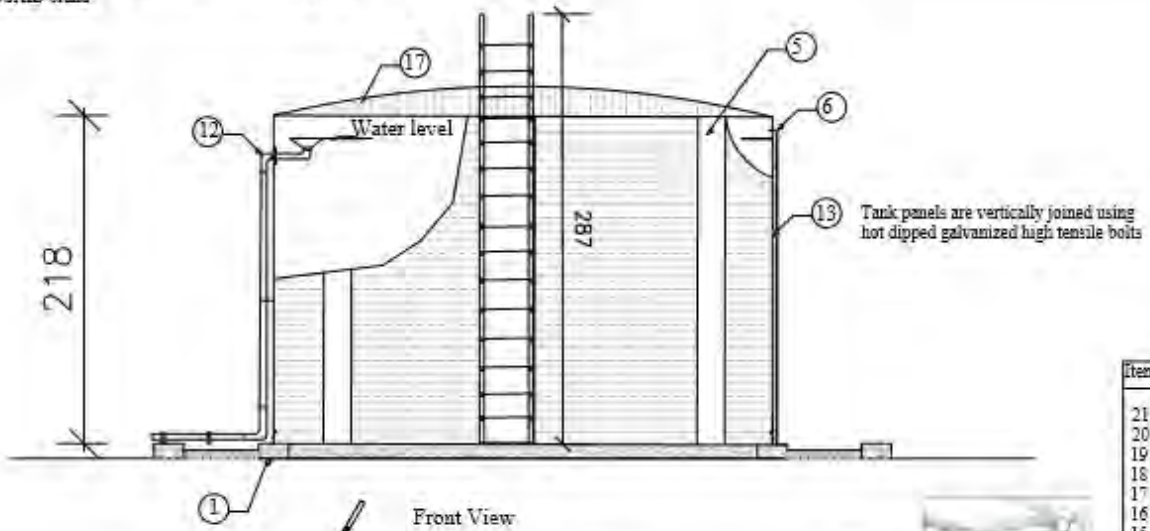


Side View

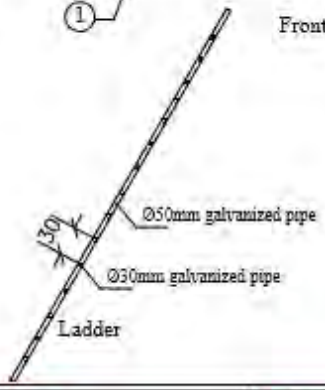
Item	Component description
21	Getotextile
20	Tank liner
19	Scour valve
18	Scour valve box
17	Dome roof sheets (galvanized)
16	Access hatch
15	Internal access ladder
14	External platform ladder
13	Tank wall panels
12	Overflow
11	Industry standard trusses
10	Concrete apron for ladder
9	Roof ventilators
8	Anti-corrosion anode tags
7	Truss foot
6	Inlet
5	Panel connection wind girts
4	Scour basin
3	Scour drain
2	Level indicator
1	Ring beam (is not necessary)

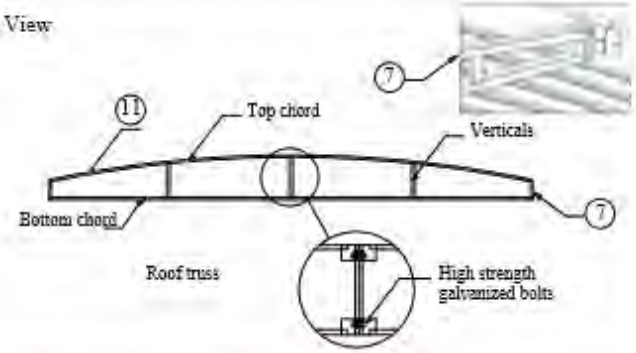
LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO:
	TYPICAL DRAWING 19 m3 PIONEER WATER TANK	LOWLAND WASH ENGINEERS	SEP 2017	CM	3/4

NOTE : The Tank will be branded with an approved USAID brand



Front View



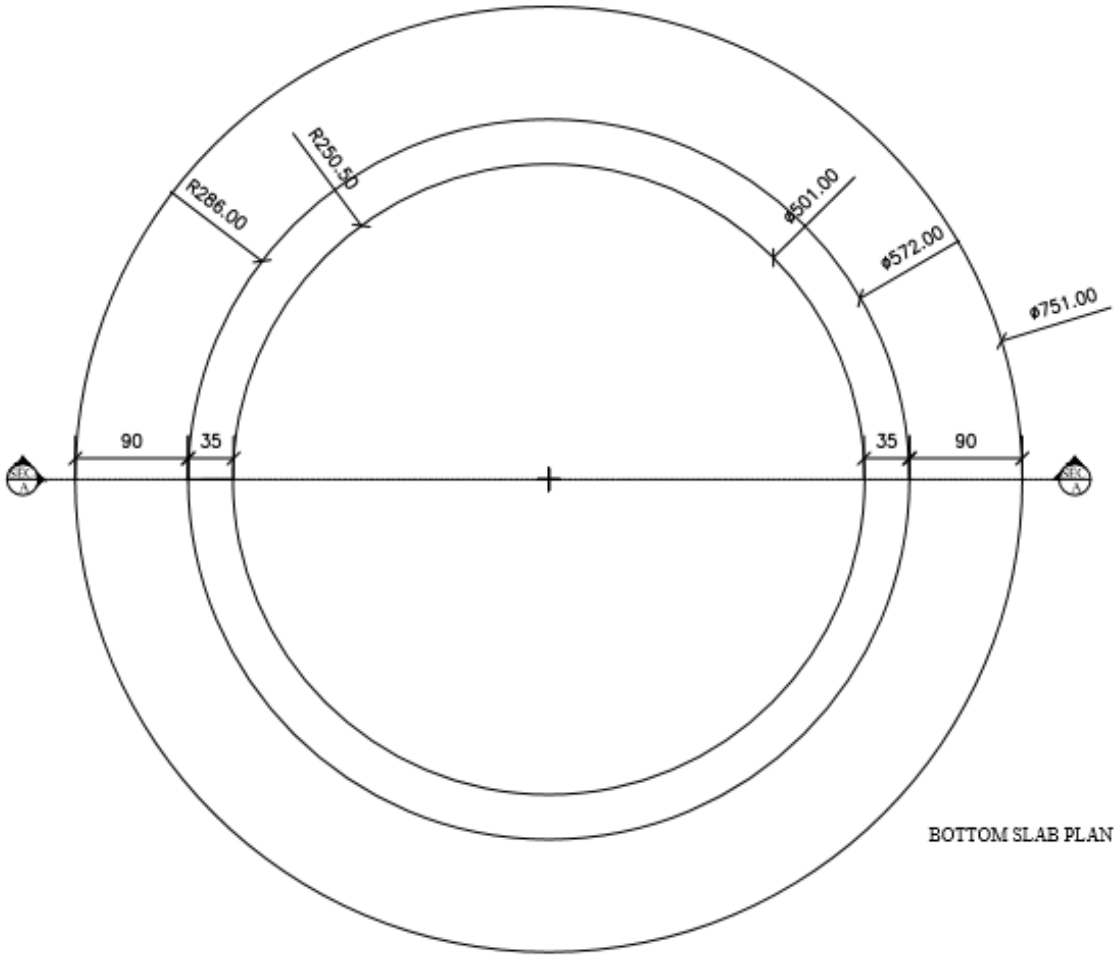


Item	Component description
21	Getotextile
20	Tank liner
19	Scour valve
18	Scour valve box
17	Dome roof sheets (galvanized)
16	Access hatch
15	Internal access ladder
14	External platform ladder
13	Tank wall panels
12	Overflow
11	Industry standard trusses
10	Concrete apron for ladder
9	Roof ventilators
8	Anti-corrosion anode tags
7	Truss foot
6	Inlet
5	Panel connection wind girts
4	Scour basin
3	Scour drain
2	Level indicator
1	Ring beam (is not necessary)

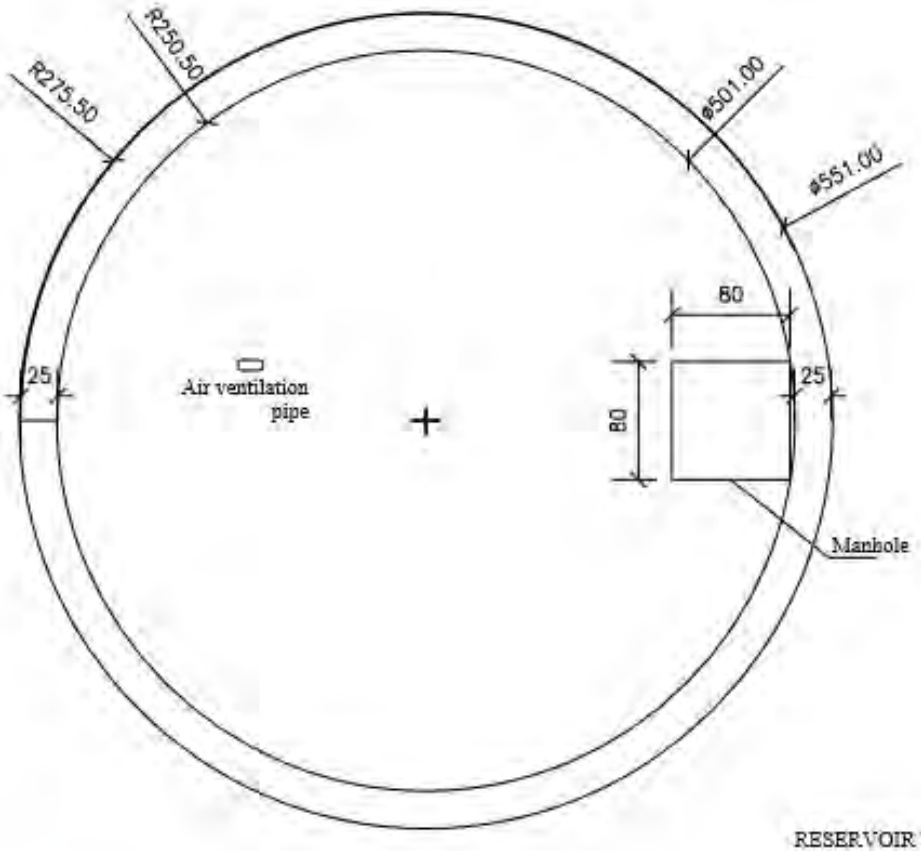
LOWLAND WASH

PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
TYPICAL DRAWING: 19 m3 PIONEER WATER TANK	LOWLAND WASH ENGINEERS	SEP 2017	CM	4/4

TYPICAL DRAWING- 50M3 ELEVATED RESERVOIR



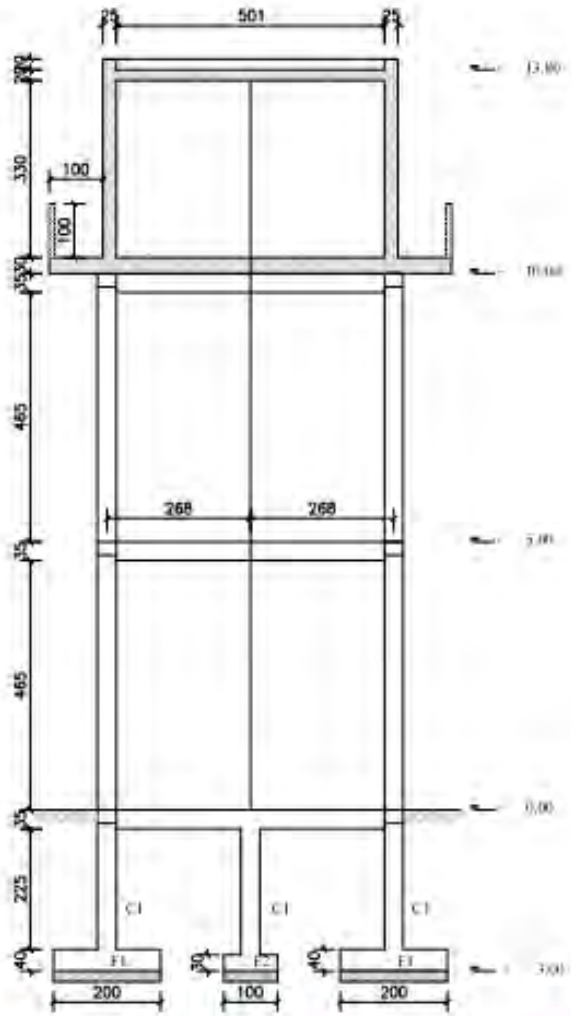
LOWLAND WASH	PROJECT TITLE.	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING- 50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	1/19



RESERVOIR TOP SLAB PLAN

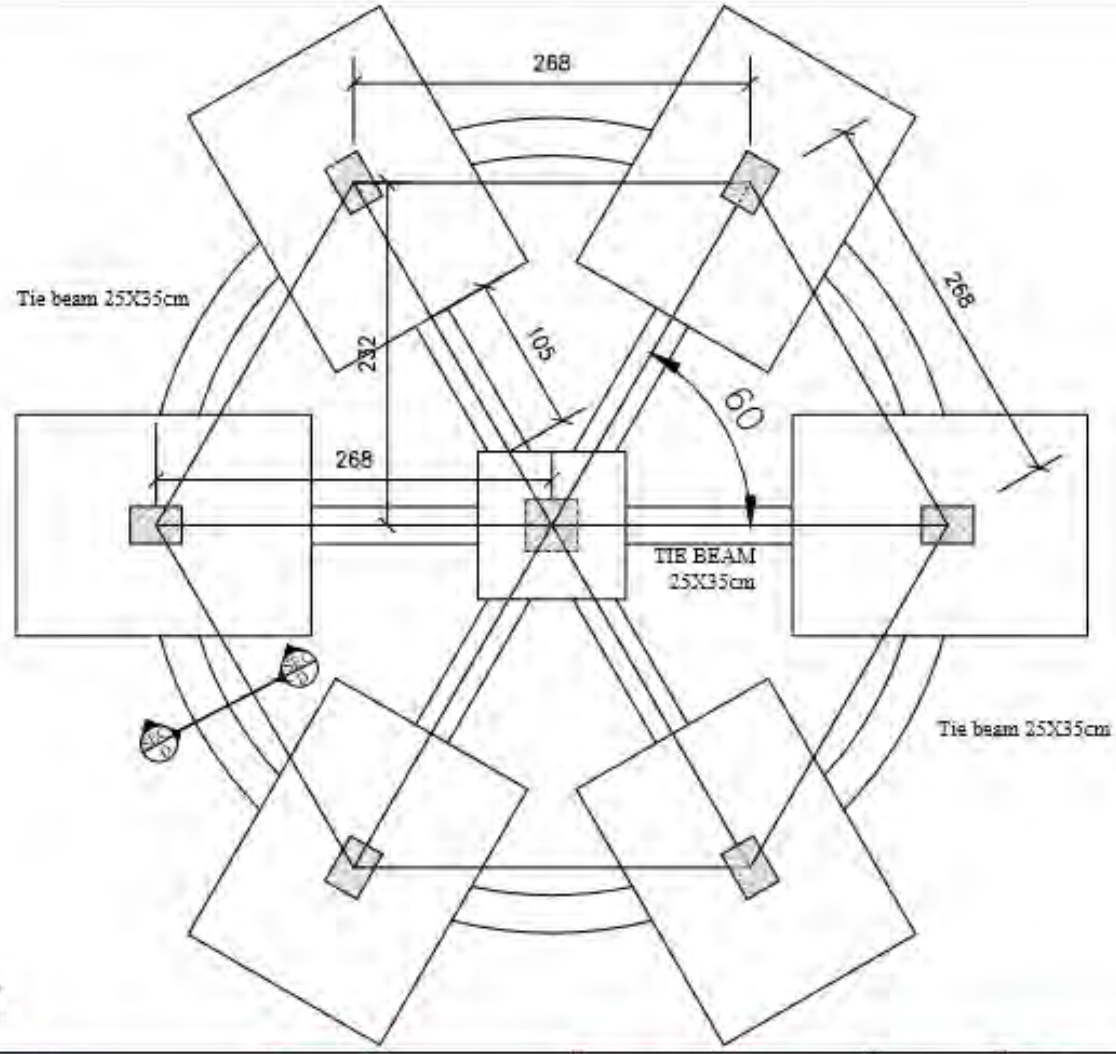
LEVEL 13.80

LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING- 50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	2/19



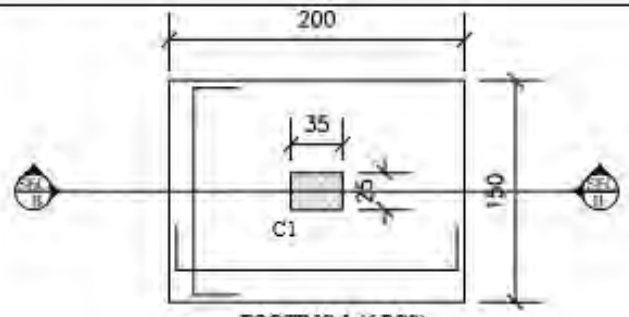
ELEVATION SECTION A-A

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING- 50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	3/19

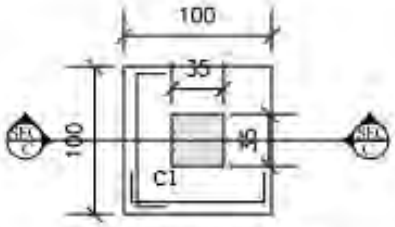


FOUNDATION PLAN
LEVEL - 3.00

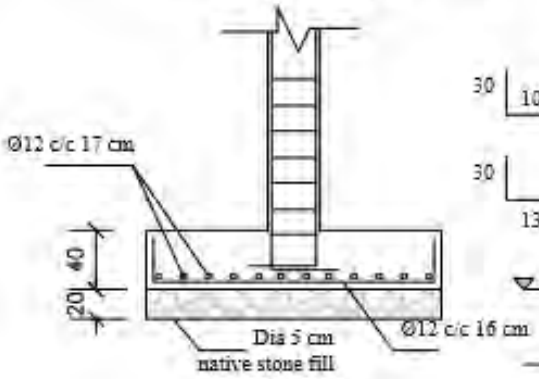
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-60M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	4/19



FOOTING 1 (6 PCS)



FOOTING 2 (1 PCS)

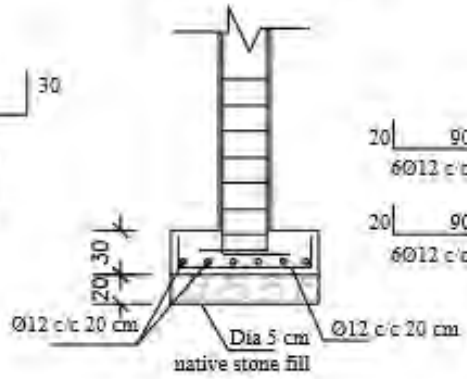


SECTION B-B

30 | 10 Ø12 c/c 16 cm L=250 | 30
190

30 | 140 | 30
13 Ø12 c/c 17 cm L=200

- 3.00

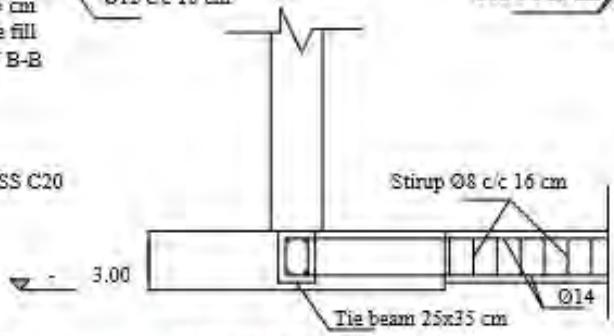


SECTION C-C

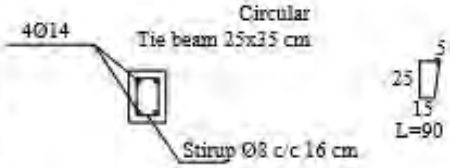
20 | 90 | 20
6Ø12 c/c 20 cm L=130

20 | 90 | 20
6Ø12 c/c 20 cm L=130

CONCRETE CLASS C20

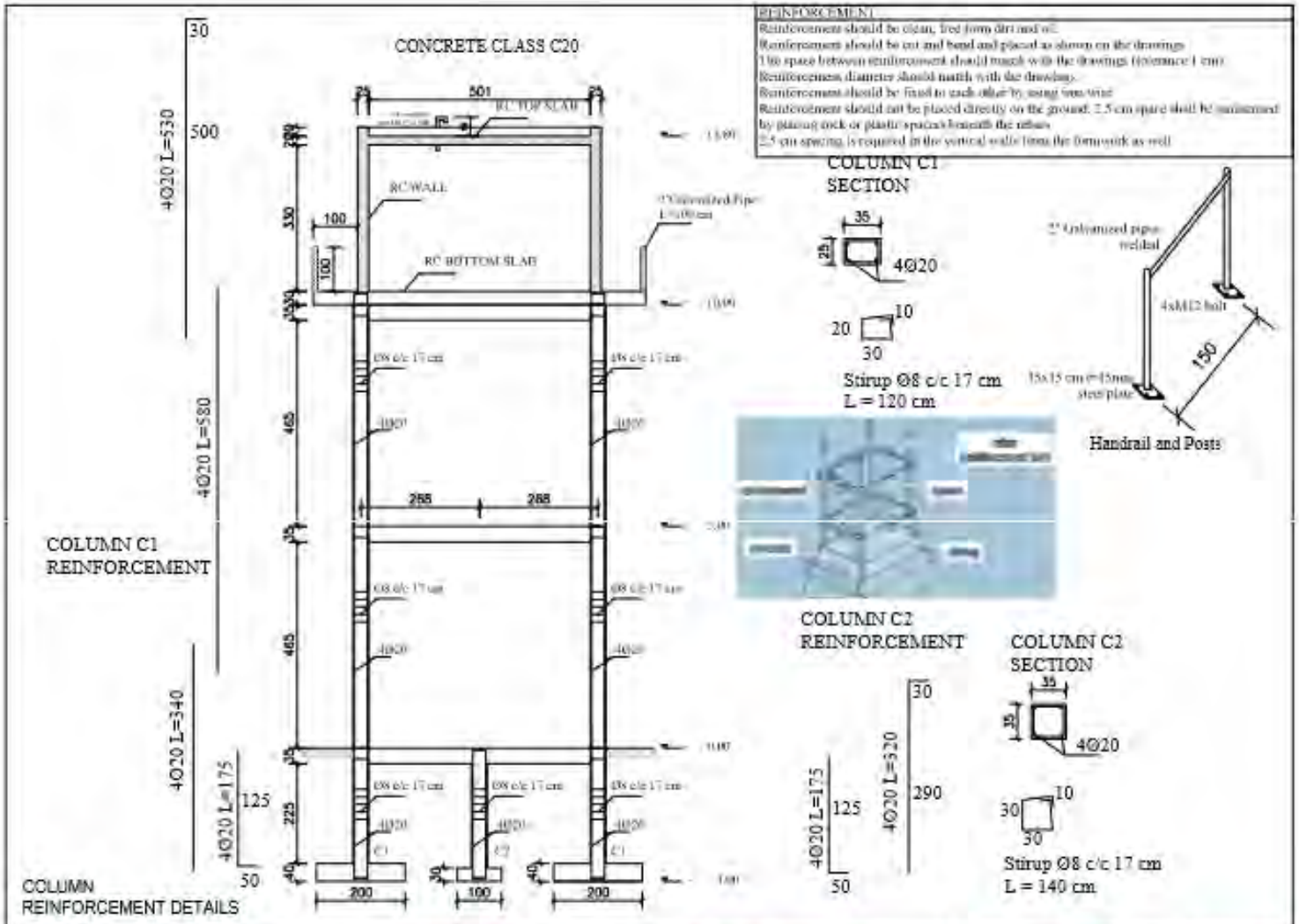


SECTION D-D (SHEET 4/19)

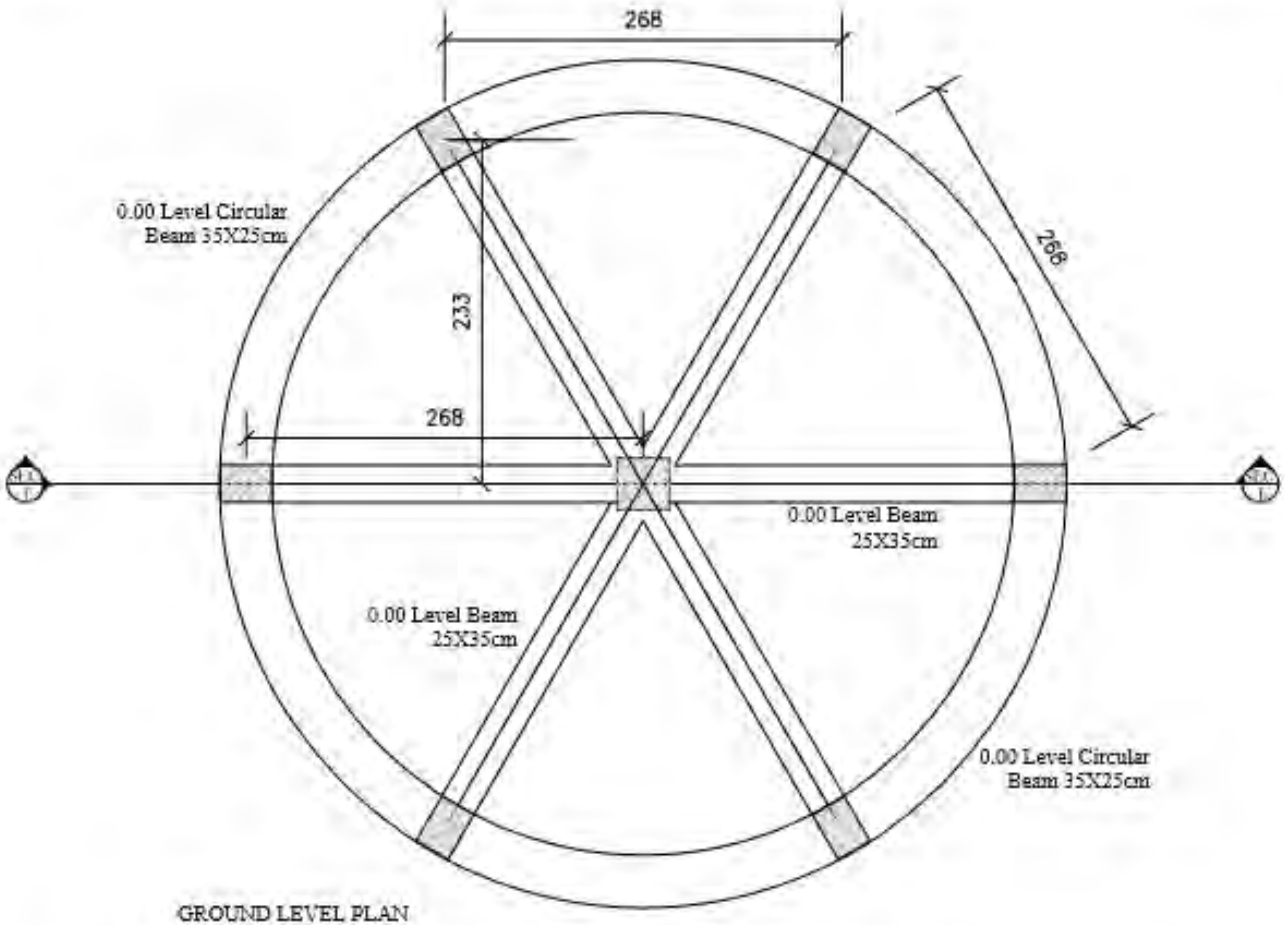


FOOTING REINFORCEMENT DETAILS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING - 50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	5/19

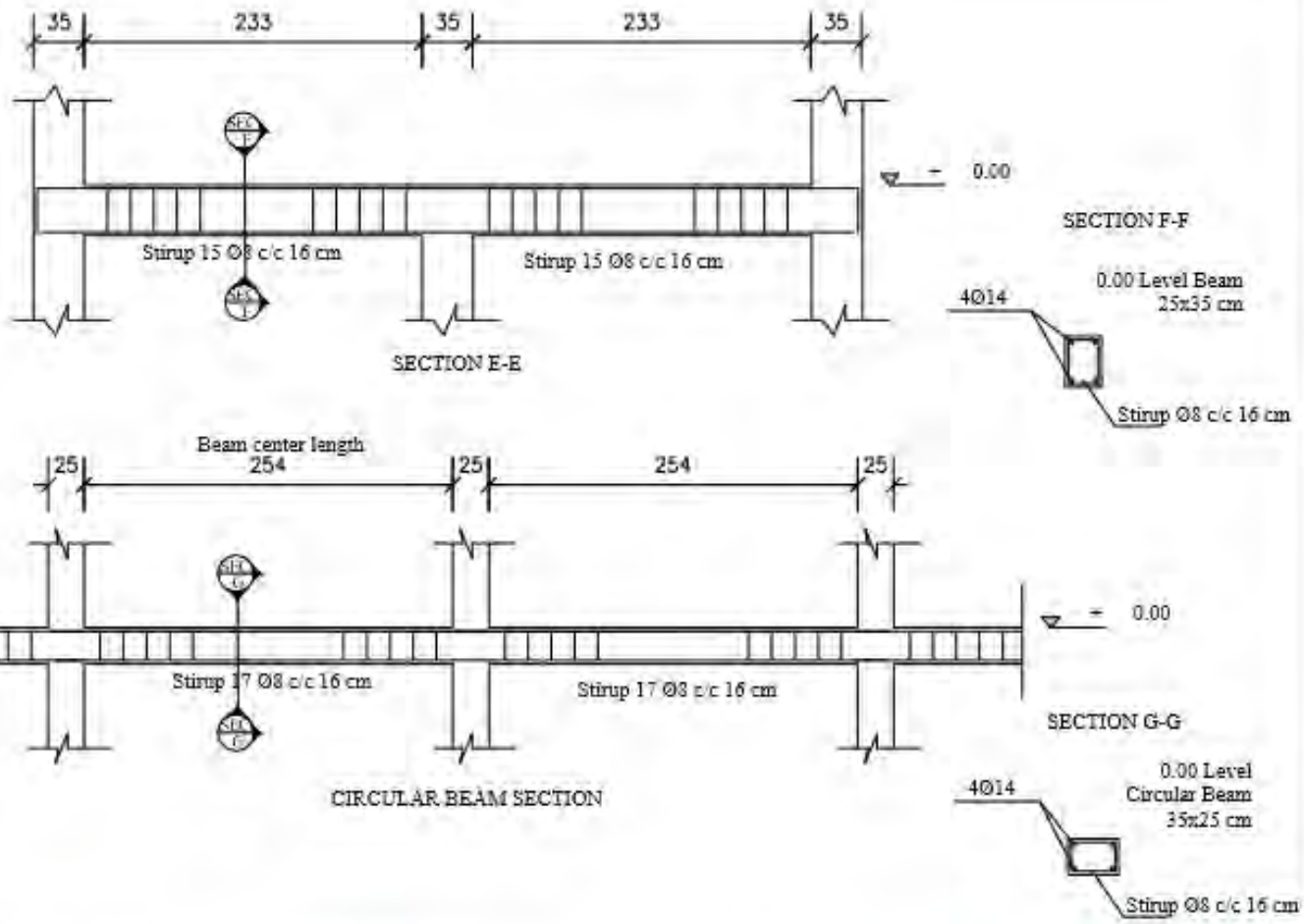


LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING- 50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	6/10

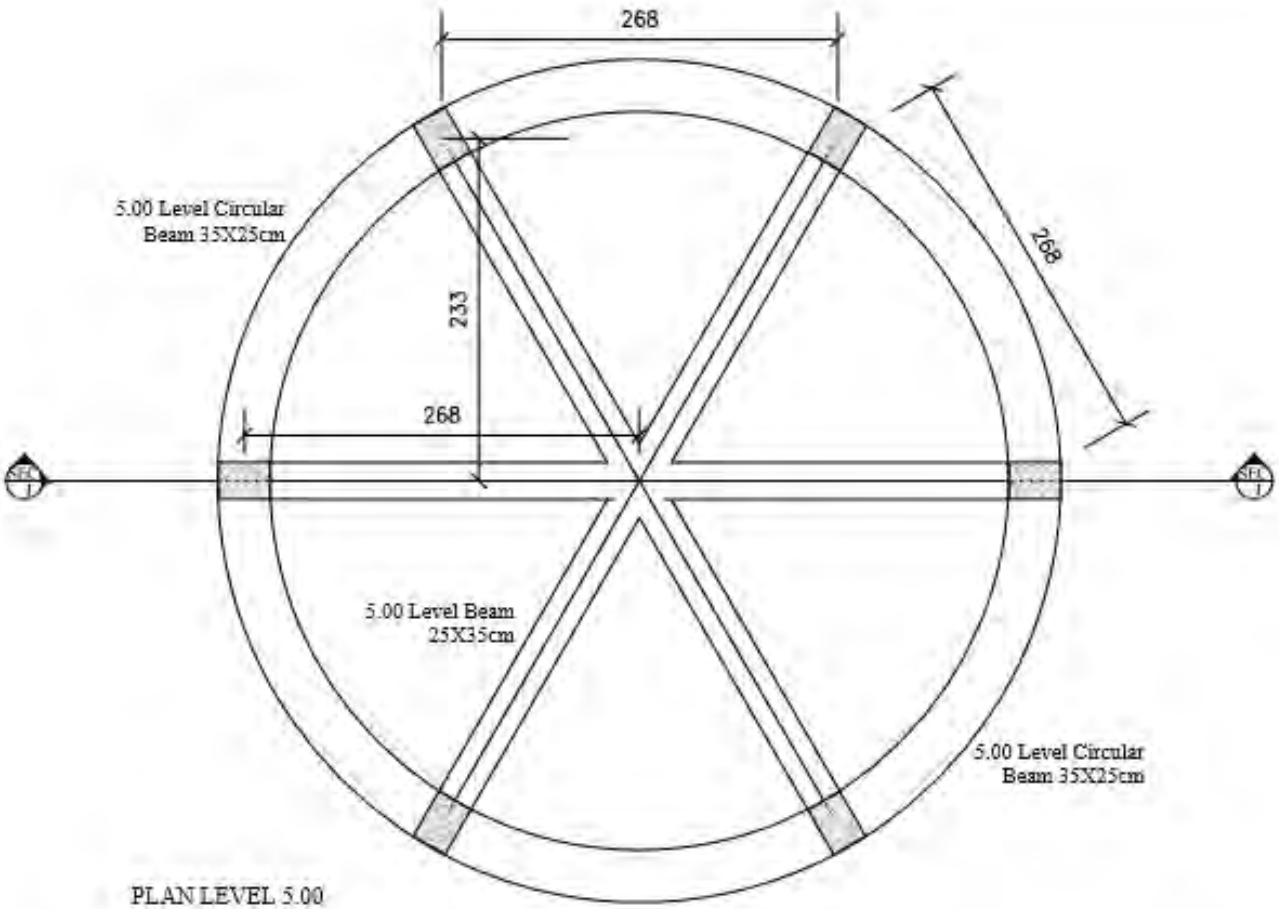


GROUND LEVEL PLAN
LEVEL 0.00

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO.
	TYPICAL DRAWING- 50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	7/19

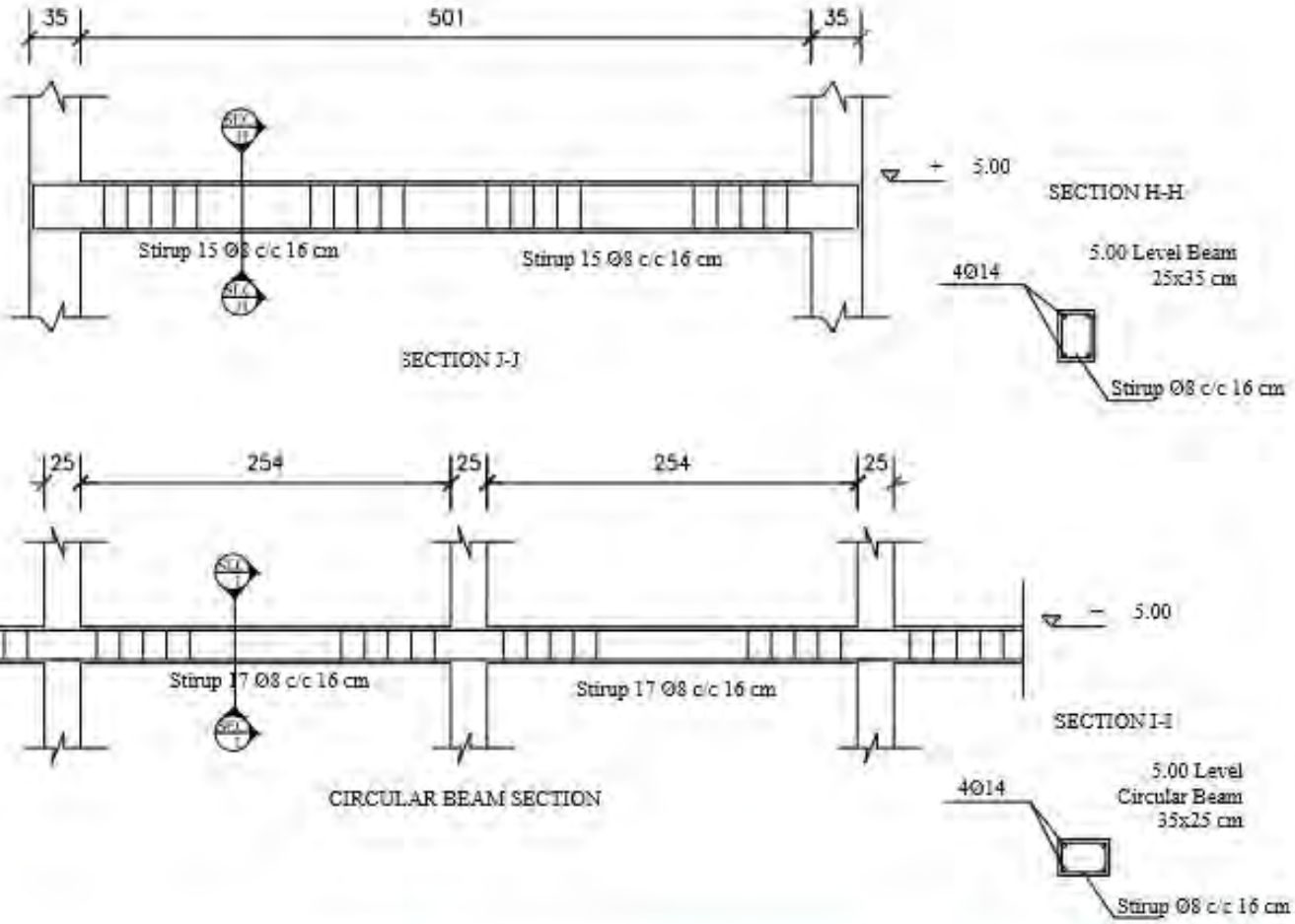


LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING- 50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	8/10

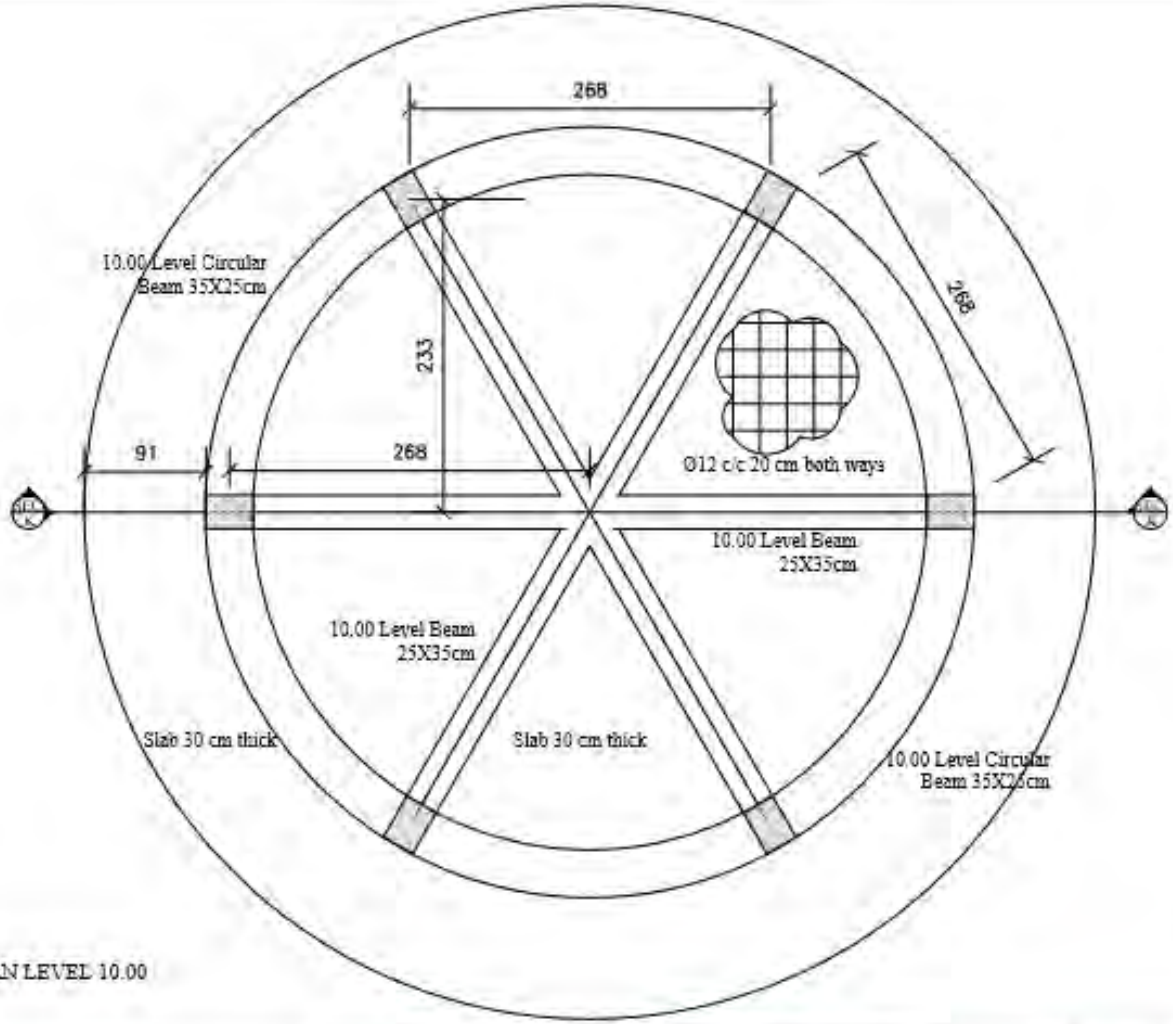


PLAN LEVEL 5.00

LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY:	DATE:	UNIT	SHEET NO:
	TYPICAL DRAWING- 50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	9/10

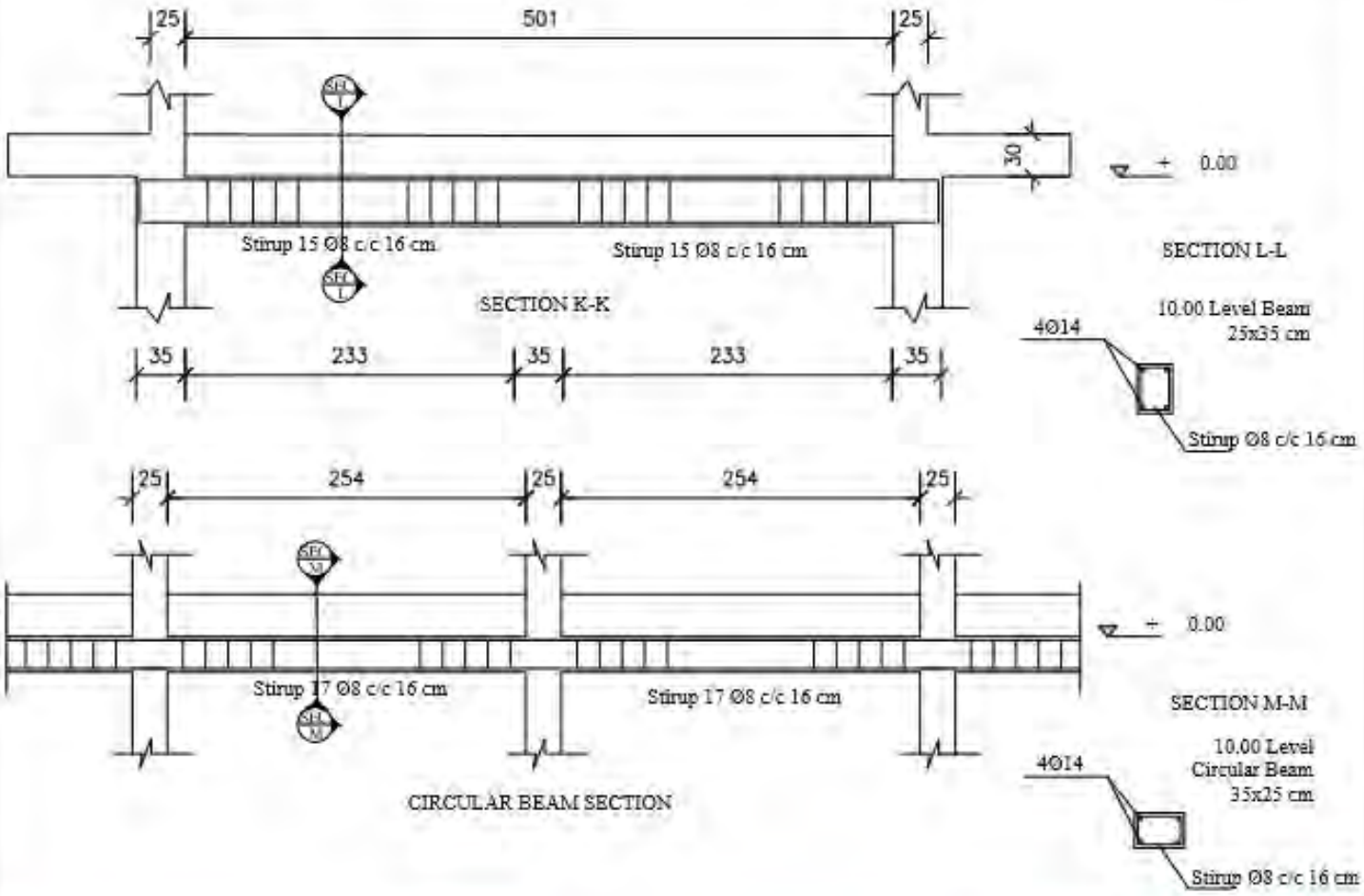


LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING-50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	10/19

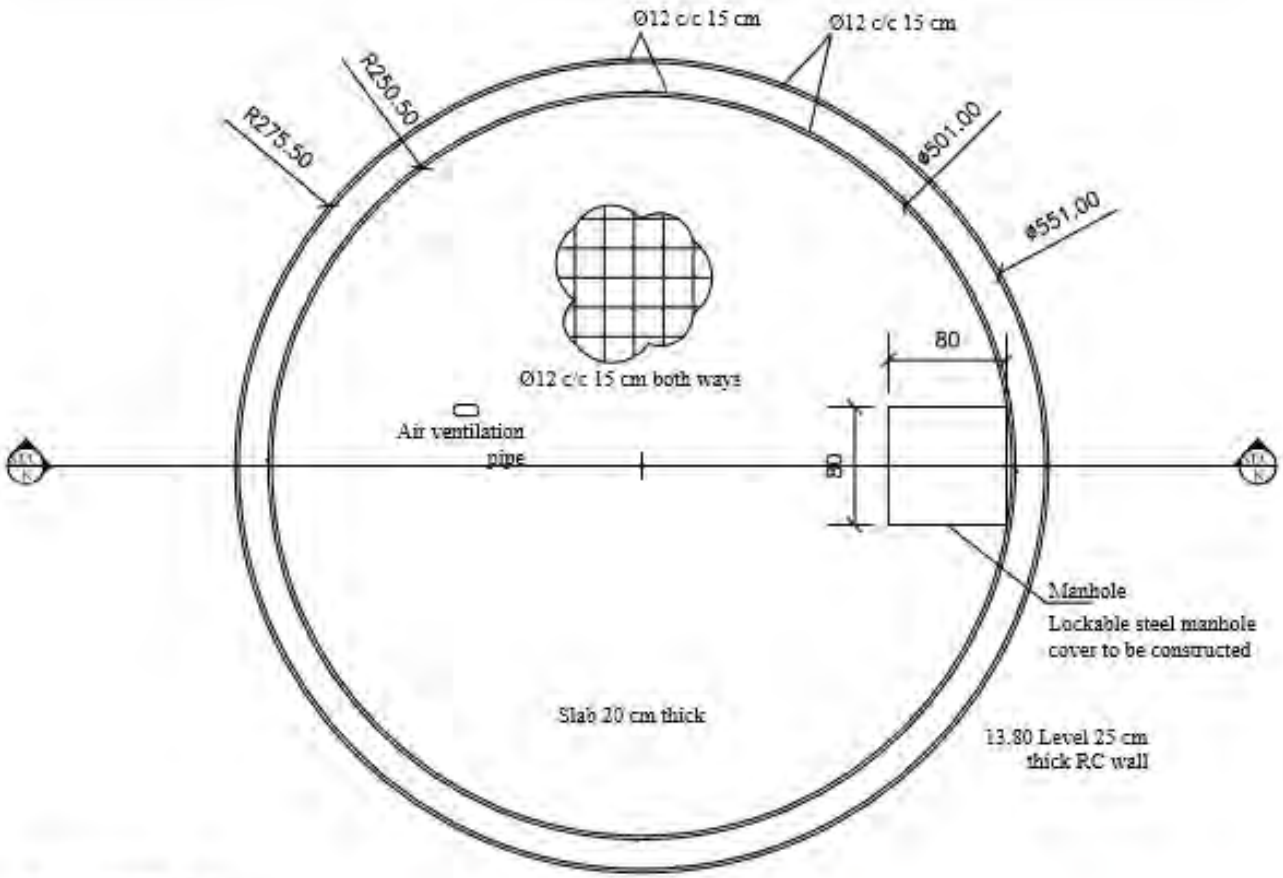


PLAN LEVEL 10.00

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING–50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	11/11

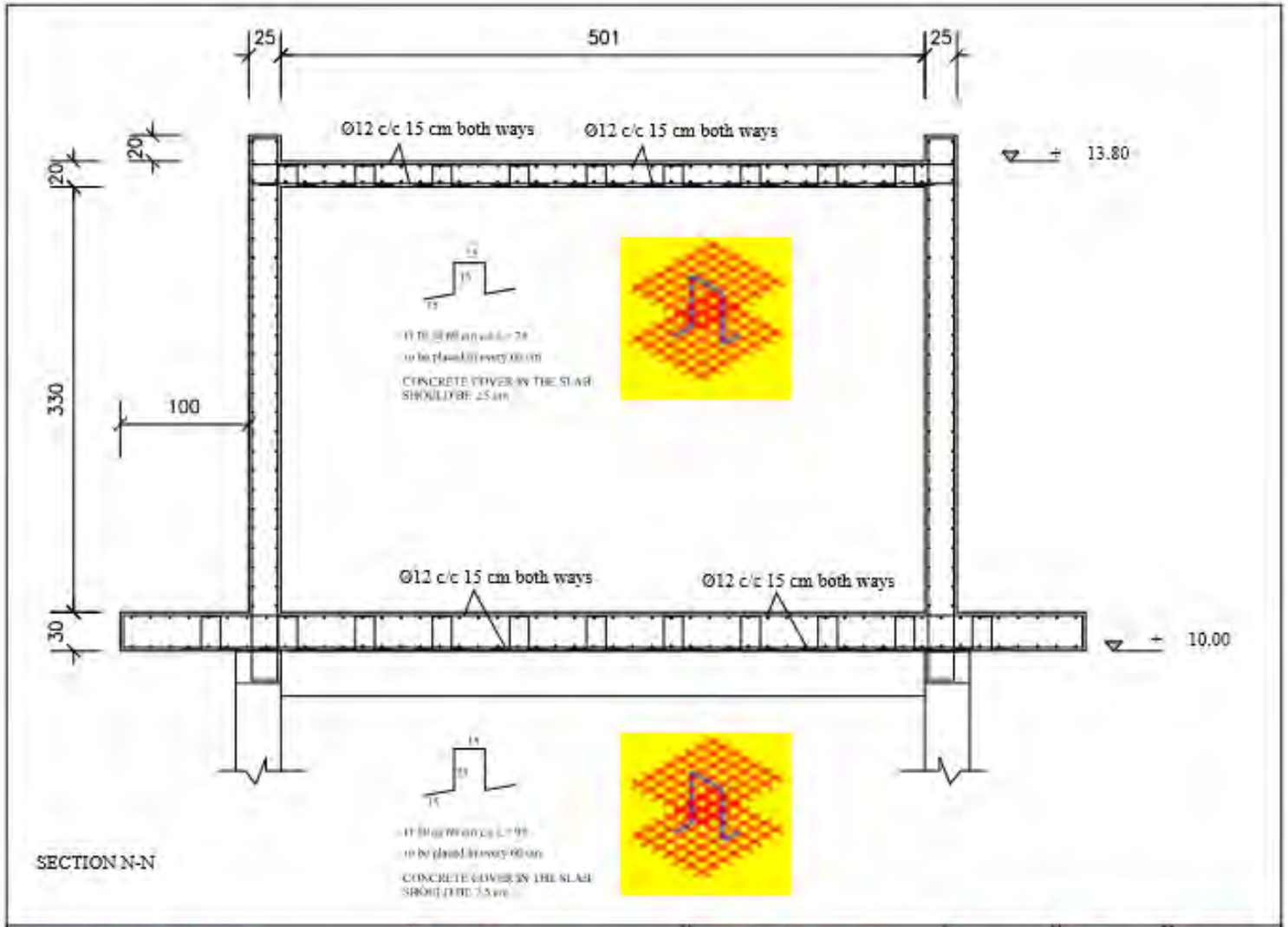


LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING- 30M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	12/19

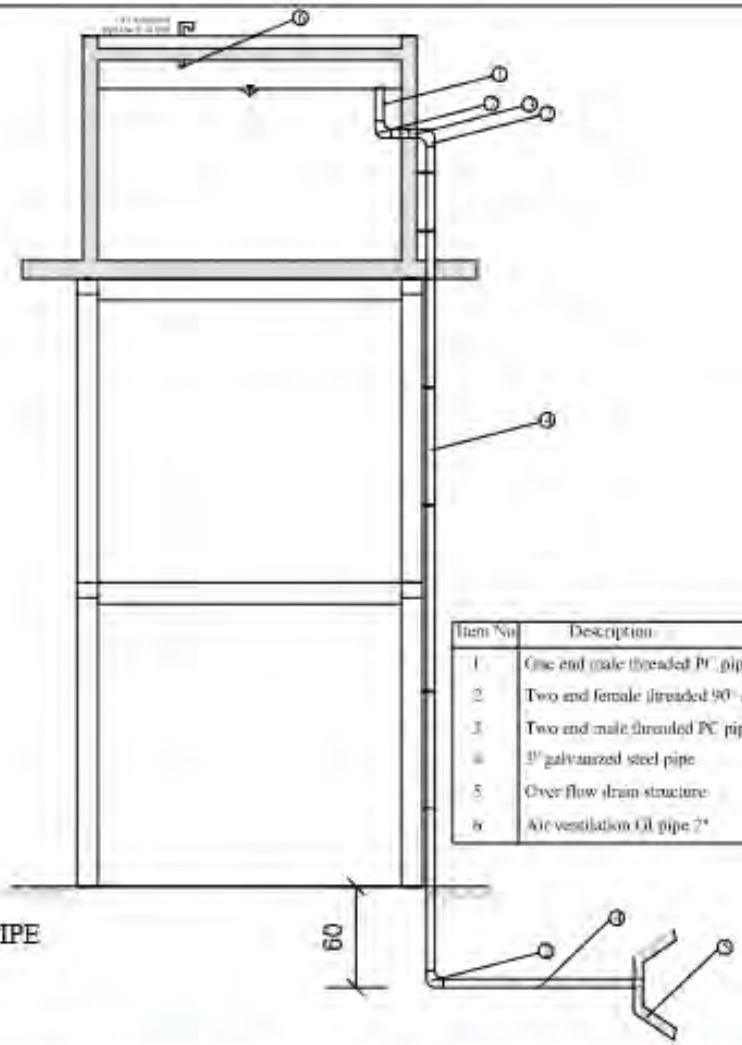


PLAN LEVEL 13.80

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING- 5000 M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	13/10



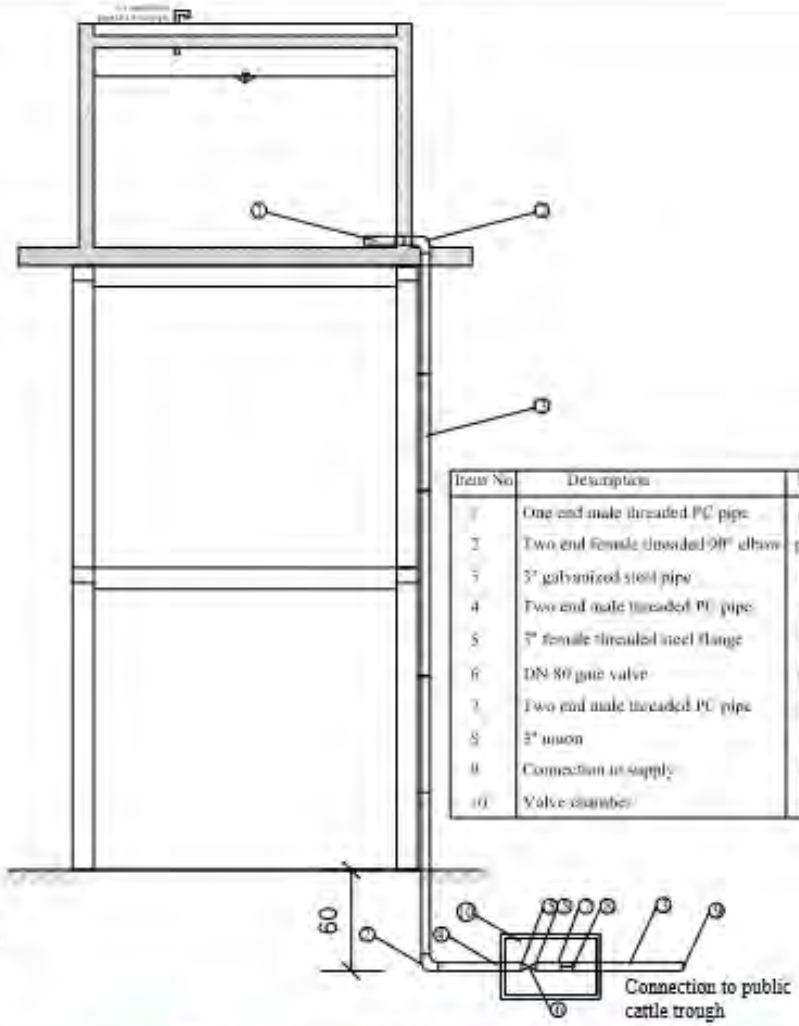
LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY:	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING- 50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	14/19



OVER FLOW PIPE

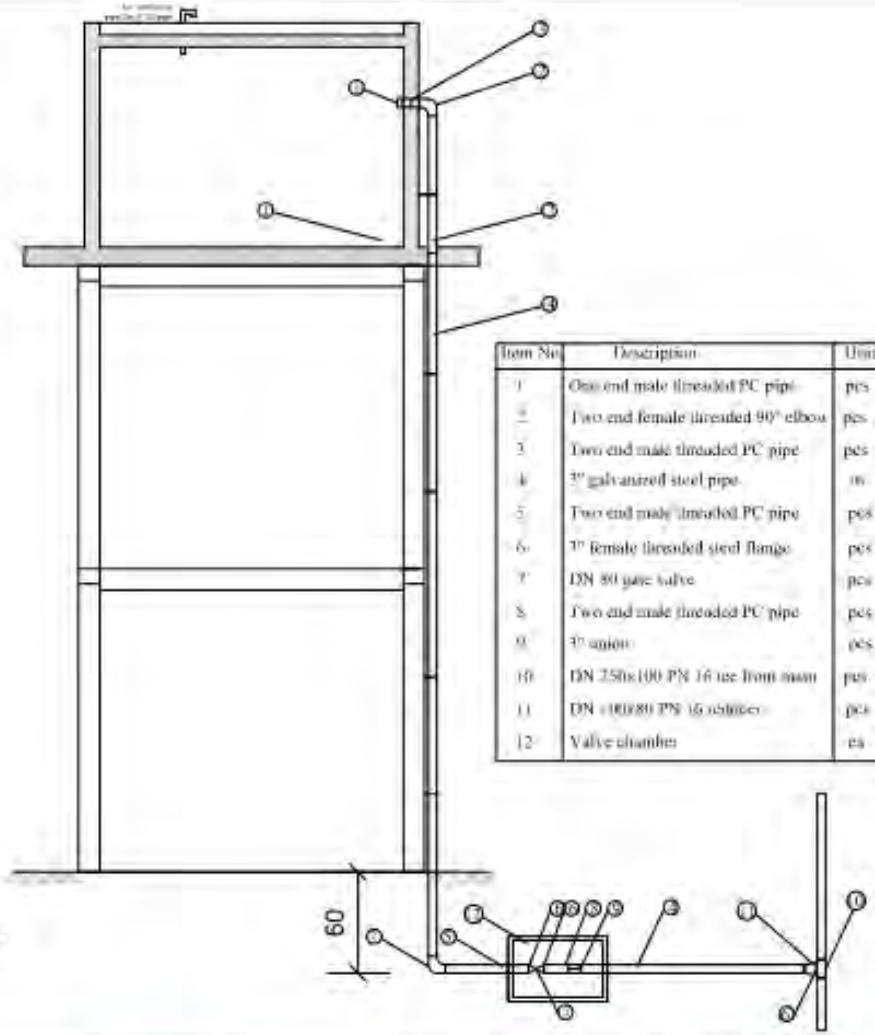
Item No	Description	Unit	Qty	Remark
1	One end male threaded PC pipe	pcs	1	
2	Two end female threaded 90° elbow	pcs	3	
3	Two end male threaded PC pipe	pcs	1	
4	3" galvanized steel pipe	m	30	
5	Over flow drain structure	ea	1	
6	Air ventilation GI pipe 2"	ea	1	

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING- 50M3 ELEVATED REBERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	15/19



Item No	Description	Unit	Qty	Remark
1	One end male threaded PC pipe	pcs	1	
2	Two end female threaded 90° elbow	pcs	4	
3	3" galvanized steel pipe	m	30	
4	Two end male threaded PC pipe	pcs	1	
5	3" female threaded steel flange	pcs	2	
6	DN 80 gate valve	pcs	1	
7	Two end male threaded PC pipe	pcs	1	
8	3" union	pcs	1	
9	Connection to supply	LS	1	
10	Valve chamber	ea	1	

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	TYPICAL DRAWING- 50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	16/19

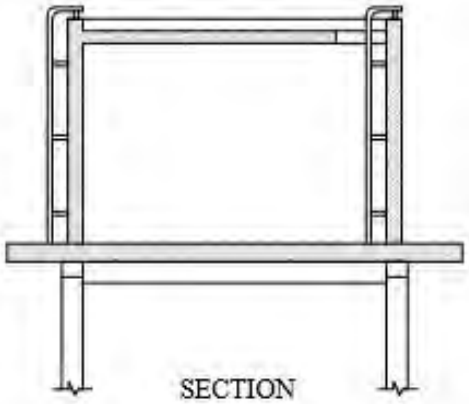


INLET PIPE

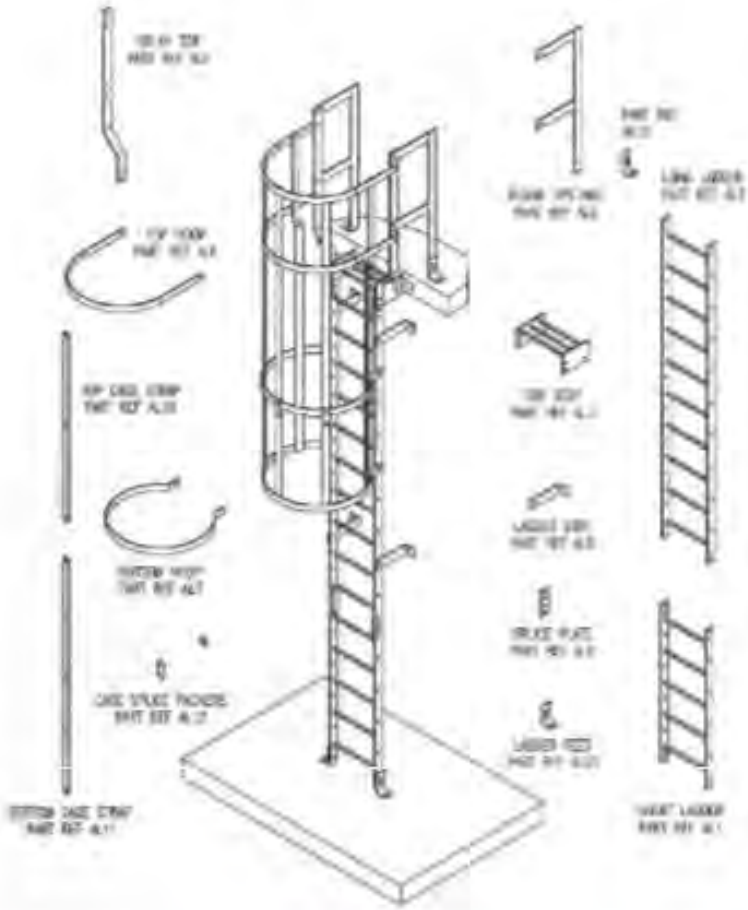
Item No	Description	Unit	Qty	Remark
1	One end male threaded PC pipe	pcs	1	
2	Two end female threaded 90° elbow	pcs	5	
3	Two end male threaded PC pipe	pcs	1	
4	3" galvanized steel pipe	m	50	
5	Two end male threaded PC pipe	pcs	1	
6	3" female threaded steel flange	pcs	5	
7	DN 80 gate valve	pcs	1	
8	Two end male threaded PC pipe	pcs	1	
9	3" union	pcs	1	
10	DN 250x100 PN 16 tee from main	pcs	1	
11	DN 100/80 PN 16 reducer	pcs	1	
12	Valve chamber	ea	1	

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING- 50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	17/19

Note: Steel ladder shall be installed to reach from the ground to the bottom slab of the reservoir at level +10.00. Steel ladder shall be constructed and fixed on to the column and bottom slab of the reservoir. Steel ladder should be provided with safety hoop as shown in the typical drawing. In addition another steel ladder shall be installed inside the reservoir for cleaning and maintenance purposes as shown in the section below.



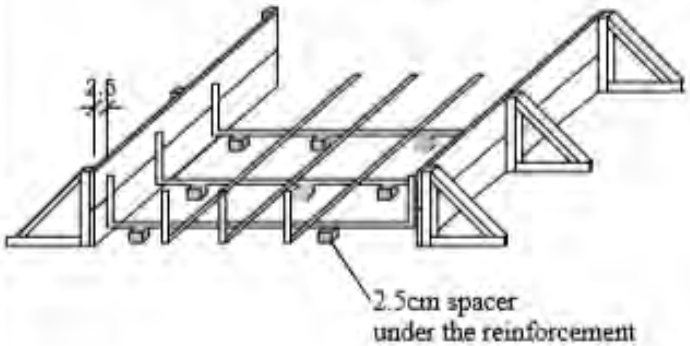
SECTION



TYPICAL STEEL LADDER DETAILS

LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	TYPICAL DRAWING- 50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	18/19

Formwork and Bracing



FORMWORK
The formwork shall be constructed so that there is no loss of fines or blemish of the concrete surface
The internal surface of the formwork must be clean and free from concrete scrap and dirt
The formwork should be levelled properly
Wood formwork used to form the top edge of the slab shall be cut straight and level
The formwork should be plumb and straight
A strong line shall be used to ensure the formwork is straight and provide required slope
Before casting internal surface of the formwork should be moistened with water
While placing reinforcement there should be 2.5 cm space remained between the rebars and formwork inner surface
The mud slab that the concrete is being placed on must be debris, dirt and dust free
The formwork should be supported with braces properly and fixed with nails or needed
The formwork shall not be removed before the structure has gained enough strength to hold its own weight and safely carry all the possible loads
The joints between the panels of the formwork should be adequately tight

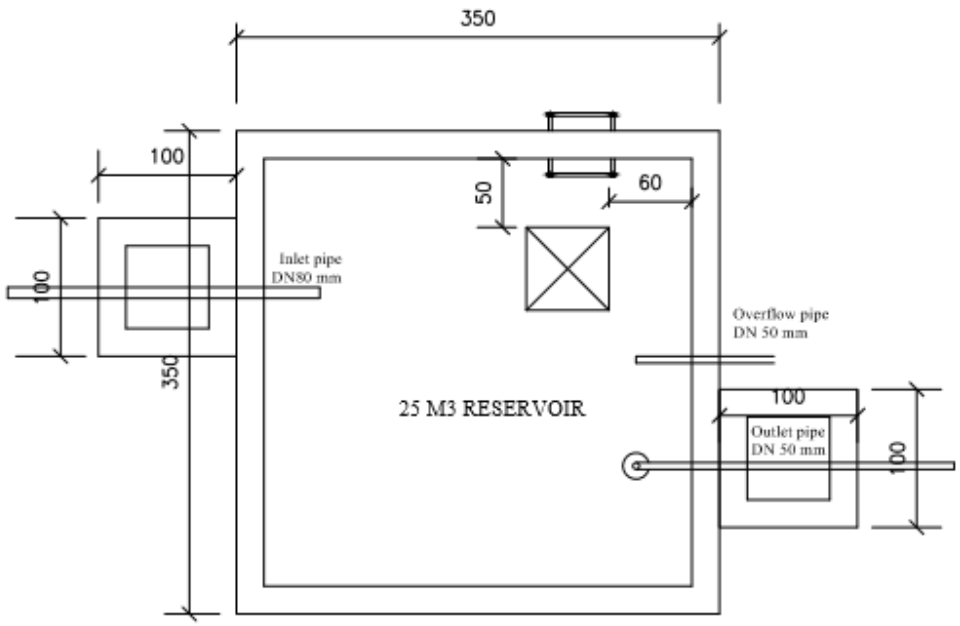
CONCRETE
Coarse sand shall be clean and free from dirt and clay
Coarse aggregate size shall be max dia 2 cm
Coarse aggregate shall be mixture of 0-1 and 0-2 size
Mixing water shall be clean
Concrete shall be mixed on steel plate or on clean surface
Concrete shall be placed within 30 min after mixing completed
Vibrator or steel bars shall be used to compact concrete during placing
Concrete surface shall be levelled using trowel
Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

1 m3 C20 concrete batching amounts	Standard Mixes for Ordinary Structural Concrete per 50 kg bag of cement
Ratio 1:2:4	
6 bags cement (300 kg cement)	1 bag cement (50 kg cement)
0.25 m3 coarse sand	275 kg crushed stone (max dia 2 cm) and coarse sand
0.50 m3 crushed stone (aggregate Dia 2cm)	0.155 m3 concrete
Max 180 lt water (W/C ratio 0.60)	Max 30 lt water (W/C ratio 0.60)

1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 50x30x20cm)
6 bags cement (300 kg cement)
5 buckets coarse sand
10 buckets crushed stone (max Dia 2cm)
Max 180 lt water (W/C ratio 0.60)
Coarse sand and crushed stone density: 2200 kg/m3

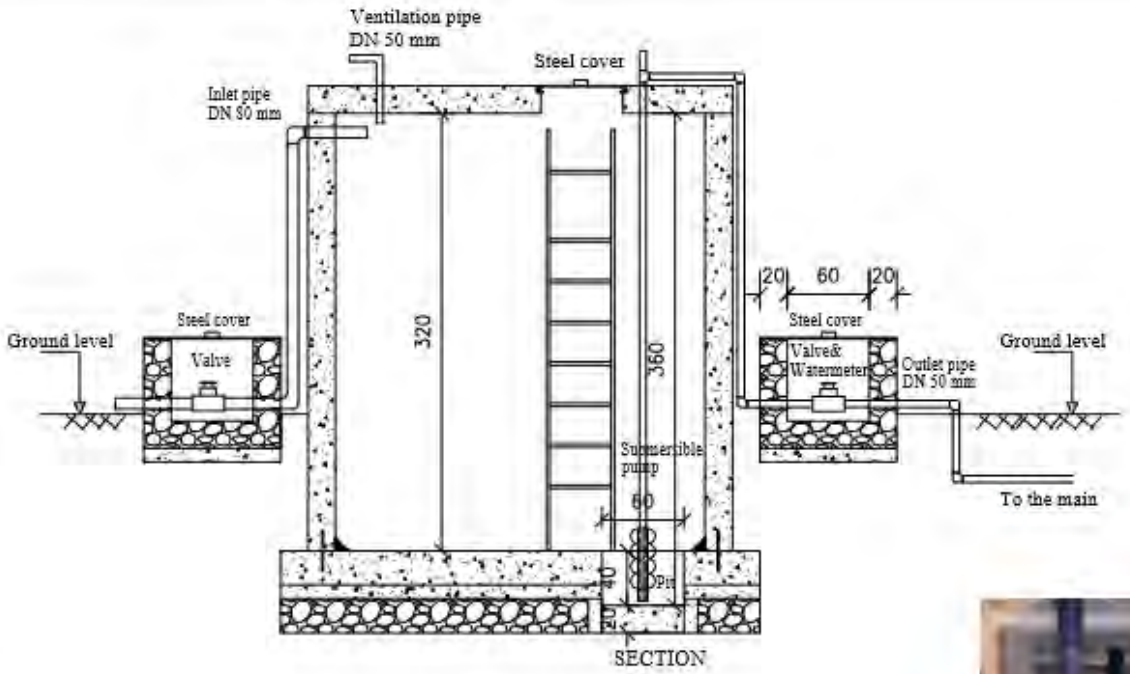
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO.
	TYPICAL DRAWING- 50M3 ELEVATED RESERVOIR	LOWLAND WASH ENGINEERS	JUNE 2017	CM	10/10

TYPICAL DRAWING WET WELL RESERVOIR AND SUBMERGIBLE PUMP



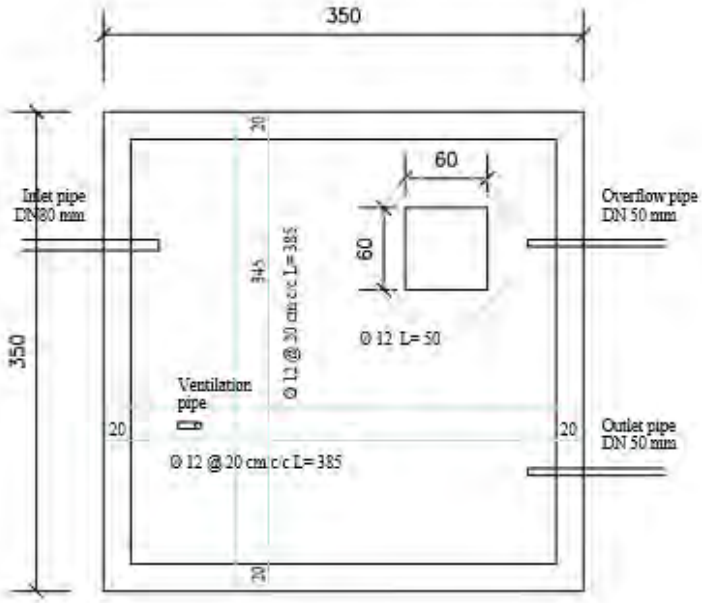
GENERAL LAYOUT

LOWLAND WASH	PROJECT TITLE.	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO
	WET WELL RESERVOIR	LOWLAND WASH ENGINEERS	AUGUST 2017	CM	1/7



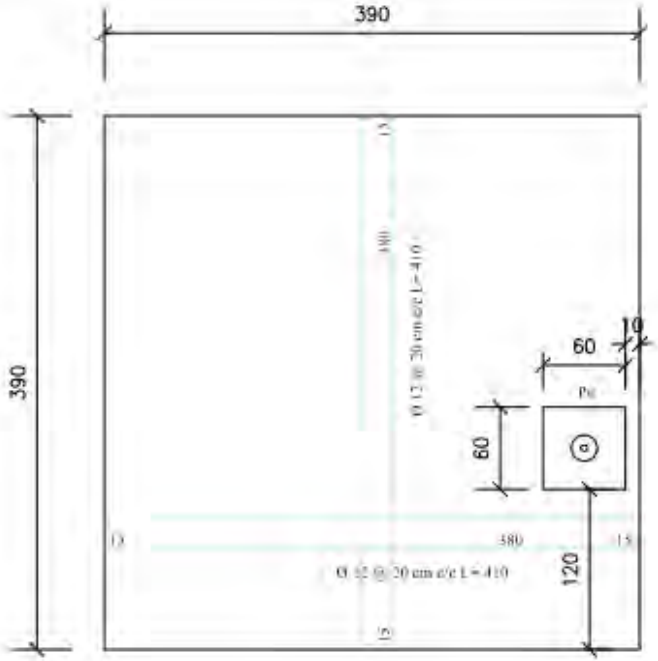
NOTES
The interior walls of the reservoir shall be covered with 2 cm thick plaster
Water proof material (SIKA brand or similar) shall be applied over the plaster
Waterstop (SIKA brand or similar) shall be placed at cold joints
The bottom slab corners shall be chamfered using mortar

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	WET WELL RESERVOIR	LOWLAND WASH ENGINEERS	AUGUST 2017	CM	2/7



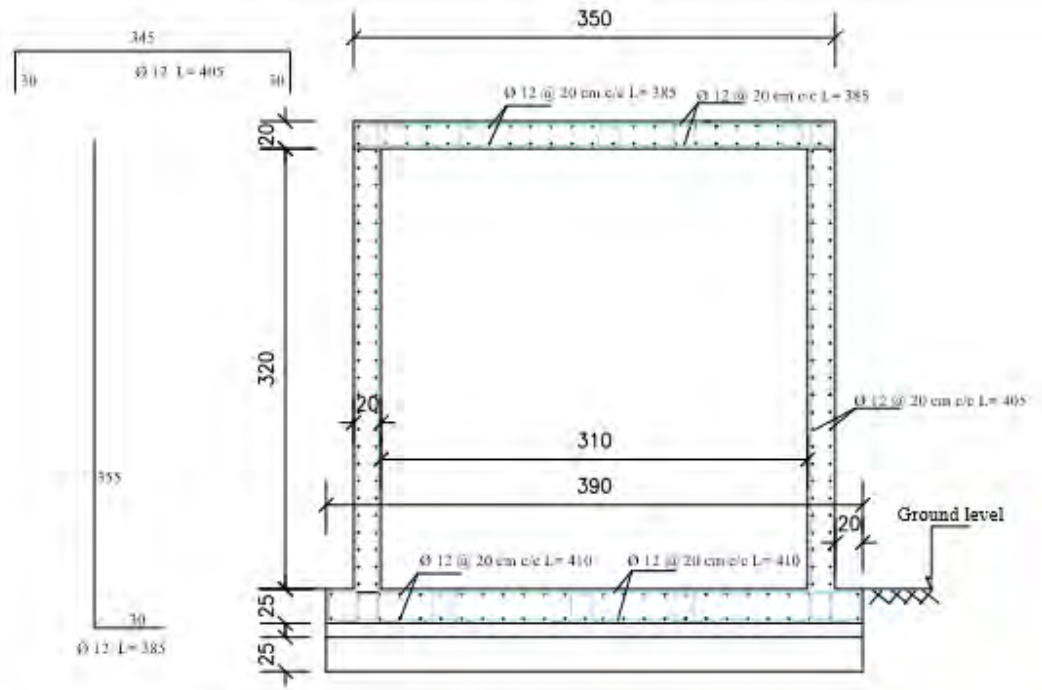
TOP SLAB PLAN-REINFORCEMENT DETAILS

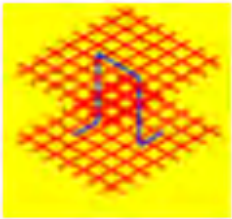
LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE	UNIT	SHEET NO
	WET WELL RESERVOIR	LOWLAND WASH ENGINEERS	AUGUST 2017	CM	3/7



BOTTOM SLAB PLAN-REINFORCEMENT DETAILS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	WET WELL RESERVOIR	LOWLAND WASH ENGINEERS	AUGUST 2017	CM	4/7





REINFORCEMENT DETAILS

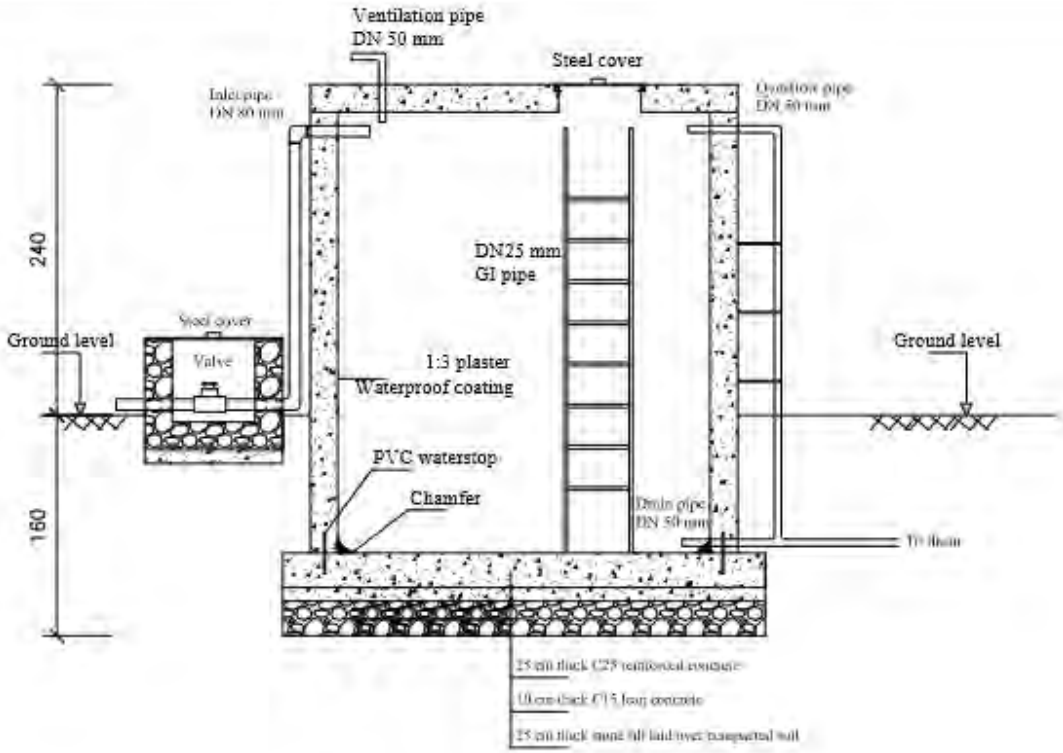
15

15

15

Ø 12 L=45

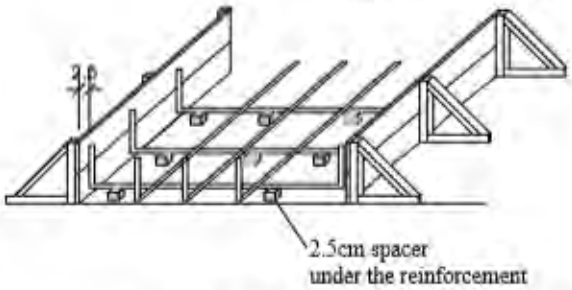
LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY:	DATE	UNIT	SHEET NO
	WET WELL RESERVOIR	LOWLAND WASH ENGINEERS	AUGUST 2017	CM	5/7



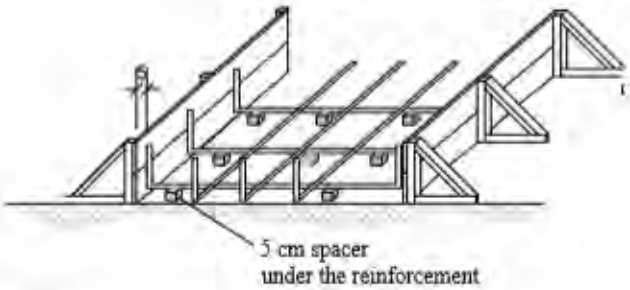
SECTION & PIPE DETAILS

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	WET WELL RESERVOIR	LOWLAND WASH ENGINEERS	AUGUST 2017	CM	8/7

SLAB Formwork and Bracing



FOUNDATION Formwork and Bracing



FORMWORK

The formwork shall be constructed so that there is no leak off lines or blemish of the concrete surface.

The internal surface of the formwork must be clean and free from concrete scrap and dirt.

The formwork should be levelled properly.

Wood formwork used to form the top edge of the slab shall be cut straight and level.

The formwork should be plumb and straight.

A string line shall be used to ensure the formwork is straight and provides uniform slope.

Before casting interior surfaces of the formwork should be moistened with water.

While placing reinforcement, there should be 2.5 cm clear concrete between the rebars and formwork interior surface.

The roof slab that the concrete is being placed on must be damp, free and dust free.

The formwork should be supported with braces properly and fixed with nails or needed.

The formwork shall not be removed before the structure has gained enough strength to bear 1 day later and safely carry all the possible loads.

The joints between the panels of the formwork should be adequately tight.

CONCRETE

Coarse sand shall be clean and free from dirt and clay

Coarse aggregate size shall be max dia 2 cm

Coarse aggregate shall be mixture of 0-1 and 0-2 size

Mixing water shall be clean

Concrete shall be mixed on steel plate or on clean surface

Concrete shall be placed within 30 min after mixing completed.

Vibrator or steel bars shall be used to compart concrete during placing

Concrete surface shall be levelled using trowel

Concrete surface shall be covered with burlap (cloth) and the surface shall be kept wet for proper curing of concrete for 2 days

1 m3 C20 concrete batching amounts	Standard Mixes for Ordinary Structural Concrete per 50 kg bag of cement
Ratio 1:2:4	1 bag cement (50 kg cement)
6 bags cement (300 kg cement)	275 kg crushed stone (max dia 2 cm) and coarse sand
0.25 m3 coarse sand	0.155 m3 concrete
0.50 m3 crushed stone (aggregate Dia 2cm)	Max 30 lt water (W/C ratio 0.60)
Max 180 lt water (W/C ratio 0.60)	

1 m3 C20 concrete batching amounts using buckets (bucket volume is 0.03 m3 - 50x30x20cm)

6 bags cement (300 kg cement)

5 buckets coarse sand

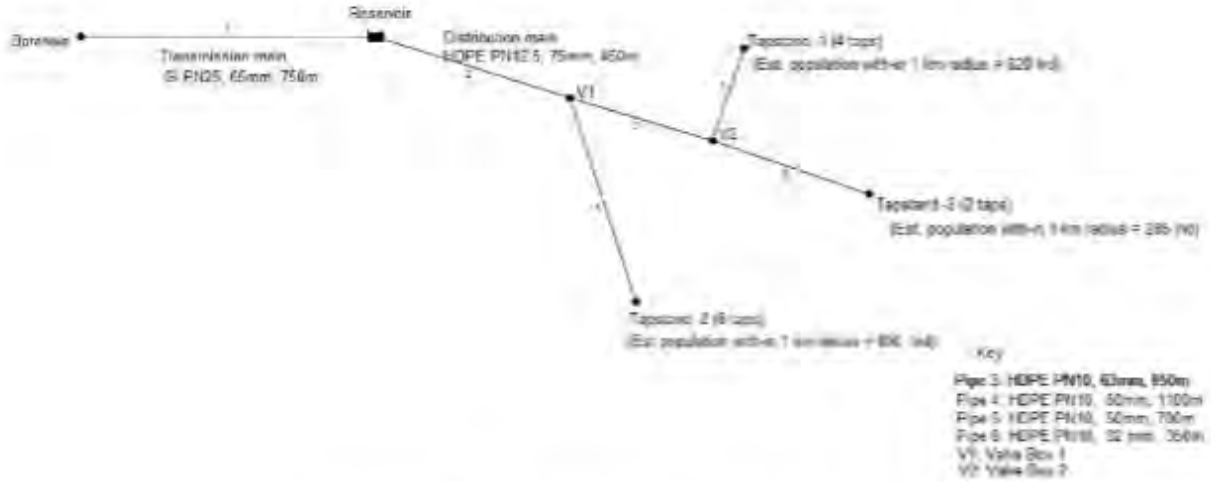
10 buckets crushed stone (max Dia 2cm)

Max 180 lt water (W/C ratio 0.60)

Coarse sand and crushed stone density: 2200 kg/m3

LOWLAND WASH	PROJECT TITLE	DESIGNED AND CHECKED BY	DATE	UNIT	SHEET NO
	WET WELL RESERVOIR	LOWLAND WASH ENGINEERS	AUGUST 2017	CM	7/7

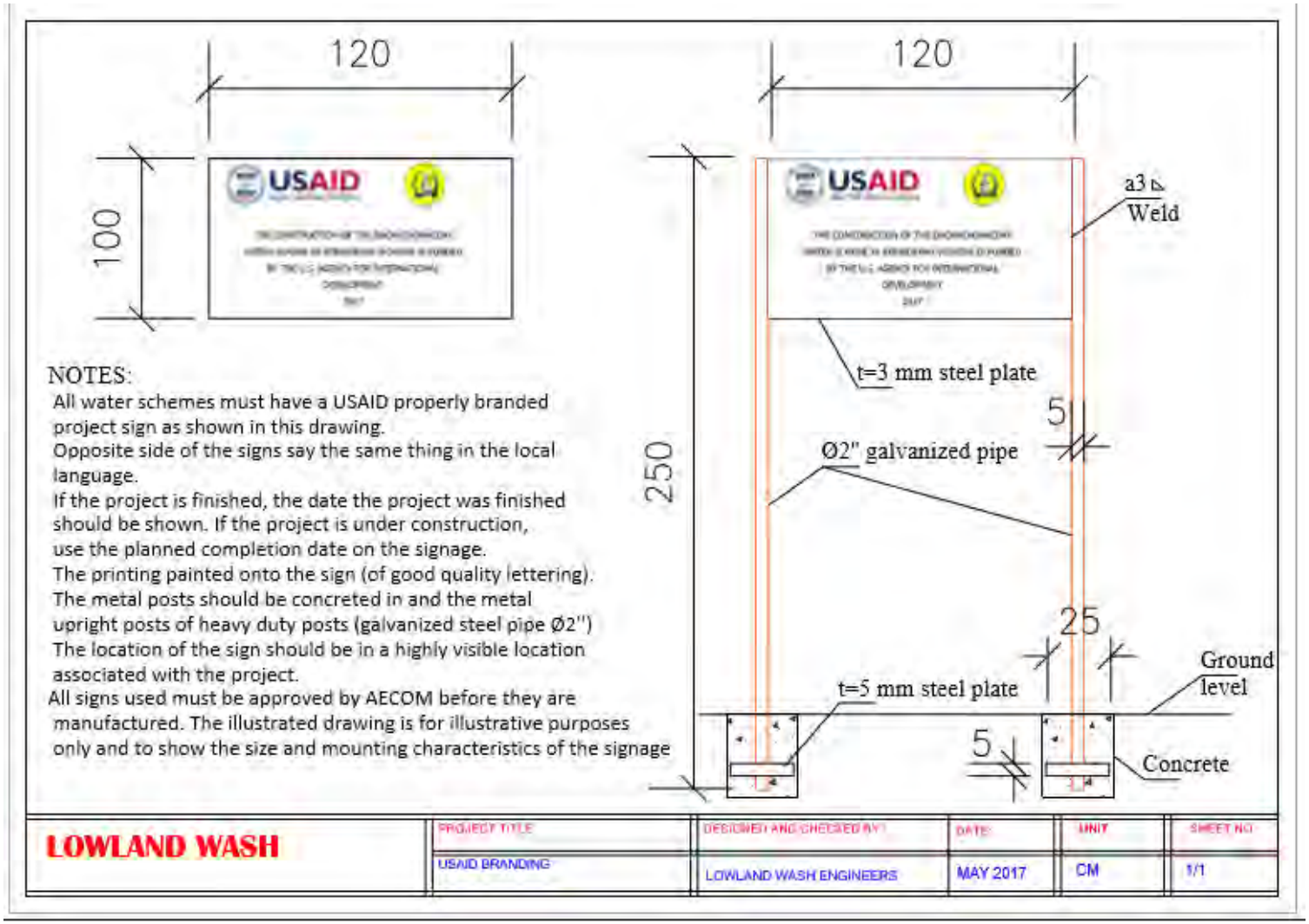
SCHEMATIC LAYOUT OF SIMPLE WATER SUPPLY SYSTEM



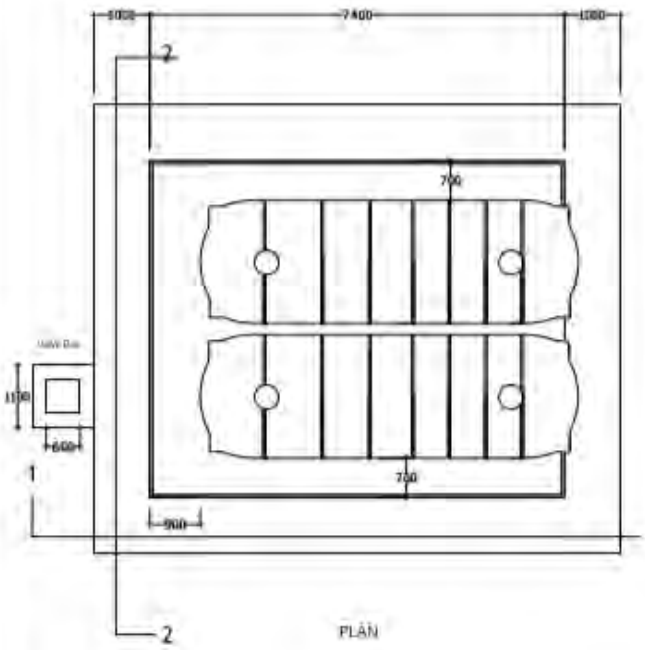
SCHEMATIC LAYOUT OF SIMPLE WATER SUPPLY SYSTEM

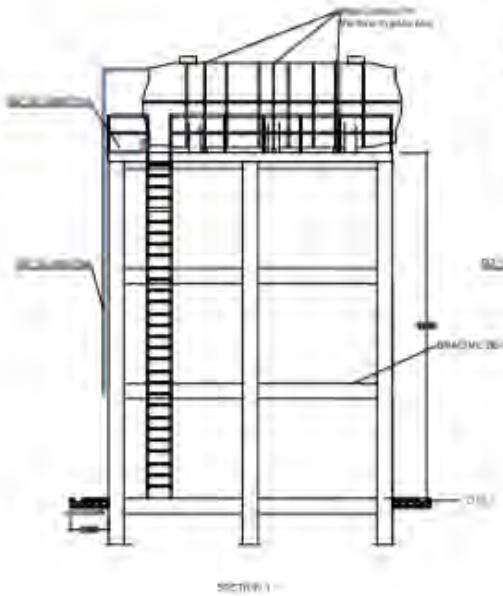
LOWLAND WASH	PROJECT TITLE:	DESIGNED AND CHECKED BY :	DATE:	UNIT	SHEET NO.
	SCHEMATIC LAYOUT OF SIMPLE WATER SUPPLY SYSTEM	LOWLAND WASH ENGINEERS	MAY 2017	CM	1/1

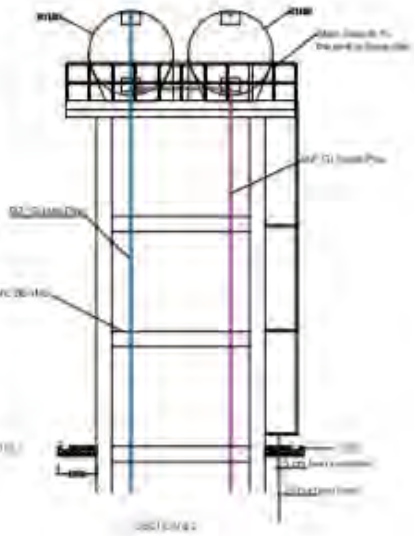
USAID BRANDING



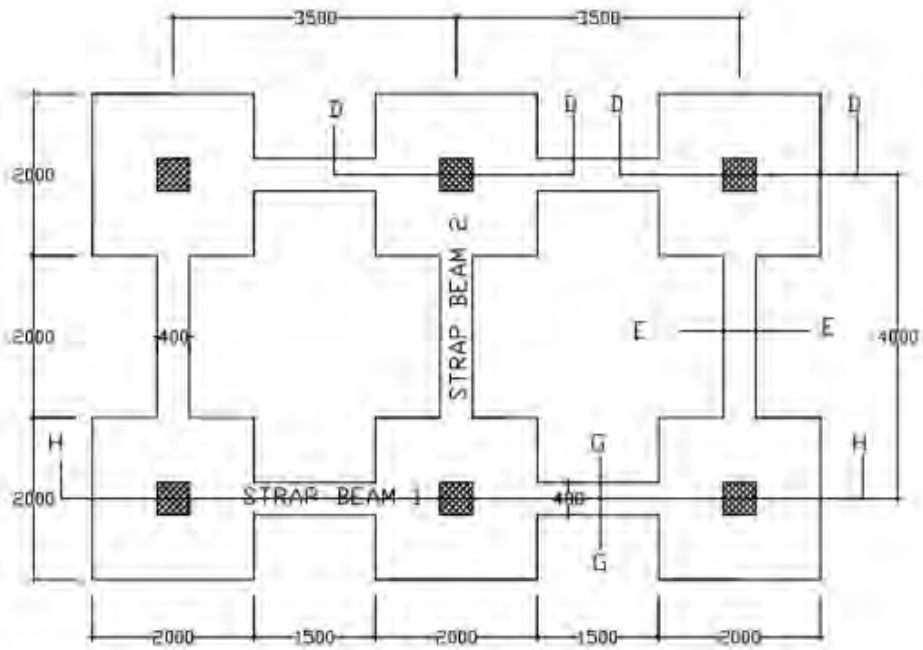
TYPICAL DRAWING 19A: RCC TOWER (9M) FOR PLACING 2X25M3 HORIZONTAL WATER TANK







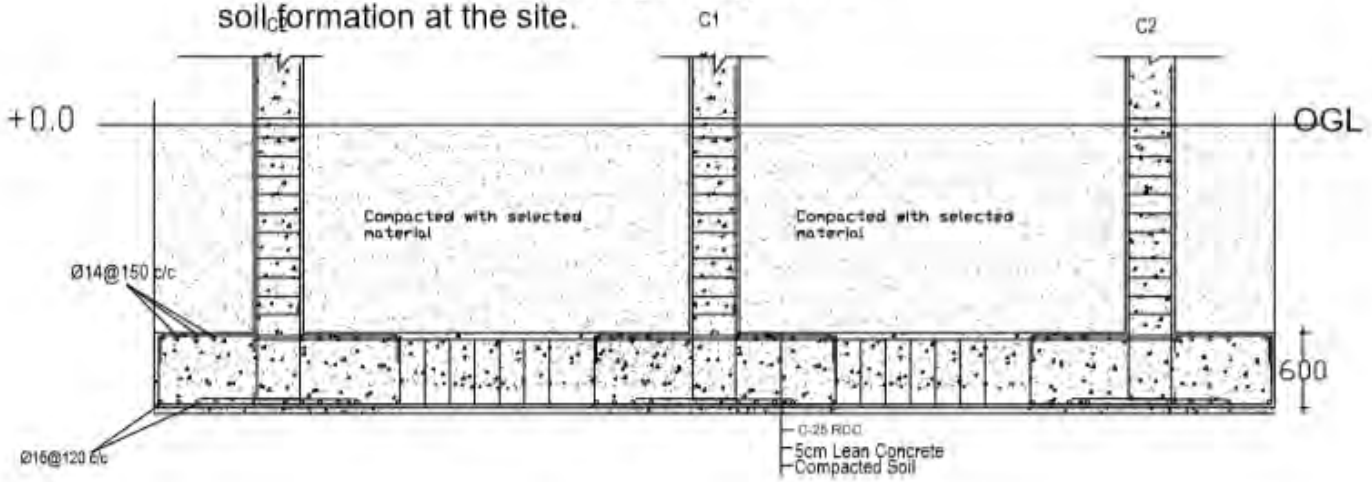
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (9m) for 2x25m3 Tank		1/8		mm



FOOTING & STRAP BEAM LAYOUT

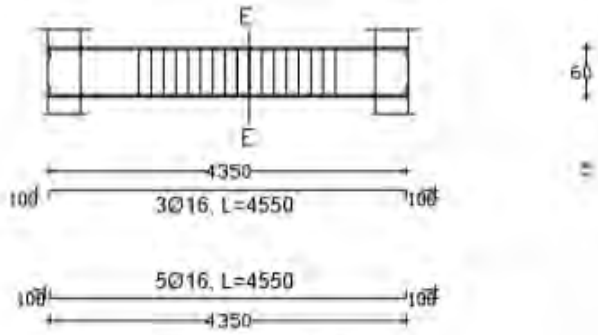
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (9m) for 2x25m3 Tank		2/8		mm

Note:
Depth of foundation is estimated as 2.5m but it can varies from 2m to 3m depending on the soil formation at the site.

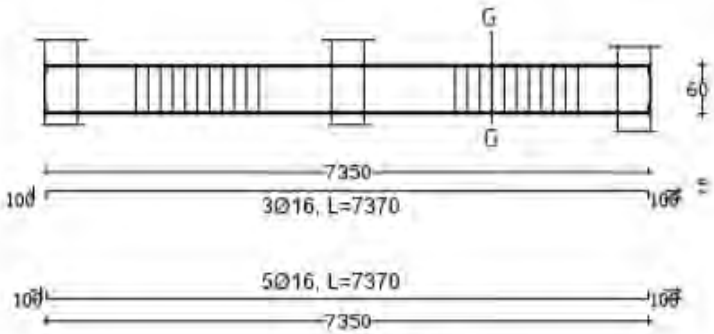


SECTION H-H

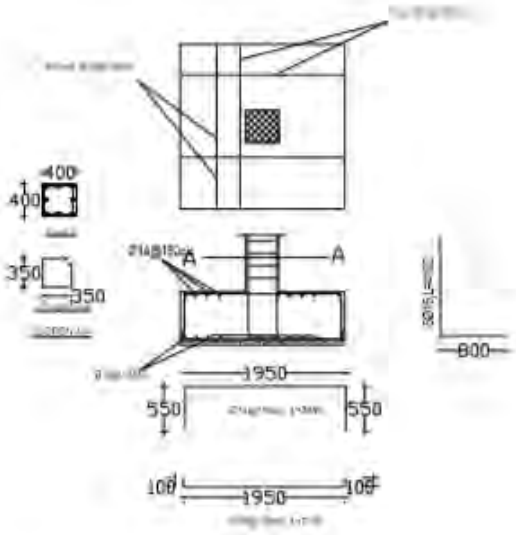
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (9m) for 2x25m3 Tank		3/8		



STRAP BEAM 2 (3)

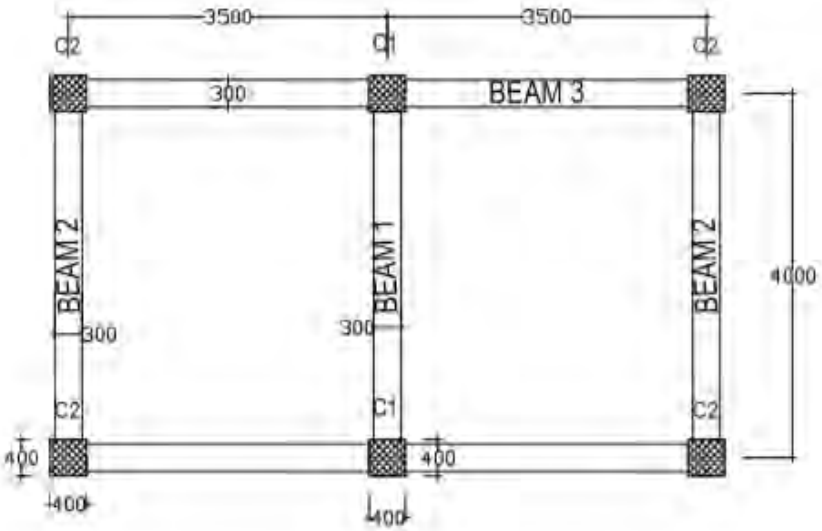


STRAP BEAM 1 (2)



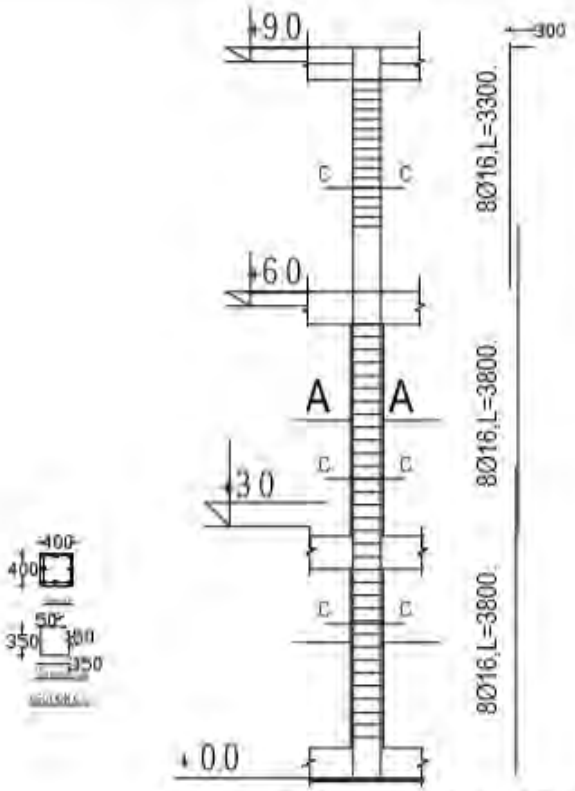
SECTION D-D

USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (9m) for 2x25m3 Tank		4/8		mm

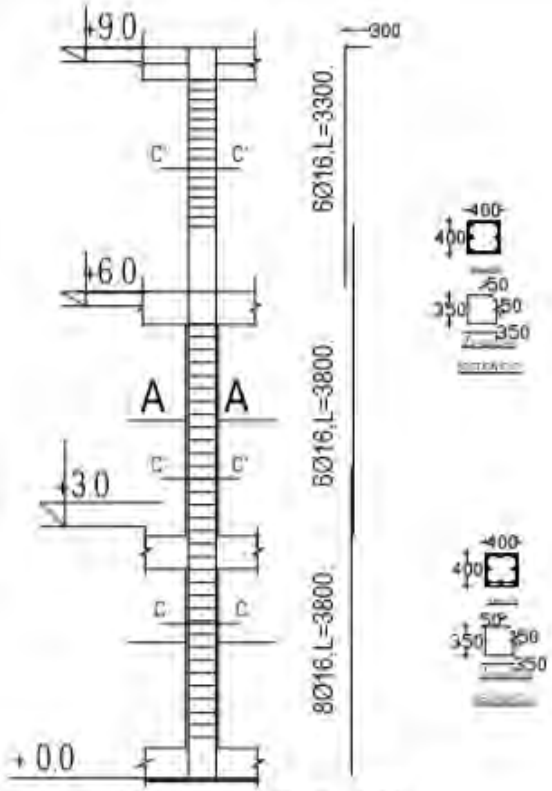


COLUMN & BEAM LAYOUT

USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (9m) for 2x25m3 Tank		5/8		mm

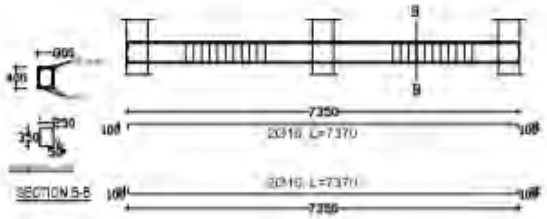


Column C-1 (2)

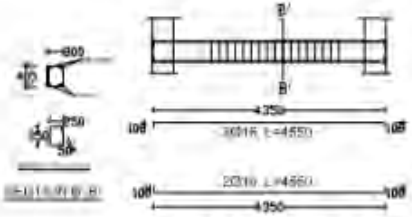


Column C-2 (4)

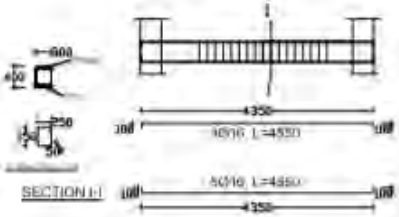
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (9m) for 2x25m3 Tank		6/8		mm



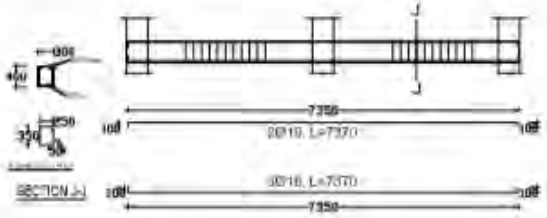
BRACING BEAM (Long side (B))



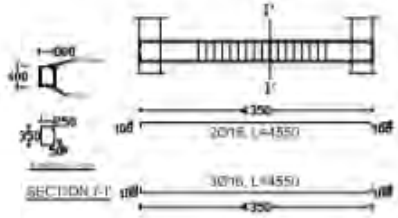
BRACING BEAM (Short side (E))



BEAM 1

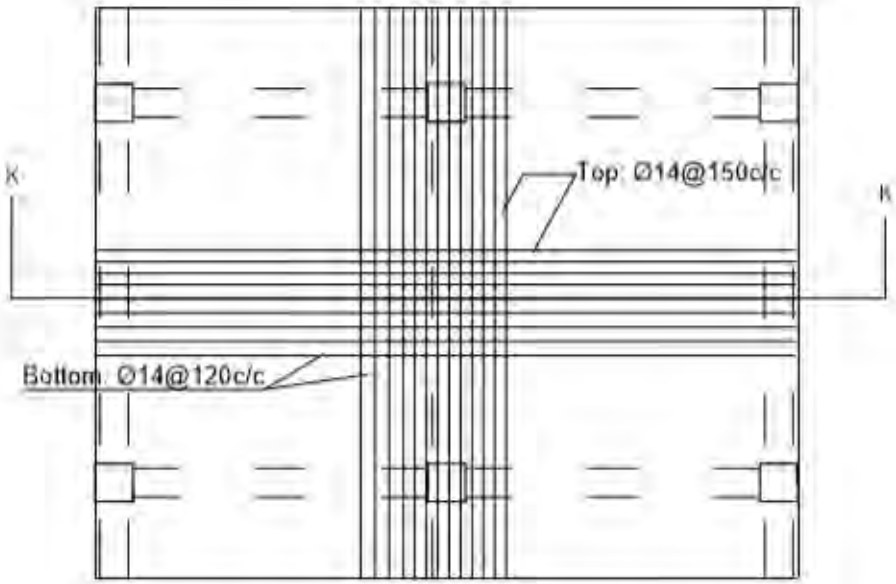


BEAM 3



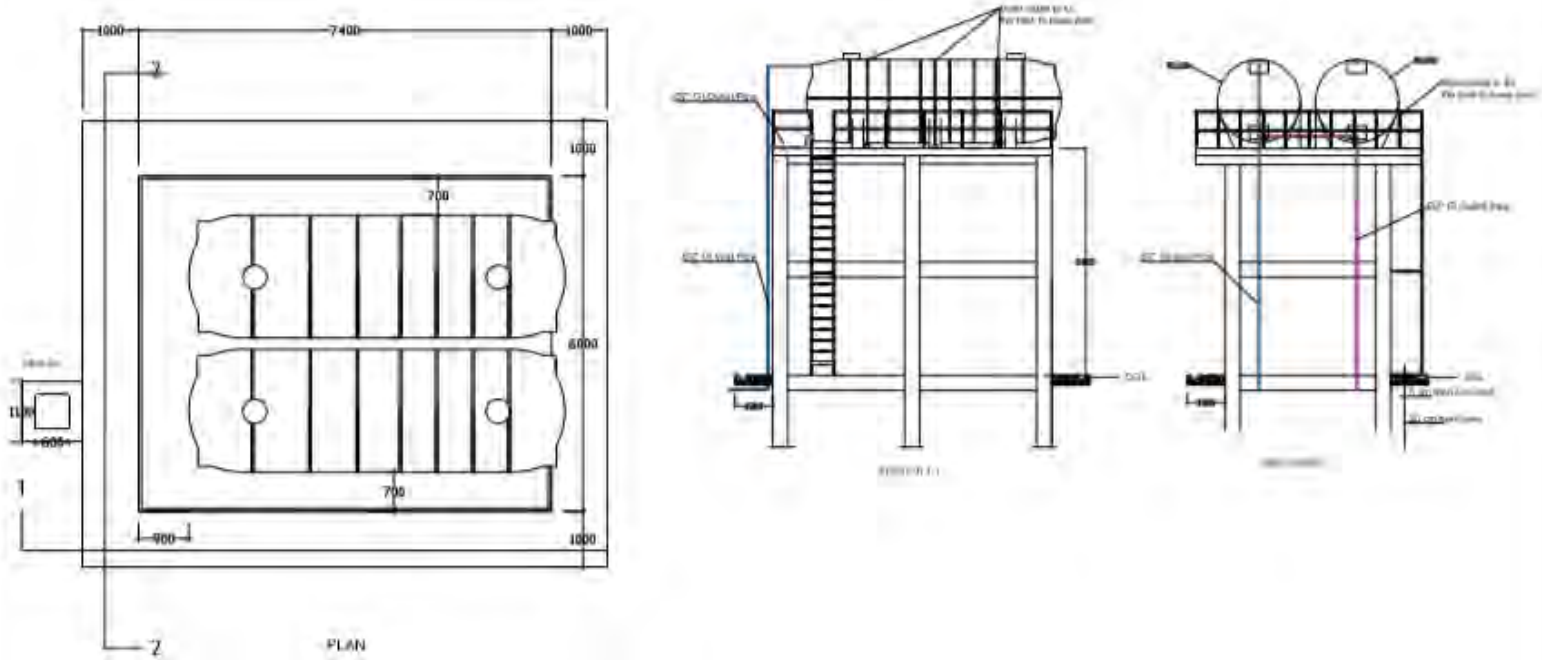
BEAM 2

USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (9m) for 2x25m3 Tank		7/8		mm

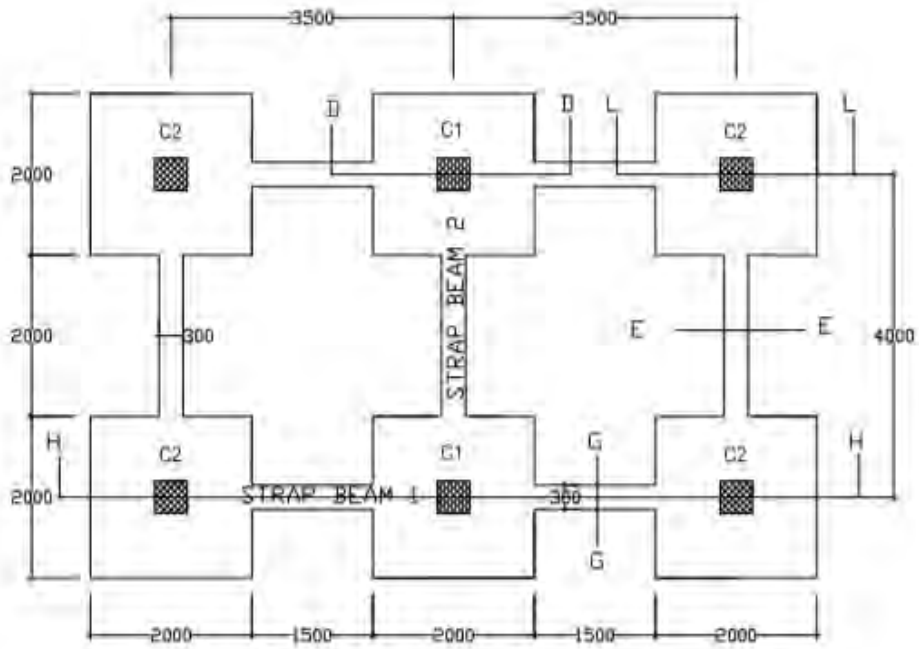


USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (9m) for 2x25m3 Tank		8/8		mm

TYPICAL DRAWING 19B: RCC TOWER (6M) FOR PLACING 2X25M3 HORIZONTAL WATER TANK



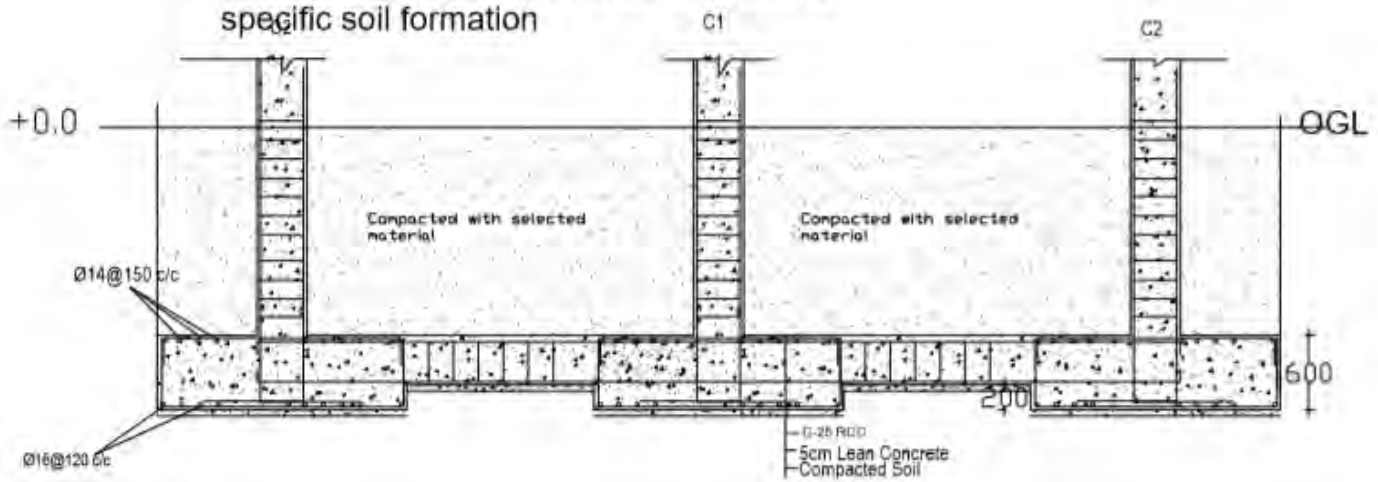
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 2x25m3 Tank		1/8		mm



FOOTING & STRAP BEAM LAYOUT

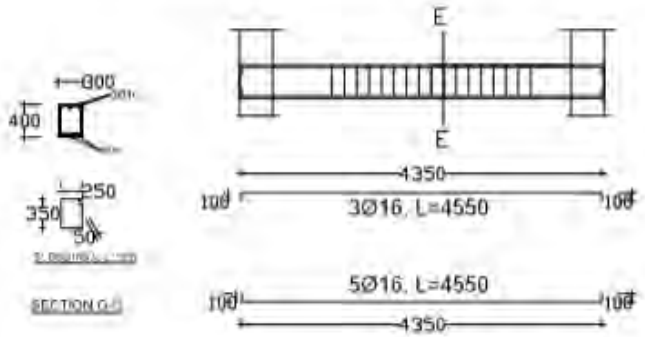
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 2x25m3 Tank		2/8		mm

Note:
Depth of foundation is estimated as 2m, but it can increase upto 2.5m depending on site specific soil formation

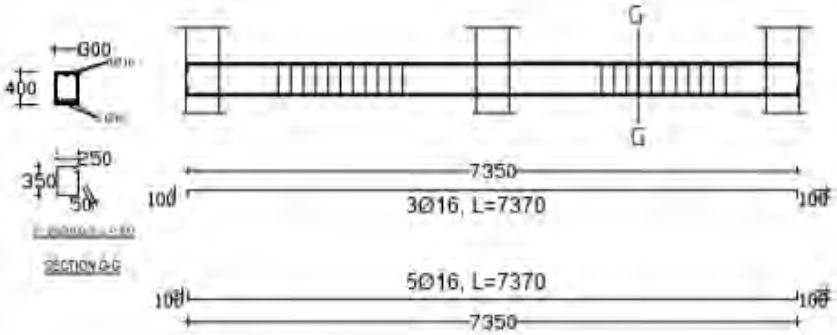


SECTION H-H

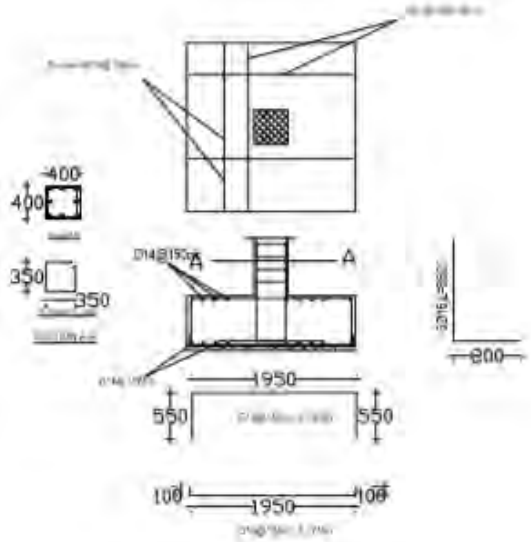
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 2x25m3 Tank		3/8		



STRAP BEAM 2

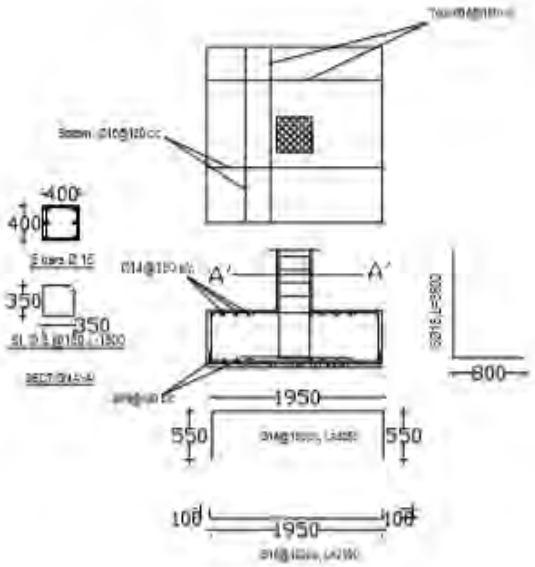


STRAP BEAM 1

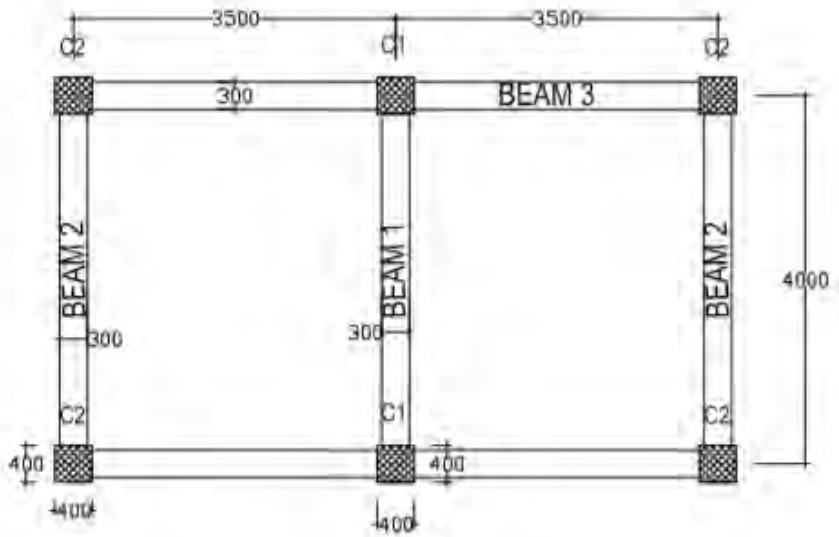


SECTION D-D

USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 2x25m3 Tank		4/8		mm

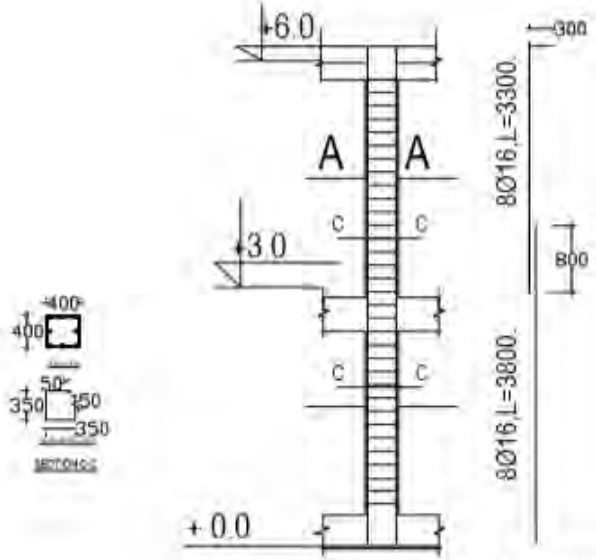


SECTION L-L

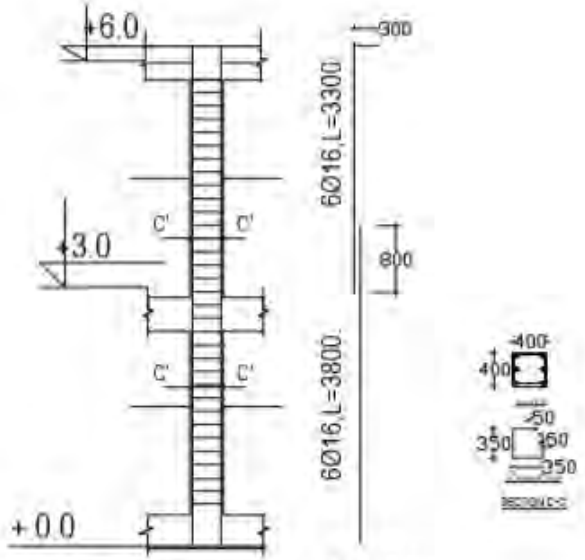


COLUMN & BEAM LAYOUT

USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 2x25m3 Tank		5/8		mm

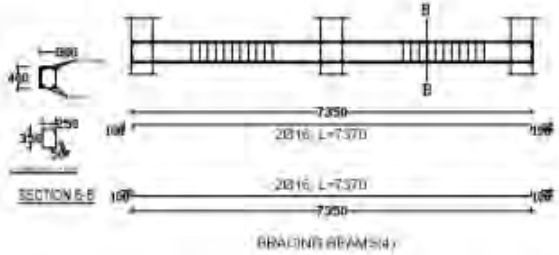


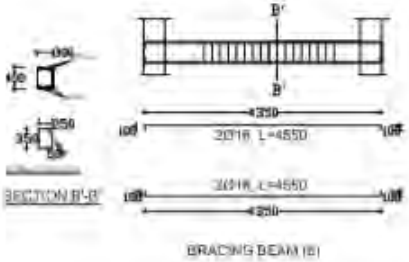
Column C-1 (2)

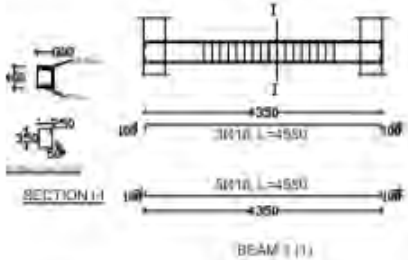


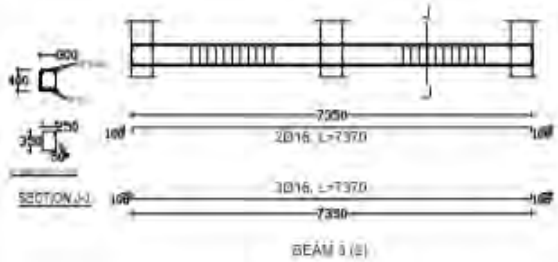
Column C-2 (4)

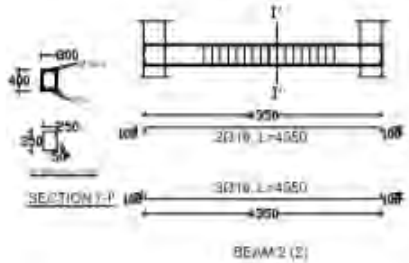
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 2x25m3 Tank		6/8		mm



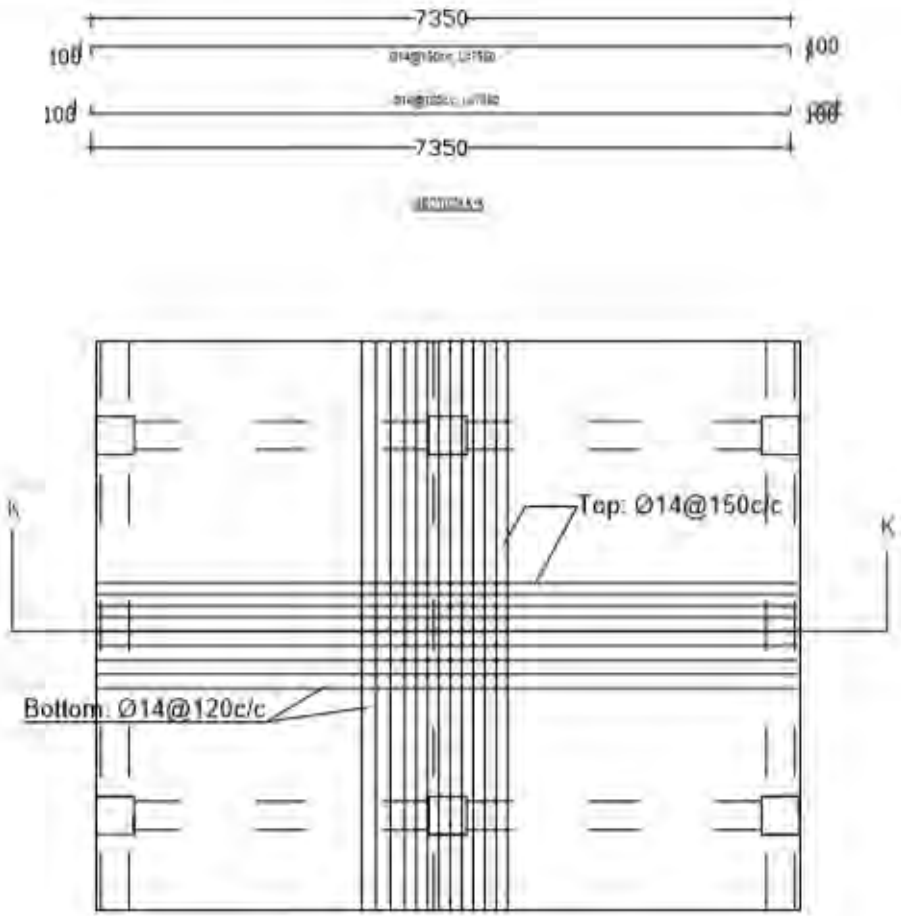






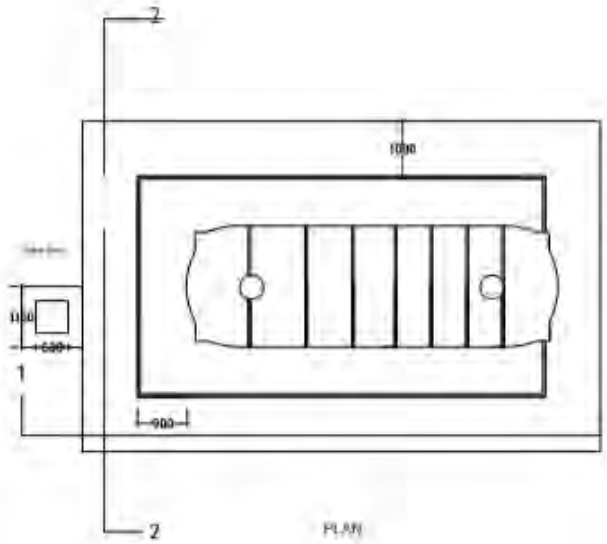


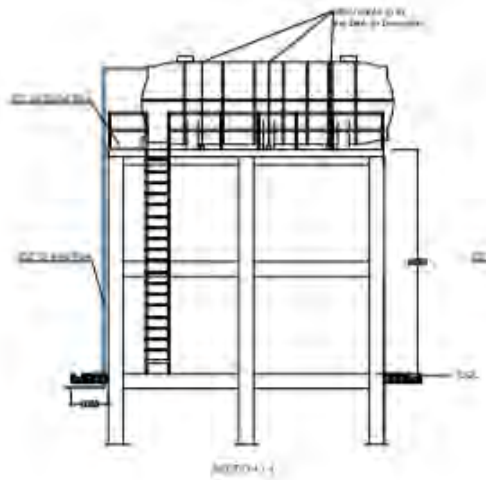
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 2x25m3 Tank		7/8		mm

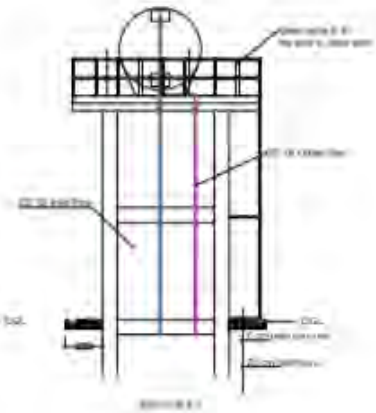


USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 2x25m3 Tank		8/8		mm

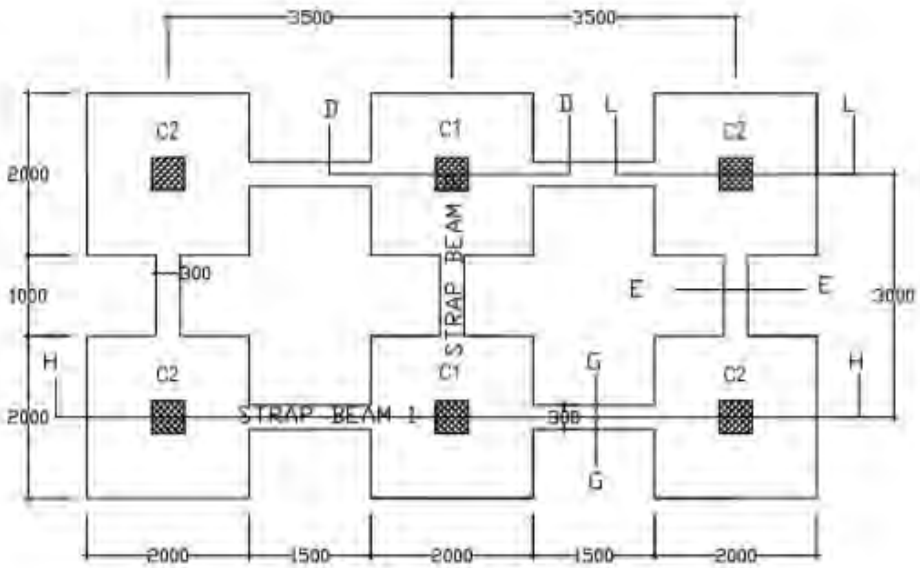
TYPICAL DRAWING 19C: RCC TOWER (6M) FOR PLACING 1X25M3 HORIZONTAL WATER TANK







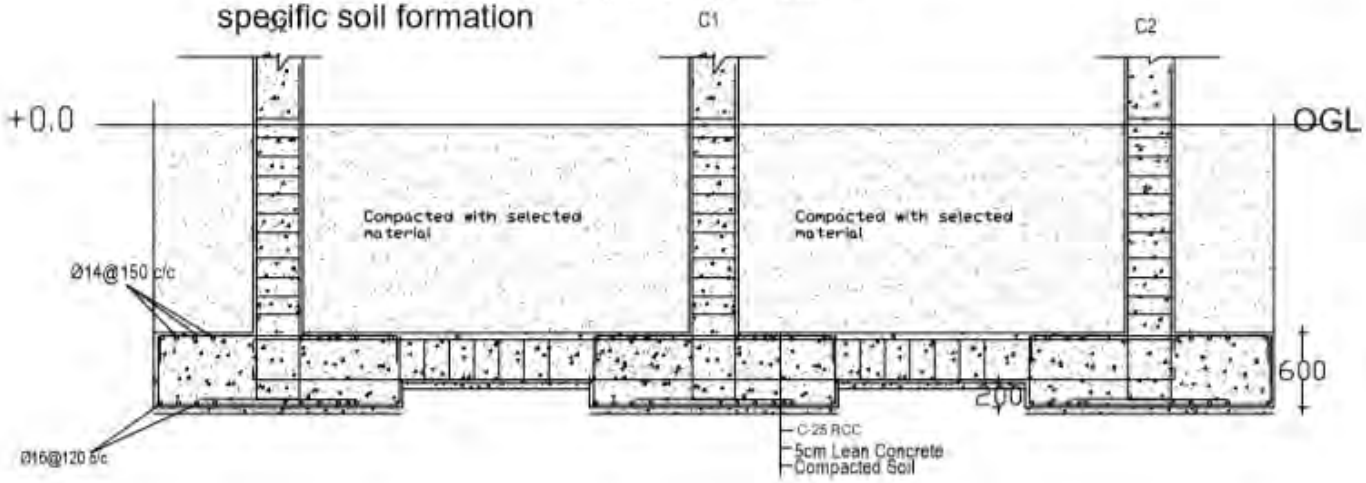
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 1x25m3 Tank		1/8		mm



FOOTING & STRAP BEAM LAYOUT

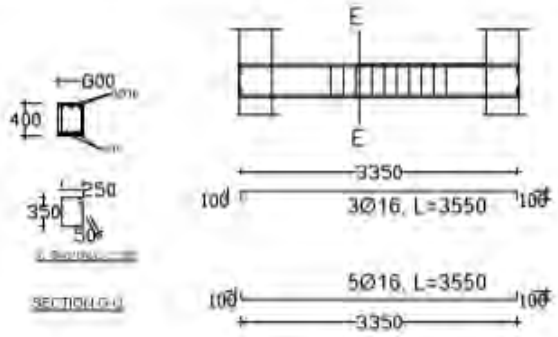
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 1x25m3 Tank		2/8		mm

Note:
Depth of foundation is estimated as 1.5m, but it can increase upto 2m depending on site specific soil formation

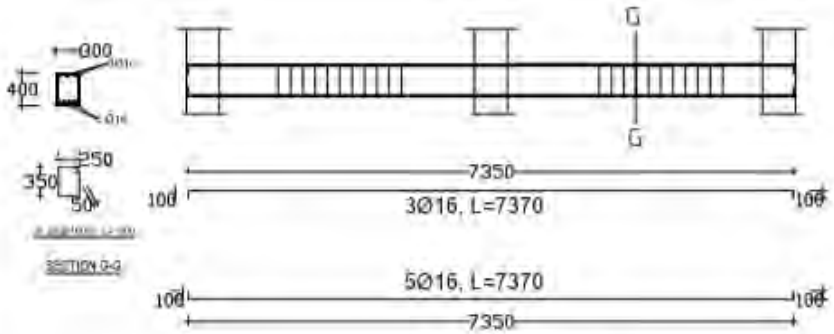


SECTION H-H

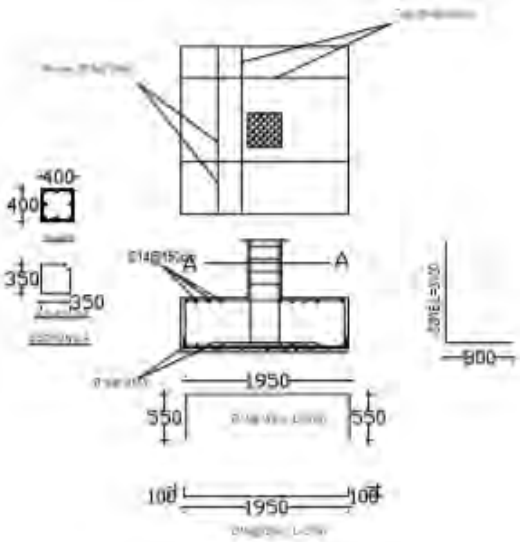
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 1x25m3 Tank		3/8		



STRAP BEAM 2 (3)

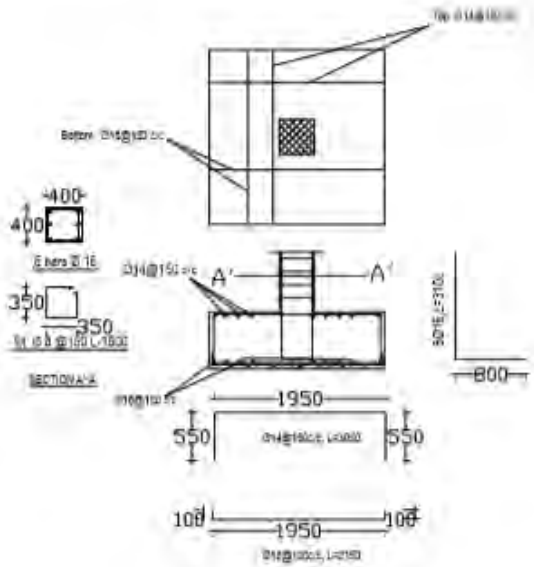


STRAP BEAM 1 (2)

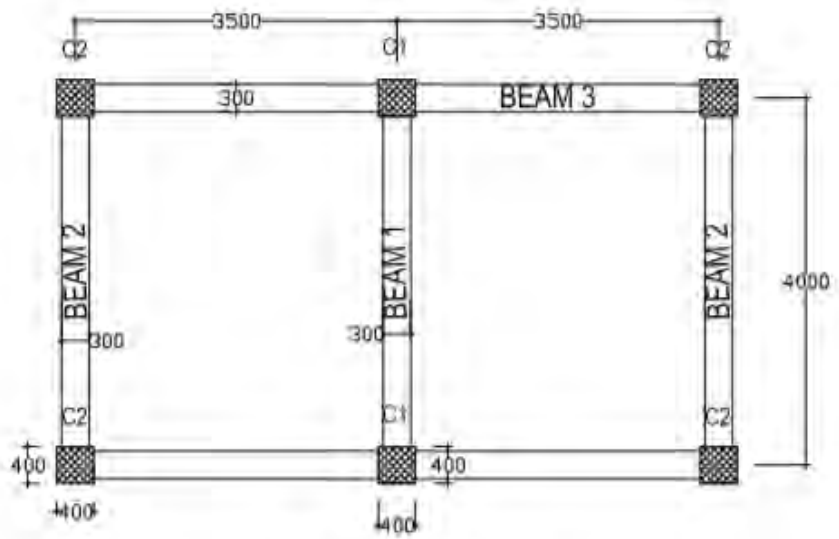


SECTION D-D

USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 1x25m3 Tank		4/8		mm

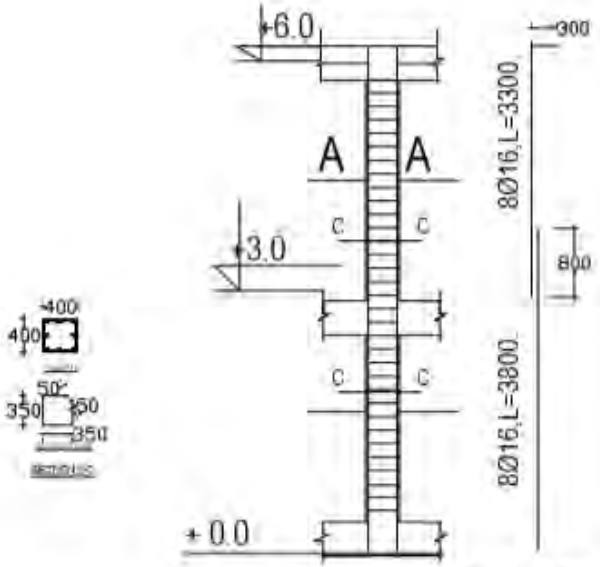


SECTION L-L

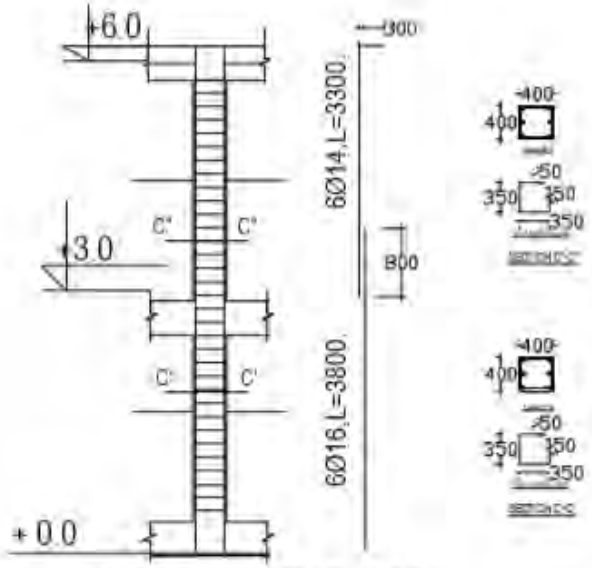


COLUMN & BEAM LAYOUT

USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 1x25m3 Tank		5/8		mm

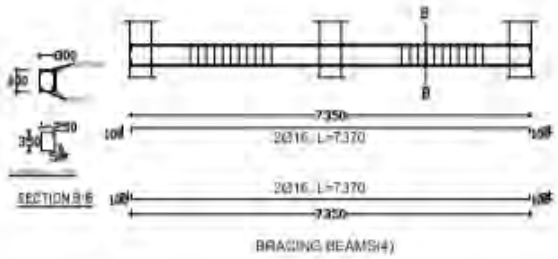


Column C-1 (2)

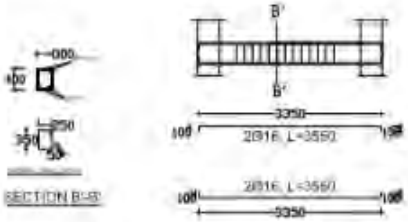


Column C-2 (4)

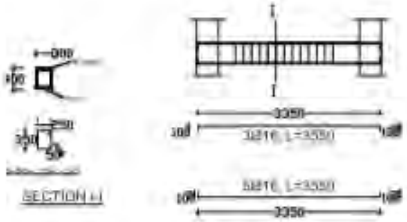
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 1x25m3 Tank		6/8		mm



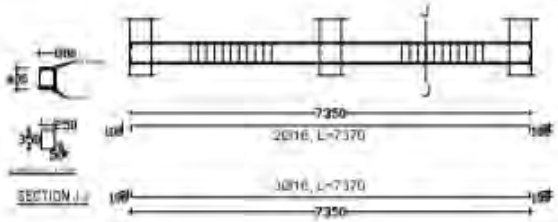
BRACING BEAMS(4)



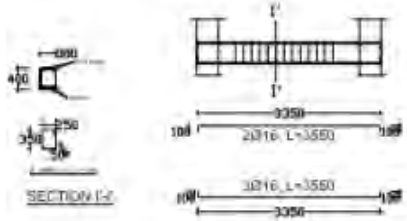
BRACING BEAM (6)



BEAM 1 (1)

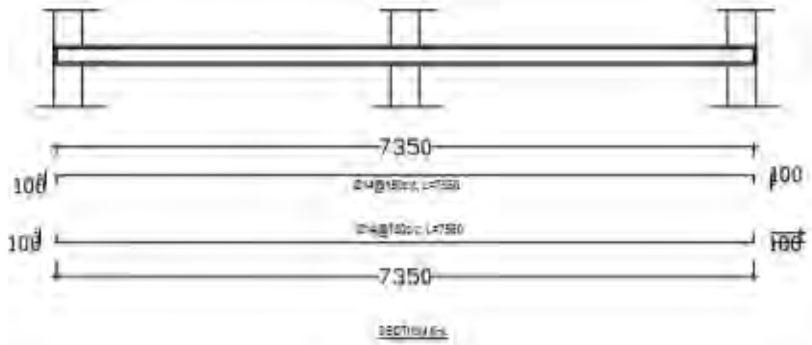


BEAM 3 (2)

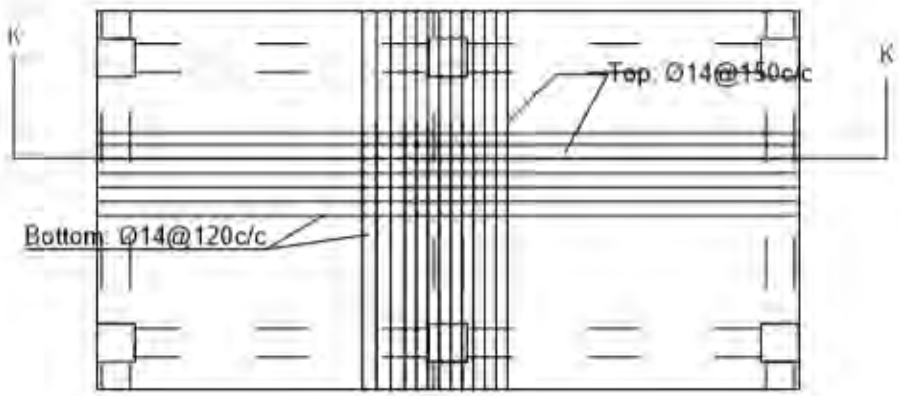


BEAM 2 (2)

USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 1x25m3 Tank		7/8		mm



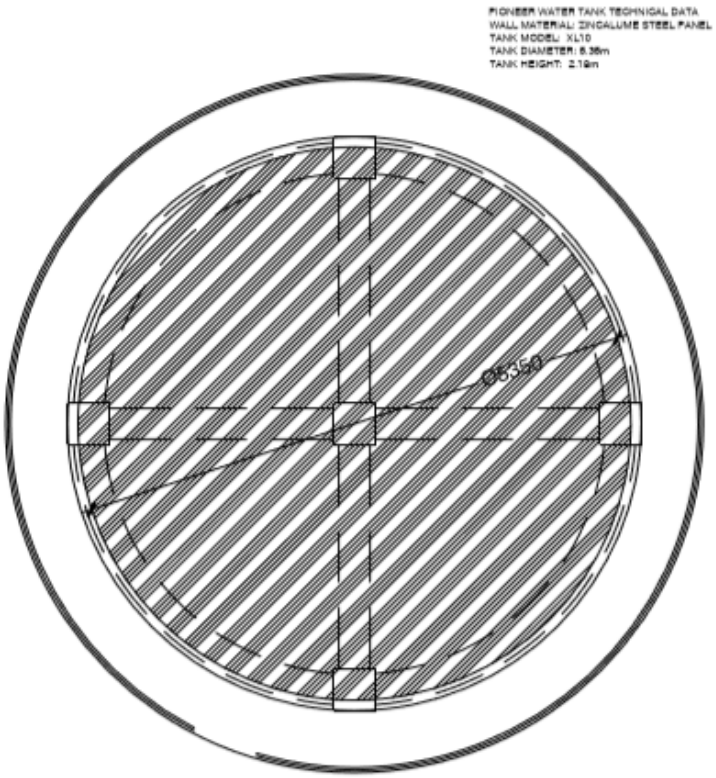
SECTION K-K



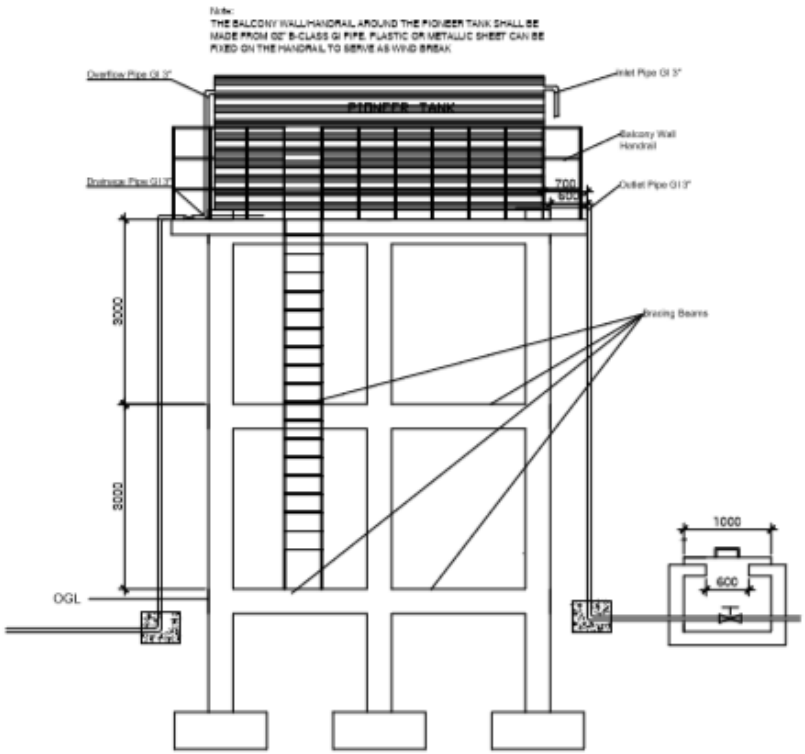
BASE SLAB

USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	RCC Tower (6m) for 1x25m3 Tank		8/8		mm

TYPICAL DRAWING 19D: RCC TOWER (6M) FOR PLACING PIONEER WATER TANK [MODEL XL10]

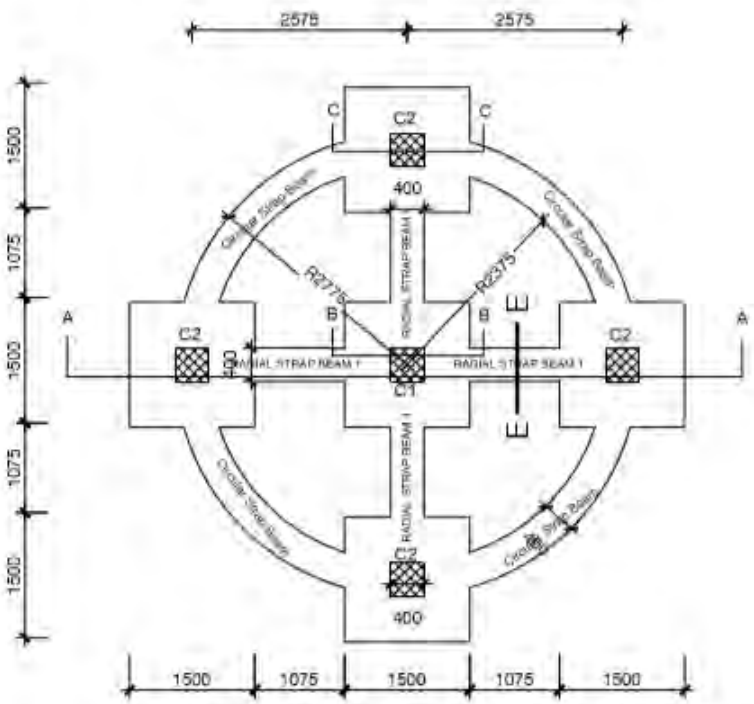


PLAN VIEW

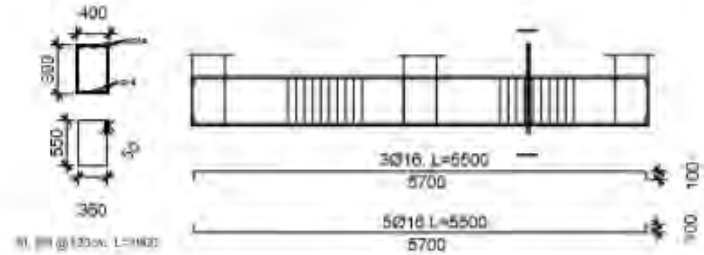


FRONT ELEVATION

USAID Lowland WASH	RCC TOWER (6M) FOR 50M^3 PIONEER TANK [MODEL XL10]			
	By:	Dwg. No 1/9	Unit: mm	Date: July2018



FOOTING & STRAP BEAM LAYOUT

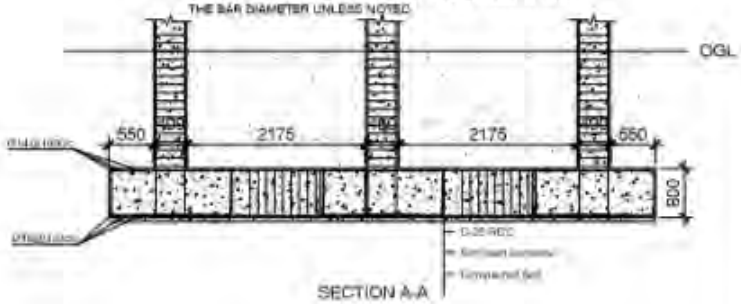


SECTION I-I

RADIAL STRAP BEAM 1 (2)

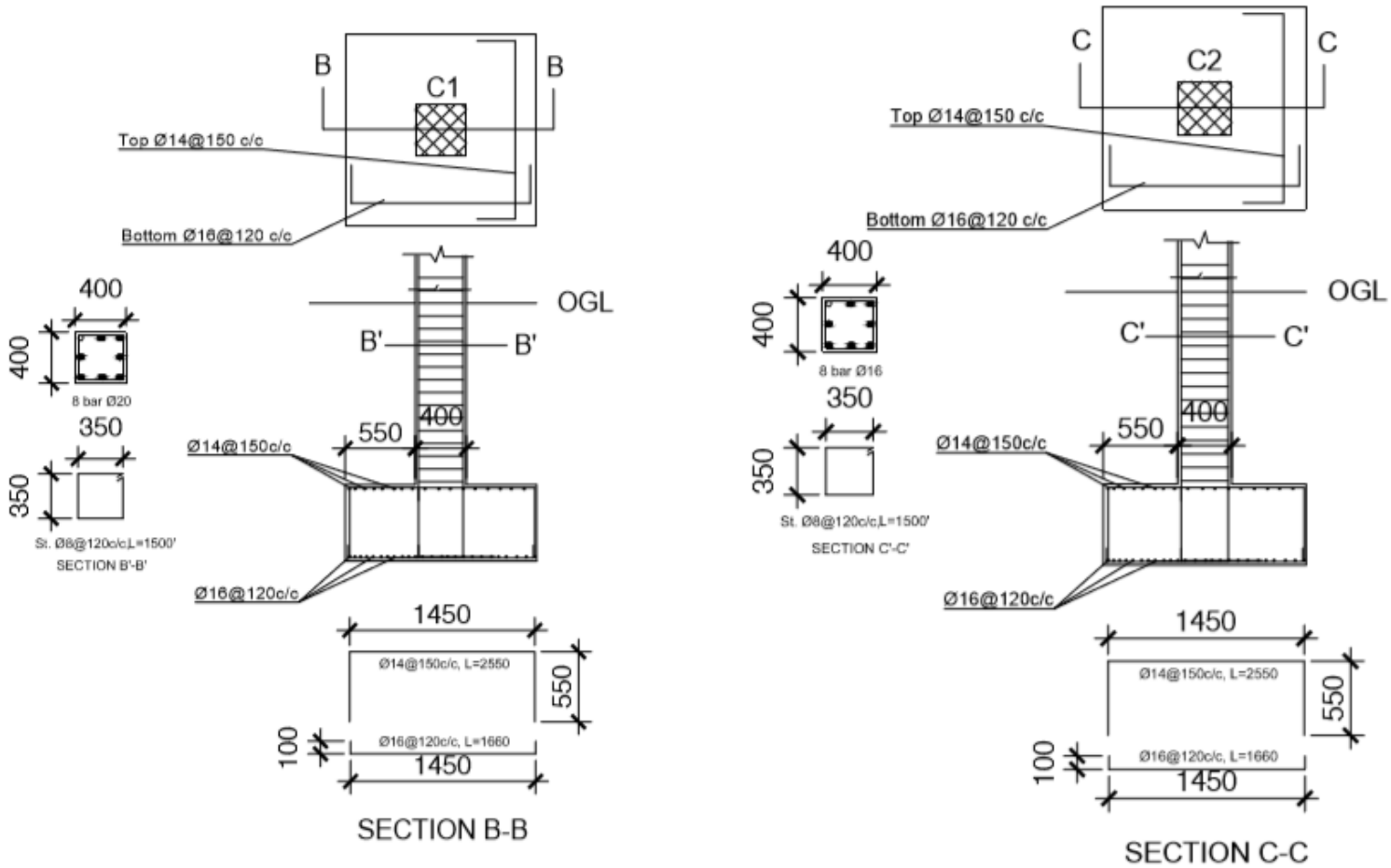
Note:

1. DEPTH OF FOUNDATION IS ESTIMATED AS 2.5M BUT IT CAN VARIES FROM 2M TO 3M DEPENDING ON THE SOIL FORMATION AT THE SITE.
2. CONCRETE SHALL BE C-25
3. REINFORCEMENTS OVERLAP LENGTH OR SPLICING LENGTH IN COLUMN, BEAM AND SLAB SHALL NOT BE LESS THAN 40 TIMES THE BAR DIAMETER UNLESS NOTED.

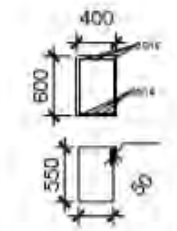


SECTION A-A

USAID Lowland WASH	RCC TOWER (6M) FOR 50M³ PIONEER TANK [MODEL XL10]			
	By:	Dwg. No 2/9	Unit: mm	Date:

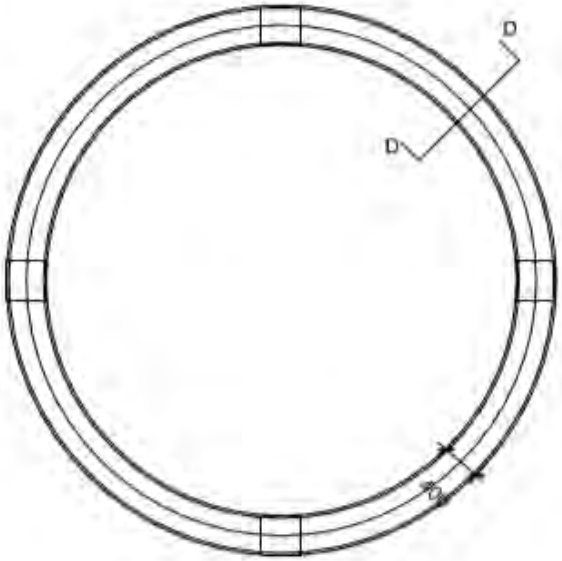


USAID Lowland WASH	RCC TOWER (6M) FOR 50M^3 PIONEER TANK [MODEL XL10]			
	By:	Dwg. No 3/9	Unit: mm	Date:

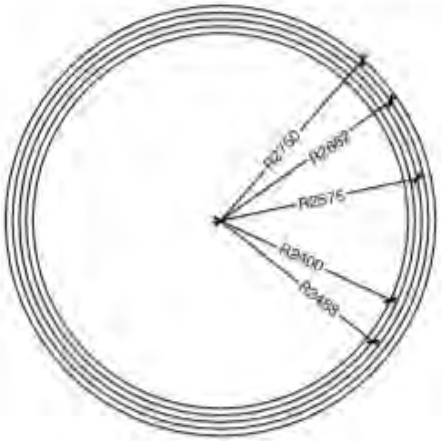


St. Ø8 @120c/c L=1900

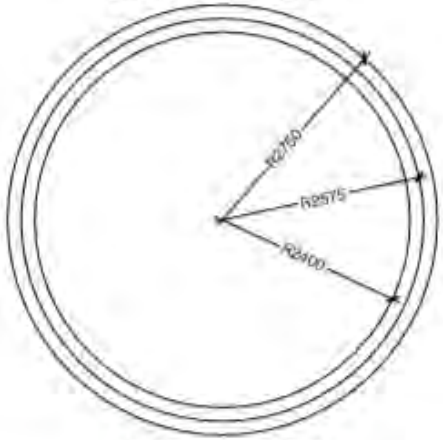
SECTION D-D



CIRCULAR STRAP BEAM 1 (1)

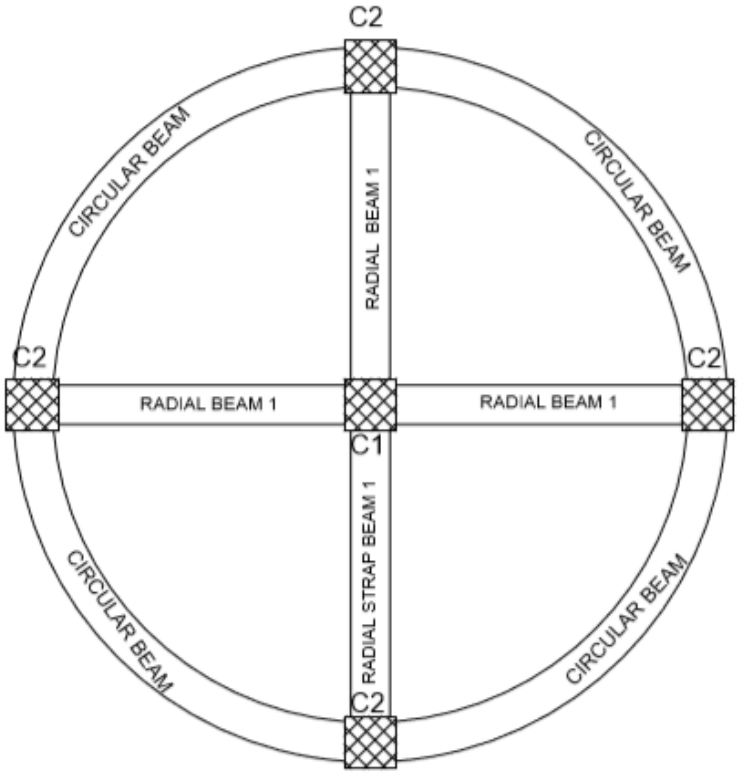


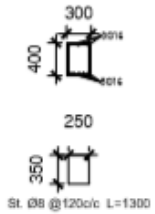
CIRCULAR STRAP BEAM
Bottom Reinforcement 5Ø16



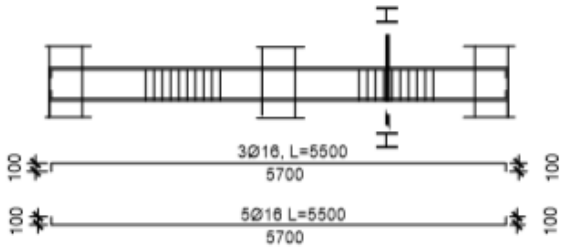
CIRCULAR STRAP BEAM
Top Reinforcement 3Ø16

USAID Lowland WASH	RCC TOWER (6M) FOR 50M^3 PIONEER TANK [MODEL XL10]			
	By:	Dwg. No 4/9	Unit: mm	Date:

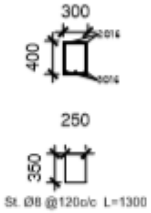




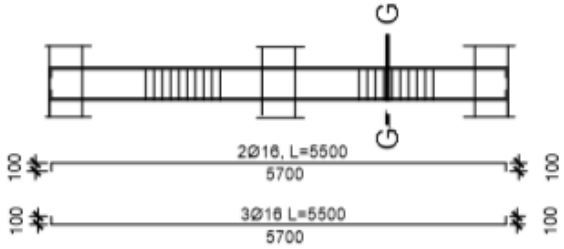
SECTION H-H



RADIAL TOP TIE BEAM 1 (2 in No)



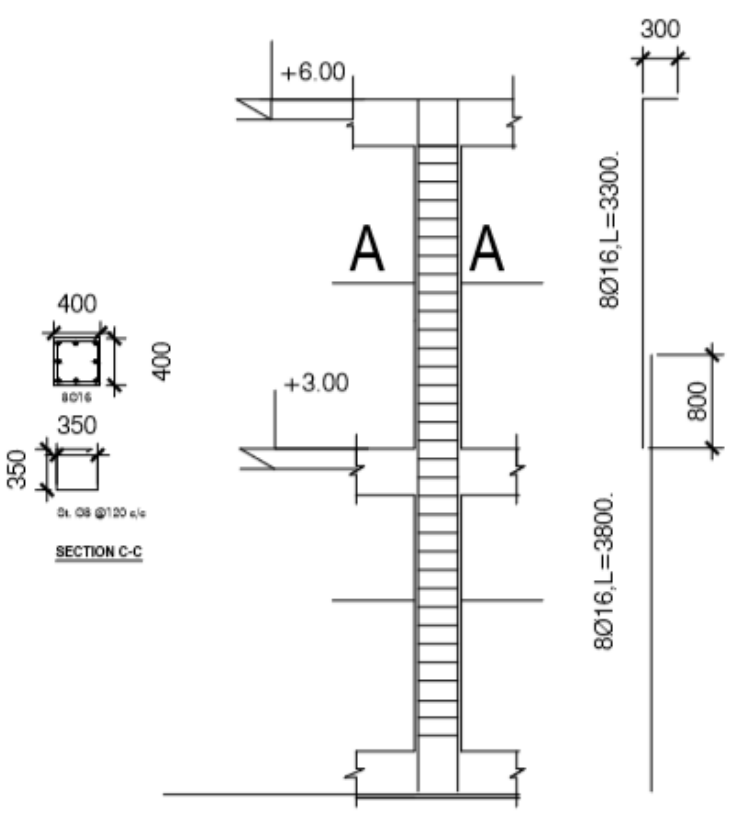
SECTION G-G



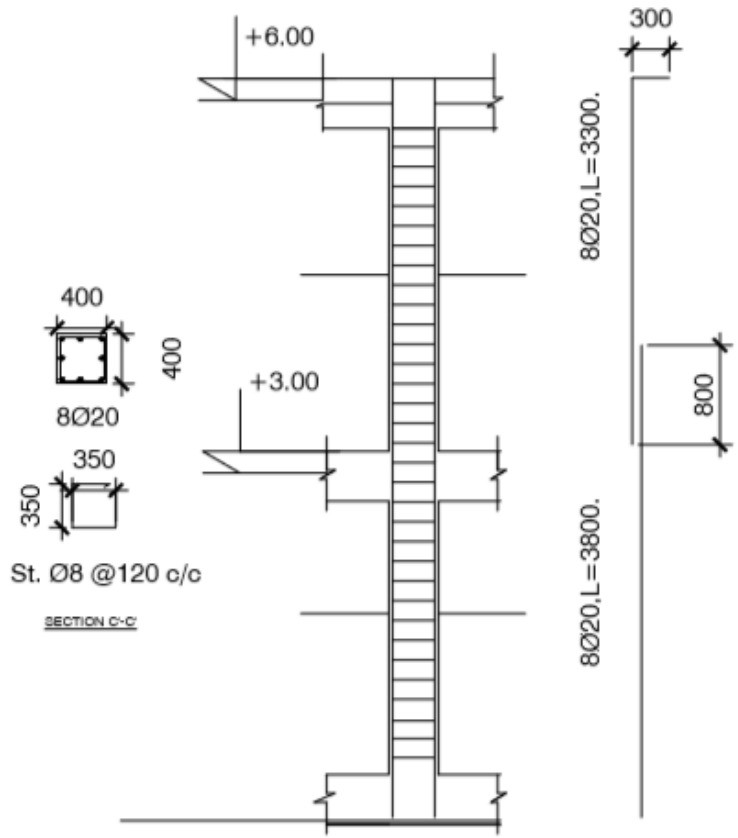
RADIAL BRACING BEAM 1 (4 in No)

COLUMN & BEAM LAYOUT

USAID Lowland WASH	RCC TOWER (6M) FOR 50M^3 PIONEER TANK [MODEL XL10]			
	By:	Dwg. No 5/9	Unit: mm	Date:

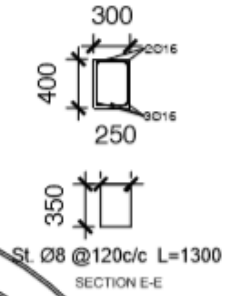


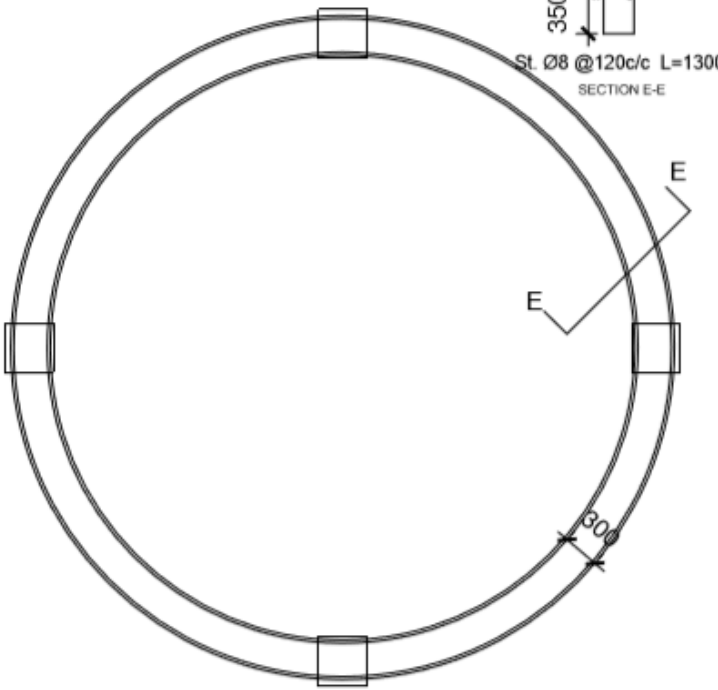
COLUMN C2 (4)



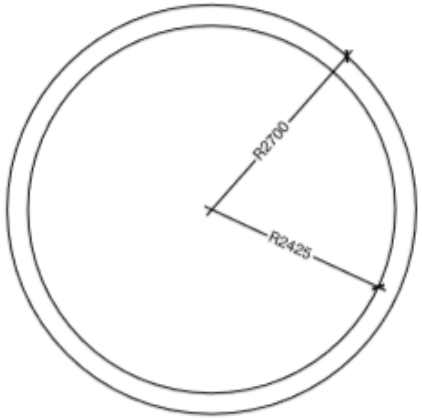
COLUMN C1 (1)

USAID Lowland WASH	RCC TOWER (6M) FOR 50M^3 PIONEER TANK [MODEL XL10]			
	By:	Dwg. No 6/9	Unit: mm	Date:

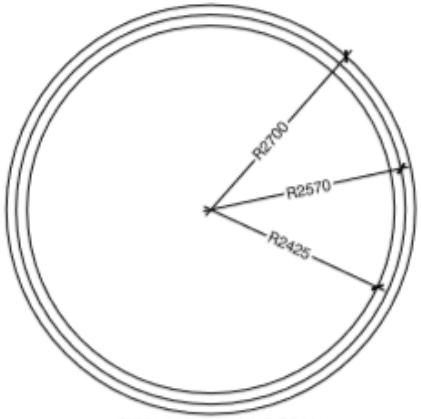




CIRCULAR BRACING BEAM (2 in No, at ground Level and middle)

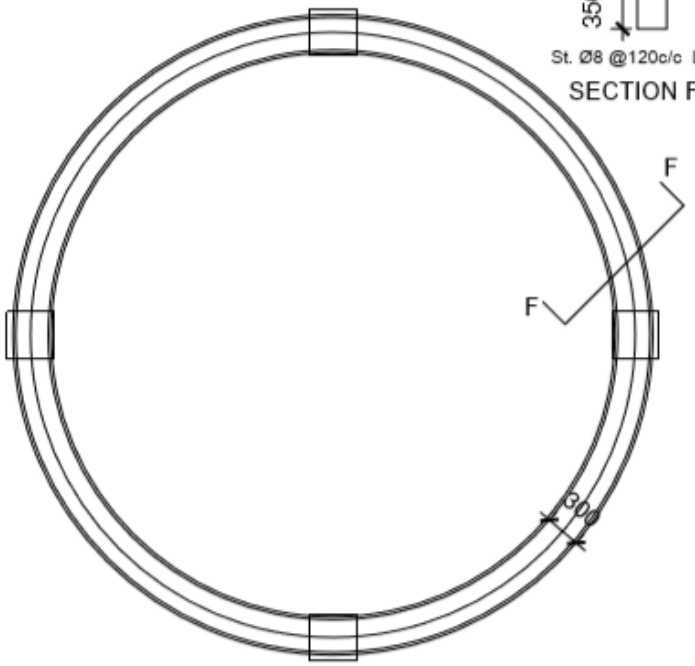


CIRCULAR BRACING BEAM
Top Reinforcement 2Ø16 (2)

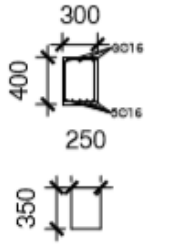


CIRCULAR BRACING BEAM
Bottom Reinforcement 3Ø16 (2)

USAID Lowland WASH	**RCC TOWER (6M) FOR 50M^3 PIONEER TANK [MODEL XL10]**				
	By:	**Dwg. No**	**7/9**	**Unit: mm**	**Date:**

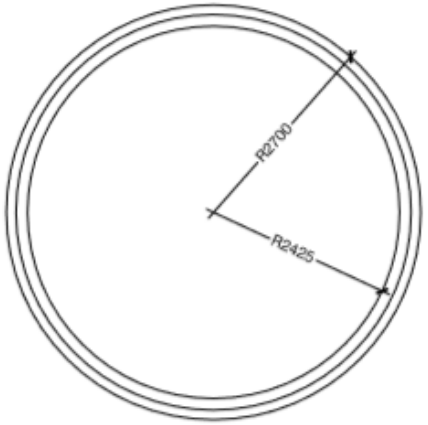


CIRCULAR TOP TIE BEAM (1 IN NO)

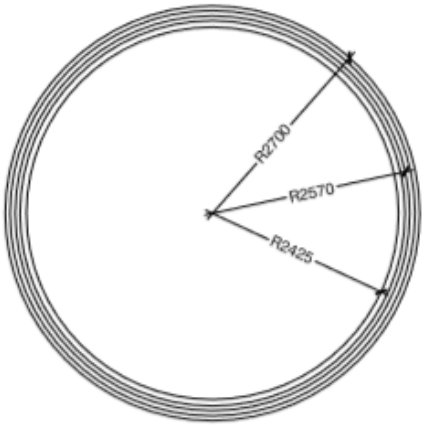


St. Ø8 @120c/c L=1300

SECTION F-F

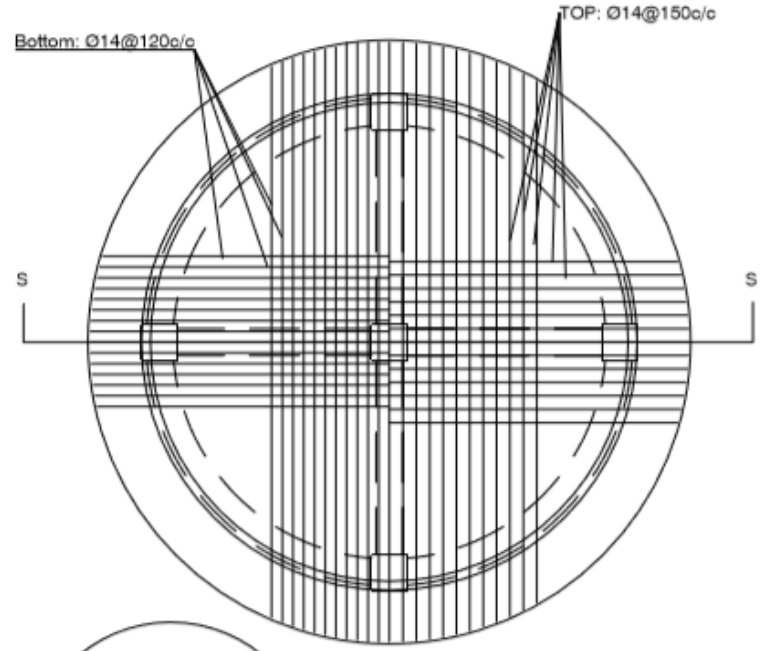


CIRCULAR TOP TIE BEAM
Top Reinforcement 2Ø16 (1)

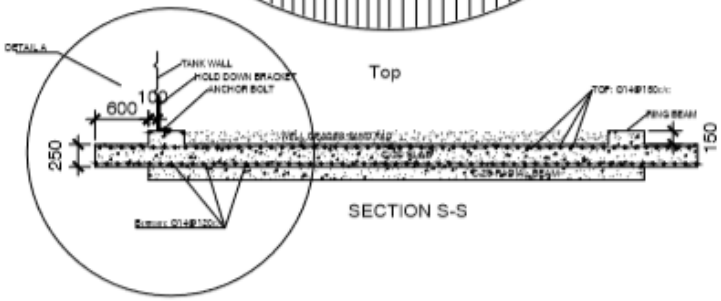


CIRCULAR TOP TIE BEAM
Bottom Reinforcement 3Ø16 (1)

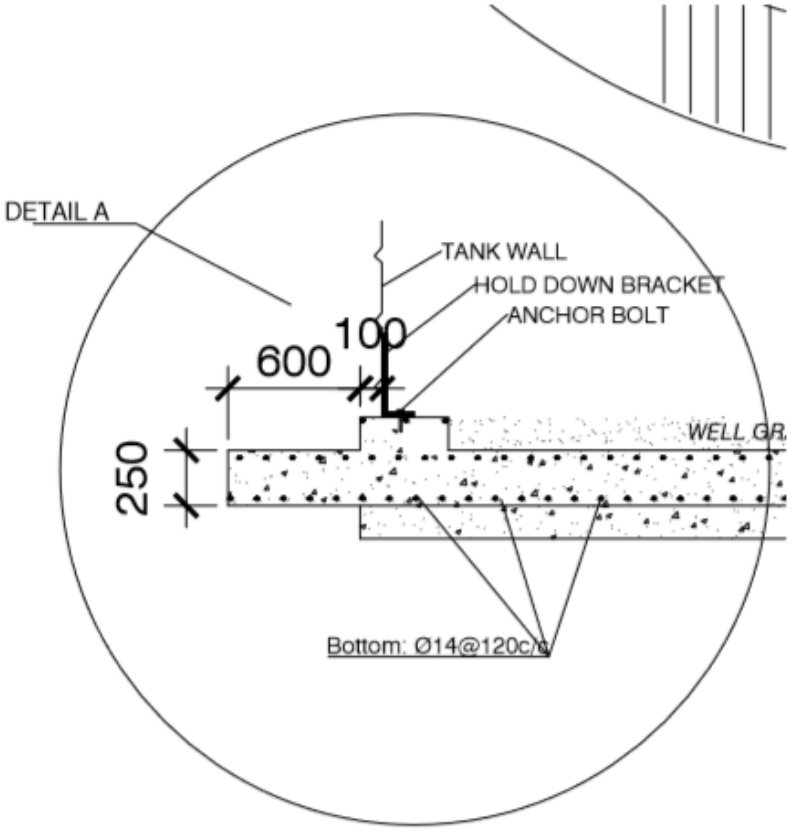
USAID Lowland WASH	RCC TOWER (6M) FOR 50M^3 PIONEER TANK [MODEL XL10]			
	By:	Dwg. No 8/9	Unit: mm	Date:



Top



SECTION S-S

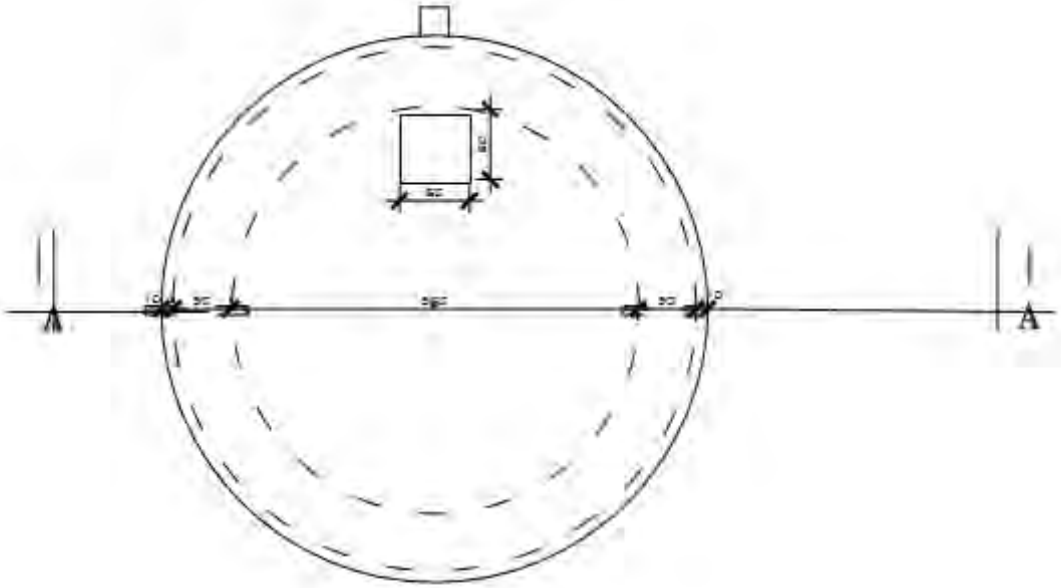


BAS

BASE SLAB DETAIL

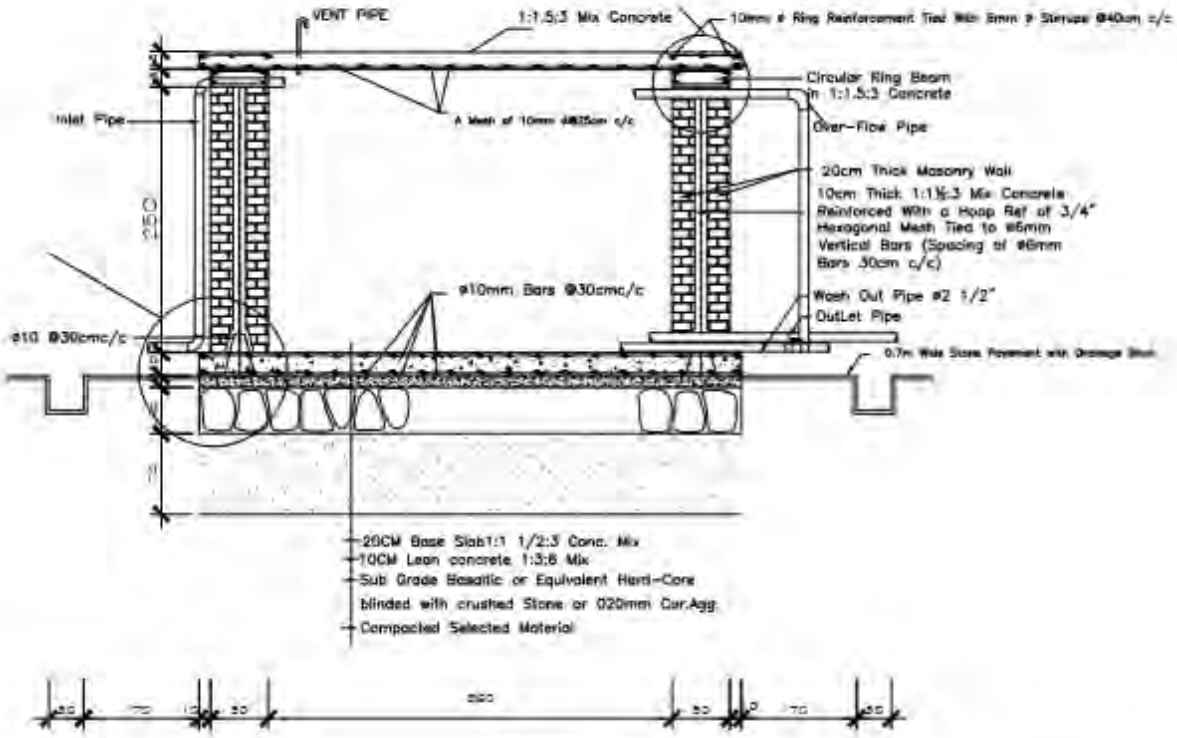
USAID Lowland WASH	**RCC TOWER (6M) FOR 50M^3 PIONEER TANK [MODEL XL10]**			
	By:	**Dwg. No 9/9**	**Unit: mm**	**Date:**

TYPICAL DRAWING 20: 25M3 CIRCULAR MASONRY RESERVOIR



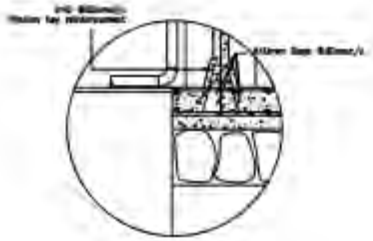
PLAN

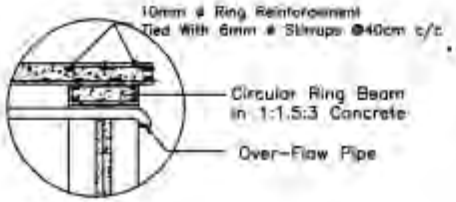
USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	25m3 Circular Masonry Reservoir		1/3		cm

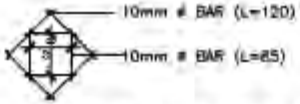


SECTION A-A

USAID Lowland WASH	Title	Designed/Checked By:	Dwg. No	Date	Unit
	25m3 Circular Masonry Reservoir		2/3		cm







DETAIL MANHOLE REINFORCEMENT

USAID Lowland WASH	**Title**	**Designed/Checked By:**	**Dwg. No**	**Date**	**Unit**
	25m3 Circular Masonry Reservoir		3/3		cm

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