GOVERNMENT OF SIERRA LEONE
Ministry of Health and Sanitation

STANDARDS & GUIDELINES

For Water, Sanitation, and Hygiene Services in Health Care Facilities in Sierra Leone

REVISED APRIL 2019

ACKNOWLEDGMENTS

The Standards and Guidelines for Water, Sanitation and Hygiene Services in Health Care Facilities in Sierra Leone is the product of a long and participatory process of intensive consultations, teamwork on specific assignments, monitoring visits, and information gathering. The process involved donors, service providers, civil society organizations, the Presidential Delivery Team, health care providers, local councils, development partners, and other key stakeholders.

Special thanks go to the Minister of Health and Sanitation for his leadership and guidance during the development of this document. Also special thanks to the chief medical officer, deputy chief medical officers I & II, and the entire team of the Environmental Health and Sanitation Directorate.

The Ministry of Health and Sanitation is grateful to everyone who contributed to the development of these standards and guidelines. Thanks to the members of the team who wrote this document, and special thanks provided to USAID, Department of International Development, and United Nation Children's Fund.

The government appreciates the financial and technical support from donors, and implementing partners, especially JSI Research & Training Institute, Inc. for its technical and financial support.

Finally, the Ministry Health and Sanitation thanks all other individuals and institutions who contributed their valuable time toward the development of this document.

Dr. Amara Jambai
Chief Medical Officer
Ministry of Health and Sanitation

TABLE OF CONTENTS

STANDARDS & GUIDELINES 1
ACKNOWLEDGMENTS 3
TABLE OF CONTENTS 3
ANNEXES 5
TABLE OF FIGURES 6
LIST OF ACRONYMS 7
Introduction 9
1 MINIMUM WASH PACKAGE FOR HEALTH CARE FACILITIES 10
TABLE 1. 10
TABLE 2. 12
TABLE 3. 14
TABLE 4. 15
1.1 Components of WASH Package in Health Care Facilities 16
1.2 WASH Hardware 16
1.3 WASH Software 16
2 PROVISION OF HARDWARE COMPONENT 17
2.1 Water Supply 17
REQUIRED MINIMUM STANDARDS 17
2.1.1 Water Quantity 17
INDICATORS 17
TABLE 5. 18
DAILY PER PERSON MINIMUM WATER QUANTITY REQUIREMENTS 18
2.1.1 Water Quality 18
INDICATORS 19
2.1.3 Water Access 19
2.2 Sanitation: Excreta Disposal, Showers/ Bathrooms/Urinals, Wastewater Disposal, and Site Drainage 20
REQUIRED MINIMUM STANDARDS 20
2.2.1 Sanitation Facility Quantity 20
2.2.1 Sanitation Facility Quality 20
2.2.1 Sanitation Facility Access 22
INDICATORS 22
REQUIRED MINIMUM STANDARDS 22
2.3.1 Handwashing Facilities Quantity 22
2.3.2 Handwashing Facilities Quality 22
2.3.3 Handwashing Facilities Access 23
INDICATORS 23
2.4 Storm Water Drainage Systems 23
REQUIRED MINIMUM STANDARDS 23
2.4.1 Storm Water Channel Quantity 23
2.4.2. Storm Water Channel Quality 23
INDICATORS 23
2.5 Laundry Facilities 24
REQUIRED MINIMUM STANDARDS 24
2.5.1 Laundry Facility Quantity 24
2.5.2 Laundry Facility Quality 24
2.5.3. Laundry Facility Access 24
INDICATORS 24
2.6. Health Care Waste Management Facilities 24
REQUIRED MINIMUM STANDARDS 25

2.6.1 Health Care Waste Segregation 25
2.6.2 Health Care Waste Collection 25
2.6.3 Health Care Waste Transportation 26
2.6.4 Health Care Waste Storage 26
2.6.5 Health Care Waste Treatment and Disposal 26
INDICATORS 27
References 28

ANNEXES

APPENDIX 1: TYPICAL DESIGN FOR POUR FLUSH LATRINE BLOCK 29

APPENDIX 2: TYPICAL SOAK-AWAY PIT DESIGN 33

APPENDIX 3: TYPICAL LAUNDRY FACILITY DESIGN 34

APPENDIX 4: TYPICAL PLACENTA PIT DESIGN 36

APPENDIX 5: TYPICAL SHARPS PIT DESIGN 29

APPENDIX 6: TYPICAL ASH PIT DESIGN 31

APPENDIX 7: DE MONTFORT MARK 8A INCINERATOR... 33

APPENDIX 8: TYPICAL SHOWER BLOCK DESIGN, PHUS 38

APPENDIX 9: TYPICAL WASTE MANAGEMENT AREA/ FACILITY SIZE, LAYOUT, PHUS40

APPENDIX 10: TYPICAL WATER AND SOLAR PANELS TOWER DESIGN 42

APPENDIX 11: TYPICAL ISOLATION UNIT & SCREENING AREA DESIGN, CHCS 46

APPENDIX 12: TYPICAL SITE PLAN FOR CHPS, MCHPS, AND SMALL HEALTH CENTERS44

APPENDIX 13: MOWR STANDARD HAND DUG WELL DESIGN WITH CAP, WELL SECTION, DRAINAGE CHANNEL AND SOAK AWAY PIT 46

APPENDIX 14: DESCRIPTION AND STANDARDS OF SMALL-SCALE SOLAR WATER SUPPLY SYSTEMS FOR CHC, CHP, AND MCHP HEALTH FACILITIES................................ 49

TABLE OF FIGURES

Figure 1 29
Figure 2 30
Figure 3 30
Figure 4 30
Figure 5 31
Figure 6 31
Figure 7 32
Figure 8 32
Figure 9 33
Figure 10 33
Figure 11 34
Figure 12 35
Figure 13 35
Figure 14 36
Figure 15 37
Figure 16 37
Figure 17 29
Figure 18 30
Figure 19 30
Figure 20 31
Figure 21 32
Figure 22 32
Figure 23 35
Figure 24 37
Figure 25 37
Figure 26 38
Figure 27 39
Figure 28 38
Figure 29 38
Figure 30 39
Figure 31 39
Figure 32 40
Figure 33 41
Figure 34 41
Figure 35 42
Figure 36 43
Figure 37 44
Figure 38 45
Figure 39 46
Figure 40 42
Figure 41 42
Figure 42 42
Figure 43 43
Figure 44 43
Figure 45 44
Figure 46 45
Figure 47 46
Figure 48 47
Figure 49 47
Figure 50 48
Figure 51 50

LIST OF ACRONYMS

CHC	community health centre
CHP	community health post
FMC	facility management committee
GFS	gravity flow system
HCW	health care waste
IPC	infection prevention and control
MCHP	maternal and child health post
MOHS	Ministry of Health and Sanitation
MOWR	Ministry of Water Resources
PHU	peripheral health unit
PPE	personal protective equipment
VIP	ventilated improved pit
WASH	water, sanitation, and hygiene
WHO	World Health Organization

Introduction

This version of the Standards and Guidelines for Water, Sanitation, and Hygiene (WASH) Services in Health Care Facilities in Sierra Leone is based on a version written and published in 2017. Its purpose is to update the standards and guidelines based on ever-changing information and daily experiences and lessons of experts and health, infrastructure, and WASH practitioners in the field.

All health professionals and practitioners are taught early in their training of the critical nature of infection prevention and control (IPC) and that clean water and sanitation are essential to its success. Without potable water and safe disposal of all waste, IPC and health care efforts are severely thwarted and success highly unlikely. The West Africa Ebola Crisis of 2014–2016 was a stark reminder of how critical and interrelated the basic principles of the WASH and IPC are to the success and failure of health care services.

These standards are meant to be followed by all health care practitioners wherever and whenever possible. In cases where that is impossible, these standards be should followed to the extent possible. One size may not fit all; in some cases, WASH facilities and features (such are water wells, pumps, and site layouts) must be designed and constructed based on the specific conditions at each site. In all cases, local conditions must guide the design and an experienced professional must prepare designs based on the specific circumstances at the facility in question. Emergencies also require exceptions.

These standards and guidelines should be the foundation for annual and project planning and budgeting for renovations, additions, and new construction of all facilities and WASH features. This starts with planning, prioritizing, budgeting, and allocating funds for new construction, renovations, and maintenance and repairs at the community, district, and central levels. These WASH and IPC standards and criteria require investments in high-quality materials and contractors. This initial investment however will pay dividends by increasing the lifespan of the facilities and features, improving the ability to deliver high quality health care services, and reducing maintenance and repair costs. These improvements will in turn attract more health care service seekers. Community involvement and ownership from the beginning is also critical to the ensure success and payback on the investment.

1 MINIMUM WASH PACKAGE FOR HEALTH CARE FACILITIES

TABLE 1.

WATER SUPPLY SUMMARY				
Facility Type	Hospital	Community Health Centre (CHC)	Community Health Post (CHP)	Maternal Child Health Post (MCHP)
1.1.1 Minimum quantity (litres/day)	< 100 beds: 20,000[1] 101–200 beds: 40,000 > 200 beds: 60,000	5,000[2]	2,500	2,500
1.1.2 Source	Protected Source[2]	Protected Source	Protected Source	Protected Source
1.1.3 Abstraction Methods	Submersible solar- or grid-powered pumps and generator back-up[3]	Submersible solar- or grid-powered pumps and generator back-up	Submersible solar-powered pumps and hand pump	Submersible solar-powered pumps and hand pump
1.1.4 Storage	Elevated black/dark tank for gravity flow system (GFS) with 2-day back-up storage based on number of beds.[4]	Elevated black/dark tank GFS with 2-day back-up storage minimum (10,000 L).	Elevated black/dark tank GFS with 2-day back-up storage minimum (5,000 L).	Elevated black/dark tank GFS with 2-day back-up storage minimum (5,000 L).
1.1.5 Distribution Systems	Pipe-borne water to labour and operating rooms and laboratories required	Pipe-borne water to labour room.	Pipe-borne water to labour room	Pipe-borne water to labour room.

[1] Minimum hospital water demand is based on 200 litres/bed. Specific average water demand per facility is based on data available for outpatient and inpatient departments, staffing, and various health services/procedures provided at CHCs, CHPs, and MCHPs. Refer to Table 5 under Water Supply for minimum per-capita consumption.
[2] Protected sources shall be pipe-borne, boreholes, hand-dug wells, and spring catchments.
[3] Pump type and specifications shall be based on applicable Ministry of Water Resources (MOWR)/Ministry of Health and Sanitation (MOHS) guidelines and recommendations.
[4] Storage volume requirements shall be informed by the Minimum quantity (litres/day) as described in section 1.1.1

1.1.6 Quality (water quality analysis at source)	Yes. MOHS/MOWR /WHO standards	Yes. MOHS/ MOWR/ WHO standards	Yes. MOHS/ MOWR/ WHO standards	Yes. MOHS/ MOWR/ WHO standards
1.1.7 Quality monitoring and treatment	Semi-annually MOHS/MOWR	Semi-annually MOHS/MOWR	Semi-annually MOHS/MOWR	Semi-annually MOHS/MOWR
1.1.8 Sustainability	Facility management and maintenance structure. Provide toolkits, start-up spare parts, and training. MOHS to make budgetary provision structure.	District and facility management committees (FMCs) oversee management and maintenance of infrastructure. Provide toolkits, start-up spare parts, training. District council to make budgetary provision.	District and FMCs oversee management and maintenance of infrastructure. Provide toolkits, start-up spare parts, Training. District/ chiefdom administration to make budgetary provision.	District and FMCs oversee management and maintenance of infrastructure. Provide toolkits, start-up spare parts, training. District/ chiefdom administration to make budgetary provision.

COMMENTS

1.1.1 In the event that the number of beds exceeds 12, revisit amount of water required at the health care facility. We need to take care of outpatients but the calculation only considers inpatients.

1.1.4 Elevated tanks should have lids.

1.1.7 All the necessary tools should be provided to MOHS for water quality monitoring and treatment. Physiochemical and biological sample collection and analysis of samples by MOHS and MOWR every 6 months.

TABLE 2.

SANITATION SUMMARY				
Facility	Hospital	CHC	CHP	MCHP
1.2.1 Toilets/ latrines/ urinals	Pipe-borne water toilets (flushable toilets, latrines) for labour room. Flushable toilet and latrines for patients.	Pipe-borne year-round flushable water toilets for labour room. If year-round pipe-born water is available, use a wet sanitary system (flushable or pour flush toilets); without year-round water, dry sanitary system (ventilated improved pit [VIP] latrines for patients). Include at least one handicapped-accessible (HC) compartment.	Pipe-borne year round flushable water toilets for labour room. If year round pipe born water is available, use a wet sanitary system; (flushable or pour flush toilets); without year- round water, dry sanitary system (VIP latrines for patients). Include at least one HC accessible compartment.	Pipe-borne year-round flushable water toilets for labour room. If year- round pipe-born water is available, use a wet sanitary system; (flushable or pour flush toilets); without year-round water, dry sanitary system (VIP latrines for patients). Include at least one HC accessible compartment.
	1 toilet per 10 inpatients	1 toilet per 10 inpatients	1 toilet per 10 inpatients[6]	1 toilet per10 inpatients
	1 toilet per 20 outpatients Total number of toilets and urinals to be determined by hospital out/ inpatient and staff capacity. Ensure gender equity, with separate staff facilities; 2 for staff in each 1 per Service delivery/department.	1 toilet per 20 outpatients Total number of toilets and urinal length to be determined by CHC capacity with a minimum of 5 stances (1 for isolation unit, 2 for staff, 2 for patients). 1 toilet for caregivers	1 squat pan (SP) per 20 outpatients Minimum 4 compartments/ stances (2 for staff, 2 for patients) with 1 urinal. 1 for caregivers	1 SP per 20 outpatients Minimum 4 compartments/stances (2 for staff, 2 for patients) with 1 urinal. 1 for caregivers

1.2.2 Shower/ bathing facilities	Privacy rooms included for bathing cubicles.	Privacy rooms included for bathing cubicles.	Privacy rooms included for bathing cubicles.	Privacy rooms included for bathing cubicles.
	1 block (2 compartments)	1 in each inpatient ward.		
	2 for staff in each ward	2 for staff	2 for staff	2 for staff
1.2.3 Handwashing facilities	New construction & rehabilitation: Handwashing basins, soap at all service points determine at each hospital.	New construction & rehabilitation: Handwashing basins, soap 7 service points.	New construction & rehabilitation: Handwashing basins, soap 6 service points.	New construction & rehabilitation: Handwashing basins, soap 6 service points.
1.2.4 Black/grey water disposal	Septic tank for black water & soak-away pits if only grey water.	Pipe-borne year round flushable water toilets for labour room. If year-round pipe-born water is available, use a wet sanitary system (flushable or pour flush toilets); without year-round water, dry sanitary system (VIP latrines for patients).	Pipe-borne year-round flushable water toilets for labour room. If year-round pipe-born water is available, use a wet sanitary systems (flushable or pour flush toilets); without year-round water, dry sanitary system (VIP latrines for patients).	Pipe-borne year round flushable water toilets for labour room. If year-round pipe-born water is available, use a wet sanitary systems (flushable or pour flush toilets); without year-round water dry sanitary system. (VIP latrines for patients).
1.2.5 Sustainability: Operations and Maintenance (O&M)	Facility management & maintenance structure. MOHS to make budgetary provision.	Yes, if training was provided to a facility management & maintenance structure. District council to make budgetary provision.	Yes, if training was provided to a facility management & maintenance structure. District/ chiefdom administration to make budgetary provision.	Yes, if training was provided to a facility management & maintenance structure. District/ chiefdom administration to make budgetary provision.

TABLE 3.

HEALTH WASTE MANAGEMENT SUMMARY				
Facility	Hospital	CHC	CHP	MCHP
1.3.1 Health care waste (HCW) management facility components	Mechanically operated incinerator min. temp 1,200^{o}C, autoclave unit, electricity power incinerator, or De Montfort 9 double - chambered incinerator glass crusher, ash pit, placenta pit, and sharps pit. See Appendices 4, 5, 6 and 7	Double-chambered incinerator, De Montfort 8a or equal, ash pit, sharps pit, placenta pit in a fenced and roofed waste disposal area. See Appendices 4, 5, 6 and 7	Double-chambered incinerator, De Montfort 8a or equal, ash pit, sharps pit, placenta pit in a fenced and roofed waste disposal area. See Appendices 4, 5, 6 and 7	Double-chambered incinerator, De Montfort 8a or equal, ash pit, sharps pit, placenta pit in a fenced and roofed waste disposal area. See Appendices 4, 5, 6 and 7
1.3.2 Other solid waste management collection bins and bin liners	Color-coded bins with lids and bin liners in all required locations. Provide biohazard plastics where applicable and sharps boxes (covered wheelbarrow bin, cart bin).	Color-coded bins with lids and bin liners in all required locations. Provide biohazard plastics where applicable and sharps boxes (covered wheelbarrow bin).	Color-coded bins with lids and bin liners in all required locations. Provide biohazard plastics where applicable and sharps boxes. (covered wheelbarrow bin).	Color-coded bins with lids and bin liners in all required locations. Provide biohazard plastics where applicable and sharps boxes. (covered wheelbarrow bin).
1.3.3 Desludging septic tank/ toilets/latrines & disposal	MOHS support on final sludge disposal.	Where feasible, MOHS support on final sludge disposal.	Where feasible, MOHS support on final sludge disposal.	Where feasible, MOHS support on final sludge disposal.
1.3.4 Sustainability (O&M)	Facility management & maintenance structure.	Yes. FMC oversees facility management & maintenance of infrastructure.	Yes. FMC oversees facility management & maintenance of infrastructure.	Yes. FMC oversees facility management & maintenance of infrastructure.

TABLE 4.

INFECTION PREVENTION AND CONTROL SUMMARY				
Facility	Hospital	CHC	CHP	MCHP
1.4.1 Isolation unit	1–4 bed Capacity	1–2 bed Capacity	1 holding room	1 holding room
1.4.2 Triage screening area	1	1		
1.4.3 Laundry	Machine washing powered by national power grid, with backup generator power and/or running water, provision of washing basin, well drained and roofed platform, including drying area.	Pipe-borne water, provision of 4-6 washing basins well drained to a soak-away pit and roofed platform enclosed by chain link galvanized fence supported by structurally sound timber or concrete columns, with provision of drying area/lines.	Pipe-borne, water provision of 2-4 washing basins well drained to a soak-away pit and roofed platform enclosed by galvanized chain link fence supported by structurally sound timber or concrete columns, with provision for drying area/	Pipe-borne water, provision of 2 washing basins well drained to a soak-away pit and roofed platform enclosed by galvanized chain link fence supported by structurally sound timber or concrete columns, with provision for drying area/ lines.

1.1 Components of WASH Package in Health Care Facilities

WASH in the health care facility package includes both hardware and software components. Below are the key aims of hardware and software components of the WASH package in healthcare facilities.

1.2 WASH Hardware

Hardware improves the quality and quantity of WASH services in health care facilities. It includes construction and rehabilitation of water points; sanitary toilets including urinals; showers; wastewater collection systems; and handwashing facilities; storm water drainage systems; laundry facilities; and HCW management facilities including collection, storage, and disposal such as ash, sharps, and placenta pits.

1.3 WASH Software[5]

Software improves and manages WASH services in health care facilities ability to prevent infections among health care workers, patients, and the community. It includes promoting key hygiene messages to enhance behavioural change and IPC measures, including personal protective equipment (PPE) use; decontamination; laundering , handling and storage of hospital linens, and other housekeeping processes; HWC management; wastewater treatment; and water quality and quantity analysis.; safe excreta disposal and other environmental health issues.

[5] This is covered under the IPC guidelines by the MOHS.

2 PROVISION OF HARDWARE COMPONENT

The hardware component of WASH in health care facilities shall be provided by constructing new or upgrading existing facilities and rehabilitating dilapidated WASH infrastructure based on the specifications and guidelines by MOHS[8] and MOWR,[9] and SHPERE standards and WHO guidelines. The minimum standards for WASH services are outlined below.

2.1 Water Supply

Water for drinking and personal hygiene including handwashing, bathing, and cleaning personal utensils, cooking, laundry, and medical activities must be safely treated, reliable, and sufficient. Ensure that on-site water collection points are functional at all times. Before building, conduct a geophysical water survey at all new proposed facility sites to determine the potential of a new water source. If the potential of a water source is low or poor, select a site that has good water supply potential.

REQUIRED MINIMUM STANDARDS

2.1.1 Water Quantity

The required number of litres/person/day[10] is defined and calculated by the services provided at each type of facility (Table 5). Underground, surface, and elevated water storage tanks with accompanying distribution networks should be constructed and installed based on MOWR and MOHS guidelines to create a functional, sustainable water supply system in health care facilities.

INDICATORS

1. Sufficient water quantity (Table 5) is available to meet minimum daily requirements in the health facility.
2. Sufficient water storage volume is available on-site to provide the health facility with 48 hours (2 days of storage capacity)[11] emergency backup supply.

[8] Sanitation technology options by the MOHS technical WASH meeting, July 30 2015; Integrated National Waste Management Policy, October 2012.

[9] RWH Guidelines, October 2014; Technical brief/guidelines for pipe laying and house connections, December 2014; Principles of Bore Hole Construction and Rehabilitation, October 2014; Technical Guidelines for the Construction and Maintenance of Hand Dug Wells, April 2014.

[10] WASH in Health Care Facilities in Emergencies, WHO 2012.

[11] It is assumed that 48 hours is the maximum shutdown time needed to fix facilities experiencing breakdown of/interrupted water supply.

TABLE 5.
DAILY PER PERSON MINIMUM WATER QUANTITY REQUIREMENTS

Activity	Minimum Water Quantity Requirement
Staff	5 litres/person/day
Outpatient	5 litres/patient/day
Inpatient	40–60 litres/patient/day 15 litres/caregiver/day
Operating theatre/maternity unit	100 litres/intervention
Dry or supplementary feeding centre	0.5–5 litres/consultation (depending on waiting time)
Wet supplementary feeding centre	15 litres/consultation
Inpatient therapeutic feeding centre	30 litres/patient/day
	15 litres/caregiver/day
Cholera treatment centre	60 litres/patient/day
	15 litres/caregiver/day
Acute respiratory disease isolation ward	100 litres/patient/day
	15 litres/caregiver/day
Viral haemorrhagic fever isolation ward	300–400 litres/patient/day
	15 litres/caregiver/day

Source: WASH in Health Care Facilities in Emergencies, WHO 2012.

Table 5 above shows WHO/SPHERE recommended minimum water quantities for different treatments and patient loads in health care facilities. While these should be used to determine minimum water quantity needs, factors like special days, (e.g., antenatal clinics), may call for adjusted amounts.

2.1.1 Water Quality

Water for drinking, kitchen activities, personal hygiene, medical activities, cleaning and laundry must be treated, disinfected, and safe. Water quality should adhere to MOWR/MOHS standards and WHO recommended guidelines including all chemical, biological, microbial, and physical parameters for potable drinking water. Water quality tests are conducted by MOHS and MOWR. The minimum standard must be reached before commissioning water sources. Conduct quality testing of all water sources every six months. The district WASH monitoring officer or the district WASH mapping officer/assistant water analyst will collect all water samples and transport them to the MOWR or MOHS laboratory within 24 hours for testing.

Provide results of water quality analysis to the respective health care facility within one week of testing.

Health facilities should have chlorine disinfectant readily available to treat water based on the monitoring results.

Provide basic tools for water system maintenance when training staff and FMC members.

The testing laboratories must have the supplies and reagents to monitor water quality in stock at all times.

Use a geophysical survey devise to determine potential groundwater at proposed new health facility sites. Do not construct a new facility at site that shows a poor or low potential for groundwater. Select another site with good potential for groundwater results.

INDICATORS

1. Thermo-tolerant coliform bacteria are not detectable in any 100ml sample of drinking water within the health facility.

2. The maximum concentration of arsenic and fluoride, as per WHO guidelines, shall not be exceeded.

3. There are no odours, tastes, or colours that would discourage consumption or use of drinking water.

4. All water supplies in the health care facility are treated with disinfectant to achieve a free chlorine residual of between 0.3–0.5mg/l and a turbidity below 5 nephelolometric turbidity units at the point of use.

5. In the case of highly infectious disease epidemics, water supplies should be disinfected to achieve free chlorine residual above 1mg/l at the point of use.

2.1.3 Water Access

Functional running water access points are available at all health care service delivery points for outpatients, inpatients, staff, and caregivers 24 hours a day. In CHCs, CHPs, and MCHPs, handwashing basins should be located at service delivery points, delivery rooms, facility entrance, and adjacent to toilets and laboratories. If pipe-born water is unavailable, hand sinks can be installed at service delivery points and water bucketed to the point. Veronica buckets should be used at entrances and laboratories when piped water is unavailable. Hand sink locations vary from hospital to hospital but should be provided at all points of service delivery. For GFSs, there should be adequate residual pressure to ensure running water at all access points, with a minimum flow rate of 3 minutes to fill a 20 litre container.

Rainwater harvesting should be considered at existing health facilities that lack a year-round, onsite water source. Rainwater harvesting systems should be well-planned and designed to maximize access to clean water. Although it can be costly, it is important to plan to have a water tank, in order to store the large quantity of water required for health facility activities during the dry season. Although rainwater can be kept clean by discarding water from the first rain after the dry season and through use of stainless steel vortex filters that require very little maintenance, harvested rainwater does not meet WHO potable water standards. Chlorination, which is required to meet WHO potable water standards, requires continual purchase and maintenance of supplies and constant attention to testing. Chlorine also requires special storage. This may be unrealistic for some MCHPs and CHPs.

2.2 Sanitation: Excreta Disposal, Showers/ Bathrooms/Urinals, Wastewater Disposal, and Site Drainage

Sufficient numbers of toilets, latrines, urinals, showers, and bathrooms should be accessible to all staff, patients, and visitors at all health care facilities. Urinals should be available to reduce use of toilets and accompanying water for flushing in busy facilities. Sanitation facilities should be clean, safe, and gender-segregated. All must make provisions for people with disabilities and ease-of-use by children. Design of these facilities should adhere to MOHS guidelines.[6] Dispose wastewater generated from toilets, bathrooms, and showers promptly and safely to avoid contaminating drinking water sources. Wastewater collection facilities can be on- or off-site depending on the location and availability of such facilities.

REQUIRED MINIMUM STANDARDS

2.2.1 Sanitation Facility Quantity

In each health care facility, there should be separate toilets or latrines and shower/ bathrooms for patients and staff with clear symbols, signs, and hygiene-promotion messages on proper use. Also, there should be sufficient toilets or latrines for staff, patients, and visitors. Minimum requirements for hospitals are 1 toilet or latrine for every 10 inpatients; 1 toilet or latrine for every 20 outpatients; and toilets for female and male staff in every ward. In all CHCs, CHPs, and MCHPs there should be at minimum 5 toilets: 2 outpatient (1 male, 1 female); 2 staff (1 male, 1 female); and 1 for caregivers/visitors. At least one shower/bathroom facility should be available per 20 inpatients, or at minimum 1 shower/bathroom facility per ward. All toilets/shower/bathroom facilities for maternity wards/delivery rooms must be indoors. In addition, there should be at least 2 shower/bathroom facilities for staff (1 for males, 1 for females) in each ward. All CHCs/CHPs/MCHPs will have at least 2 shower/bathroom facilities for staff (1 male, 1 female). There will be at minimum 1 toilet with urinal and shower at the isolation unit in all hospitals and CHCs where these units exist.

2.2.1 Sanitation Facility Quality

Based on recognized improved wet system standards, septic tanks and leach fields/pits should be constructed to allow proper collection, on-site treatment, and percolation of wastewater. Based on the same improved system standards, where year-round water is unavailable, VIP latrines should be installed. Where available infrastructure and equipment to empty and properly dispose black water septic waste is lacking, use VIPs. Facilities that have high groundwater tables, which can be polluted by septic tanks and leach fields, should replace wet (water flush) sanitary systems with dry systems (VIPs).

Infiltration disposal systems must be 30 meters away from water source; 1.5 meters above the groundwater table; and based on the type of local soil formation. In areas

[6] Sanitation technology options by the MOHS, technical WASH meeting, July 30, 2015.

where offsite waste treatment is available, septic and holding tanks should be de-sludged by MOHS when they are three-quarters full. In areas where offsite waste treatment and disposal systems are unavailable, dry VIP systems are recommended.

Toilets with urinals and wastewater collection facilities, including septic tanks, leach fields/pits, and holding tanks, should be constructed according to MOHS/MOWR specifications to ensure that excreta and wastewater are safely managed. These facilities should be located at least 30 meters and downhill from water sources. Septic tanks and any leaching pits should be located at least 5 meters away from main buildings and at least 1.5 meters above the maximum groundwater table height in all cases. Sanitation facilities should be cleaned and maintained daily.

2.2.1 Sanitation Facility Access

Sanitation facilities should be accessible and gender-specific for staff, patients, and visitors, including children, handicapped people, and people who have reduced mobility. Toilets should be no more than 30 meters from all patient waiting areas and consultation and treatment areas/departments.[7]

INDICATORS

1. The health care facility grounds and environment is free of human faeces.

2. A sanitary survey of the wastewater disposal chain from point of origin to point of disposal indicates a low-level of public health risk for staff, patients, and the environment at every stage.[8]

3. Wastewater is removed rapidly and cleanly from the point where it is produced.

REQUIRED MINIMUM STANDARDS

2.3.1 Handwashing Facilities Quantity

Handwashing facilities must be within five meters of a toilet and conveniently located throughout the health care facility, including consultation rooms, and all areas where health care procedures are performed, including delivery rooms Patient wards with more than 20 beds should be provided with at least two basins.[9] If handwashing facilities are absent, waterless antiseptic should be readily available (wall-mounted or in small bottles, depending on availability).

2.3.2 Handwashing Facilities Quality

Handwashing facilities should be constructed according to the specifications issued by MOHS and provided with soap to ensure they are user-friendly and safely managed. Handwashing facilities should be cleaned and maintained daily and have with good waste-water drainage. Post clear signs, symbols, and health and hygiene messages to encourage use of handwashing facilities.

---

[7] Essential environmental health standards in health care, WHO 2008.

[8] Use Sanitary Survey Risk Score Tool to measure level of risk, WASH in Health Care Facilities in Emergencies, WHO 2012.

[9] Essential environmental health standards in health care, WHO 2008.

2.3.3 Handwashing Facilities Access

Handwashing facilities should be accessible and easy to use by every person at a health care facility, especially children.

INDICATORS

1. A functional handwashing facility with soap is available in every area where health care procedures are performed.
2. Patients and caregivers are informed about essential hygiene behaviours for limiting disease transmission repeatedly, starting within 30 minutes of arrival.
3. Where appropriate (at inpatient facilities), food for patients, staff, and caregivers is stored in a way that eliminates/minimizes the risk of disease transmission.

2.4 Storm Water Drainage Systems

All health care facilities should have a well-designed storm water drainage system with properly sized, functional, unblocked storm water channels. It should also ensure that rainwater does not flood or carry potentially infectious agents to nearby residents/communities or pond within the facility to encourage mosquito breeding. Rainwater runoff should not be directed to septic tanks because these wastewater collection facilities do not have sufficient capacity to absorb the volume.

REQUIRED MINIMUM STANDARDS

2.4.1 Storm Water Channel Quantity

Storm water channels are designed according to the size and design of each building. They are placed under the roof eaves to collect and direct storm water runoff to locations where soak-away pits are provided to allow the water to settle and soak into the soil without creating erosion, swampy, or standing water conditions at the health care facility.

2.4.2. Storm Water Channel Quality

Storm water channels should be constructed according to MOWR specifications to ensure safe management. Rainwater harvesting systems for storm water management should be designed and constructed according to MOWR guidelines.

INDICATORS

1. Rainwater and surface runoff is safely disposed and does not carry contamination from the health care facility to the outside surrounding environment.

2.5. Laundry Facilities

Laundry facilities should be designed with enough space to allow sorting, washing, and temporary storage of clean linen. A good drainage system should be in place and all laundry facilities should be kept dry to avoid accumulation of moisture or standing water. Professionally designed and installed electrical wiring should be provided when and where laundering is done by machines.

REQUIRED MINIMUM STANDARDS

2.5.1 Laundry Facility Quantity

At minimum, one laundry facility should be available in each hospital and CHC. Where possible, machine laundering should be the preferred method for the occupational safety of laundry workers.

2.5.2. Laundry Facility Quality

Laundry facilities should be constructed or rehabilitated in accordance with MOHS specifications to ensure that facilities are well-located, safe, user-friendly, safely managed, and with adequate grey water drainage and disposal systems. Adequate water supply, soap or detergent, disinfectant, and Handwashing facilities should be available in a laundry facility.[10] Facilities that use manual laundry should have adequate access to water, at least three washing basins with wastewater drainage system, a roof, and a provision for drying appropriately drained linen.

2.5.3. Laundry Facility Access

The main entry to the laundry facility should facilitate smooth movement of handcarts and containers carrying both clean and soiled linen. Limit access to laundry staff and other authorized personnel.

INDICATORS

1. Laundry facilities, soap or detergent, water, and a disinfectant (such as chlorine solution) available in all patient settings.

2.6. Health Care Waste Management Facilities

Collect HCW in leak-proof and puncture-resistant containers, store safely prior to and during transport to treatment site, and treat and dispose safely. The health care facility surroundings should be free of uncontrolled HCW. Waste handlers should adhere strictly to MOHS IPC protocol and waste management guidelines.[11]

---

[10] Essential environmental health standards in health care, WHO 2008
[11] Integrated National Waste Management Policy, October 2012.

REQUIRED MINIMUM STANDARDS

2.6.1 Health Care Waste Segregation

HCW should be segregated at the point of generation and by type of waste, (i.e., sharps, highly infectious, infectious, and non-infectious). Color-coded HCW containers/bins and bin bags should marked per MOHS guidelines[19] as detailed in the following section.

Collect and store hazardous waste (e.g., pharmaceutical waste, lab reagents and radioactive materials, insecticides) in appropriate labelled containers placed in a secure location. Further segregation can be done depending on health care facility level. Domestic or general waste can be segregated to facilitate recycling of paper, cardboard, plastic, glass, and metal, depending on recycling opportunities.

2.6.2. Health Care Waste Collection

With the exception of sharps containers designed for on-site incineration, health care waste collection bins should be made of plastic with adequate strength (puncture resistant and leak proof) with the approved color-coded containers and clear labels indicating the contents to ensure safe handling as detailed below. Clearly marked and color-coded bins protect waste handlers by providing understandable and easy-to-follow identification of types of HCW, and should be maintained throughout the HCW management chain for the segregation, collection, transport, storage, treatment, and final disposal of waste.

- Sharps containers shall be cardboard yellow safety boxes, where treatment and final disposal option is incineration or the sharps pit. Sharps containers should be located within arm's reach of generation points (injection rooms, laboratories, and patient wards) and disposed when three-quarter full.
- **Highly infectious waste containers** shall be red plastic 20–40 litre-capacity bins of adequate strength (puncture resistant and leak proof) and red covers/lids and liners. This waste will be disposed immediately into the placenta/organic waste pit. These containers shall be within arm's reach of all locations where this waste is generated.
- **Infectious waste containers** shall be yellow plastic 20–40 litre-capacity bins of adequate strength (puncture resistant and leak proof), and yellow covers/lids and liners. This waste will be disposed when bins three-quarters full into the incinerator. The resulting ash shall be placed into the ash pit. These containers shall be within arm's reach of all locations where this waste is generated.
- **Non-infectious waste containers** shall be black plastic containers of up to 60 litre-capacity bins with adequate strength (puncture resistant and leak proof), and black covers/lids and liners.
- **Hazardous waste** shall be collected and stored in appropriate labelled containers in secure location for disposal, either through destruction and disposal on-site, or in a secure landfill per MOHS guidelines.

[19]Integrated National Waste Management Policy, October 2012, Page 27.

- At least one set of black and yellow containers should be allocated per 20 beds in each ward, in patient waiting areas, and consultation rooms.
- Once containers are three-quarters full, waste handlers should remove waste bags and replace with new liner bags. Bags should be tied and held by the neck. In the event of leakage, remove, clean, and disinfect containers before replacing liner bag. All HCW bins should be removed for thorough cleaning and disinfection on a weekly basis.

2.6.3. Health Care Waste Transportation

All movement of HCW either on- or off-site should be in line with the MOHS guidelines (refer to INWM Policy 5.1.12, 5.1.13.2 & 5.1.13.4). On-site transportation of HCW from the point of collection to storage, treatment or final disposal facility should be done by using leak proof waste collection trolleys or at minimum metal handcarts/wheelbarrows. Generally, both on- and off-site transport equipment should allow easy loading and unloading of waste. Bags should be held by the neck so as not to tear or cause any leakage while transferring to trolleys, handcarts, and trucks.

2.6.4. Health Care Waste Storage

Where applicable all HCW should be stored in designated storage facilities as per the MOHS guidelines (refer to INWM Policy 5.1.13.1 & 5.1.13.3) as it applies to any facility storing waste awaiting on-site treatment or offsite transportation. At a minimum, hospitals shall have HCW storage facilities/provision within the incinerator facility. Waste generated from the other facilities should be treated and disposed of daily at the respective disposal facilities located in demarcated waste disposal zones to minimize the need for storage. Waste disposal zones shall be situated at least 50 meters (preferably downhill and downwind) from any buildings or public areas, fenced off and locked, and all pits adequately locked and covered. In all facilities, organic waste should be disposed of daily.

2.6.5. Health Care Waste Treatment and Disposal

Health care waste shall be treated prior to final disposal per the MOHS guidelines (refer to Intergraded National Waste Management Policy 5.1.14 & 5.1.15). On-site treatment methods such as incineration at temperatures no less than 1,200 degrees centigrade for hospitals are recommended. At a minimum, double-chambered De Montfort incinerators must be used in hospitals (Mark 9), CHCs, CHPs and MCHPs (Mark 8a). (See attached DE Montfort Description, Construction and Use Guidelines). Treated HCW should be disposed in a safe manner to avoid environmental contamination. Dispose incinerated ash (normally 5–10 percent of incinerated waste) in lined pits. At a minimum, sharps waste shall be disposed into a sharps pit that uses medium- to low-burning incinerators. If incinerators will not be operational for a few days beyond the capacity of the storage facility, waste should be disposed by burning in primitive incinerators, barrels, or pits under MOHS supervision (and ash disposed in an ash pit).

INDICATORS

1. Health care waste is segregated at the point of generation according to type: organic waste, sharps and non-sharps infectious waste, hazardous, and general waste.

2. Color-coded waste containers or containers bearing clearly understood signs and symbols available in all places where HCW is generated.

3. Each category of waste is treated and disposed of according to the safest feasible method available.

4. A specific waste-disposal zone exists, where waste can be stored and disposed safely and effectively.

5. The health care facility grounds and environment is free of uncontained HCW.

6. Staff has sufficient and adequate waste handling equipment and PPE and are correctly trained to collect, handle, and dispose HCW safely.

References

1. Ministry of Health & Sanitation GOSL. Intergraded National Waste Management Policy. October 2012.

2. Ministry of Water Resources GOSL. Technical Brief/Guidelines for Pipe laying and House Connections. December 2014.

3. Ministry of Water Resources GOSL. Principles of Bore Hole Construction and Rehabilitation. October 2014.

4. Ministry of Water Resources GOSL. Technical Guidelines for the Construction and Maintenance of Hand Dug Wells. April 2014.

5. WHO. Guideline on hand hygiene in health care in the context of filovirus disease outbreak response. November 2014.

6. WHO. Essential environmental health standards in health care. 2008.

7. Ministry of Health & Sanitation GOSL. Sanitation Technology options by the Technical WASH meeting. July 30 2015.

8. WHO. WASH in Health Care Facilities in Emergencies. 2012.

9. The Sphere Project. Humanitarian Charter and Minimum Standards in Humanitarian Response. 2011.

ANNEXES: TYPICAL DESIGNS

APPENDIX 1: Typical Design for Pour Flush Latrine Block (with a provision for the disabled)

Figure 1: Typical Design for Pour Flush Latrine - Plan

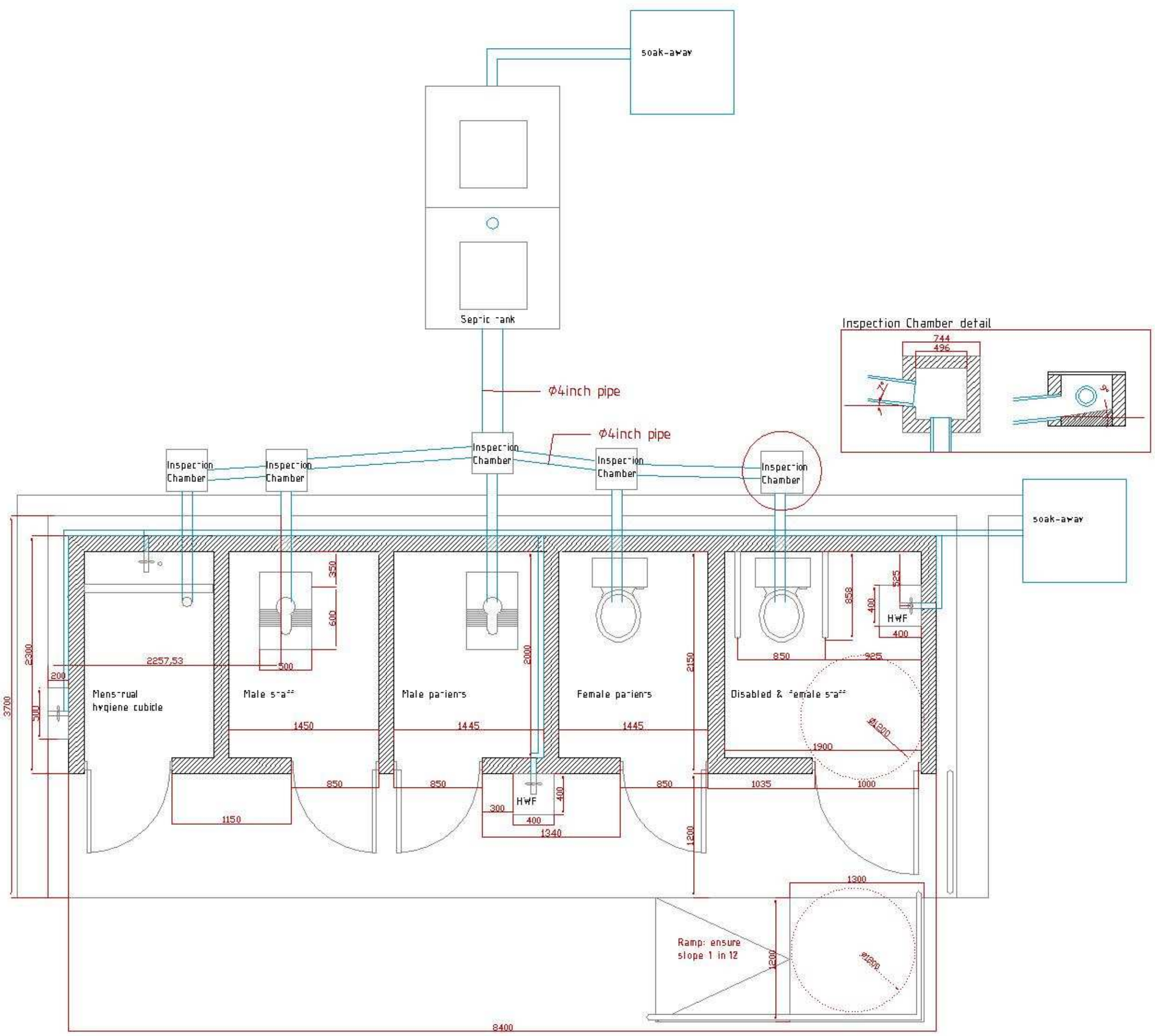


Figure 2: Typical Design for Pour Flush Latrine - Left Elevation

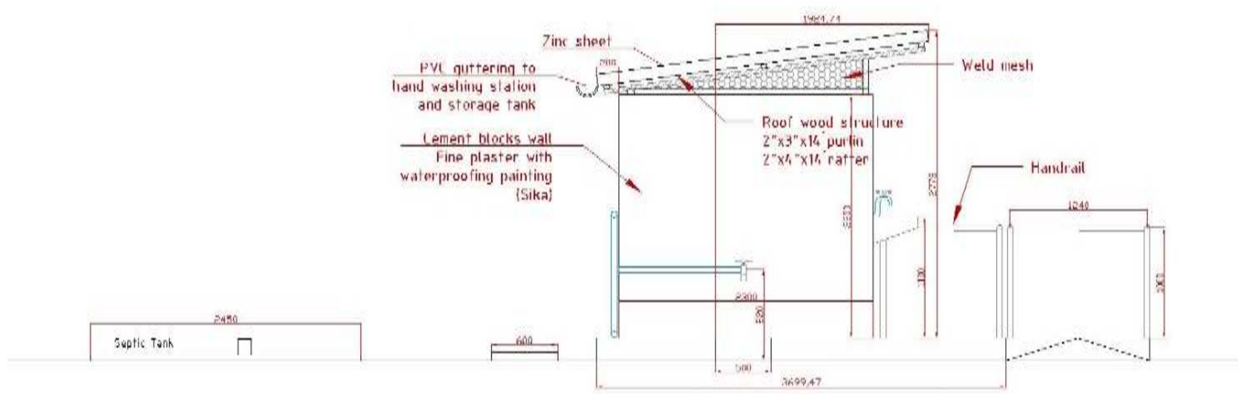


Figure 3: Typical Design for Pour Flush Latrine – Front Elevation

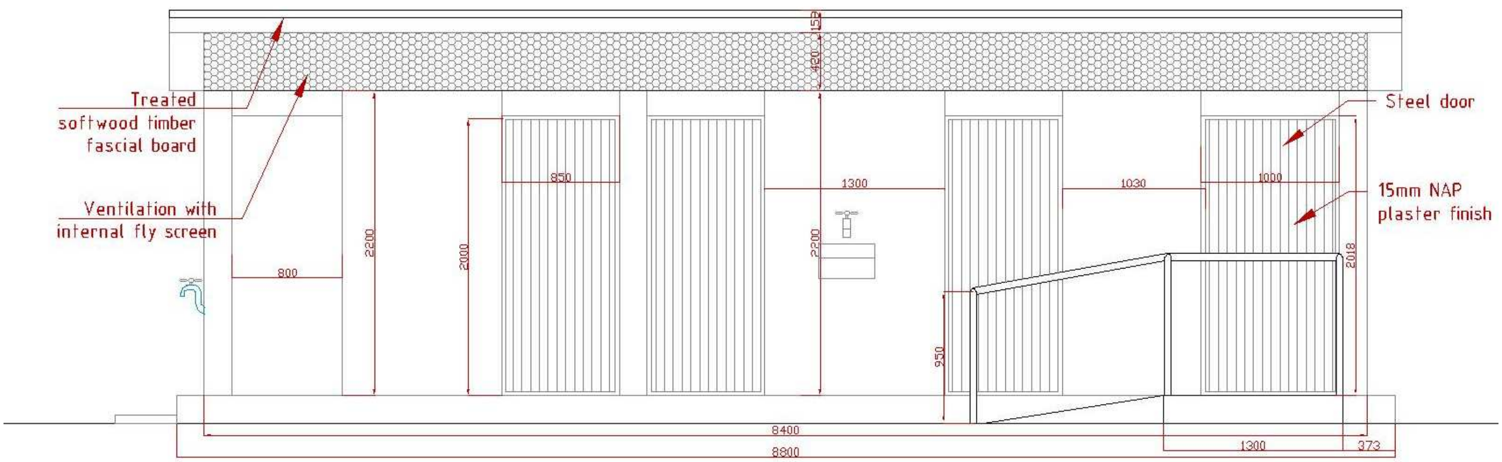


Figure 4: Typical Design for Pour Flush Latrine – Front Section

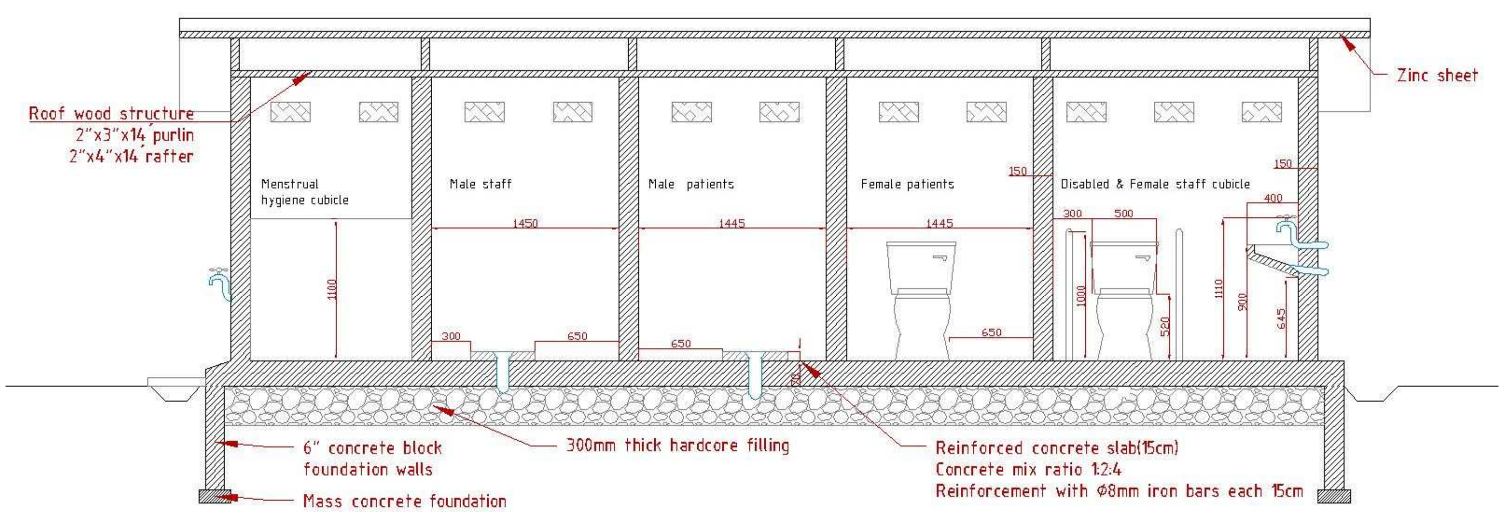


Figure 5: Typical Design for Pour Flush Latrine – Transversal section

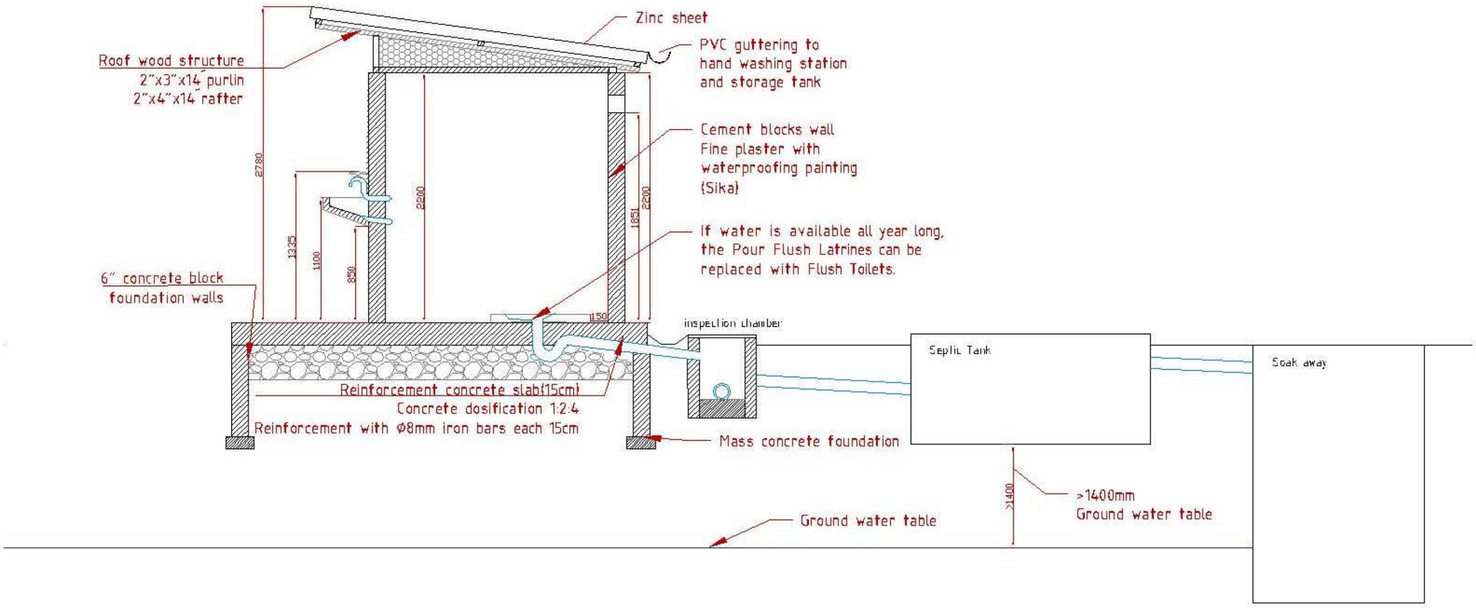


Figure 6: Typical Septic Tank Design - Section

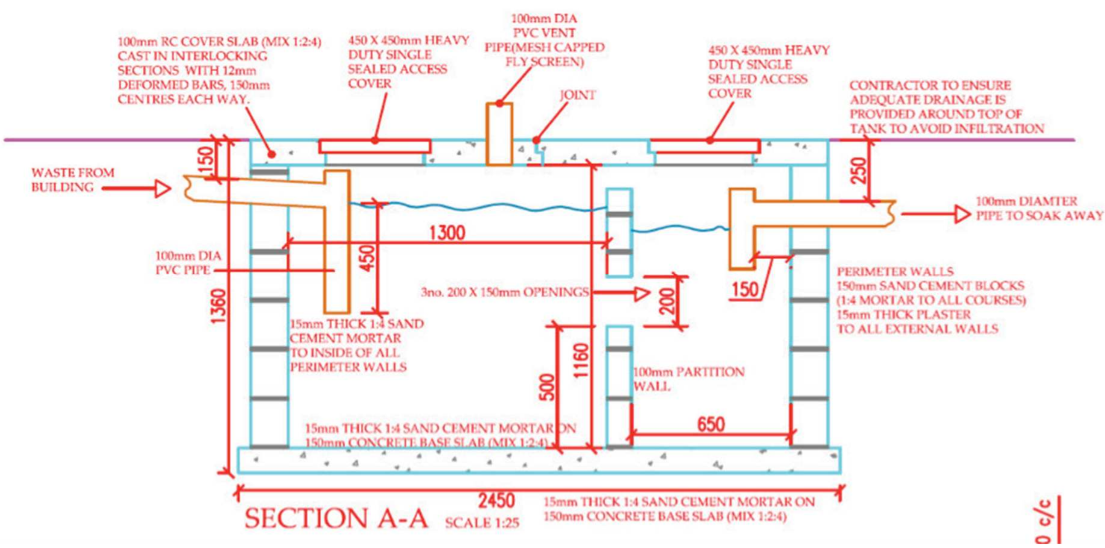


Figure 7: Typical Septic Tank Design - Plan

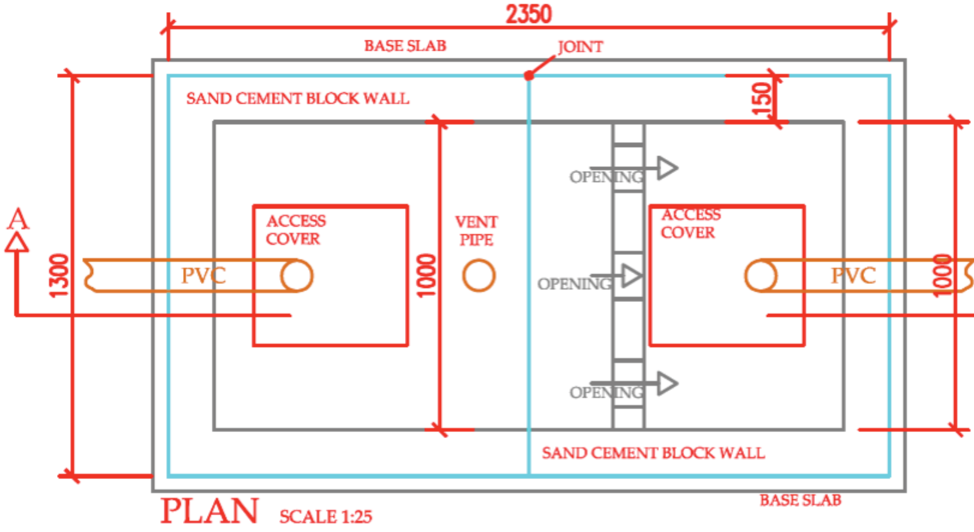
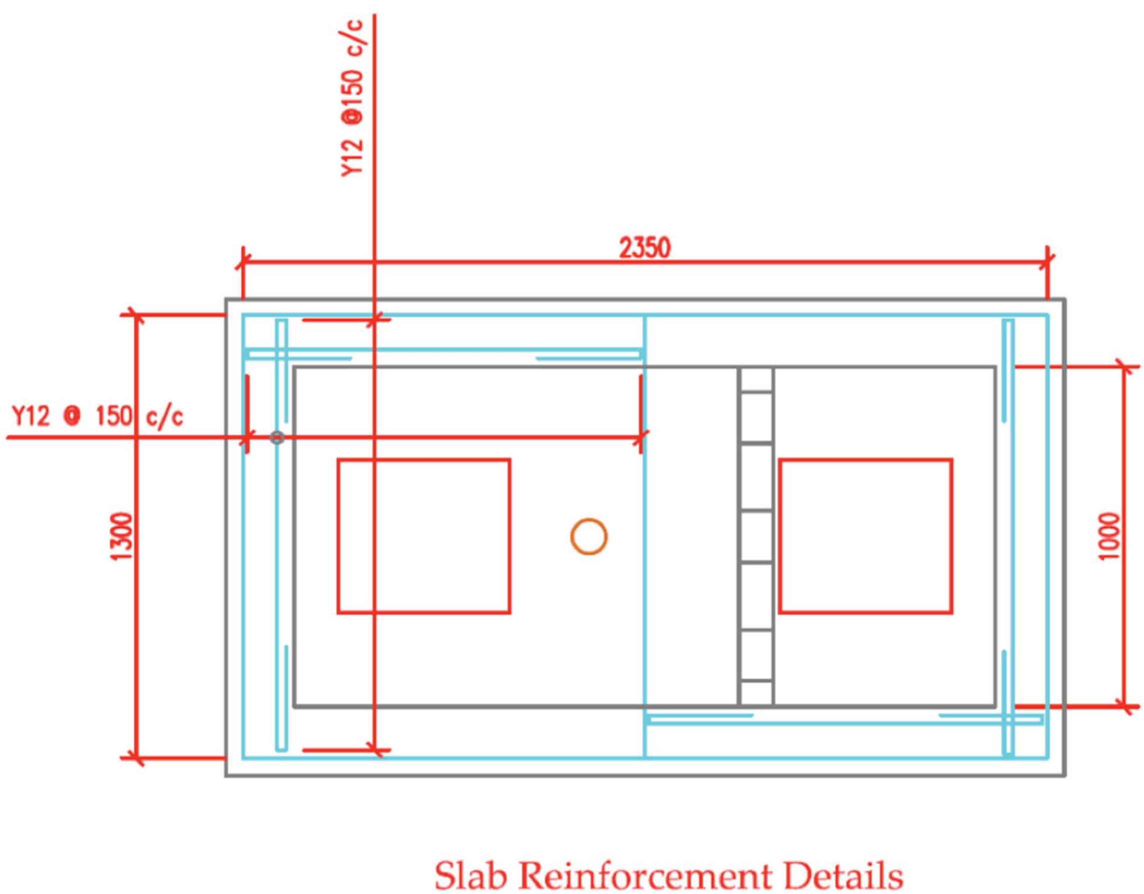


Figure 8: Typical Septic Tank Design – Slab



APPENDIX 2: Typical Soak-away Pit Design

Figure 9: Typical Soak-away Pit Design - Pit

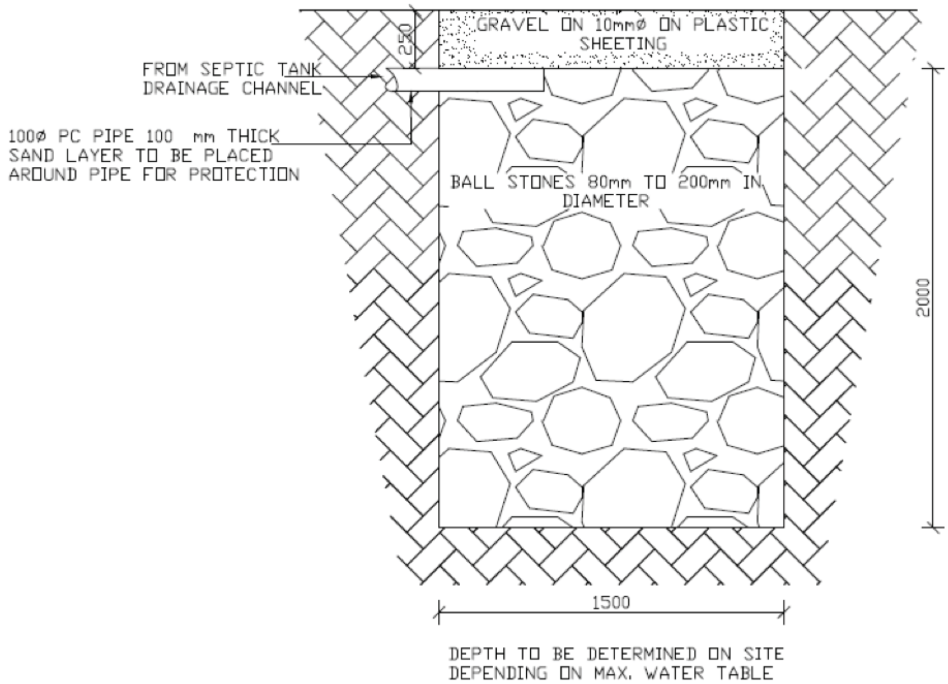
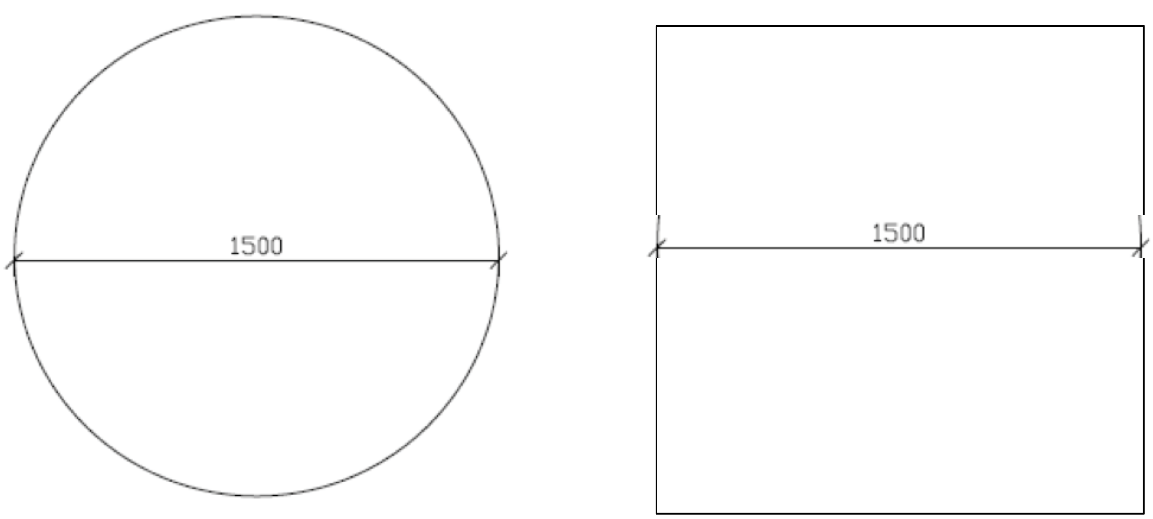
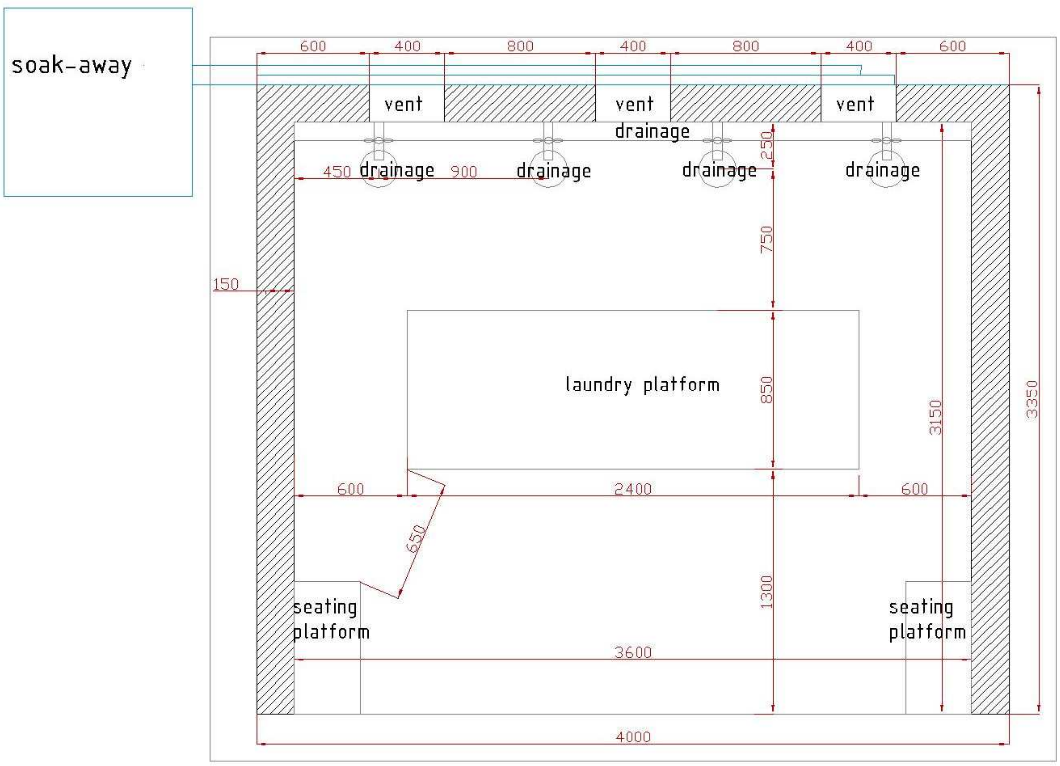


Figure 10: Typical Soak-away Pit Design – Plan (two options, round or square)



APPENDIX 3: Typical Laundry Facility Design (Hospitals to Complement Machine Laundry, CHCs)

Figure 11: Typical Laundry facility Design - Floor Plan



CEMENT and CONCRETE mixture.
Cement/Sand/Stone/Water
foundation: 1/4/4/14-15
slab: 1/3/3/11-12
beam&pilars: 1/2/2/9-10
blocks: 1/6/0/as needed
plastering: 1/2/0/as needed

Figure 12: Typical Laundry Facility Design – Front Elevation

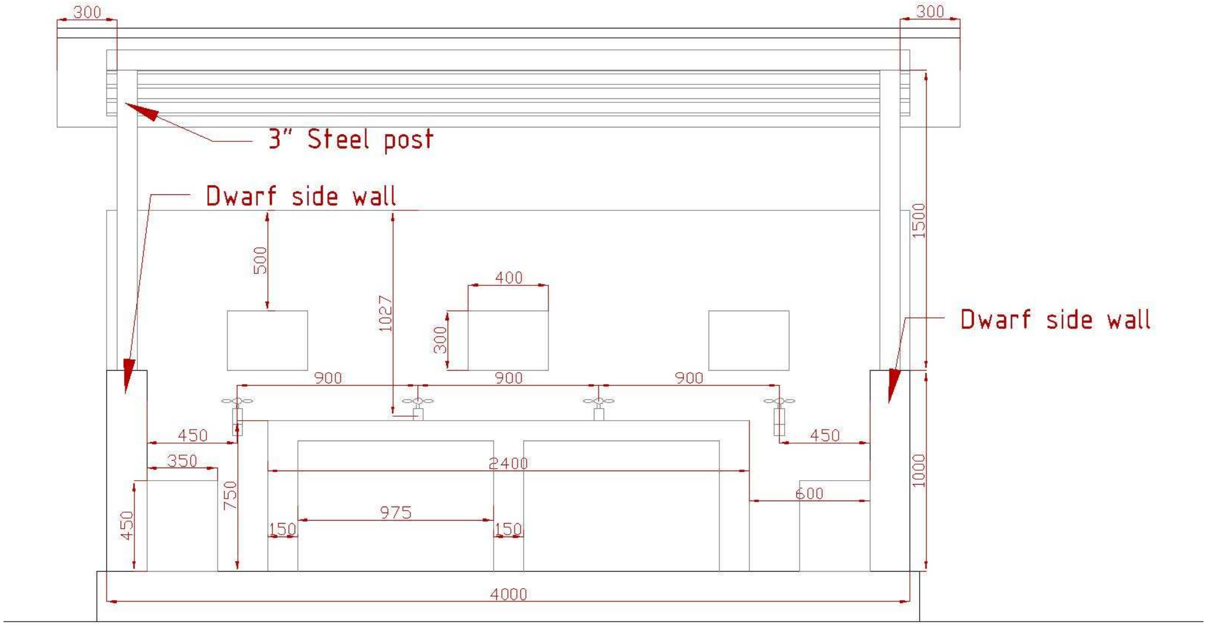
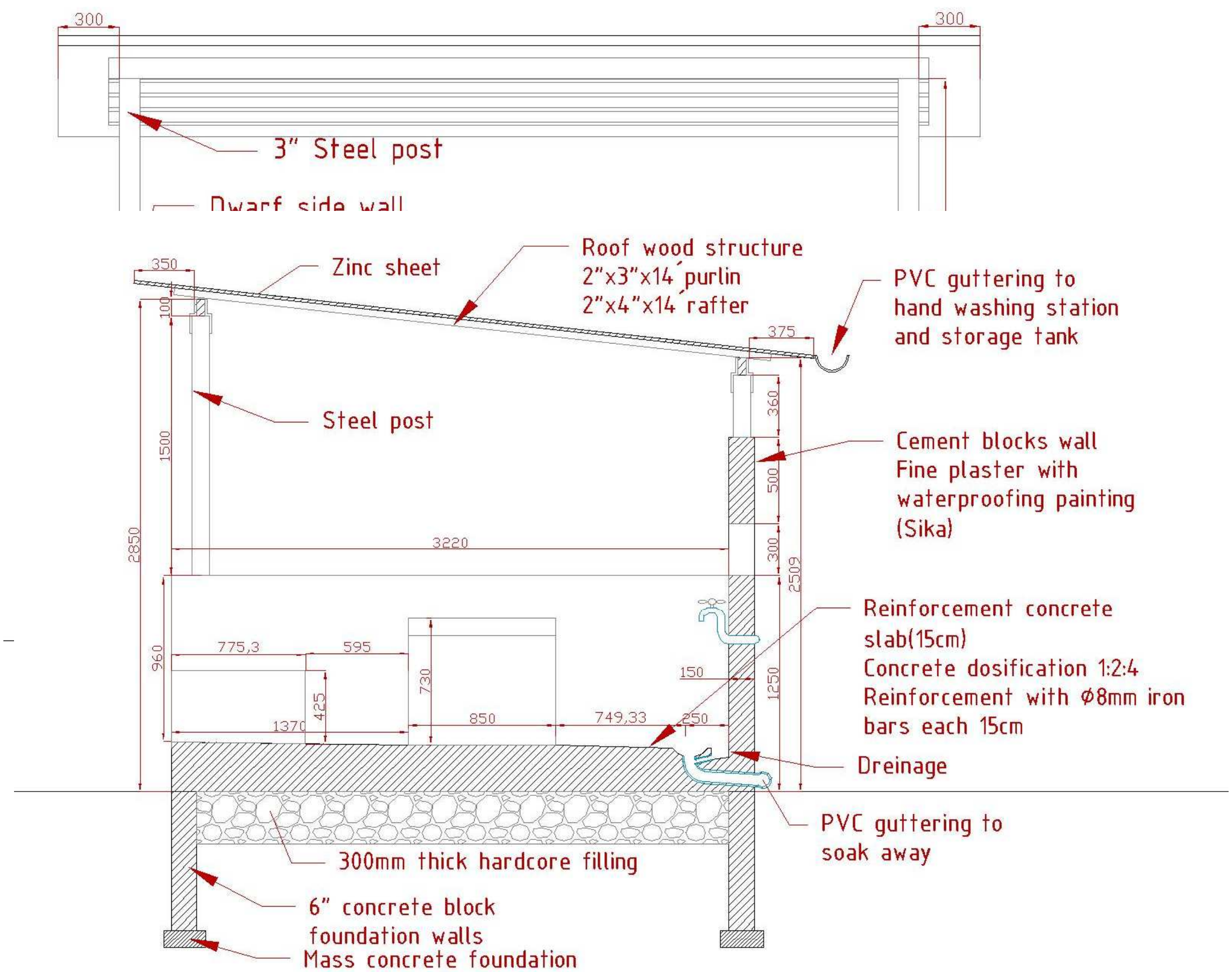


Figure 13: Typical Laundry Facility Design - Section



APPENDIX 4: Typical Placenta Pit Design

Figure 14: Typical Placenta Pit Design – Cross-Section, Total Depth – 2m.

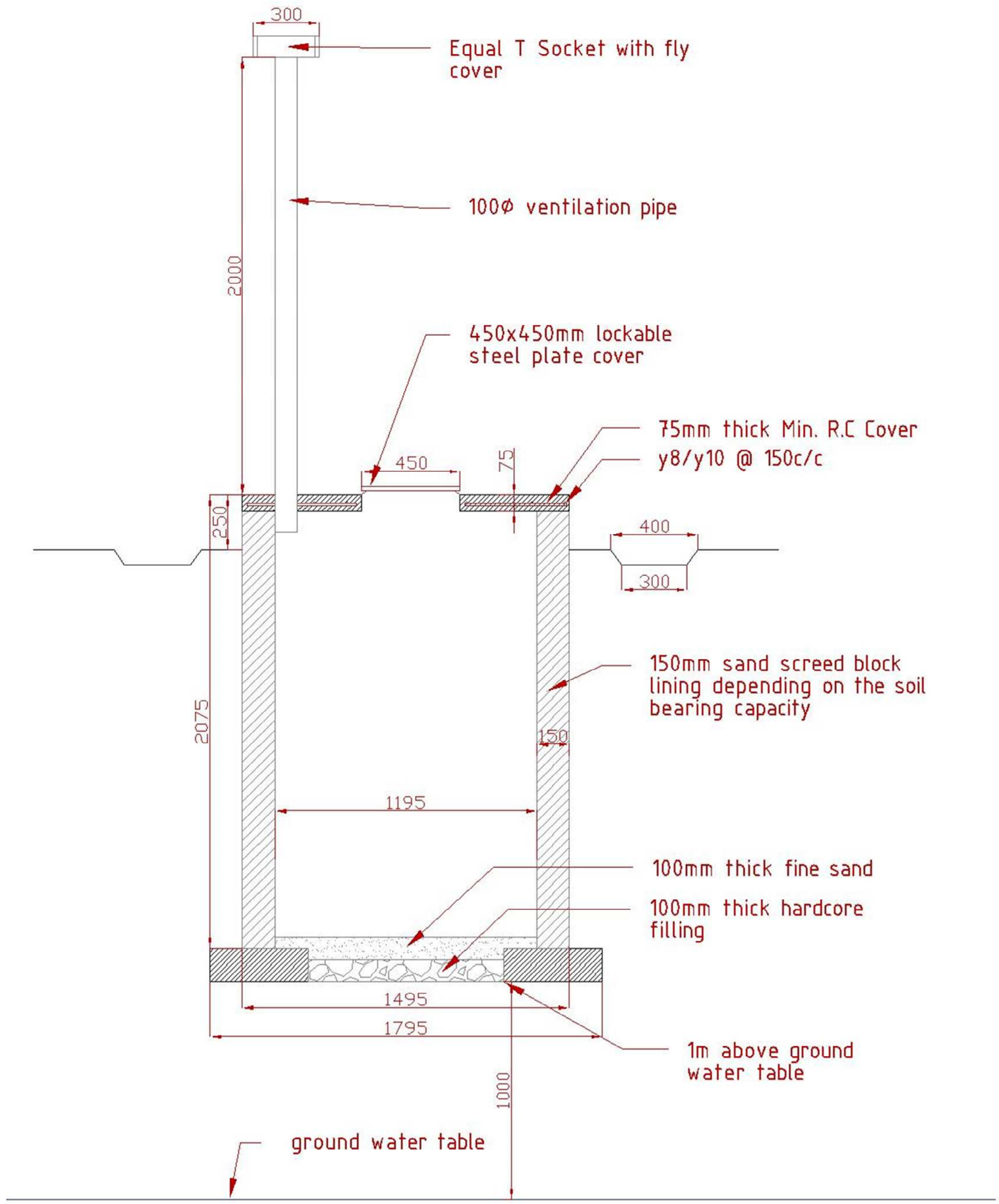


Figure 15: Typical Placenta Pit Design - Plan Views

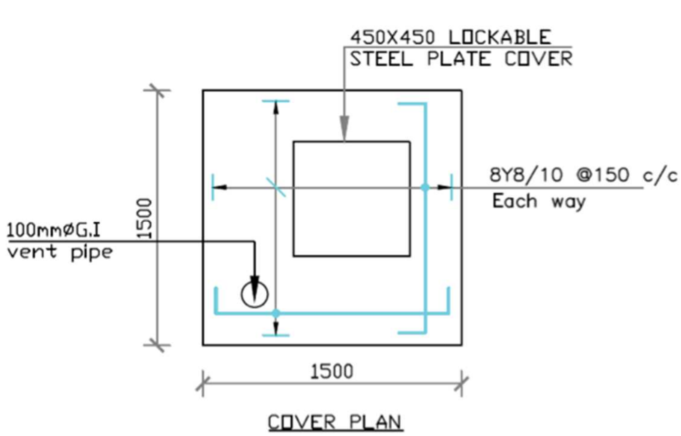
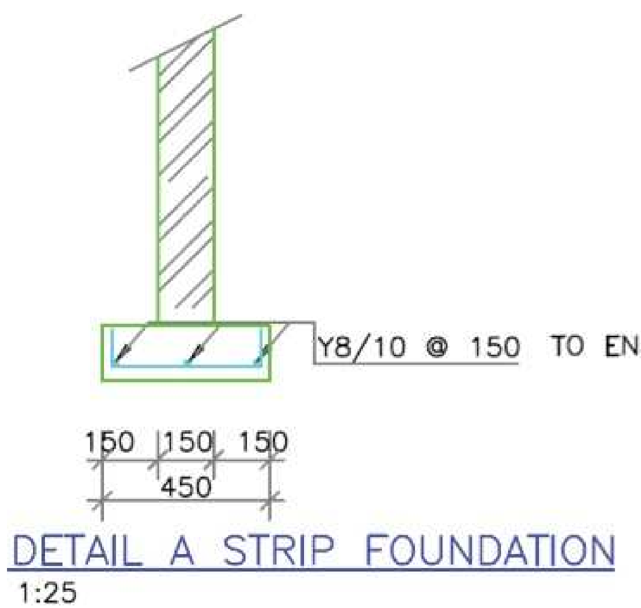


Figure 16: Typical Placenta Pit Design - Strip Foundation



APPENDIX 5: Typical Sharps Pit Design

Figure 17: Typical Sharps Pit Design – Cross-Section, Total Depth – 2m

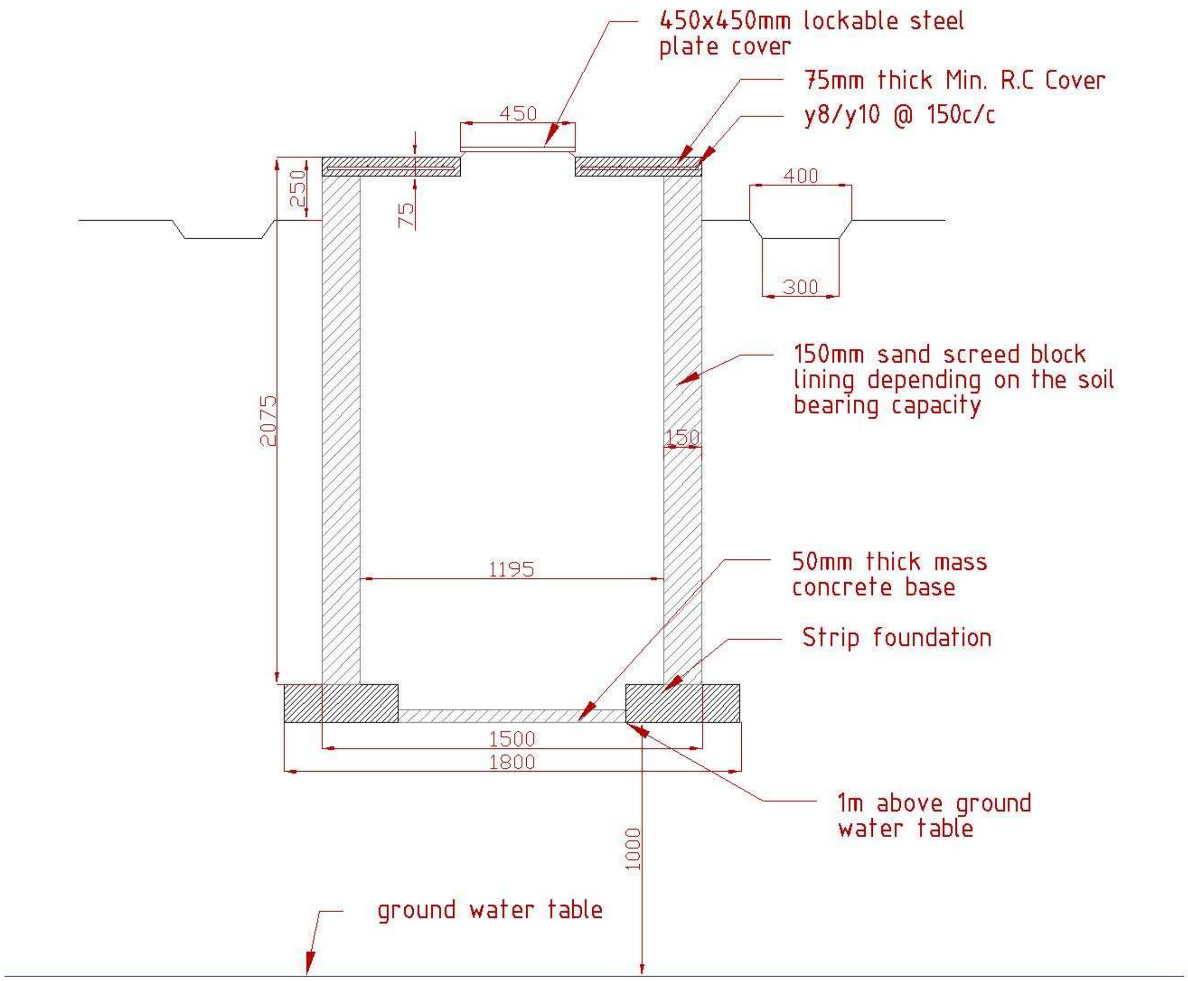


Figure 18: Typical Sharps Pit Design - Plan Views

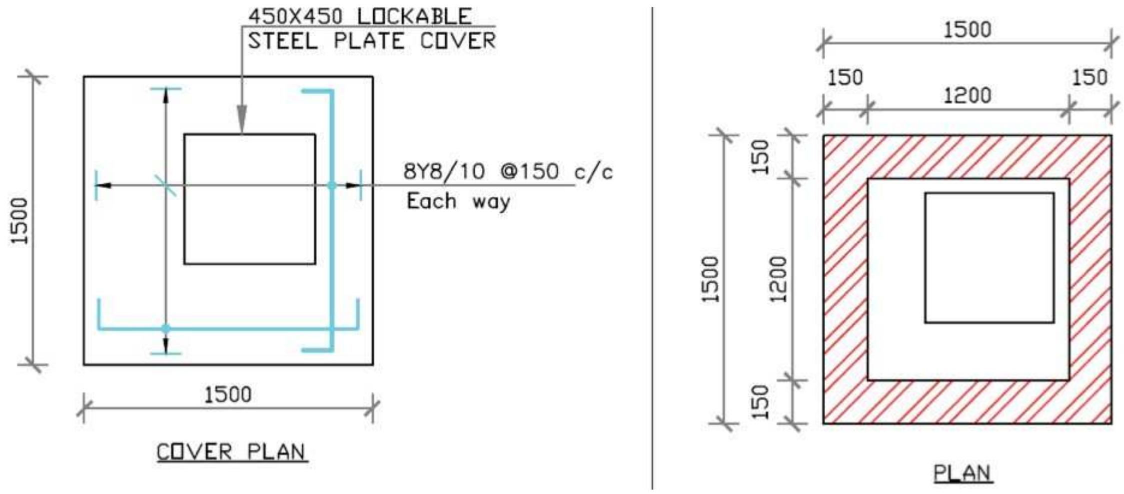
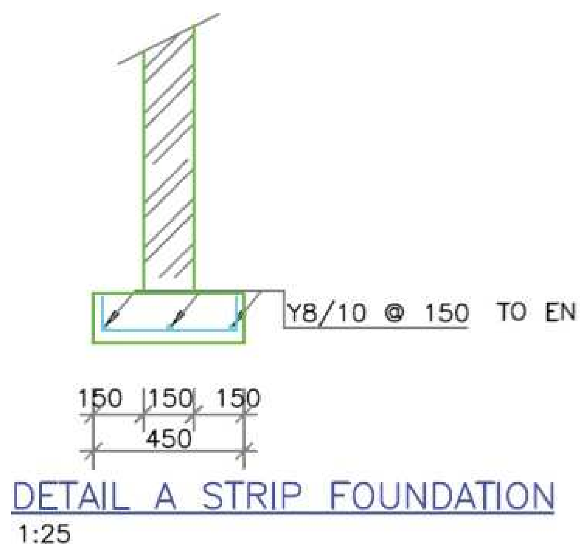


Figure 19: Typical Sharps Pit Design - Strip Foundation



APPENDIX 6: Typical Ash Pit Design

Figure 20: Typical Ash Pit Design – Cross-Section, Total Depth – 2m.

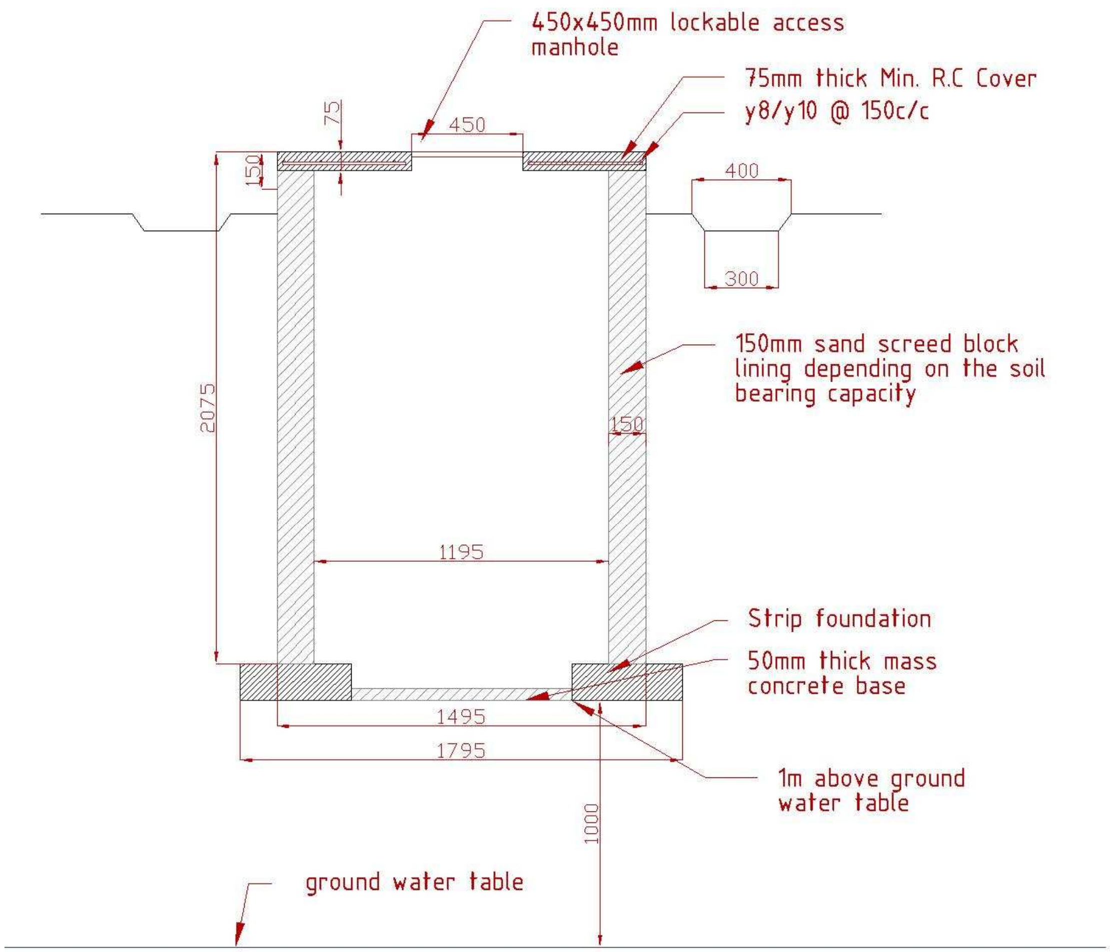


Figure 21: Typical Ash Pit Design - Plan Views

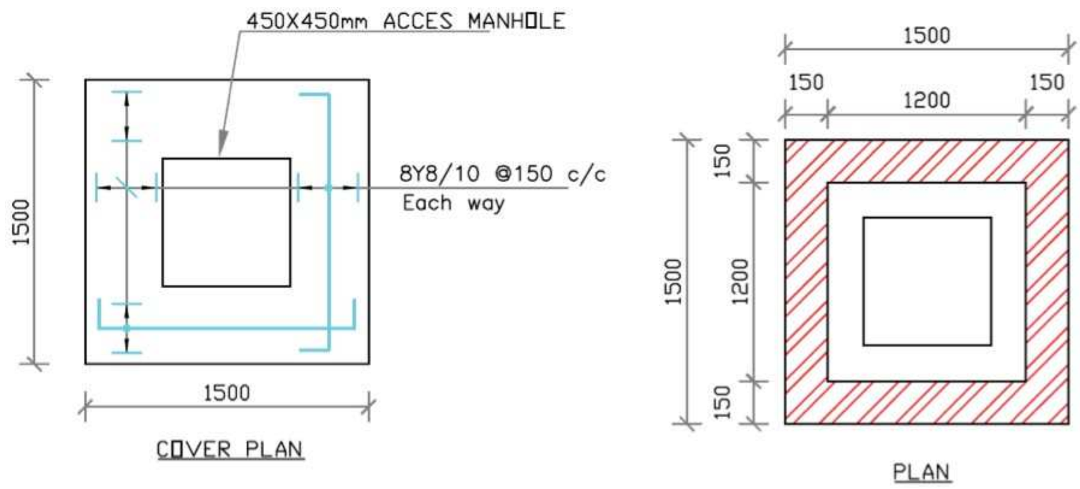
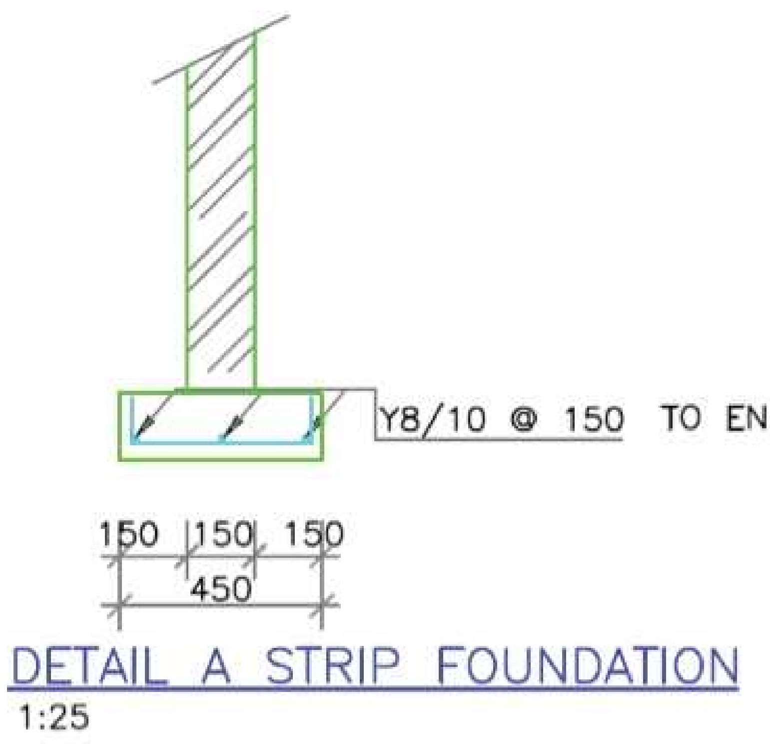


Figure 22: Typical Ash Pit Design - Strip Foundation



APPENDIX 7: De Montfort Mark 8a Incinerator

Introduction

This is the recommended incinerator for all but large hospitals.

The instructions which follow are meant to be used in all countries. The building instructions give the number and position of the bricks, but not the overall dimensions of the incinerator. This is because bricks differ slightly in size between one country and another, and it is simpler to adjust the overall size of the incinerator to the available bricks than to have to cut bricks to an exact dimension.

Similarly, only approximate dimensions of the steelwork are given. The correct procedure is to lay out the first two layers of bricks, and then measure the length and breadth of the steel which fits on top. The steel top can then be made to fit the finished brickwork.

The steel tunnel and ash door can also be dimensioned to fit the brickwork by taking measurements from the brickwork once the tunnel is formed in the first five layers of bricks.

Summary of characteristics

Use: designed especially for most healthcare facilities, except large hospitals (more than 300 - 400 beds)

Capacity: 12 kg/h

Lifespan (average)**:** 3-5 years
Approximate unit cost in USD (materials only): 250 - 1'000 depending on the availability of refractory bricks

Time necessary to build: 3-4 days

Remarks: Where the load to be burned consists almost entirely of sharps boxes filled with used hypodermics, special conditions apply:

1. The plastic in the syringes has a very high calorific value and additional fuel will not be required after the initial warm up period.
2. Boxes should be introduced one at a time. There will be a brief delay, then an increase in smoke level followed by a gradual decrease. The next box should be introduced when the smoke level is observed to be decreasing.
3. Tests have shown that this means that boxes of up to 100 syringes can be burned at a rate of about one every 10 minutes.
4. Introducing boxes at a higher rate than this will result in very high smoke rates and molten plastic at the base of the incinerator.

List of materials

TABLE 6.

ITEM	DIMENSIONS	QUANTITY
Fire bricks		200 (approx.)
Sand		200 kg
Fire cement (high alumina)		50 kg
Rolled steel angle (mild steel)	30x30x3mm thick	12 meters
Rolled steel channel (mild steel)	100x40x5mm thick	4 meters
Flat sheet (mild steel) for loading door	600 x 750 x 3mm	1 sheet
Flat sheet (mild steel) for ash door	250 x 250 x 3mm	1 sheet
Flat sheet (mild steel) for chimney spigot support	250 x 150 x 3mm	1 sheet
Mild steel pipe	150mm diameter x 3mm thick (approx.)	4 meters
Hinges for ash door		
Pipe, for loading door hinge	1 inch	1
Rod, for loading door hinge	3/4 inch	1
Masonry plugs (rawlplugs), srews, etc.	no 10	16
Welding rods (mild steel)		40
Steel cable (optional)	5 mm 7 strand	40 meters
Turnbuckles (optional)	M8 x 150 mm long	4 (not essential)
Wire Mesh (optional)	Any fine gauge	loose fill
Fuel tank, tap and pipe (optional)		1 set

Note:

If required, the incinerator body can be clamped together with steel bars. It can also be surrounded by an outer case of common bricks to give extra strength and weather protection. In this case, the two thicknesses of brick should be “capped” with cement. Materials should be obtained before starting the construction!

Figure 23: De Montfort incinerator Mark 8a

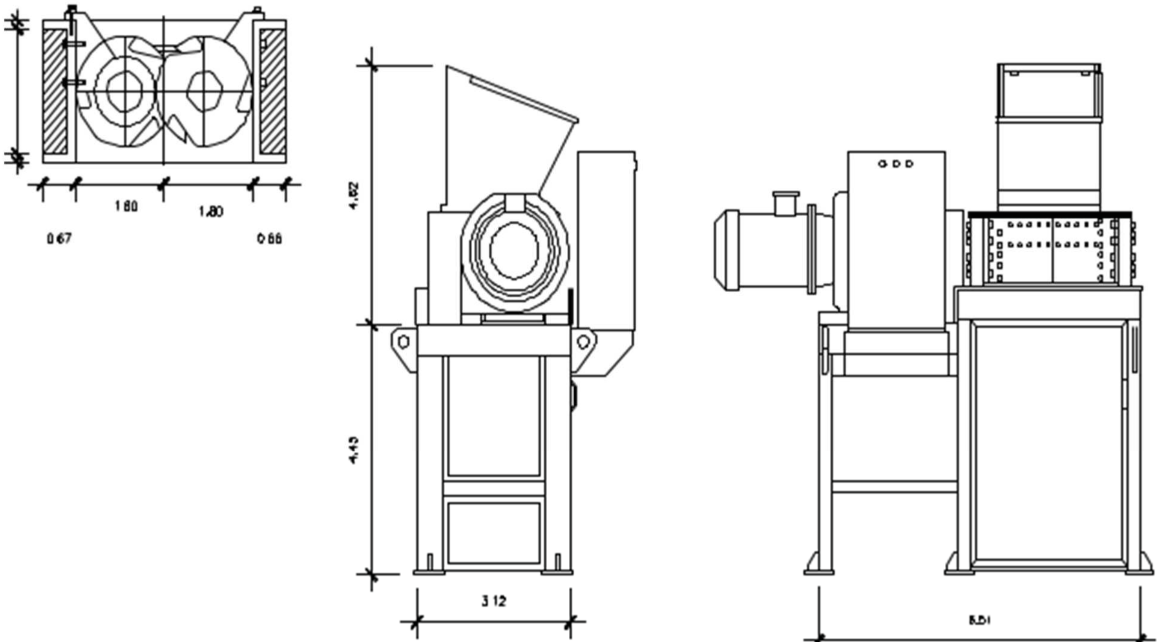
WASTE TYPES REQUIRING INCINERATION:

- Medical waste, disposable syringes, used infusion sets, cotton yarn, operating room, residual limbs, waste rubber gloves, protective clothing, infectious hospital bed supplies, etc.

DESIGN BASIS (hospitals only):

- Furnace body type: Vertical closed furnace combustion chamber.
- Burning capacity: 100–120kg/time (daily burn 3–6 times, each lasting about 1 hour).
- Ignition manner: automatic.
- Fuel type: 0# or-10# diesel.
- Feeding mode: Solid waste manual feeding.
- Take ash manner: manual.
- Furnace inner pressure: adopt negative pressure design, no back-fire,
- —3~—10mmH2O.
- Design heat value: waste mix 1,500 kcal/kg ~2,500 kcal/kg, 0# diesel 10,000 kcal/kg.
- Flue gas treatment manner: Gasification combustion chamber (first combustion chamber) + blower + mixed combustion chamber + high temperature secondary combustion chamber + flue gas purification room (calcium hydroxide filter brick) +exhaust fan + independent chimney.
-
- Burning temperature: First combustion chamber: 600–800^{o}C
- Secondary combustion chamber:1,500^{o}C
- Flue gas residence time≥2s
- Combustion efficiency: ≥99.99%.
- Incinerator during operation to ensure system is in negative pressure condition, avoid harmful gas escape.
- Glue gas discharge standard GB18484–2001< hazardous waste incineration pollution control standards.

Figure 24: Low-Speed Shredder



Elevation

Elevation

Figure 25: Pyroltyic HCW Management Incinerator

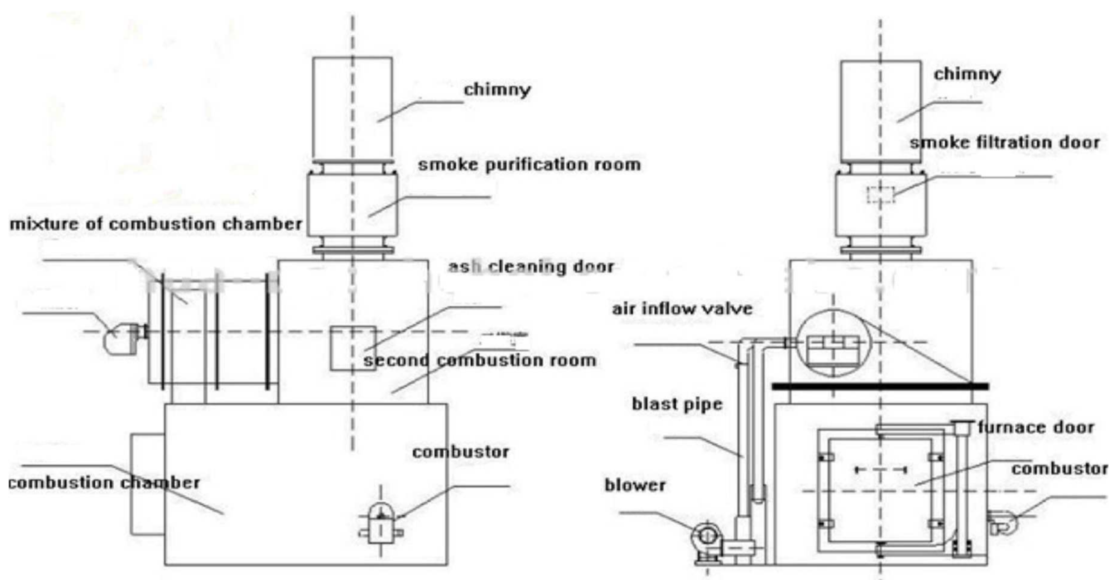


Figure 26: Autoclave Unite for HCW Management

Notes:

Chamber Capacity = 0.241m3

Jacket Capacity= 0.016m3

Minimum Safe

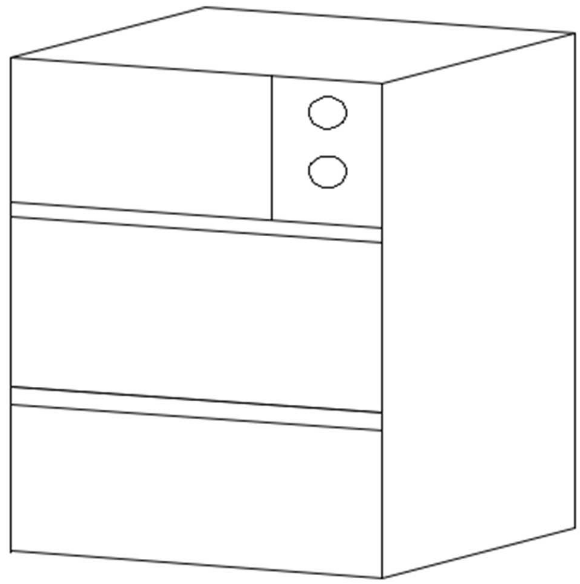
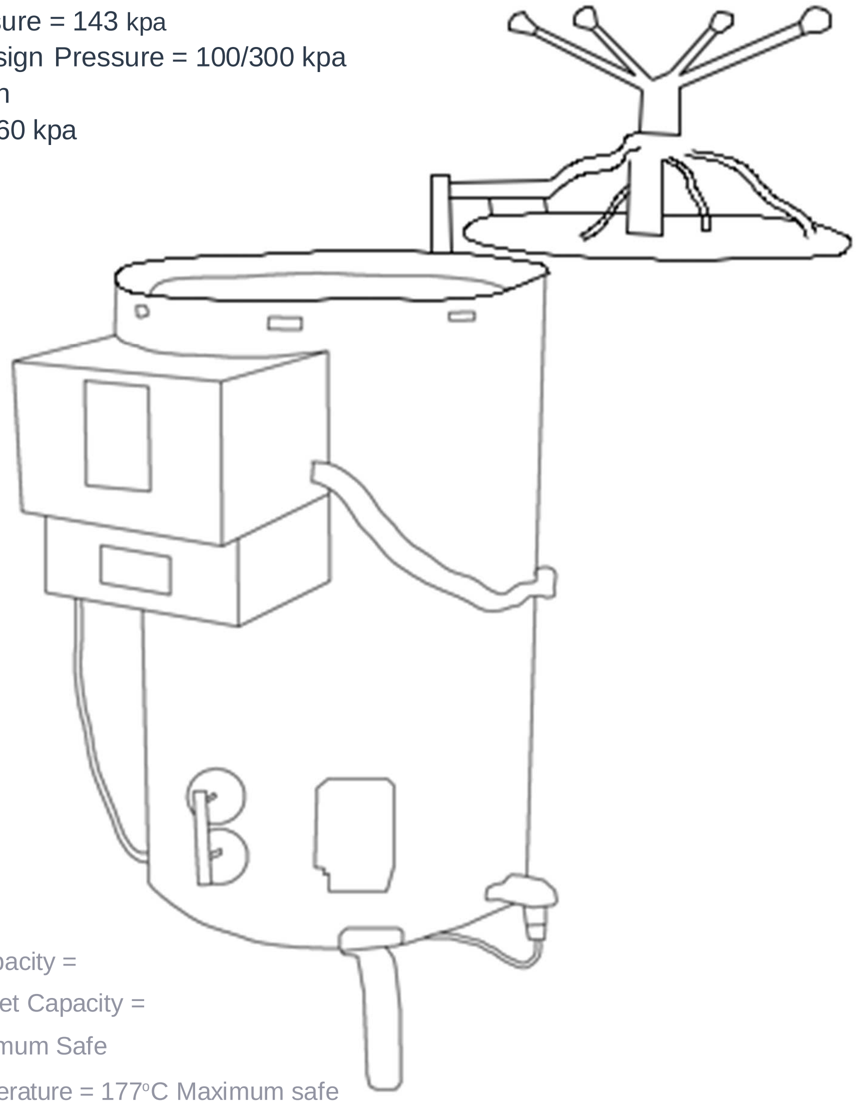


Figure 27: Cyclic Autoclave Unit for HCW Management

Design Temperature = 177°C
Maximum Safe
Design Pressure = 143 kpa
Chamber Design Pressure = 100/300 kpa
Jacket Design
Pressure = 360 kpa



Notes:

Chamber Capacity =
0.241m^3 Jacket Capacity =
0.016m^3 Minimum Safe
Design Temperature = 177°C Maximum safe
Design Pressure = 143 kpa Chamber Design
Pressure = 100/300 kpa
Jacket Design
Pressure = 360 kpa

1. A
ll waste management area must be covered to prevent rains and direct sun ray penetration.

APPENDIX 8: Typical Shower Block Design, PHUs

Figure 28: Typical Shower Block Design - Plan

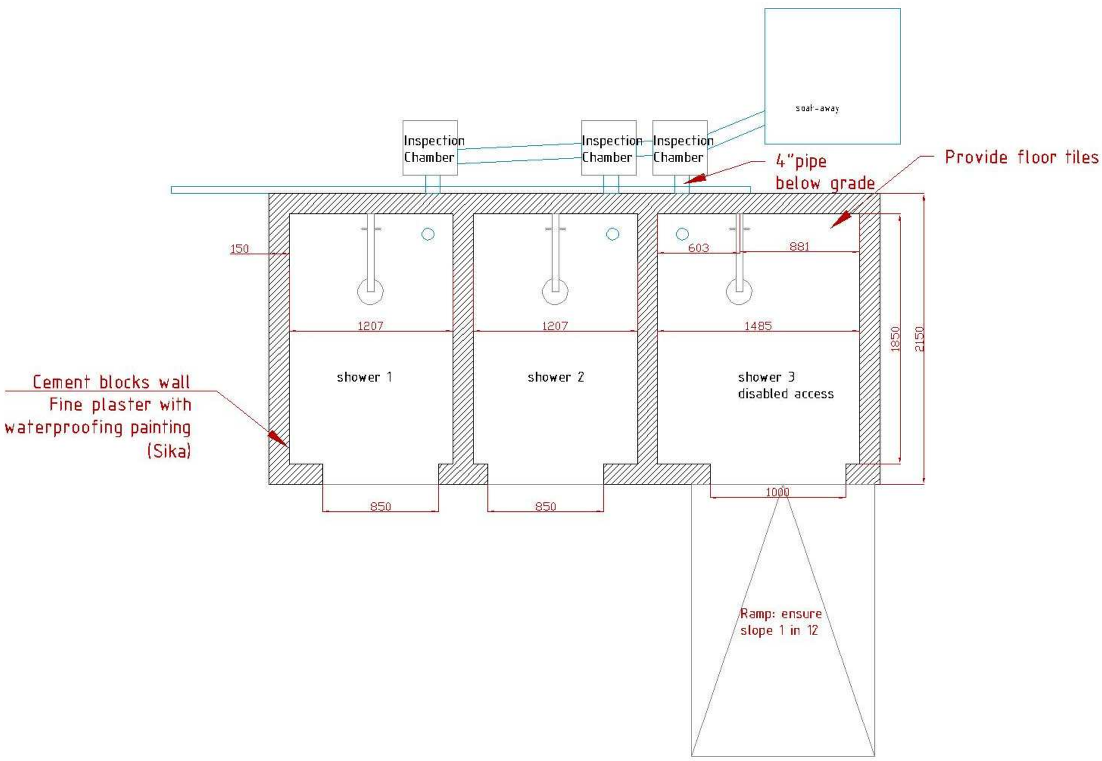


Figure 29: Typical Shower Block Design - Front Elevation

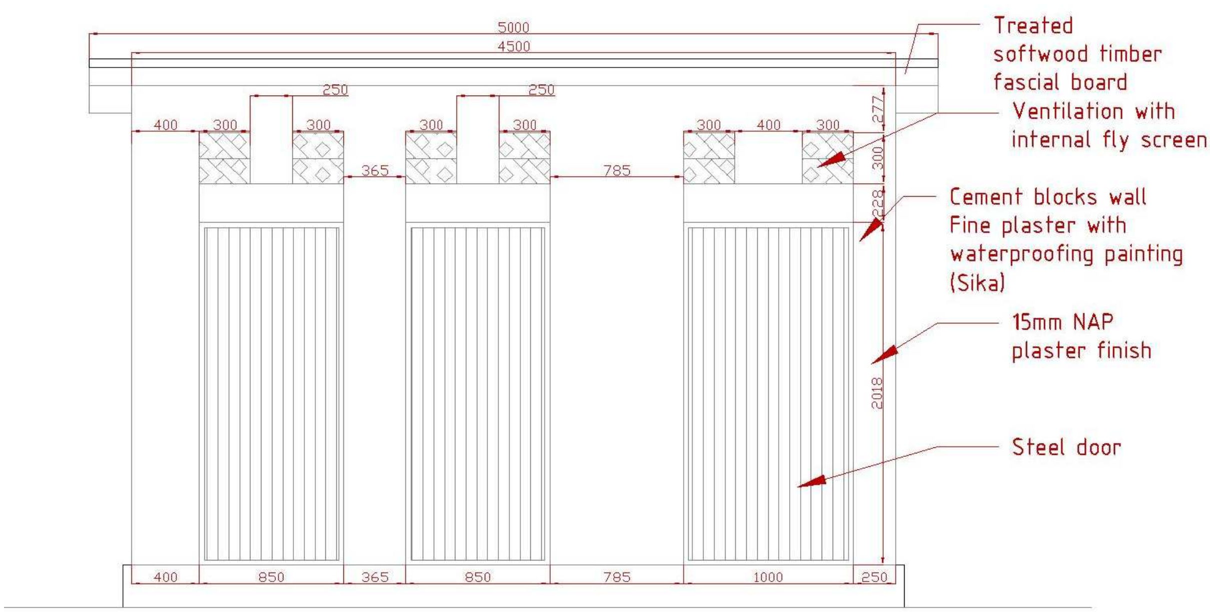


Figure 30: Typical Shower Block Design – Transversal Section

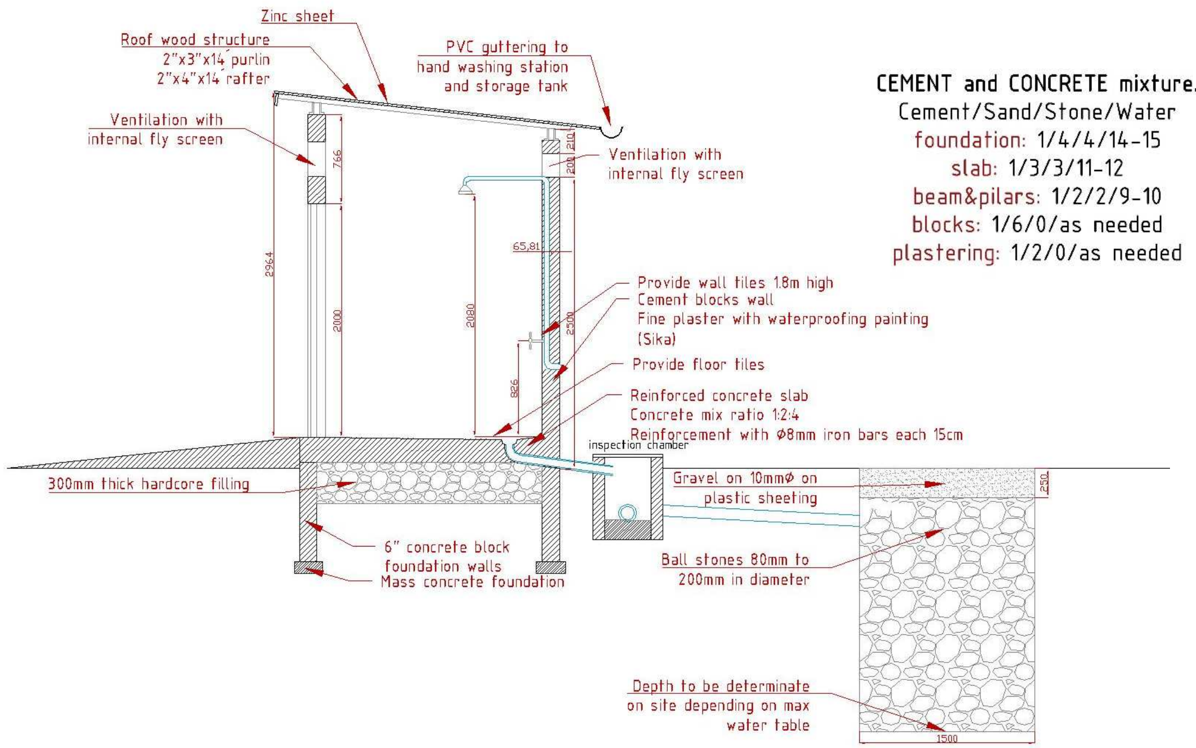
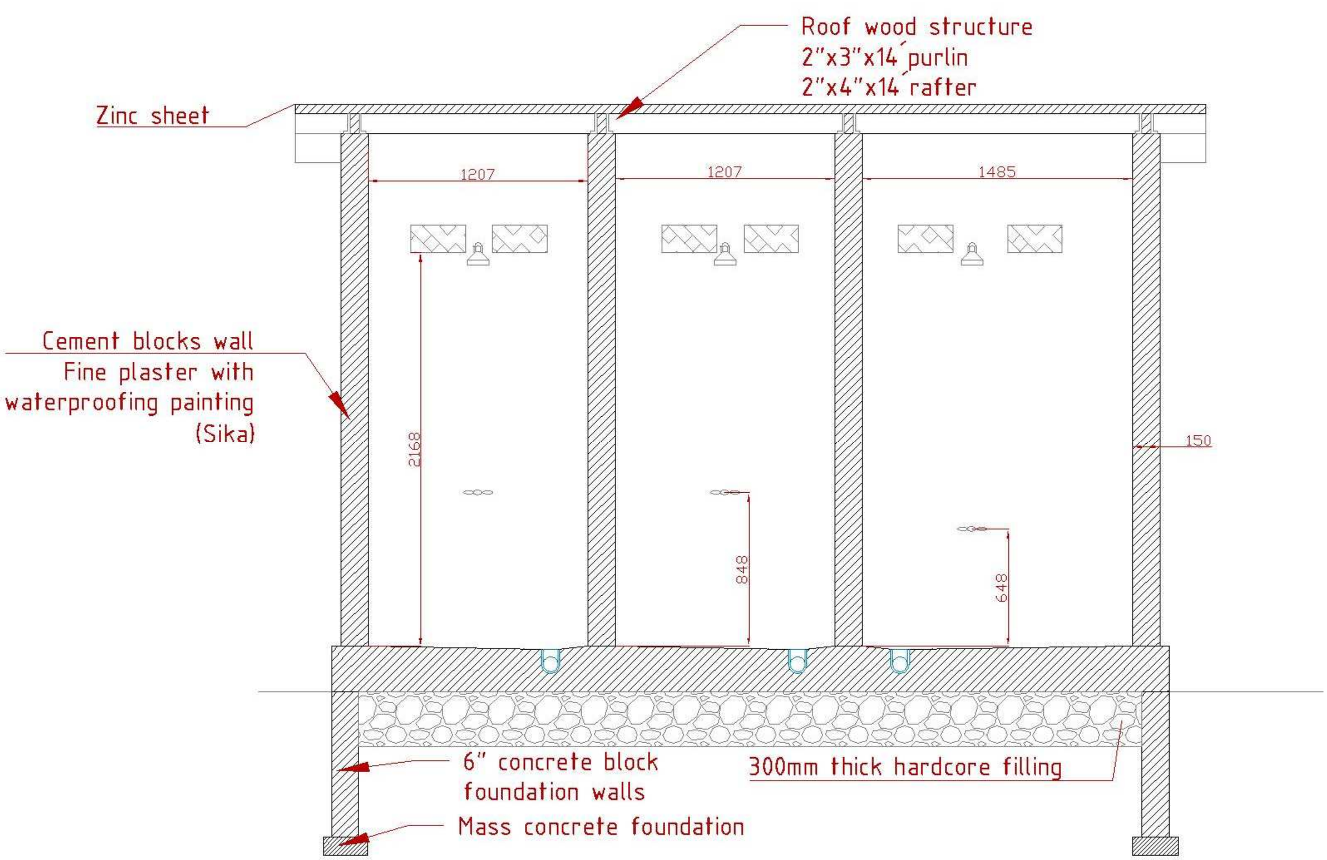


Figure 31: Typical Shower Block Design –Front Section



APPENDIX 9: Typical Waste Management Area/ Facility Size, Layout, PHUs

Figure 32: Typical Waste Management Area/Facility Size. Floor Plan

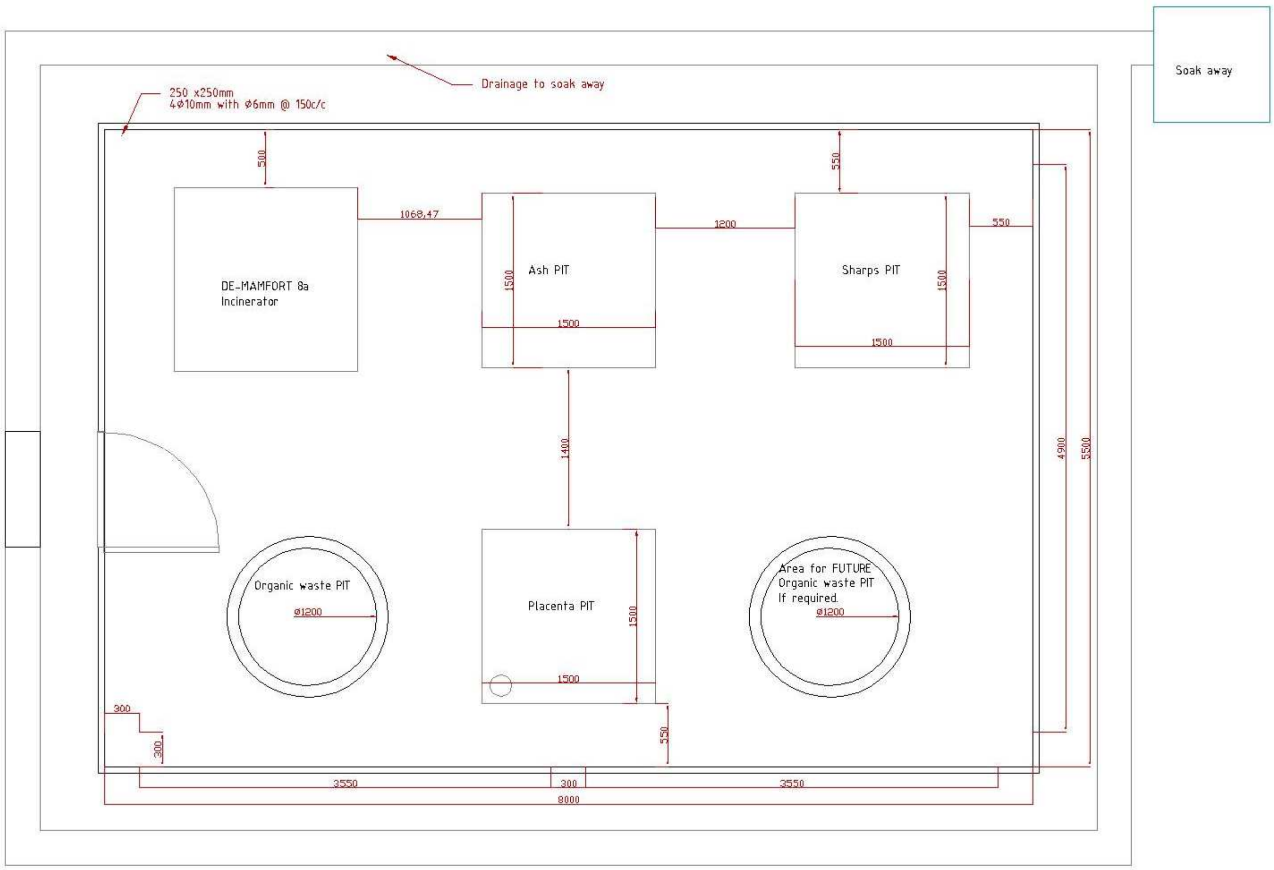


Figure 33: Typical Waste Management Area/Facility Size, Front Elevation

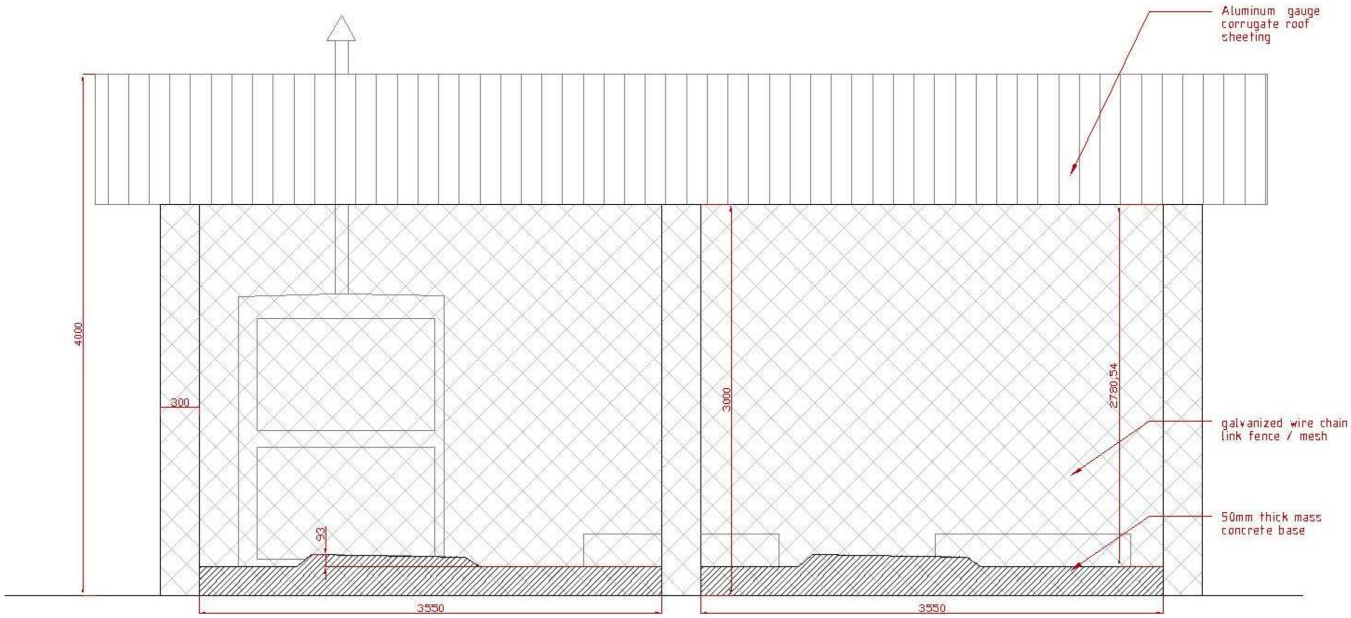
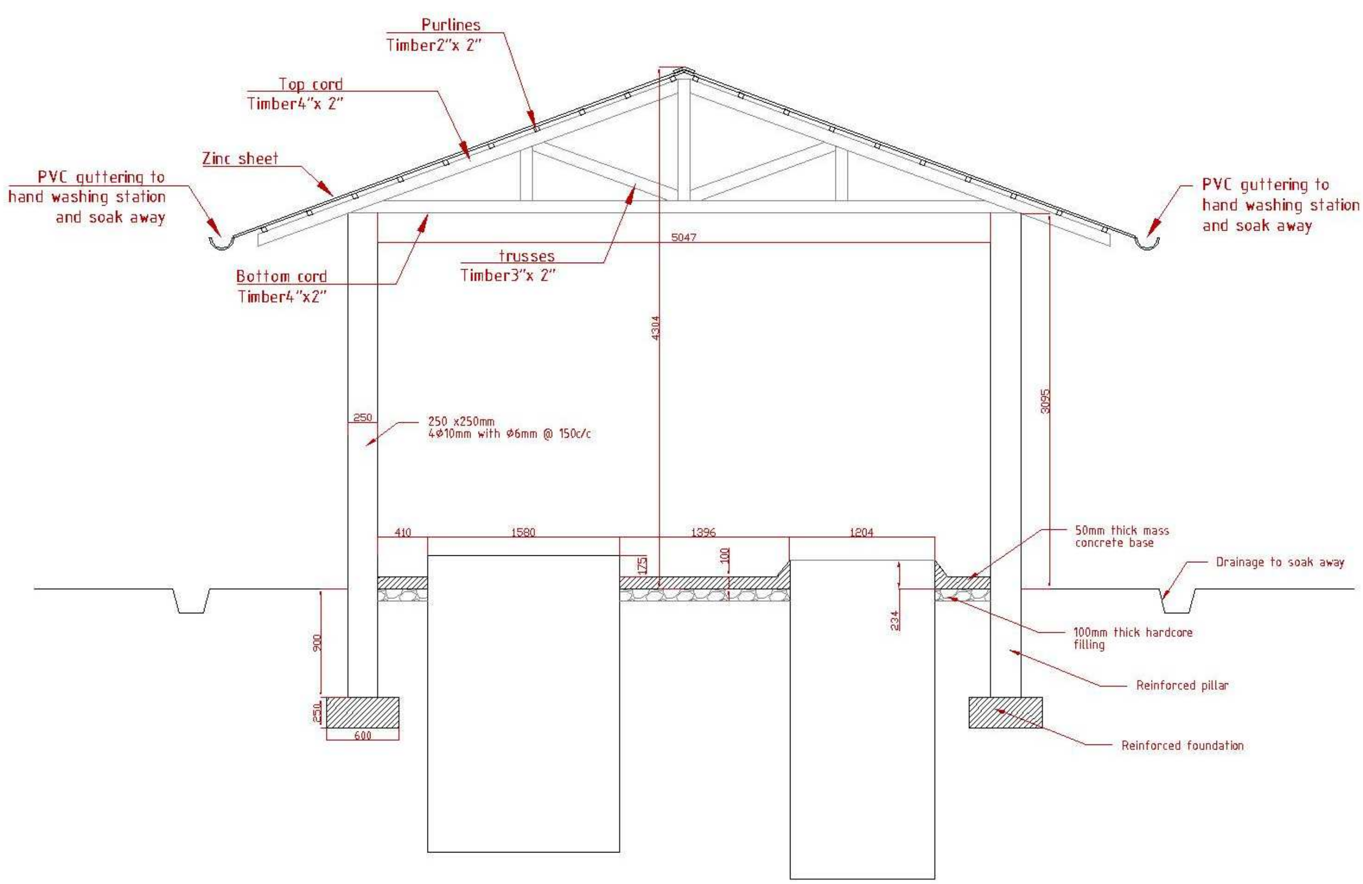


Figure 34: Typical Waste Management Area/Facility Size, Section



APPENDIX 10: Typical Water and Solar Panels Tower Design

Figure 35: Typical Water and Solar Panels Tower Design – Foundations, Slab, Tank, and Panels Plan

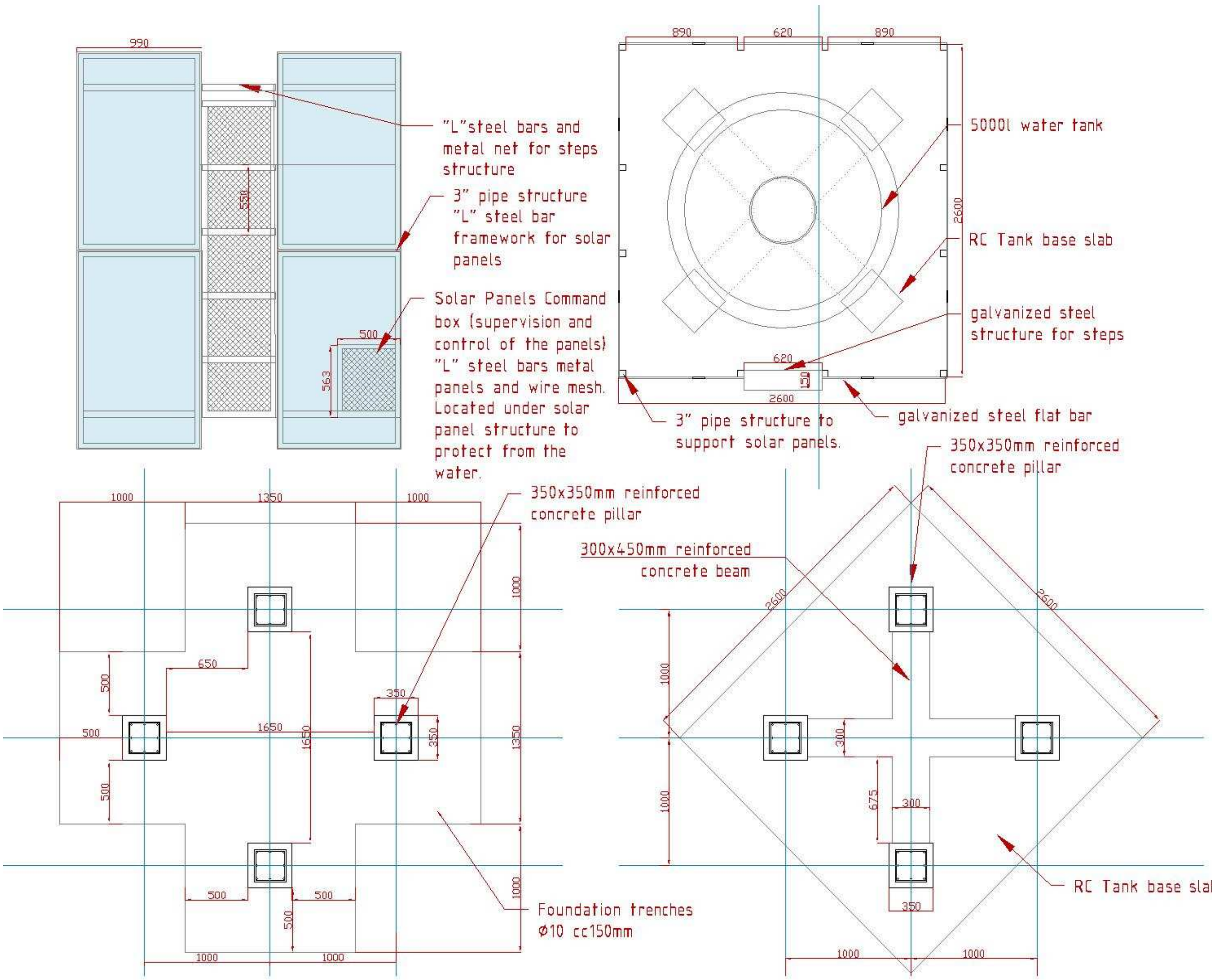


Figure 36: Typical Water and Solar Panels Tower Design – Details

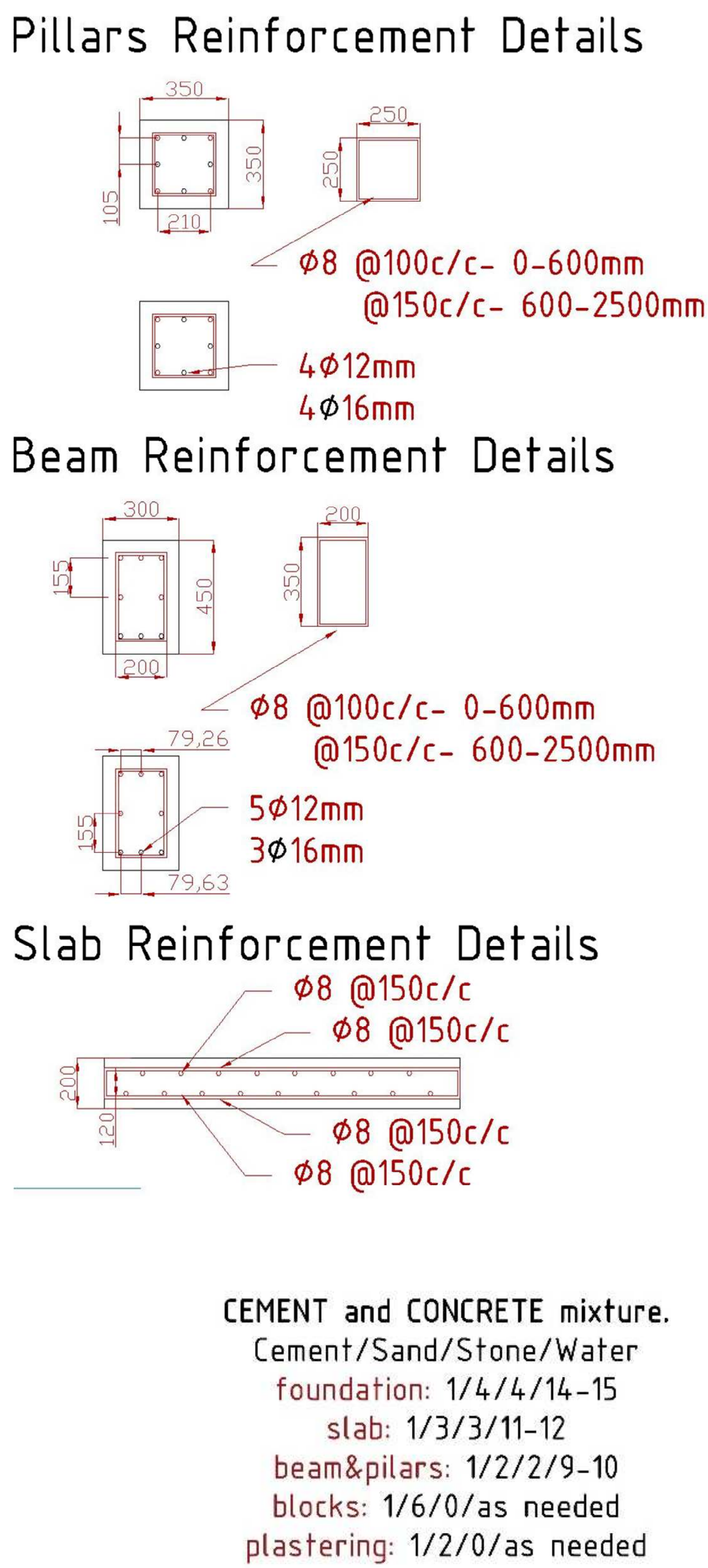


Figure 37: Typical Water and Solar Panels Tower Design – Elevations

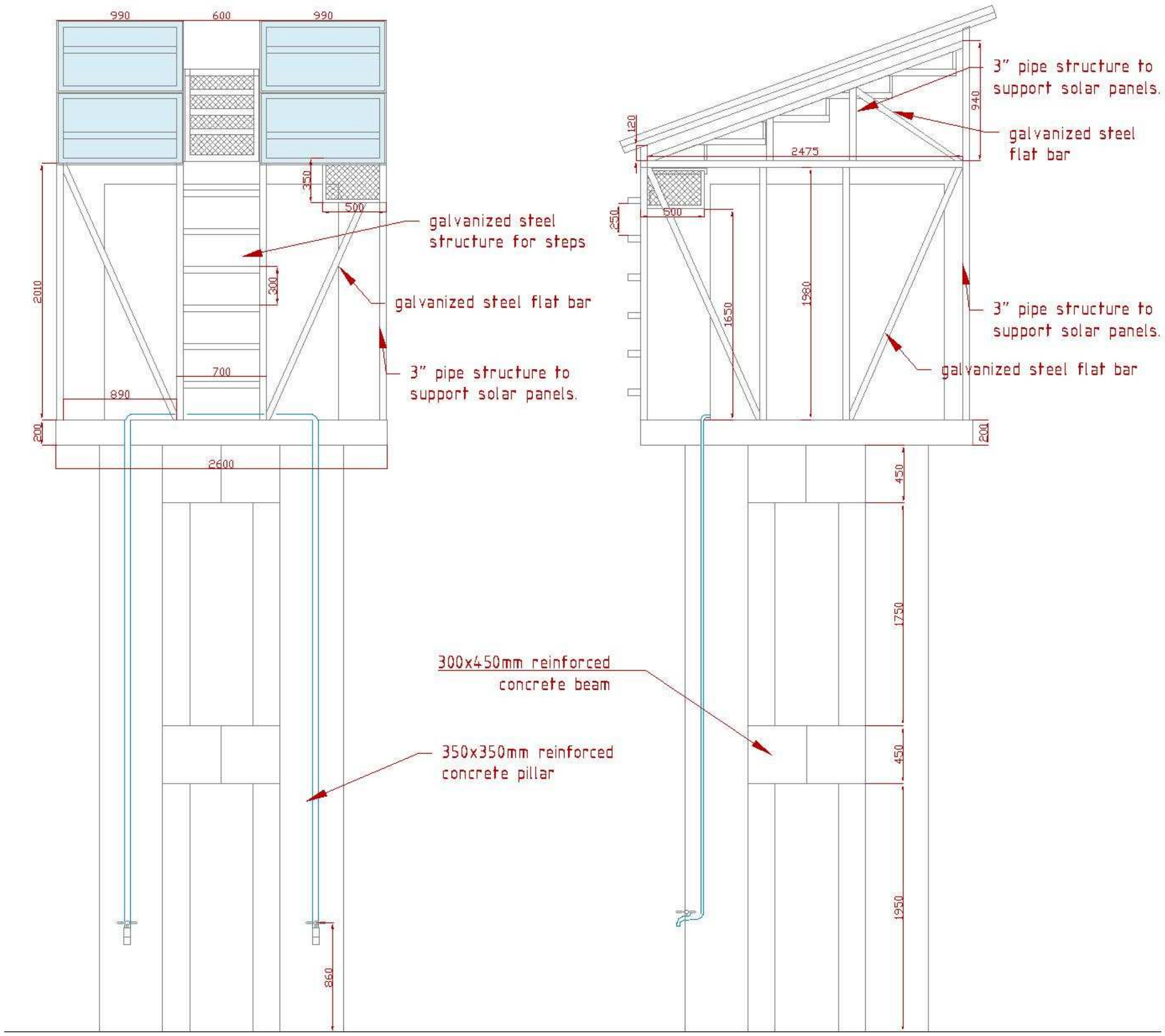
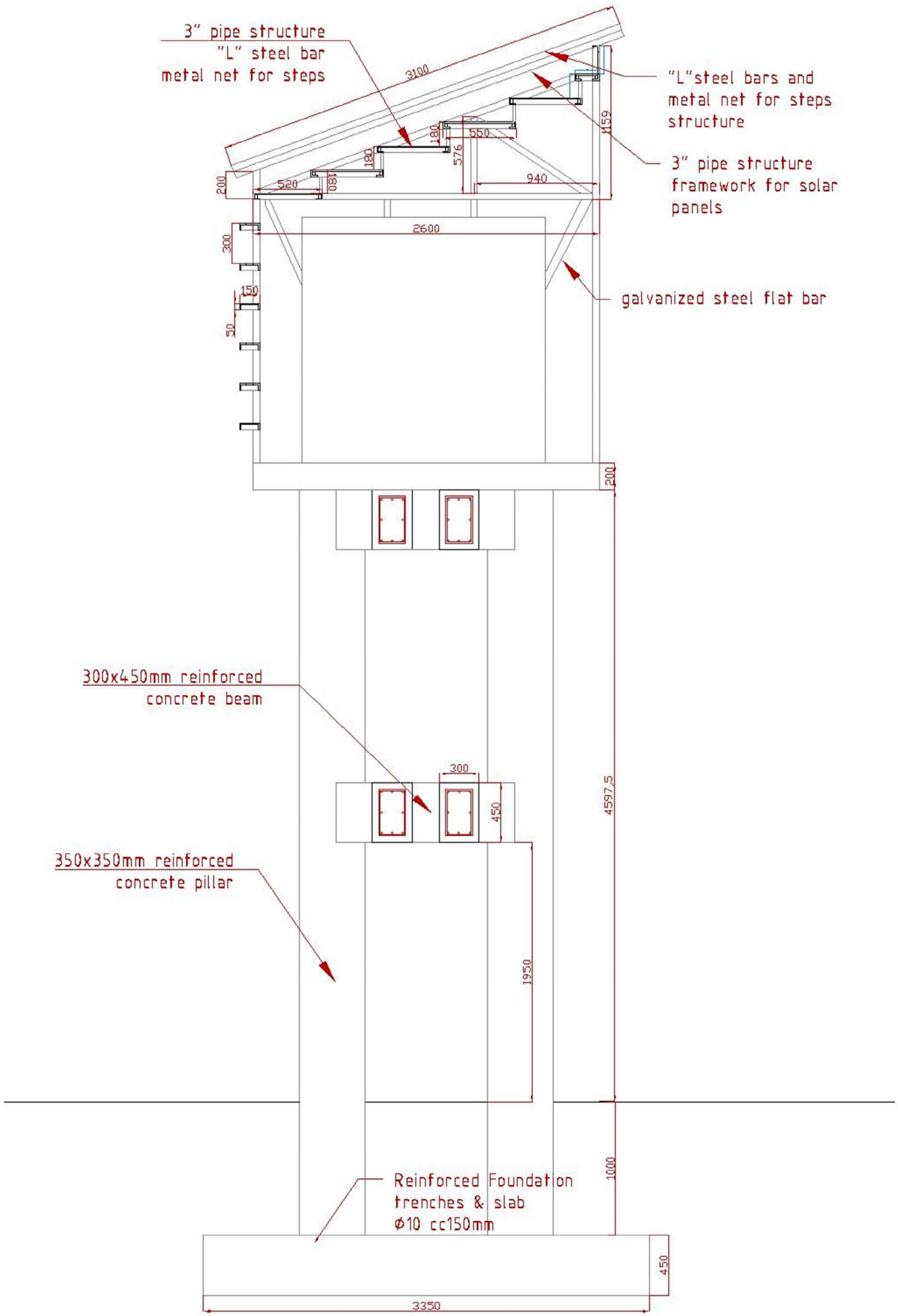


Figure 38: Typical Water and Solar Panels Tower Design – Section



APPENDIX 11: Typical Isolation Unit & Screening Area Design, CHCs

Figure 39: Typical Isolation Unit & Screening Area Design - Floor Plan

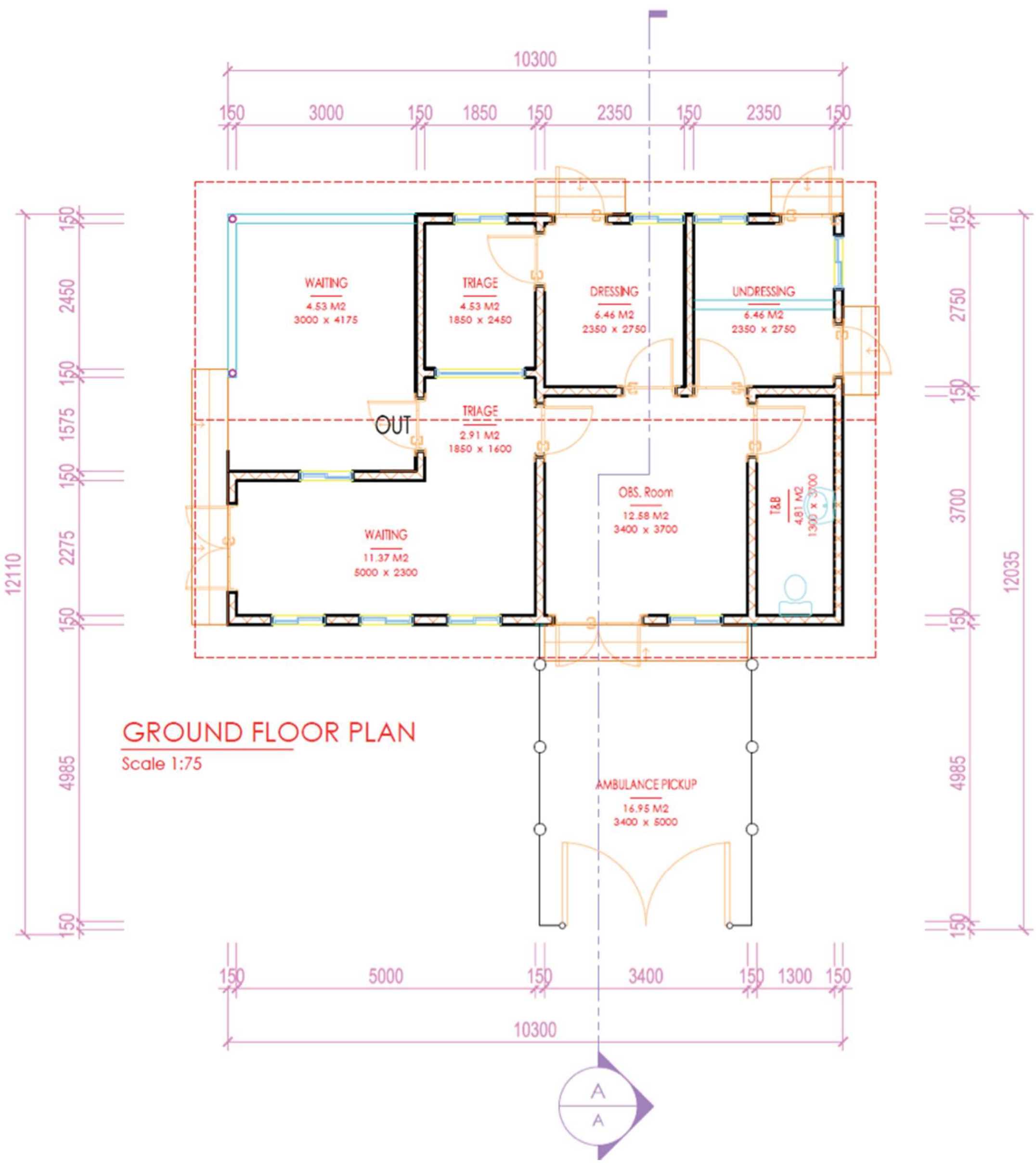


Figure 40: Typical Isolation Unit & Screening Area Design - Section A-A

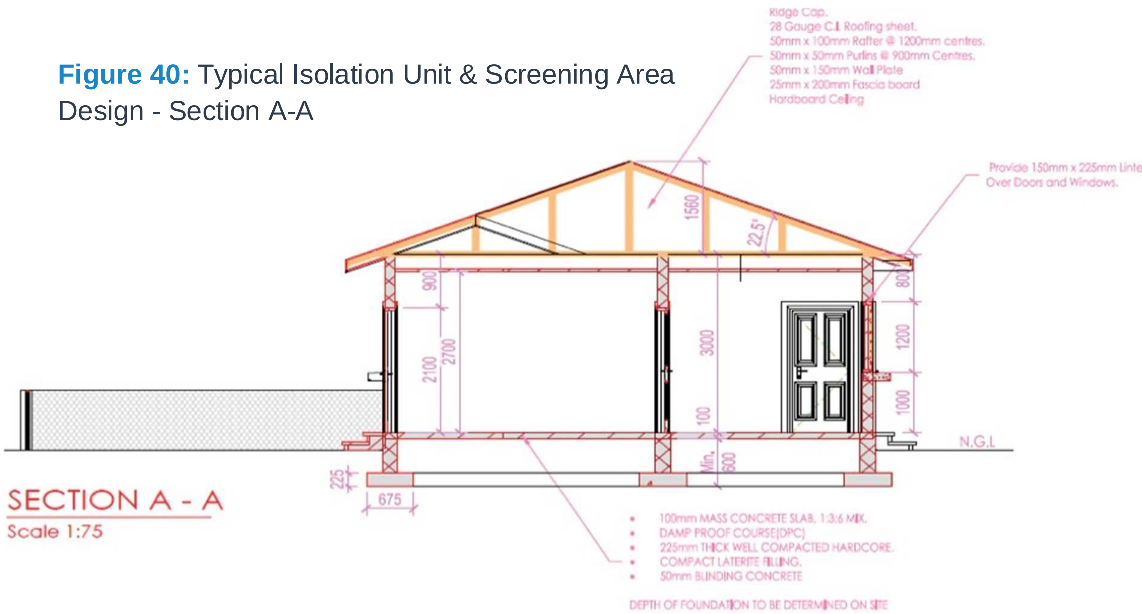


Figure 41: Typical Isolation Unit & Screening Area Design - Right Elevation

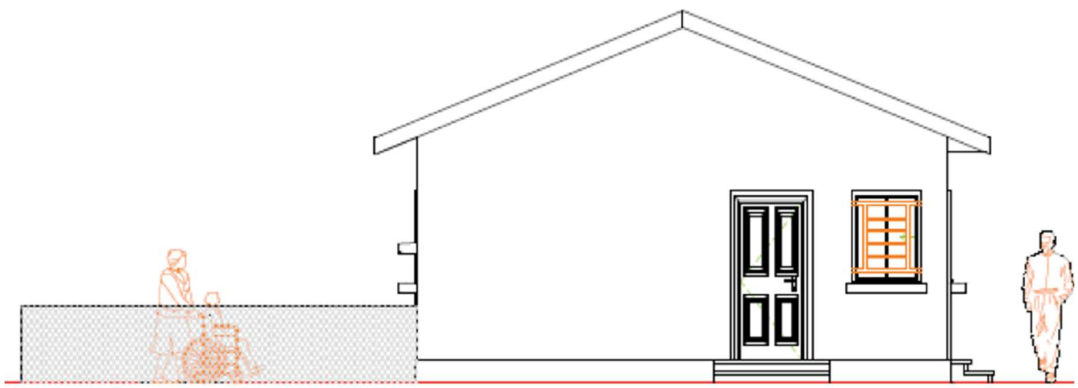


Figure 42: Typical Isolation Unit & Screening Area Design - Left Elevation

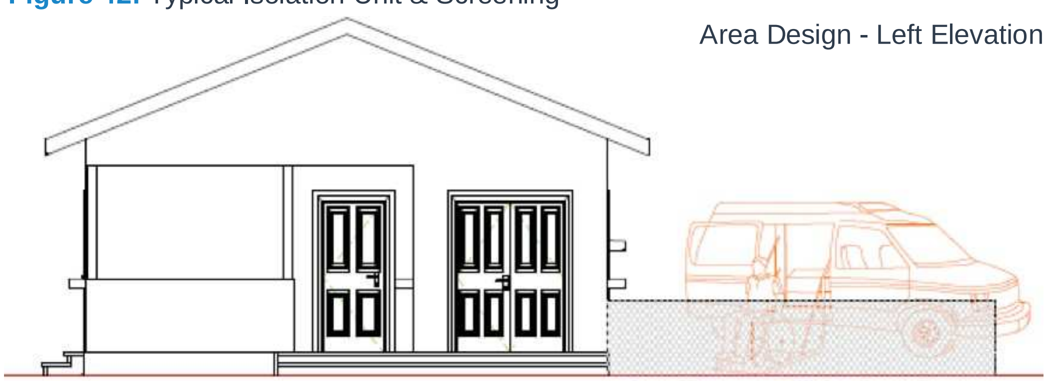


Figure 43: Typical Isolation Unit & Screening Area Design - Front Elevation

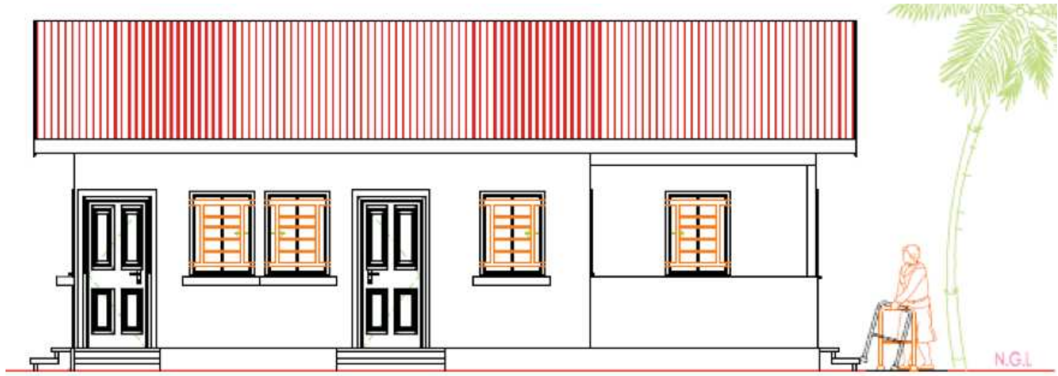
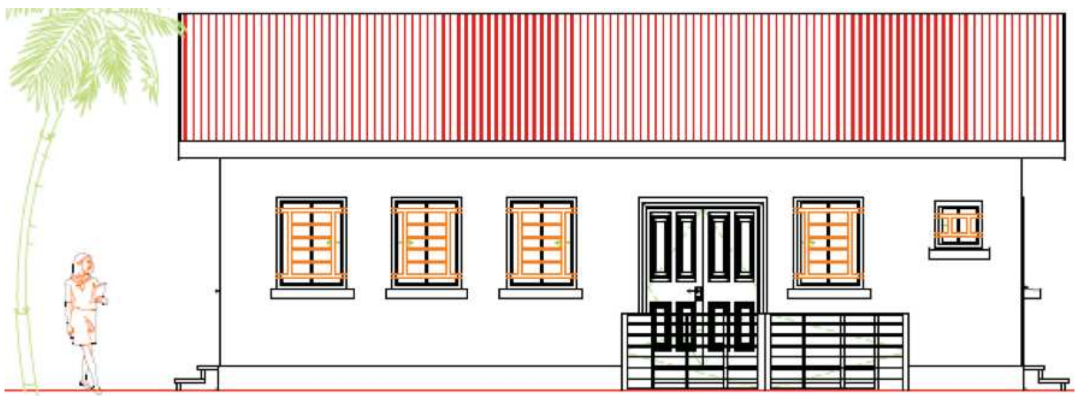


Figure 44: Typical Isolation Unit & Screening Area Design - Rear Elevation



APPENDIX 12: Typical Site Plan for CHPs, MCHPs, and Small Health Centers

Figure 45: Typical Layout and Required Water and Sanitation Distances (CHPs & MCHPs)

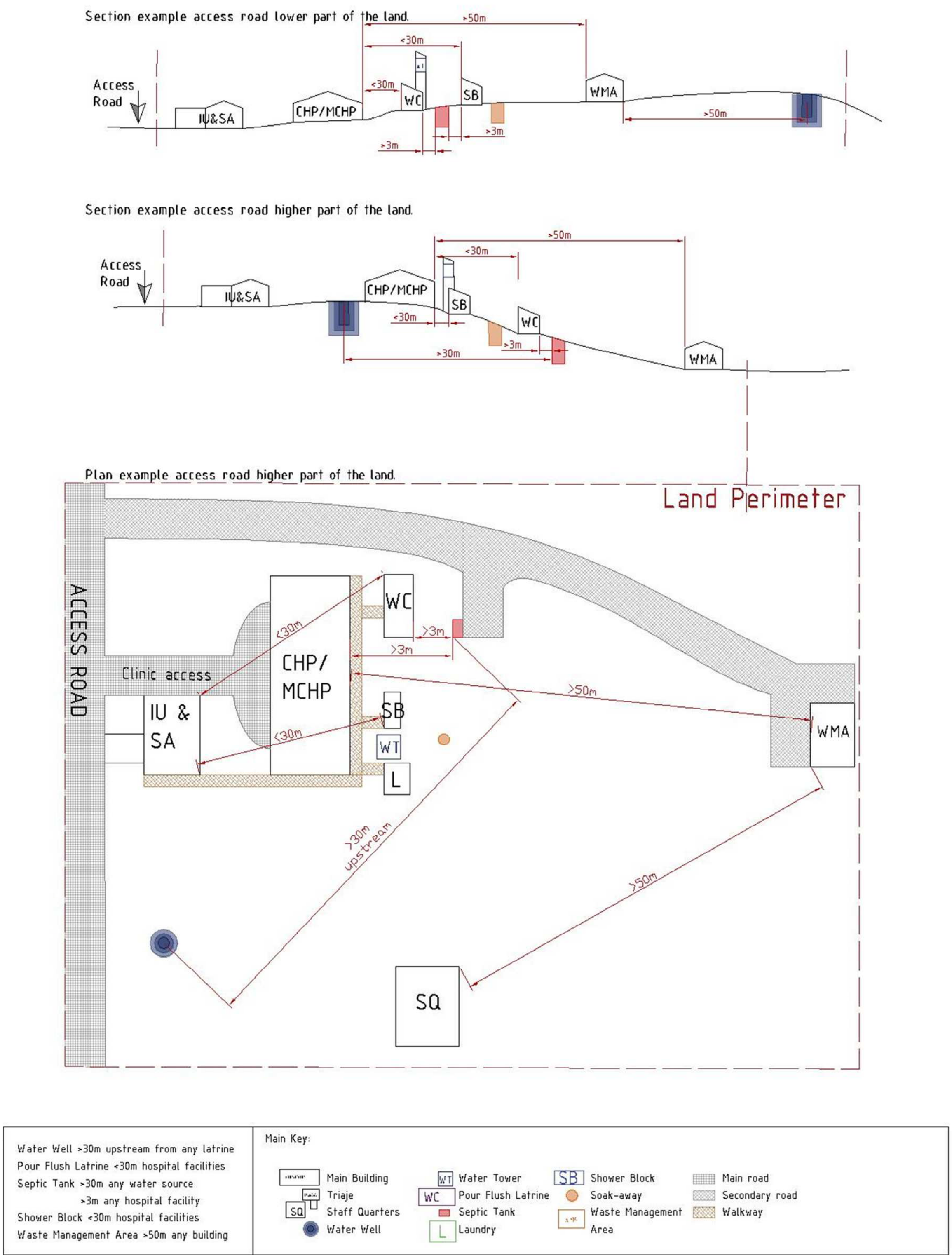
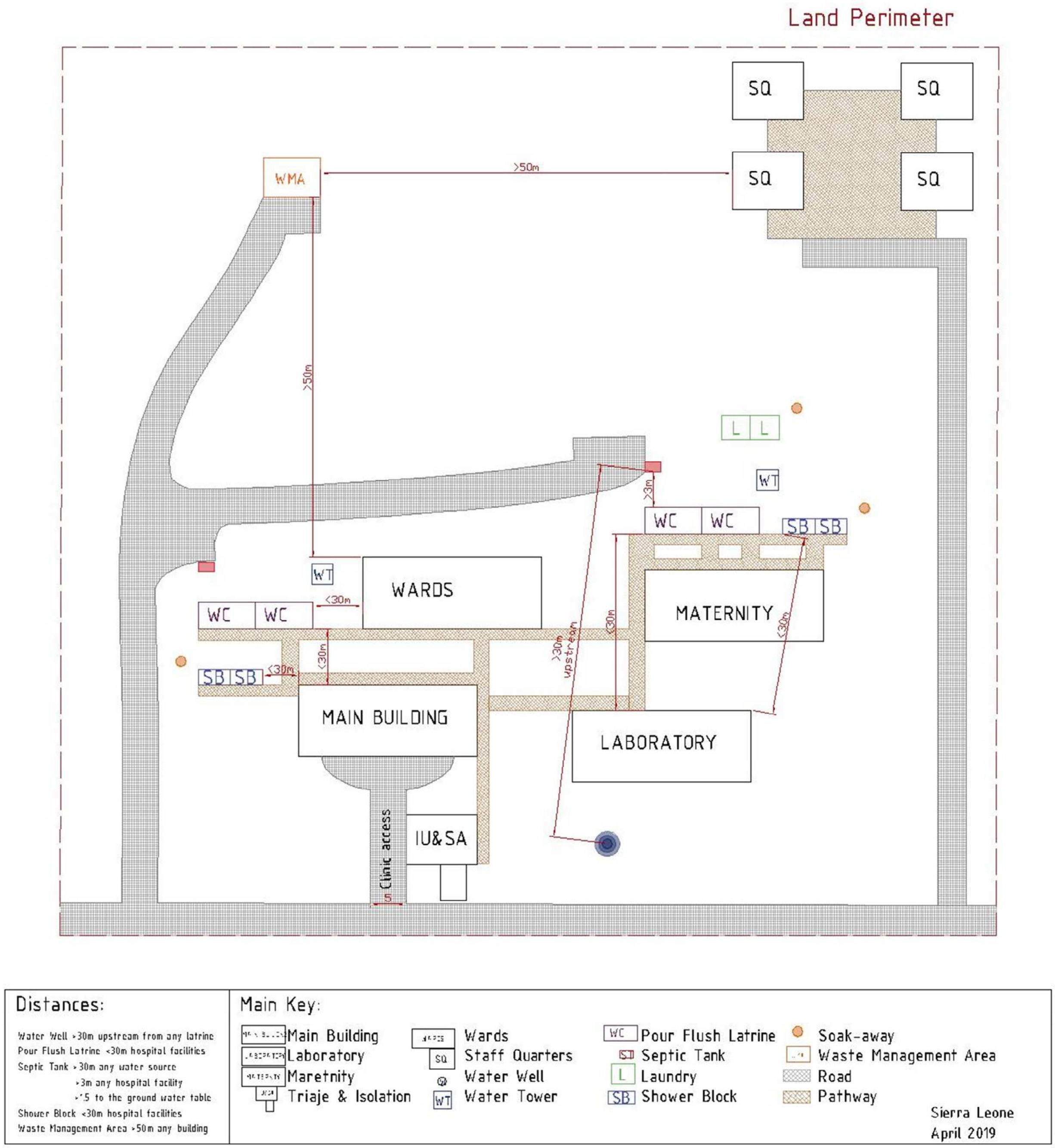


Figure 46: Typical Layout and Required Water and Sanitation Distances (Health Center)



APPENDIX 13: MOWR standard Hand dug well design with cap, well section, drainage channel and soak away pit

Figure 47: Technical Drawings for Hand dug well

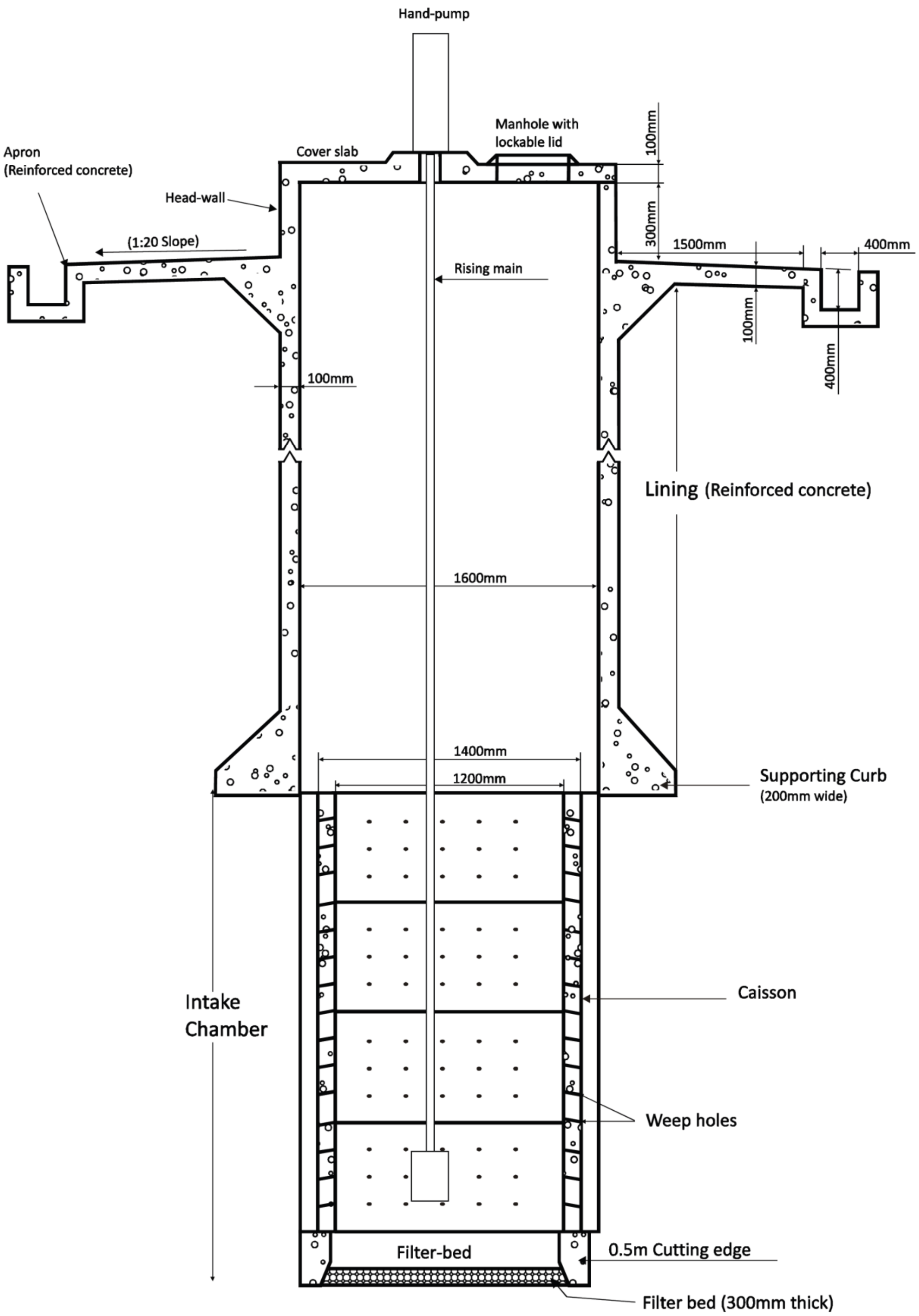


Figure 48: Hand Dug Well Apron

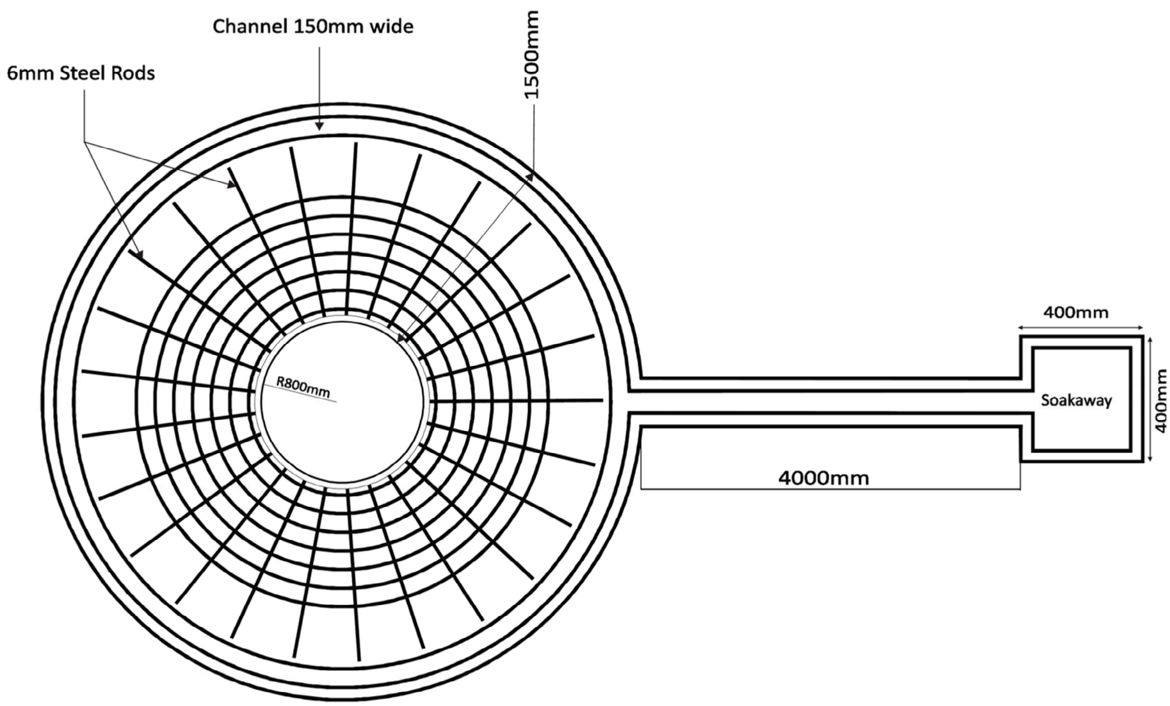


Figure 49: Hand Dug Well Cover Slab

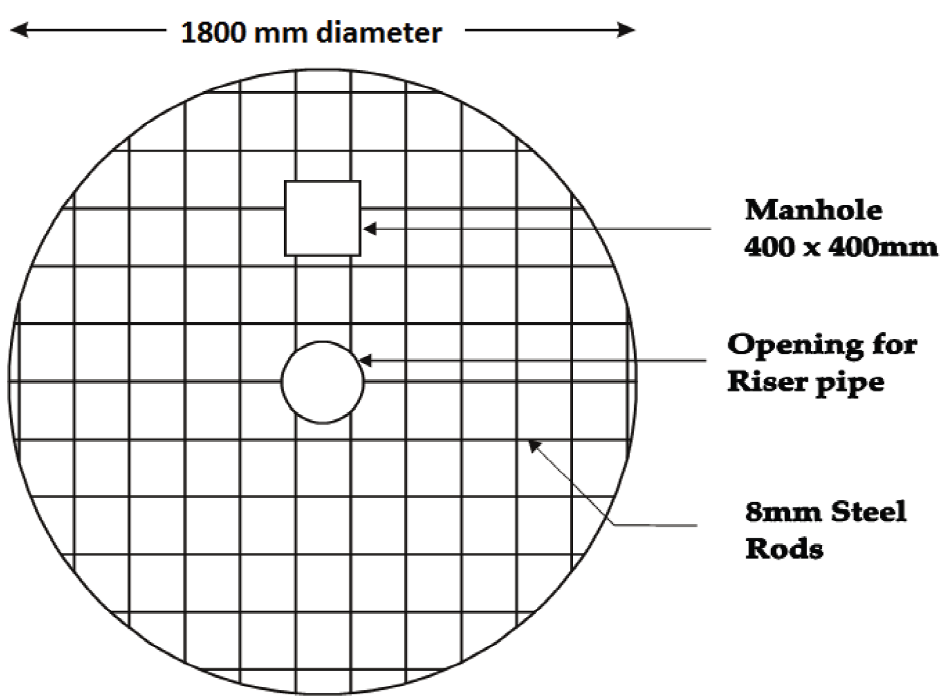
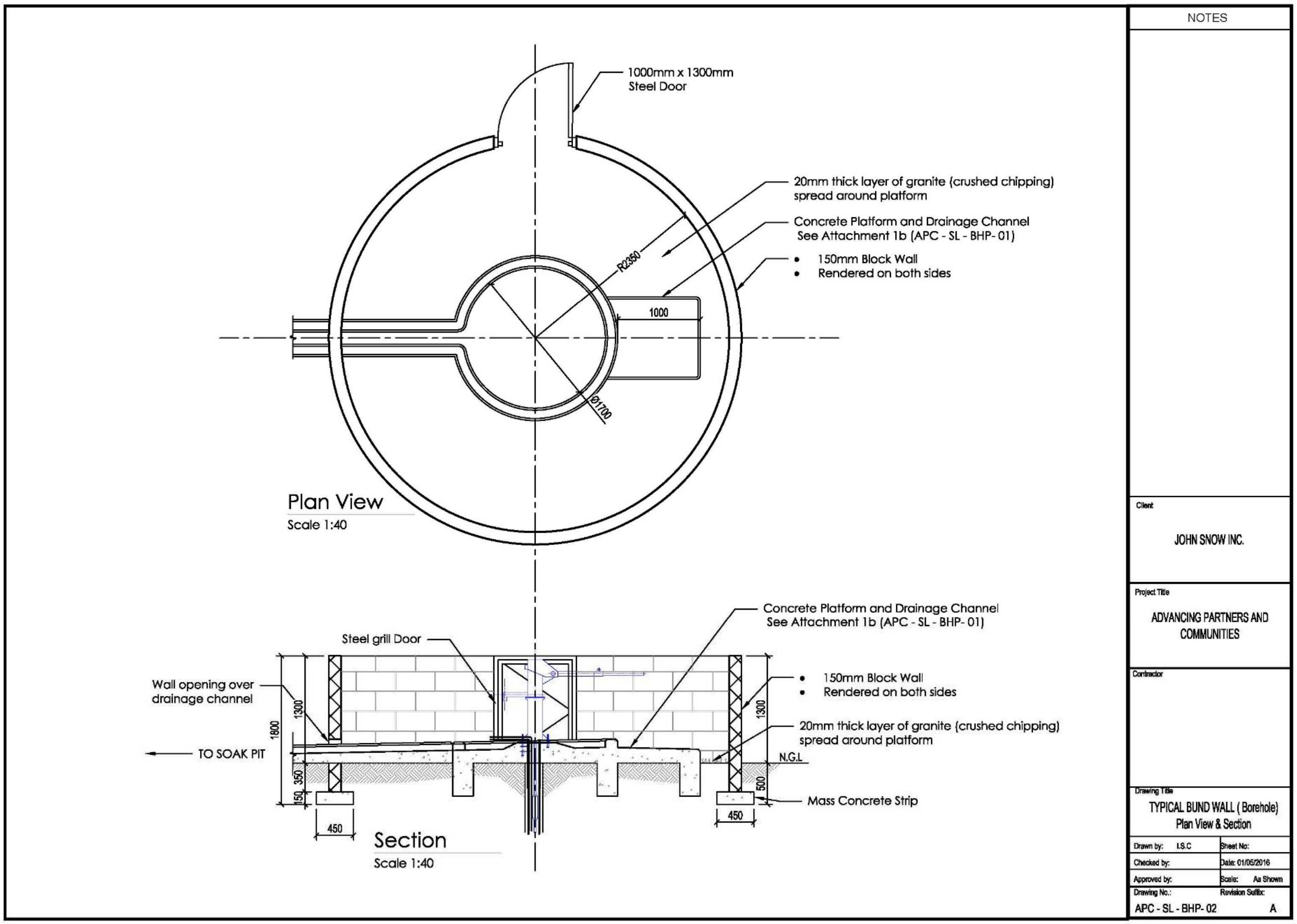


Figure 50: Typical Bund Wall (hand dugn well & Boreholes)



APPENDIX 14: DESCRIPTION AND STANDARDS OF SMALL-SCALE SOLAR WATER SUPPLY SYSTEMS FOR CHC, CHP, AND MCHP HEALTH FACILITIES

SIERRA LOENE 2018

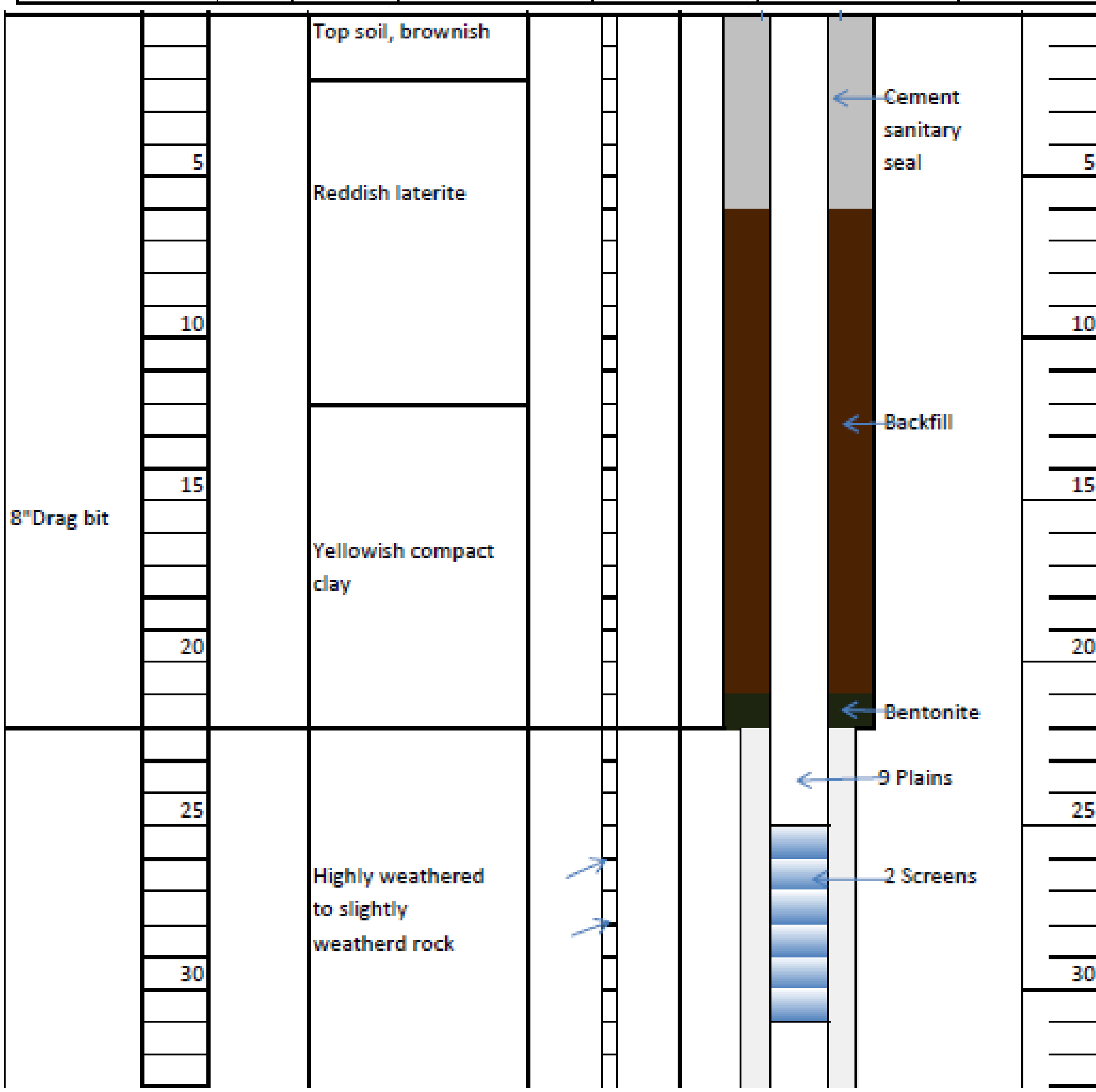
Water supply systems should be designed according to quantity and quality requirements. Lower-level PHUs require smaller quantities of high-quality water and need to be able to function with a minimal amount of operator skill and the lowest possible maintenance cost because the environments in which they are placed lack resources to repair complicated technology sophisticated equipment. Newer solar-powered pumping systems combined with boreholes have potential to meet this need due to their potentially lower maintenance requirements and durability, but they must be designed properly with carefully selected components. The following are recommendations for achieving a reliable PHU water supply system.

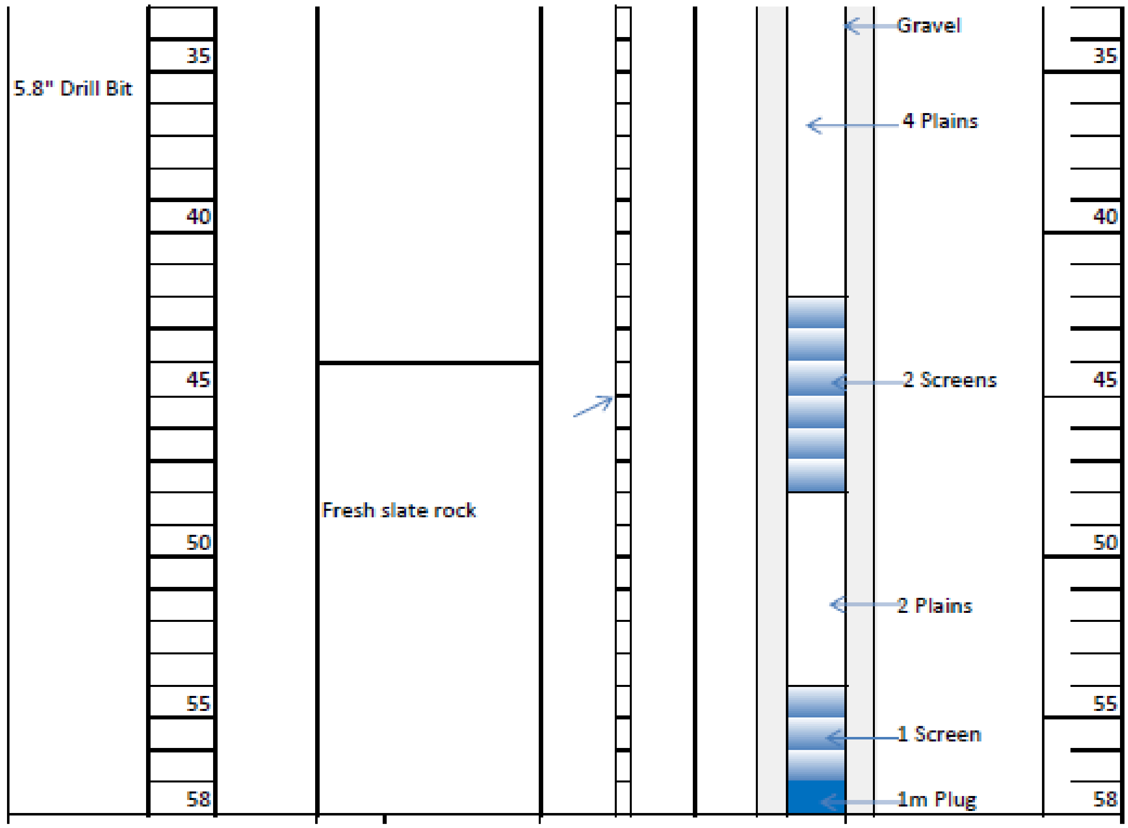
Borehole specifications:

- Minimum safe yield of 0.3l/s (1,000l/hour).
- Plain casing: uPVC, flush threads, outside diameter 125mm, wall thickness 6–6.5mm, from the ground surface to 1–2m into the aquifer (length to be determined from drilling profile).
- Screen casing: same diameter as above with slots of 0.75 to 1.0mm, sandwiched between the casings on top and downward, the bottom plug. Length to be determined by the aquifer characteristics of each borehole or well.
- Bottom plug and sump of 1m–3m.
- Gravel pack: clean, rounded river sand or alluvial origin with grains from 1.5mm– 4mm; placed in the annular space between the drilled hole wall and outer face of the casing up to 2m above screen or as described in the specifications.
- Lower sanitary seal: sand 1m then bentonite or cement for 1m; placed upon gravel pack.
- Top screen: generally should be 20m lower than ground level, but this is flexible depending upon the water strikes and aquifer characteristics.
- Backfill material: drill cuttings without organic matter of the topsoil; clay is best.
- Grouting or sanitary seal: the protective seal shall be placed from 4–6 meters below ground level up to 0.25 meters above ground and will occupy an annular space between the drilled borehole wall and outer face of the casing.
- Well cap: steel or uPVC cap or lid placed over the mouth of the borehole to prevent entrance of all material, including surface water and insects, into the well.
- Once the borehole has been completed and tested, it must be sterilized with a chlorine solution yielding at least 50 mg/l of active chlorine in all parts of the borehole for at least 24 hours.

Figure 51: Borehole Drilling Lithographic Report Example

Yield:				**BH Status:**	
Final Casing Length:		**SWL:**		**Bore type**	
		Drilling start date			
Geophysics ref No.		**Drilling compl. Date**		**Rig make**	
District		**Method**		**Top of screen**	
Contractor		**Driller**		**Client**	
SWL		**Pump Installed**		**GPS coordinates**	
Borehole I.D		**Chiefdom**		**Elevation**	
BIT SIZE & TYPE		**PROFILE**		**WELL DIAGRAM**	





Gravel for gravel pack			**Prepared By**	
Cement for grouting			**Designation**	**Geologist/Supervisor**
Bentonite for grouting				
Cleaning & Development				

Water Storage facility:

- Elevated tank gravity flow system with 2-day backup storage. Minimum 5,000 litres in light-blocking black storage tanks to prevent algae growth.

Distribution system:

- Water supply network within PHU in accordance with Standards and Guidelines for WASH in Health Care Facilities, 2019.

Solar Pump Systems

A solar pump system should be designed by a professional electrical engineer who has at least 5 years' experience in solar energy. Each water source is different and the system should be based on the characteristics of each well. The following is an example of a system that has demonstrated suitability for operation and maintenance in rural locations with limited human, physical, and financial resources. Again, this is only an example; a professional must study every situation and evaluate options accordingly before selecting and installing an electrical solar pump system. If this is not done, the system may fail and a large investment will be wasted.

Sample system component specifics:

- Submersible stainless steel solar pump suitable to be used in boreholes with output capacity 1,200L/hr. (0.4L/s output) that meets stated requirement with total dynamic head of 45m and shut-off head of 90m. Only high-quality pumps should be installed. Grundfos and Lorentz pumps are recommended. Components for the system should be purchased from the same manufacturer to the extent possible to avoid incompatible parts, which increases risk of failure.
- Solar pumps function in respect to available sunlight, which in Sierra Leone averages six hours per day, varying widely throughout the year due to cloud cover in the rainy season (June – September). The capacity of a solar water pump does not depend simply on full sunlight hours but also on the type of pump and capacity of solar panels/batteries installed. In August, the recommended Grundfos system can operate for an average of 5 hours per day, and this is the minimum specification in the design of that system. In February, sunlight is sufficient for this system to operate nine hours per day, on average, allowing for surplus output.
- Pump should be capable of pumping up to 10,000 L/day.
- DC pump motors are recommended to run directly from solar panels. DC pumps are more robust, efficient, and do not required inverters to convert DC electricity to AC electricity). Do not try to connect personal devices, such as TVs and DVERs, to these systems. This reduces the available power.
- The smallest size pump is in general the most efficient for water sources with small amounts of water because it requires fewer solar panels to operate. 1–1.5 HP pumps should be sufficient, depending on depth of a given well, its static water level and its recharge rate. Pumps that are unnecessarily large will reduce system performance, are more costly, and increase possibility of failure due to overheating.
- The pump should come with a compatible controller from the manufacturer and have automatic operation, protection, and measuring instruments such as voltmeter and ammeter, incorporated and assembled in lockable box. Other features should include:
    - — Control unit with manual on/off switch.
    - — Control unit located inside a locked building to protect it from tampering, weather, and theft.
    - — Unit should be as close as possible to borehole, tank, and tower to be cost-efficient. Longer distances require a larger gauge, and therefore more expensive wire to transmit electrical current to the pump.
- Other required features:
    - — Soft-start feature to reduce torque upon pump start up.
    - — Dry-run protection to shut off automatically pump before the water level drops below intake ability (this will avoid pump burnout).
    - — Over-voltage protection to avoid damage from electrical power surges
    - — A float switch to turn pump on and off automatically in the tank and connected to the controller/pump. The float switch turns off the pump when the tank is full and turns on the pump when the tank is not full (this is an

electrical switch, not a float valve).

- Electrical cable to the pump should supplied and/or specified by the pump manufacture and engineer; be waterproof; and match the pump's power and cable length requirements. Underwater wire and cable splice kits must be provided and used.
- Restraining cable to support pump (and avoid pulling the pipe apart due to pump weight and torque). In water with high ph (6.9 or above) a stainless steel cable is recommended to avoid corrosion. Stainless steel wire is expensive; nylon rope may be used if stainless steel is unattainable. Galvanized cable should not be placed in the same well with the stainless steel pump because dissimilar metals will cause rusting and failure.
- Lightning arrester able to stop an electrical surge of 115,000 volts.
- Earthing/ground system sized with bare cooper wire and grounding rod designed by engineer.
- Operation, maintenance, and installation manuals and circuit diagrams of the control panel and pump shall be supplied at the time of delivery of the goods and remain on-site.
- Owner/operator maintenance training.

Sample pump panel specifications:

- Solar panel wattage and array layout to match pump electrical specifications. It should be designed by an electrical engineer and procured from a professional supplier to ensure compatibility of all components. Manufacturer should specify the amount of power required from the solar panels.
- Attach panels to sturdy painted or galvanized steel or aluminium framework capable of withstanding wind speed of 90km/hr. At least one fastener every 2 feet around panel perimeter. At least 2 security bolts/fasteners per panel or a metal angle iron welded continuously over the panels' edges.
- If possible, install panels above the tank to avoid theft and shade from trees and buildings. If the tower will carry the module, design layout so that panels face south.
- Fixed panel position on slope of 10 degree-angle facing south for maximum power production, or per manufacturer's instructions. For example, Grundfos recommends a 9 degre tilt be used in solar panels installed in Freetown, but tracking solar system degree and direction of slope is variable.

Warranty

The PV panel modules must be warranted in writing by the manufacturer for output wattage, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years.

The whole system, including submersible/surface pumps, shall be warranted in writing by the manufacture. All spare parts and tools provided by the manufacture or contracted installer should be transmitted to and received in writing by the district medical officer and district health management team (DHMT) and stored safely and securely by the DHMT.

Operation and Maintenance Manual

An easy-to-use operation and maintenance manual, in simple English, should be provided with the solar PV pumping system. The manual should have information about solar energy, photovoltaic, modules, DC/AC motor pump set, tracking system (where applicable), mounting structures, electronics, and switches. It should also have clear instructions about mounting of PV module, dos and don'ts, and regular maintenance and troubleshooting of the pumping system, and name and address of the DHMT focal point to be contacted by other health care facilities in case of complaints or water or pump failure. Manufacturer contact details should be provided to the focal point to report difficulties during and after warranty period.

Additional References

1. *Guidelines for drinking-water quality - 4th ed. (2011) (https://apps.who.int/iris/bitstream/handle/10665/44584/9789241548151_eng.pdf;jsessionid=F81F33C08E763818E78CF4A982BEA331?sequence=1)*

2. *De Montfort construction documentation • Mark 8a last updated June 2004 (https://mw-incinerator.info/en/pdf/Mark8a_construction.pdf)*

3. *De Montfort construction documentation • Mark 9 last updated June 2004 (http://www.frankshospitalworkshop.com/equipment/documents/incinerators/equipment/De%20Montfort%20Mark%209%20Incinerator%20-%20Construction.pdf)*