

# **UNHCR Household Domed Slab Fabrication**

**D402-2015a**

**Tools and Guidance for  
Refugee Settings**



**UNHCR**  
The UN Refugee Agency

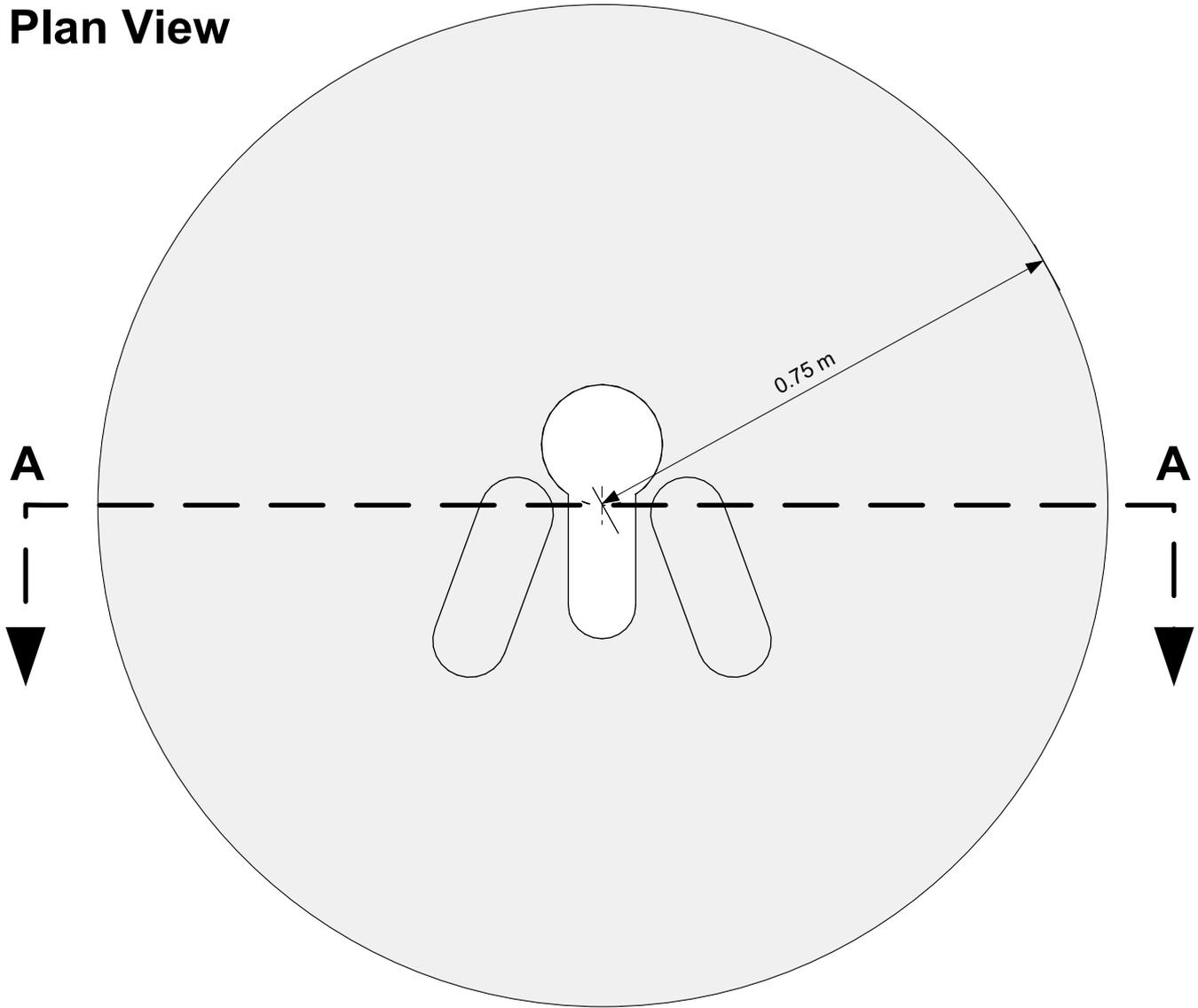
## UNHCR Standardized WASH Designs Household Domed Slab Fabrication

### FOREWORD

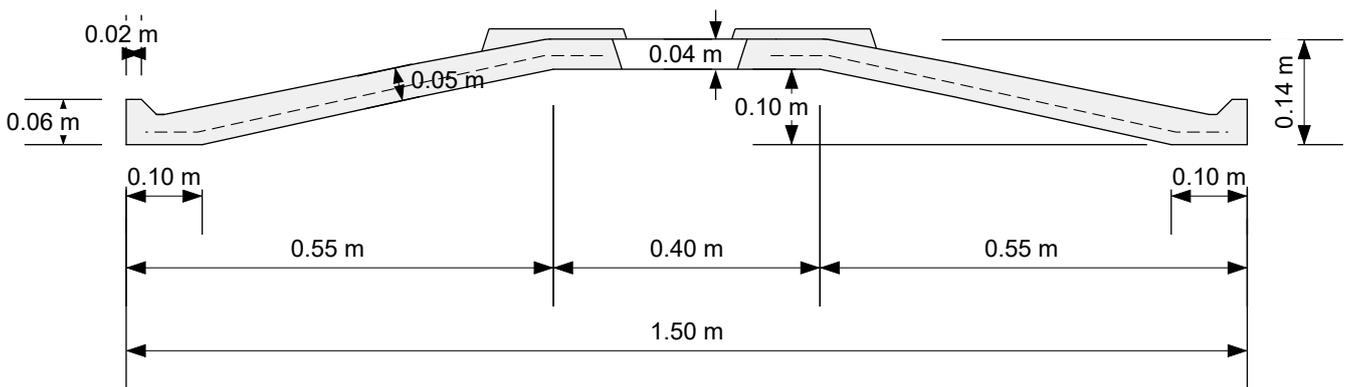
These domed slab designs form part of UNHCR’s series of Standardized WASH Design Guidelines for Refugee Settings which are the result of an extensive review process with WASH actors active in refugee settings. It is recognized that the Standardized WASH Designs will require continuous review and amendment in response to changes in engineering best-practice and feedback from the field. Therefore further review will be managed by a Technical Review Committee which will meet regularly to discuss issues related to the use of the design and an annual review will be reported back to the WASH community. More urgent amendments will be reported as, and when, required. Note that this slab is based on a design implemented in many refugee settings across Eastern Africa.

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# Plan View



# Section A-A



### NOTES

1. Slab 5cm thick (cement mortar dosage 510 kg/m<sup>3</sup> - 1 part cement, 3 parts coarse sand).
2. Cement mortar to be well tamped to remove voids. Ensure that mix is not over watered (max slump test reduction of one quarter).
3. Add three layers of BWG 20 chicken wire reinforcement towards the lower edge of the slab with 10 mm min cement mortar cover.
4. Slabs should be kept damp and out of direct sunlight during curing. Cure for at least 10 days before removing from shuttering.

**D-402**

**TITLE**

**Domed Latrine Slab**

General Layout

**PROJECT**

Standard WASH Drawings

**DRAWN BY**

B. Harvey - 11/10/15

**APPROVED BY**

M. Burt - 15/11/15

**SCALE**

1:10

**UNITS**

metres

**SHEET**

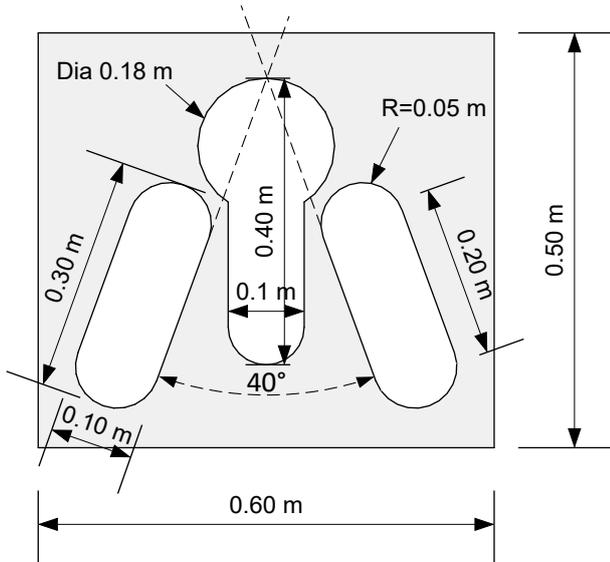
1 of 3

**DATE PUBLISHED**

15/11/15



# Keyhole and Foot Pad Template

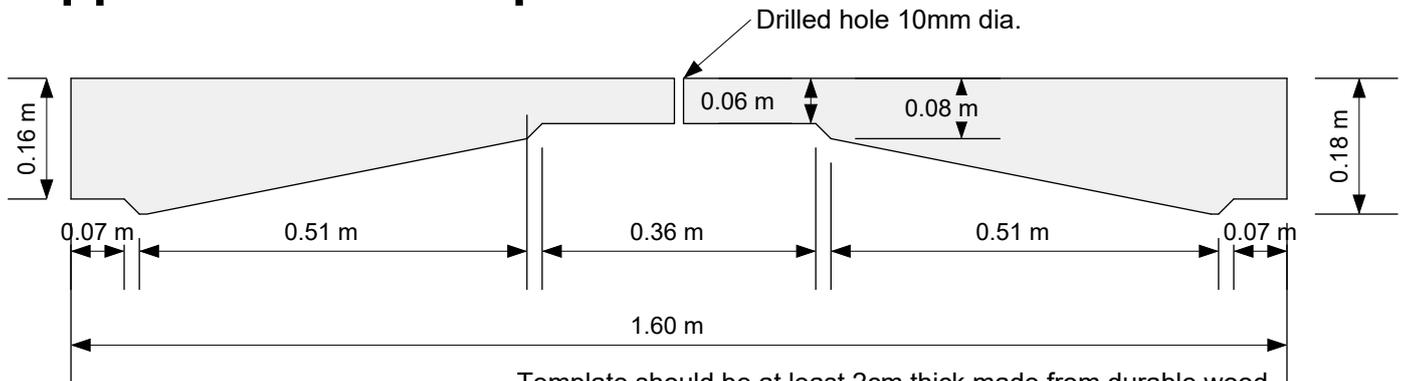


Template should be at least 2cm thick made from durable wood.

Interior surfaces of keyhole should be chamfered at 30 degrees to facilitate keyhole plug entry.

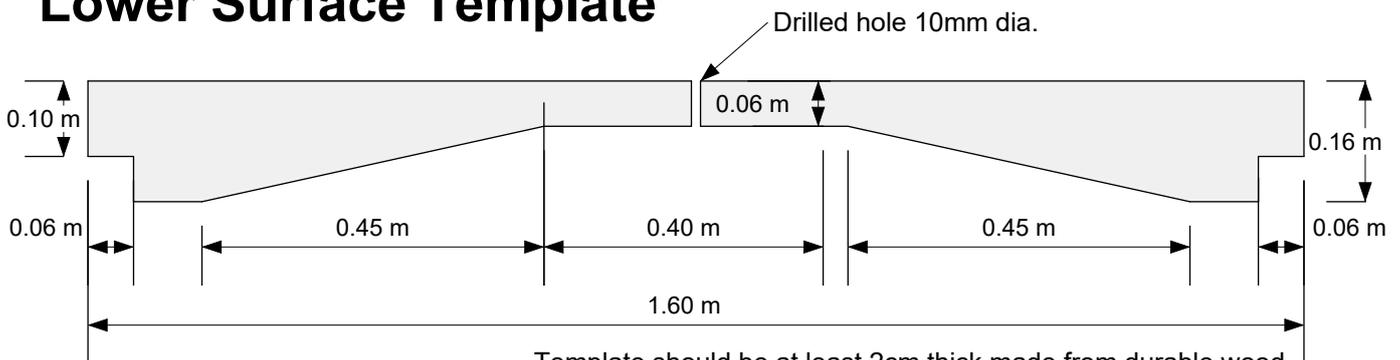
Interior surfaces of foot pad template should be chamfered at 30 degrees to facilitate template removal.

# Upper Surface Template



Template should be at least 2cm thick made from durable wood.

# Lower Surface Template

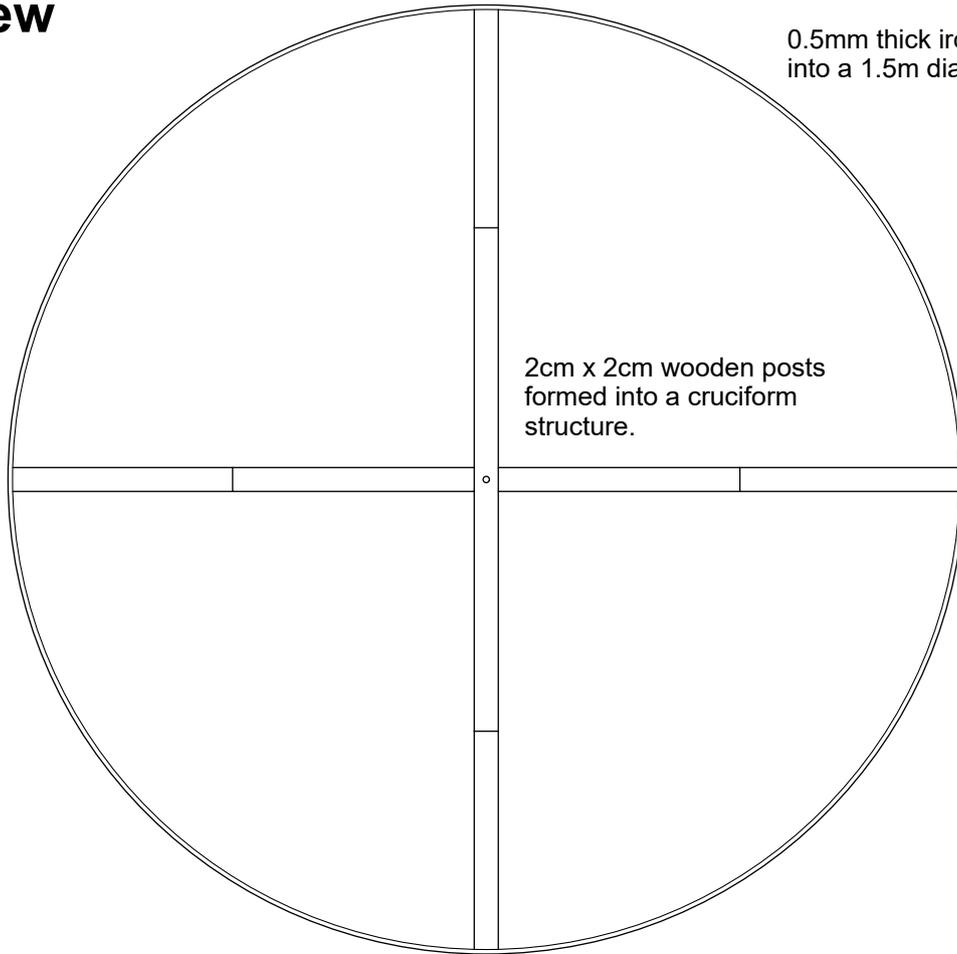


Template should be at least 2cm thick made from durable wood.

## NOTES

1. Ensure shutter and forming assembly is perfectly level when using the upper and lower surface templates to form the slab surfaces.
2. Use keyhole and feet pad template to cut keyhole shape and create raised feet pads.
3. Keyhole interior should be chamfered to facilitate keyhole plug entry. Alternatively a male plug mould may be used to create the hole.
4. Once the slab has cured, a chamfered male plug may be formed by lining the plug hole with a non-stick material (e.g. cement bags, or plastic sheeting) and casting directly into the keyhole. Alternatively male plugs can be mass manufactured in a female mould.

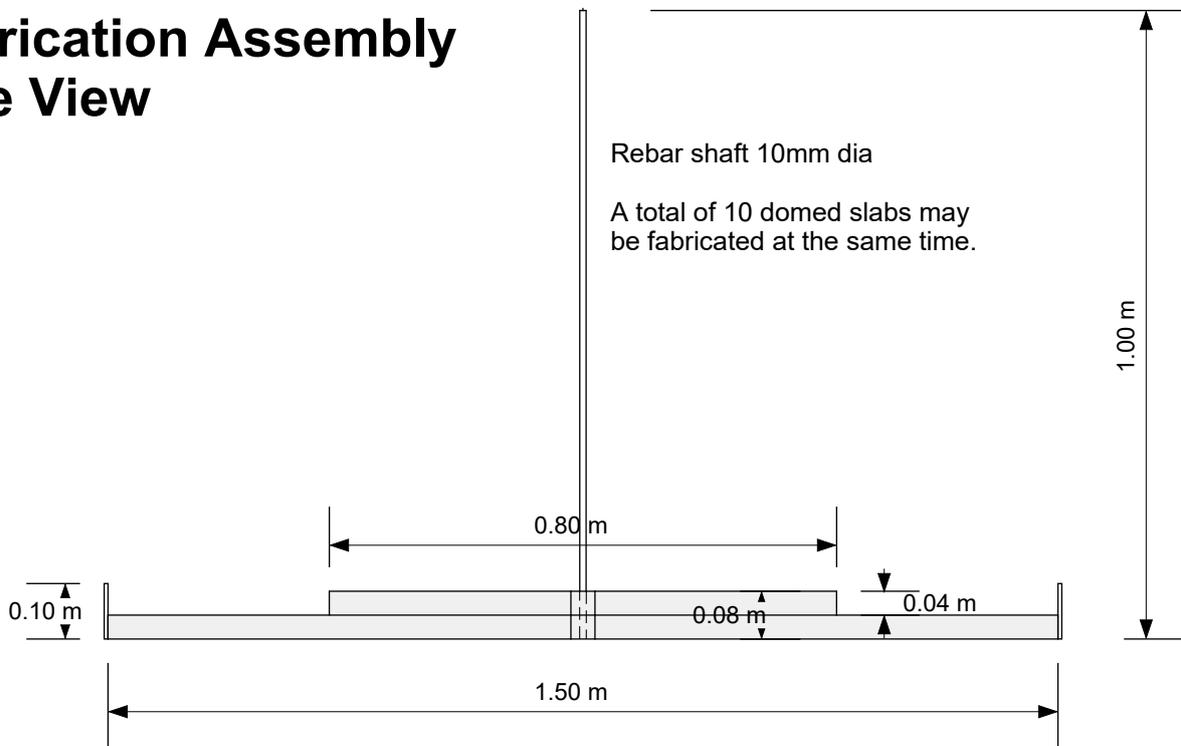
# Fabrication Assembly Plan View



0.5mm thick iron shuttering formed into a 1.5m diameter ring.

2cm x 2cm wooden posts formed into a cruciform structure.

# Fabrication Assembly Side View



Rebar shaft 10mm dia

A total of 10 domed slabs may be fabricated at the same time.

1.00 m

0.80 m

0.10 m

0.08 m

0.04 m

1.50 m

**D-402**

**TITLE**  
**Domed Latrine Slab**  
Fabrication Frame Assembly  
**PROJECT**  
Standard WASH Drawings

**DRAWN BY**  
B. Harvey - 11/10/15

**APPROVED BY**  
M. Burt - 15/11/15

**SCALE**  
1:10

**UNITS**  
metres

**SHEET**  
3 of 3

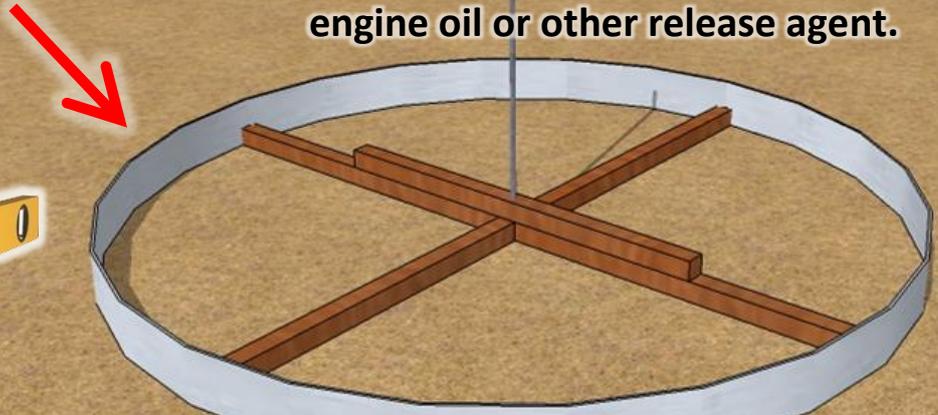
**DATE PUBLISHED**  
15/11/15



**1.**

Shutter diameter = 150cm  
Shutter height = 10cm

Coat the inside of the shutter with engine oil or other release agent.



Ensure shutter and forming assembly is on perfectly leveled ground.

**2.**

Template #1  
Lower Surface



Add damp coarse sand and spin the bottom template to create the base shape removing the excess sand as required.

**3.**

Template #2  
Upper Surface

0.08m<sup>3</sup> cement mortar  
slab 5cm thick (dosage  
510 kg/m<sup>3</sup>)  
1 part cement:  
3 parts coarse sand

Add three layers of  
BWG 20 chicken  
wire towards the  
base of the slab  
with at least 10mm  
cement mortar  
cover.

Add cement mortar and spin the  
upper surface template to create  
the domed slab form, removing  
any excess as required.

Vigorously tamp the mix to remove air bubbles and any voids.

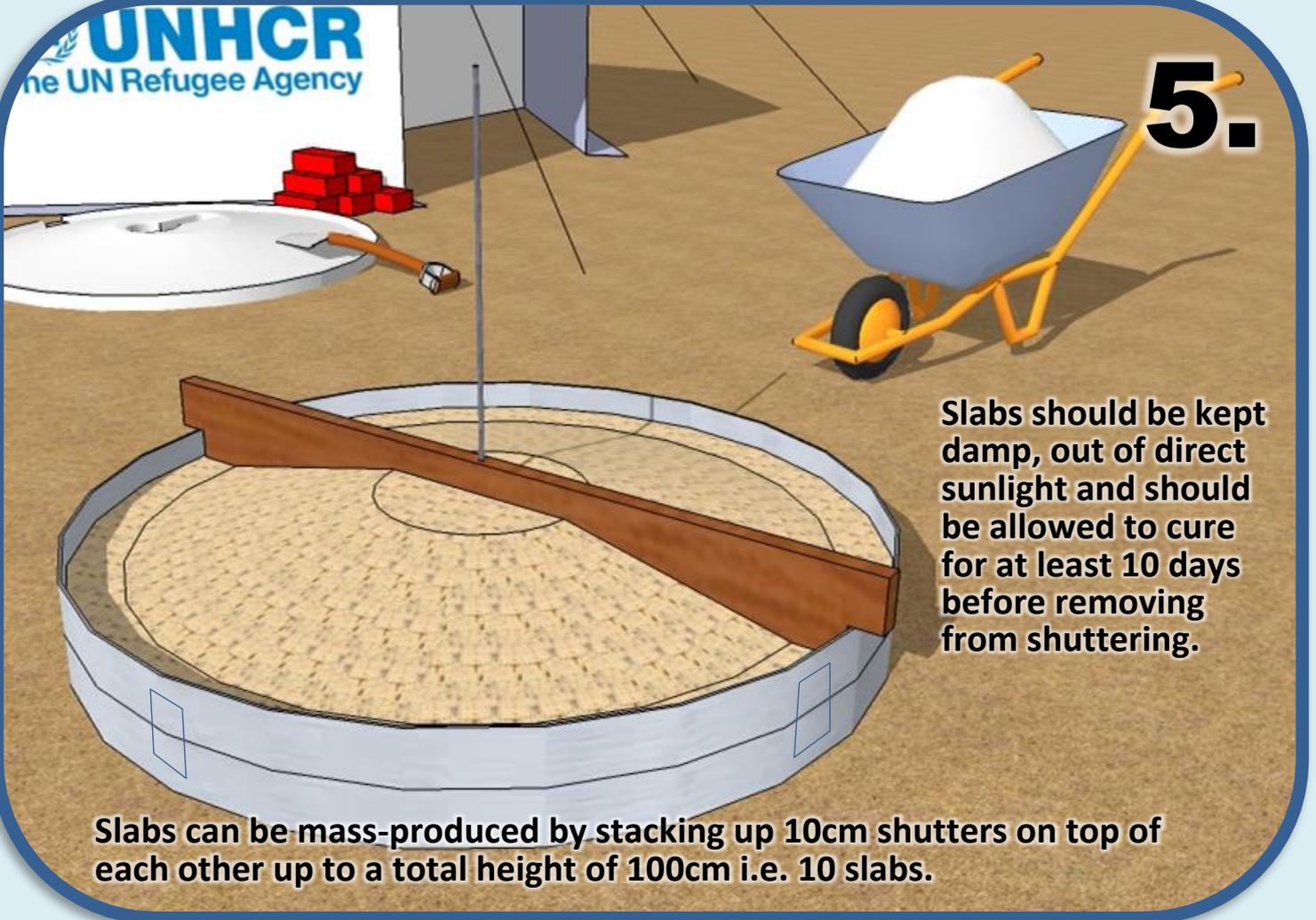
Use template to cut keyhole shape and create raised feet pads.

**4.**

Keyhole Template

Keyhole interior should be chamfered to facilitate keyhole plug entry.  
Alternatively a male plug mould may be used to create the hole shape.

**5.**

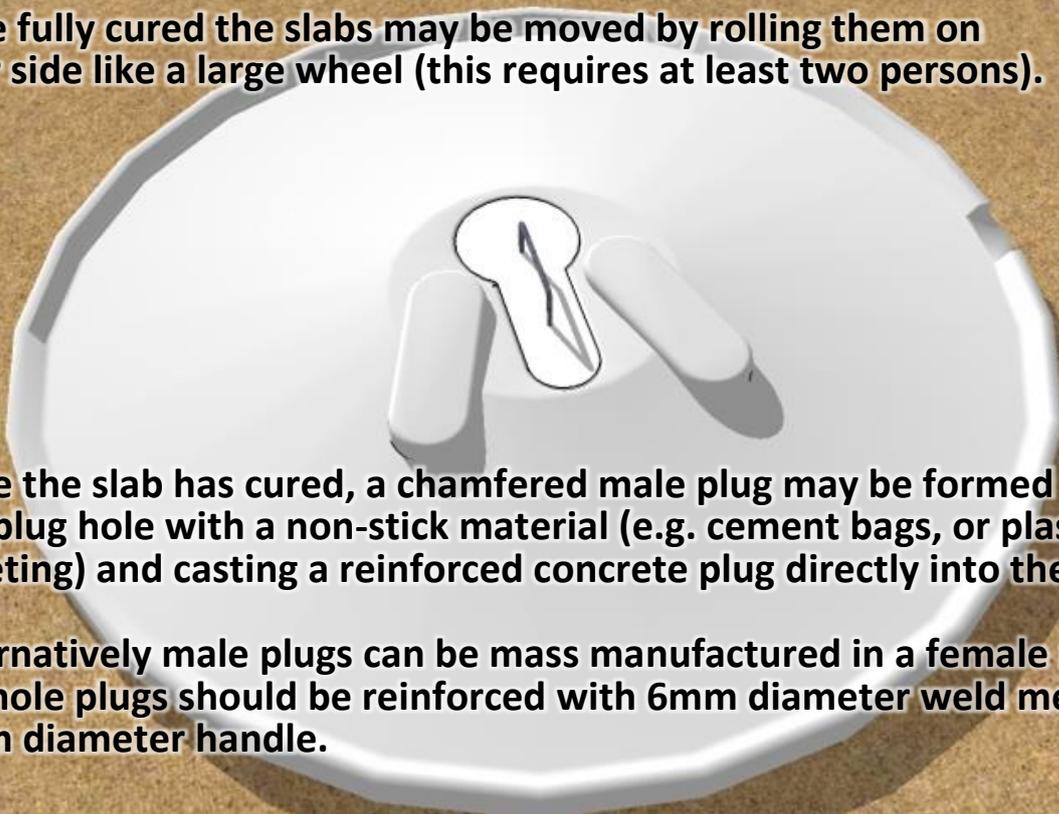


Slabs should be kept damp, out of direct sunlight and should be allowed to cure for at least 10 days before removing from shuttering.

Slabs can be mass-produced by stacking up 10cm shutters on top of each other up to a total height of 100cm i.e. 10 slabs.

Once fully cured the slabs may be moved by rolling them on their side like a large wheel (this requires at least two persons).

**6.**



Once the slab has cured, a chamfered male plug may be formed by lining the plug hole with a non-stick material (e.g. cement bags, or plastic sheeting) and casting a reinforced concrete plug directly into the keyhole.

Alternatively male plugs can be mass manufactured in a female mould. Keyhole plugs should be reinforced with 6mm diameter weld mesh and a 6mm diameter handle.

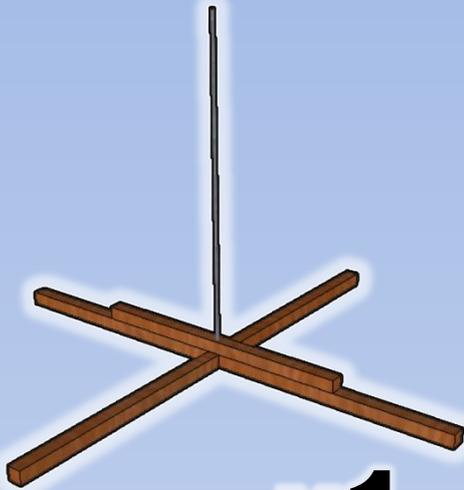
A drainage hole may be cut in the lip during the curing stage if the slab is to be used as part of the UNHCR household toilet/bathing unit design.

## BILL OF QUANTITIES

Description	QTY
Wooden Forming Assembly	1 pc
Iron Shuttering Rings 10cm x 150cm	10 pcs
Lower Surface Spinning Template (160cm x 2cm x 16cm)	1 pc
Lower Surface Spinning Template (160cm x 2cm x 18cm)	1 pc
Galvanized Chicken Wire (50mm x 80mm Openings) 20 BWG	53.0 m <sup>2</sup>
Steel Weld-Mesh Ø6mm for Plugs (10cm x 10cm)	1.0 m <sup>2</sup>
Coarse Sand	1.8 m <sup>3</sup>
Cement (50kg sacks)	8 sacks

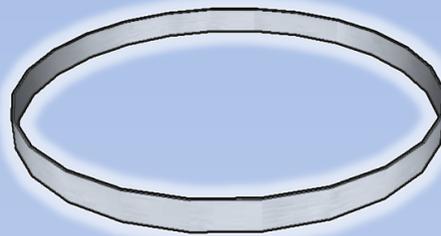
# Bill of Quantities

1. Forming Assembly (pc)



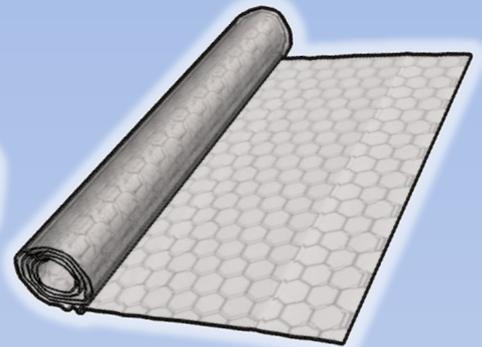
**x1**

2. Shuttering Rings (pc)  
10cm x 150cm



**x10**

3. Galvanized Chicken Wire 50mm x 80mm Holes 20 BWG (m<sup>2</sup>)



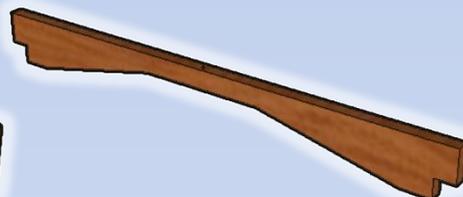
**x53m<sup>2</sup>**

4. Upper Surface Spinning Template (pc)



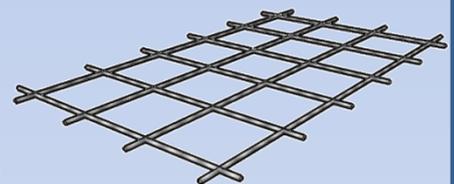
**x1**

5. Lower Surface Spinning Template (pc)



**x1**

6. Steel Weld-Mesh 6mmØ x 10cm x 10cm



**x1m<sup>2</sup>**

7. Cement 50kg (sacks)



**x8**

8. Coarse Sand (m<sup>3</sup>)



**x1.8**

**Note: Quantities of sand, cement and reinforcement sufficient to make 10 domed slabs and keyhole plugs.**

## **SPECIFICATIONS FOR TOILET CONSTRUCTION IN REFUGEE SETTINGS**

### **400 SCOPE**

400.1 These design guidelines specifically define the quality of materials and workmanship to be used when constructing toilets in refugee settings. A description of principles of excreta management programmes in addition to excreta management technical options and their advantages and disadvantages can be found in the UNHCR WASH Manual.

### **401 SITE SELECTION**

401.1 A basic requirement is that the site selected for the toilet facility is free from the risk of high winds, flooding, subsidence, or erosion.

### **402 PREVENTION OF SURFACE OR GROUND WATER CONTAMINATION**

402.1 UNHCR and WASH actors must ensure that all excreta containment systems including any pits, tanks, lagoons, sewerage or soakaway do not contaminate surface water or shallow groundwater sources.

402.2 All excreta management systems must be located at least 30 metres away from groundwater sources. The bottom of any pit or soak-away must be at least 1.5m above the highest average groundwater table level. These distances should be increased for fissured rocks and limestone.

402.3 In some situations temporary groundwater contamination from on-site excreta management systems may not be of immediate concern if the groundwater is non-potable. An example of this can be found in coastal areas where groundwater is heavily saline beyond drinking water health limits of  $1,500\mu\text{S}/\text{cm}^2$ . In all cases, local legislation should be respected.

### **403 GUIDELINES FOR PIT REINFORCEMENT**

403.1 All toilet pits should have an upper reinforcement ring of either: wooden beams, wooden trunks, brick masonry or concrete to evenly spread the load of the superstructure and raise it above ground level by at least 20 - 30cm to avoid water entering the pit.

403.2 Any toilet built on soft, sandy or collapsing soils should have a brick or concrete lined pit to at least 1m below the ground surface or greater if the soil is still unstable. Any desludgable toilet should have a fully lined pit that is able to withstand repeated evacuation. Safety should be of the utmost consideration when manually excavating pits. In soft soils, pit walls should be adequately cross-braced and excavation must never exceed 2.0m depth.

## **404 GUIDELINES FOR TOILET SLAB STRENGTH**

- 404.1 The toilet slab and supporting beams must be sufficiently strong to support the weight of users and should not flex or give the user reason to doubt its strength. Support beams should span at least 50cm into each of the pit walls.
- 404.2 Wooden, concrete or plastic slabs should be tested with the weight of 4 persons before use. Concrete slabs should be reinforced regardless of their type. Wooden planks, trunks and beams should be free from insect attack of any kind with no other defects which would affect its strength. Wooden structures in contact with the ground should be treated with used engine oil or diesel to deter termites.

## **405 GUIDELINES FOR TOILET SLAB ANCHORAGE**

- 405.1 Latrine slabs should be firmly anchored in place. If plastic latrine slabs are used they should be firmly attached to the support structure either through the use of sufficiently long nails, bolts with washers, metal stakes, or heavy gauge wire.

## **406 GUIDELINES FOR SANITARY SEALING**

- 406.1 In all toilet installations there should be no visible gaps between the squat plate and the pit walls either through the use of at least 30cm of tamped clay soil or 30cm of concrete sanitary seal.

## **407 GUIDELINES FOR THE USE OF PLASTIC SHEETING**

- 407.1 Plastic sheeting used in toilet super structures should meet the international minimum humanitarian standards (i.e. 200g/m<sup>2</sup> 700N tensile strength, UV stabilized laminated woven or braided mesh of black high density polyethylene between two white layers of low density polyethylene). Plastic sheeting is typically supplied as sheets 6m x 4m or in rolls 4m x 50m long. Before using plastic sheeting consider if there are more suitable durable materials available locally.
- 407.2 Plastic sheeting should be attached to wooden toilet frames using domed head nails, or standard nails with either wooden battens or some other form of load spreading structure (e.g. bottle tops). The most effective way of attaching plastic sheeting to a wooden frame is to wrap it around a wooden batten and then nail the batten to the support structure. Nails spacing should be no more than every 30cm. Some humanitarian plastic sheeting contains reinforcing bands of grey colour and nails should pass through these bands.
- 407.3 Plastic sheeting should be securely fixed to the ground by wrapping the edge in a wooden post and burying it to at least 40cm deep. If rope is attached to plastic sheeting it should either be attached through a reinforced eyelet or it should be tightly tied around a knot in the plastic sheeting itself.



- 407.4 The use of plastic sheeting toilet superstructures is an emergency solution and must be phased out after the first six months of any response. Flaps of plastic sheeting may be used in the initial first phase response provided they are adequately weighted at the bottom of the flap and they are phased out within 3 months. Female blocks with plastic flap doors should be equipped with a privacy screen.

## 408 GUIDELINES FOR TOILET DOORS

- 408.1 Every toilet door should be hung straight and vertical with no more than 3mm gap between both sides of the door and the door frame and a maximum 10-20mm gap between the door and floor. All doors should open and close properly without fouling on the floor or door frame.
- 408.2 Each door should have at least three hinges of good quality heavy duty steel at least 50mm long, and every hole in the hinges should be filled with a screw of at least 4cm length.
- 408.3 All doors should be fitted with a long upright handle of at least 50cm length on the inside and the outside that allows both children from 3 years of age and adults to open and close the toilet. A simple to use yet secure internal locking device should be installed that is positioned for use by children and adults (such as a metal bolt).

## 409 GUIDELINES FOR COMMUNAL TOILET PRIVACY WALLS

- 409.1 Privacy walls should be installed completely around all female toilet facilities. Solid wooden fencing posts of at least 3m length should be installed every 4m to a depth of at least 1m. Wooden braces should be used every 5 posts and at corners. Small holes of 2 or 3cm should be cut in the plastic sheeting every 20cm to reduce wind load and deter theft. A double privacy screen with a small gap may be required in some cultures and contexts where there is a risk of people creating peep holes. Care should be taken on steep ground and a privacy roofing structure may be required to prevent onlookers.

## 410 GUIDELINES FOR LIGHTING

- 410.1 Ideally all toilet facilities should be adequately illuminated to at least 50 lumens per square metre (this can be easily verified using a smart

phone light meter app). However, lighting should not be provided solely at toilet blocks as there is a risk that men will congregate at these locations. Lighting for toilet blocks should be planned in consultation with users in particular women and girls.

## 411 GUIDELINES FOR VECTOR CONTROL MEASURES

- 411.1 UNHCR and WASH actors should ensure that the toilet design eliminates fly and mosquito breeding. All vent pipes should be fitted with galvanized metal fly screens. Toilet cubicles should be kept shaded with lightly sprung self-closing doors. If the toilet is not of the VIP design, tightly fitting closable lids should be used.



## 412 GUIDELINES FOR RAIN AND STORMWATER PROTECTION

- 412.1 The ground directly around the outside of the toilet facilities should be backfilled and compacted to slope outwards and prevent surface water entering or eroding the toilet facilities. A drainage ditch at least 30cm deep should be installed around the WASH services to minimize external surface water entering the block.

## 413 GUIDELINES FOR ADDITIONAL WASH BLOCK ACCESSORIES

- 413.1 Small modifications to toilet blocks can greatly increase the dignity of users. UNHCR and WASH actors should ensure that all toilet cubicles are equipped with either hooks or shelves so that users are able to hang additional clothes or possessions off the floor when using the facilities. If possible, the relatively cheap addition of a mirror can greatly improve the experience of using WASH facilities.

## 414 COLLECTION OF ANAL CLEANSING AND SANITARY MATERIALS

- 414.1 UNHCR and WASH actors should ensure that provision is made for the separate collection and disposal of used anal cleaning materials or women's sanitary material if there is a risk they may block or damage the toilet infrastructure or any desludging equipment. This also has the added advantage of extending the life of the system.

## 415 MATERIAL SPECIFICATIONS OF COMMON CONSTRUCTION MATERIALS

- 415.1 Gravel used for constructing concrete toilet slabs must be clean and free from mud, dust and plant material. UNHCR and WASH actors must ensure that only crushed aggregates (not river gravel) between 6mm and 10mm are used to prevent inter granular crack propagation across the thin toilet slab and to ensure an adequate covering under bars.
- 415.2 Sand used for latrine slabs should be coarse (no fines), clean and free from mud, dust and plant material.
- 415.3 Water should be non-saline and free from organic matter.
- 415.4 Bricks should be fully burnt (ringing sound when two bricks are hit together), of consistent shape and size and should be sufficiently strong (crush test) with a high proportion of clay.
- 415.5 Cement must be fresh (manufactured in the last three months) dry, and should be stored in a safe, dry, place at least 15cm off the ground. Toilet slabs should be cast with a 1:2:4 concrete mixture. Care should be taken to ensure that the mixture is not over watered (bucket slump test should show no greater than ¼ reduction in the slump height). Cast slabs should be immediately covered with straw, cement bags, sacking or leaves to keep the concrete moist and cool. The concrete should be cured with frequent watering at least twice daily for at least 10 days before use.
- 415.6 Reinforcement bars should be free from rust and of the correct type and size for concrete construction work (typically a characteristic yield stress of at least 210 N/mm<sup>2</sup>). Steel reinforcement should be placed on the lower side of the slab (the part in tension) with at least 12mm concrete covering under every bar. Reinforcement should be laid in both directions. Where the slab is rectangular, the bars parallel to the smaller span should be below the bars reinforcing the greater span. Domed Mozambican slabs must be reinforced with the correct size chicken wire covered with wire mesh and a mixture of 1 part cement to two parts sand.

**Box: Spacing of mild steel bars for concrete toilet slabs**

Span	65mm Slab		80mm Slab	
	Ø 6mm	Ø 8mm	Ø 6mm	Ø 8mm
1.00m	150mm	250mm	150mm	250mm
1.25m	150mm	250mm	150mm	250mm
1.50m	125mm	200mm	150mm	250mm
1.75m	75mm	150mm	125mm	200mm
2.00m	50mm	125mm	75mm	150mm

Source: Franceys, Pickford & Reed (1992)  
 'Guide to the development of on-site sanitation'.  
 World Health Organization, Geneva.

## **416 HANDWASHING STATIONS DESIGN CONSIDERATIONS**

- 416.1 UNHCR and WASH actors must plan for at least one functional hand washing dispenser per communal or public toilet block, ensuring at least one handwashing dispenser for every five toilet cubicles. Handwashing dispensers should be conveniently located within 10m of each toilet exit and their use should be actively promoted. The water dispensing device and soap must be located within easy reach of all users, especially children. Liquid soap, or bars attached to string, may be used if there is soap theft. All handwashing units that use bars of soap should have a fixed self-draining dish where the soap can be placed between use without getting dirty or becoming mislaid.
- 416.2 Hand-washing water storage containers should be sized to hold at least half a day of hand-washing water. To conserve water and avoid wastage, the hand-washing taps may need to be restricted with orifice plates to flows of 50 cubic centimetres per second (0.05 litres per second). Calculation of the total volume of hand-washing water required should be based on 0.5 to 1.0 litre of water per person per day. Hand washing reservoirs must be covered to prevent contamination or vector breeding.

## **417 ENVIRONMENTAL CONSIDERATIONS FOR SOURCING WOOD**

- 417.1 Ensure that all supplies of wood for household latrine slabs, latrine superstructures, privacy screens, and latrine brick production has been procured from sustainable sources outside of the refugee camp environment.

## **418 DECOMMISSIONING**

- 418.1 The toilet should be decommissioned when the level of excreta is within 50cm of the surface (DO NOT WAIT FOR THE PIT TO FILL TO THE SURFACE OF THE LATRINE SLAB). The superstructure should be removed and the pit should be back-filled with earth to a height of approximately 50cm to allow for settlement. Approximately 10 kg of lime may be used per cubicle to help neutralize the pH of the pit and assist in decomposition and drying. Where possible, quick growing plants or trees should be planted on the site to assist with drying of the pit.

## **419 UNHCR STANDARD TOILET DESIGNS FOR REFUGEE SETTINGS**

- 419.1 The following drawings should be used in conjunction with these technical design guidelines.

D-400/2015a	Communal Trench Latrine (Poles + Plastic) – EMERGENCY
D-401/2015a	Communal Trench Latrine (Wood + Plastic) – EMERGENCY
D-402/2015a	Household Domed Slab Mass Fabrication
D-403/2015a	Household Toilet / Bathing Unit (1 Family, Dome Slab, Alternating)
D-404/2015a	Household Toilet / Bathing Unit (Septic Tank and Drain Field)
D-405/2015a	Raised Storage Latrine (Holding Tanks) - EMERGENCY
D-406/2015a	Urine Diverting Dry Toilet (UDDT)
D-407/2015a	Institutional Latrine (Desludgable with Raised Option)
D-408/2015a	Institutional Latrine (Septic Tanks and Drain Field)

## USEFUL REFERENCES

- ◆ ACF (2005), 'Water, sanitation and hygiene for populations at risk – second edition'. ACF, Paris, France.  
[http://www.actioncontrelafaim.org/publications/fichiers/wsh\\_acf\\_0.pdf](http://www.actioncontrelafaim.org/publications/fichiers/wsh_acf_0.pdf)
- ◆ Bastable A. (2000). 'Guidelines for excreta disposal in emergencies. An Oxfam Technical Manual'. Oxfam GB, Oxford, UK.  
[http://ec.europa.eu/echo/files/evaluation/watsan2005/annex\\_files/OXFAM/OXF7%20-%20Guidelines%20for%20exceta%20disposal%20%20in%20emergencies.PDF](http://ec.europa.eu/echo/files/evaluation/watsan2005/annex_files/OXFAM/OXF7%20-%20Guidelines%20for%20exceta%20disposal%20%20in%20emergencies.PDF)
- ◆ CAWST (2011) 'Introduction to low-cost sanitation'. Centre for Affordable Water and Sanitation Technology CAWST, Calgary, Canada.  
[http://resources.cawst.org/system/files/Sanitation\\_Manual\\_2011-02\\_en.pdf](http://resources.cawst.org/system/files/Sanitation_Manual_2011-02_en.pdf)
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- ◆ Harvey P. A (2007) 'Excreta disposal in emergencies: A field manual'. WEDC, Loughborough University, UK. <http://www.unhcr.org/4a3391c46.html>
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