UNIVERSITY CAPACITY BUILDING PROGRAM
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MINISTRY OF EDUCATION & MINISTRY OF CAPACITY BUILDING

gtz IS International Services

Urine Diverting Dry (UDD) Toilet at Adama University

P a r t I

Concept, Design, Operation and Maintenance & Construction of the Demonstration Project

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Abbreviations

Ecosan	Ecological Sanitation
GTZ-IS	German technical cooperation-International services
M&E	Monitoring and Evaluation
MoU	Memorandum of Understanding
N	Nitrogen
O&M	Operation and maintenance
PVC	Poly vinyl chloride
UCBP	University Capacity Building Program
UDDT	Urine Diverting Dry Toilet
UV	Ultra violate
WHO	World Health Organization

A	m^2	Area
d	m	Diameter
g	m^2/s	Gravity
H	m, mm	height
h_N	mm	Rainfall
k_b	mm	roughness
k_f	m/s	Infiltration rate
L	m	Length
Q_d	m^3/d	Daily flow
Q_m	m^3/h, l/s	Maximum flow
q_A	m/h	Surface load
Re		Reynold's number
S		Energy gradient
t	min,h	Time
V	m^3, l	Volume
v	m/s	Velocity of flow
λ		Pipe friction value
ν	m^2/s	Viscosity
ξ		Loss coefficient

Indices

FM	Faecal matter
GW	Grey water
PA	Percolation area
Prec	Precipitation
Sed	Sedimentation
U	Urine

A Introduction

The objective of the Urine Diverting Dry Toilet (UDDT) is to demonstrate a cost and resource reduced sanitation system that is suitable for implementation on institutional level. Therefore GTZ IS decided to install a UDDT for 400 users at Adama University.

The system works independently from water and sewer systems and in the same time produces fertilizer for agricultural use. Compared to conventional measures, costs for investment are reduced by more than 30%, operation costs by 10%.

Starting with a small-scale demonstration unit the suitability will be examined, evaluated and continuously optimized.

The philosophy of ecological sanitation is regarded as one technique to help solving the worldwide sanitation problem described in the Millennium Development Goals.

The Manual is divided in two parts and will share the knowledge with all persons interested in the topic of resource management:

Part I Concept, Design, Construction and Operation & Maintenance of the UDDT-Demonstration-Toilet

Part II Experience, Lessons Learned and Modification of the UDDT-Demonstration-Toilet for further Applications
(will be published later).

B Concept of UDDT and Treatment of Outlets

B.1 UDDT System in General

The UDDT system is based on the separation and reuse of three different material flows. The separation of the liquids (urine, grey water) from the solids (faecal matter) enables the operation of the toilet without the use of any water for the flushing of human excreta. Furthermore the lack of flushing water is the prerequisite for the appropriate treatment and the use of the material as fertilizer on the farmlands. A flow scheme of the system is given in Figure 1.

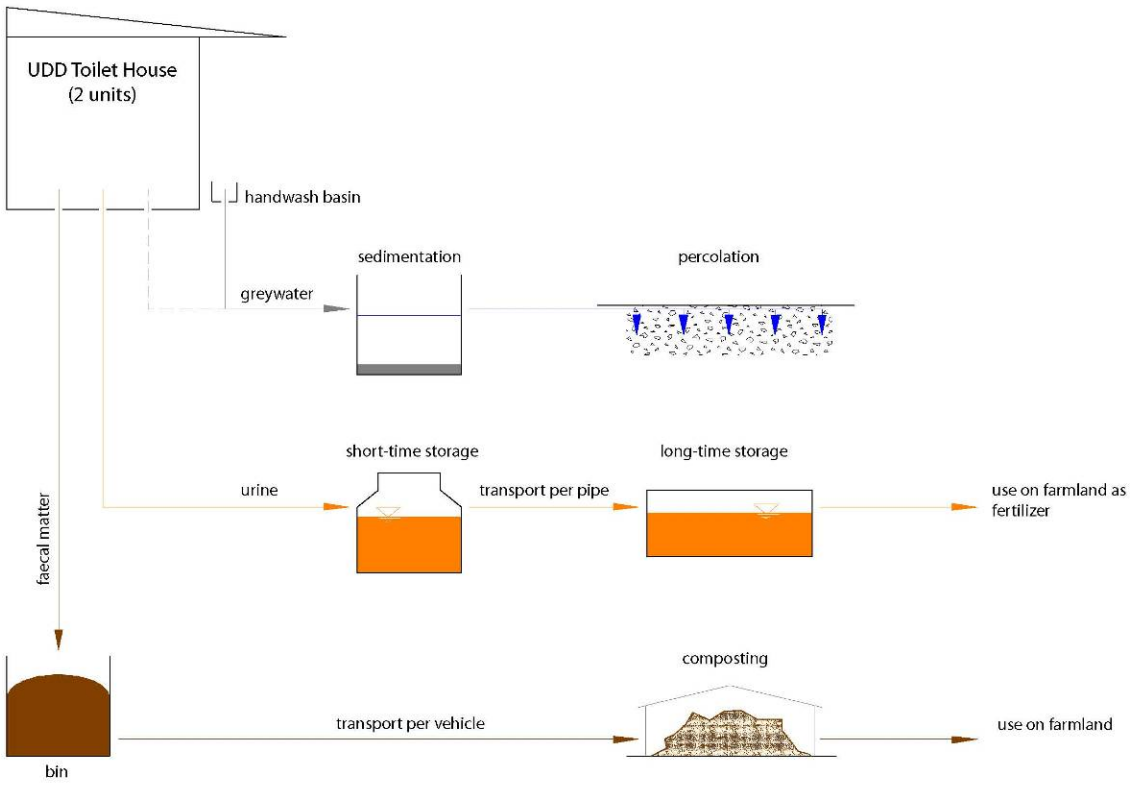

Figure 1: Flow scheme of the UDD-Toilet System

The UDDT system requires two locations for operation, one is the toilet building itself in-between faculty buildings easy to reach for the students; the second one is the treatment site off-campus in the southern part of the compound, where long term urine storage and composting take place.

B.2 Concept of UDDT Building – User Level

The UDDT is constructed similar to conventional public toilets. Two units – one for males and one for females – are equipped with toilet rooms. The unit for the females has 15 rooms; the unit for the male persons has 9 rooms and in addition 6 urinals. The two entrances at the site of the buildings have stairs as the user level is approx. 1 m above the ground. The toilets in the toilet rooms are Turkish toilets for squatting use. They are more hygienic for public areas than pedestal ones.

To ensure the separation of the liquid (urine) from the solid matter (faeces) a special toilet mould is installed. The mould has two outlets: A larger one in the back for the faecal matter and a small one in the front for the urine (see Figure 2). Six toilets in the female's unit and two units in the male's unit are equipped with a third outlet in front – this is for the people using water for the anal cleansing due to religious or other attitudes (Muslims etc.). A flushing system is not required. The urinals are integrated in the building for the male persons. In front of both buildings basins for hand-washing are installed.

Due to the open construction a good ventilation of the building takes place and the installation of openings lightens up the building and prevents from dark areas in which garbage could be disposed or collected.

For the user the toilet system is the same as the conventional ones. The difference is the missing water flush and the two outlets. After the use of the toilet the use of dry material (ash, soil or compost) is recommended. This added material covers the faecal material and will avoid the creation of smell because of the adsorption of liquids. The reduction of the moisture content additionally avoids the accumulation of bugs or vermin.

Figure 2:

Example for different urine diverting dry toilets:

left: ceramic mould – produced in Ethiopia
right: toilet for washers with a separate third outlet in front for water from anal cleansing

B.3 Concept of Treatment

The faecal matter is collected in a bin system. The bins will be replaced in specified intervals with new ones. The empty bins are equipped with a layer of organic material (e.g. compost) at the bottom for the adsorption of liquids. The bin system has advantages in situations of misuse or too much liquid – in this case the bin can be replaced by a new one and the material collected in other bins is not affected by this dilution.

The filled bins will be transported to the treatment place. Together with the added material (ash, soil or compost) and organic bio waste from other sources (kitchen, gardening etc.) it will be composted at the composting site. The composting site is located nearby the area of the wastewater treatment plant at a distance of approx. 300 m from the toilet building.

After emptying, the bins are cleaned and prepared for the next cycle.

The faecal matter remains approx. 6 - 12 months in the composting ditches until all the organic material is converted to compost. Then the ditches are emptied and the compost can be used at the university site for different purposes (see: faecal matter – treatment and co-composting).

The urine from the urine diversion dry toilets as well as from the urinals is transported in a pipe to a collection tank near the buildings. The pipe has a larger diameter than necessary because precipitation may occur in the urine.

A short-term tank that storages the urine for a few days is installed closed to the UDDT building. It is connected to the long-term storage tank which is located nearby the treatment site via pipe. In this way the urine is drained by gravity. The connection is controlled by a valve which has to be opened frequently for discharge.
By emptying this tank a larger volume of urine is flushed in one process to the long-term storage tank. The direct connection of the urine outlet of the toilet building (without the short-term storage tank) would create a long transport way for small amounts of urine rinsing down to the storage. Because of the possibility of precipitation during transport of the small volumes and flows the decision is made for flush by emptying the short-term storage tank. In this way the installation of the short-term storage tank increases the operational safety and reduces the possibility of disruptions caused by low flow volumes.

The storage in the long-term storage tanks is necessary because of two reasons: On the one hand, urine is treated by storage in accordance to the guidelines of the WHO. On the other hand, the use of the nutrient rich urine as a fertilizer on farmland is only possible during the sowing season that is during two short periods per annum.

The grey water from the hand washing, anal cleansing and cleaning is treated in-between the two toilet buildings. In a sedimentation tank solids and other materials settle down. This sedimentation is necessary for the avoidance of clogging of pipes of the following treatment step. The pre-treated grey water is fed into a percolation field on both sides of the sedimentation tank by percolation pipes. Both percolation areas are made up of gravel and planted with reed. The plants as well as the bio film located on the gravel bed degrade the pollution of the low polluted grey water before its infiltration in the ground.

C Design of UDDT-Building and Treatment Facilities

C.1 Location and User Rates

Location of the UDDT- Building

The UDDT is located in the southwest of the campus, nearby the faculty buildings of the first construction phase of the University's extension, in one of the future main traffic areas.

Since the class rooms, libraries and lecture halls around are not equipped with toilets for students, there is a great demand especially during the teaching time. The dormitories have their own sanitation facilities; therefore the UDDT will be closed during the night-time.

The catchment area of the toilet will vary during the times because of the extension of the Adama University in the frame of UCBP and the increasing student intake. Due to this development the user frequency will start on a low level and will increase within the next months / years. Therefore only assumptions and estimations can be made for the user rates.

Estimation of User Rates and Volumes

Due to the unknown behaviour of the students and the acceptance of the new UDDT system the user frequency is not known yet. For the design of the sanitation system the maximum user frequency is estimated and taken as the basis for the design. The maximum user frequency is limited by the capacity of the toilet building.

Table 1 shows the maximum user rates (pers/d) and the volumes calculated on the basis of these theoretical numbers of users.

	Unit	Male	Female	Total
Toilets	[pcs]	9	15	24
Urinals	[pcs]	6	0	6
Number of users1)	[pers/d]	240	150	390
User frequency defecation urinating (max. 5 per day)	 [1/d] [1/d]	 0.5 3	 0.5 3	
Volumes Faeces (0.3 l/(pers*d)[2)] Urine (1.0 l/(pers*d))[3)] Grey water (2.5 l/(Pers*d))[4)]	 [l/d] [l/d] [l/d]	 36 144 300	 23 90 188	 59 234 976
Volumes (6 days per week) Faeces Urine Grey water	 [m³/week] [m³/week] [m³/week]	 0.86	 0.54	 0.4 1.4 7.0
Volumes (11 months/year) Faeces Urine Grey water	 [m³/year] [m³/year] [m³/year]			 17 67 364

1) German design values for school buildings (full persons):
1 toilets per 10 female pers., 1 toilet per 20 male pers., 1 urinal per 10 male pers.
2) incl. addition of ash or sand
3) volume less than in Europe
4) only hand washing, 5 washings / day with 0.5 l each for 50% of users (incl. water for anal cleansing)
5) 10 months with students (100 %) and 2 months only staff (50 %)

Table 1: Estimation of input data per day (as maximum values – after finishing phase IV):

It is obvious that, during the first years of operation, the user rates are much lower and will increase during the extension of the University. Experience of the operation and maintenance will be collected and the system can be optimised if necessary. An estimation of the volumes during the extension time of the project is given in Table 2.

Phase	**Unit**	**I**	**II**	**III**	**IV**
Capacity of UDD-Toilet used	[%]	30	35	55	100
Volumes per day					
faecal matter	[l/d]	18	21	33	59
urine	[l/d]	70	82	129	234
grey water	[l/d]	293	342	537	976
Volumes per week (6 days per week)					
faecal matter	[m³/week]	0.12	0.14	0.2	0.4
urine	[m³/week]	0.42	0.49	0.77	1.4
grey water	[m³/week]	1.76	2.5	3.9	7.0
Volumes per year (11 months per year)					
faecal matter	[m³/year]	5.1	6	9	17
urine	[m³/year]	20	23	37	67
grey water	[m³/year]	109	128	200	364

Table 2: Estimated capacity and volumes of the UDDT

C.2 Panning Criteria regarding Treatment Facilities

Urine – Collection

The urine of all cabins and urinals is collected via pipes in two short-term storage tanks of 1 m³ at the long side of each unit. For this purpose normal water tanks made of fibre glass are used. The design predicts more urine from the females unit (0.86 m³/week) than from the males unit (0.54 m³/week). In order to equalise of the urine volumes between the two tanks a connection pipe is designed. Both tanks together have a volume of 2 m³ (2 x 1.0 m³), which is much more than the calculated accruing weekly volume of 1.4 m³/week.

Urine - Transport

From the short-term tanks the urine will be transported by pipe to the long-term storage tanks, which are located at the treatment site, in the south of the campus. Because of chemical reactions urine may form precipitations (e.g. Struvit) which can cause clogging in the pipe system, especially when the flow is only rinsing in a low gradient system. For preventing this, the transport pipe is only used for emptying of the short-term storage tank. The short-storage tanks have to be emptied once a week. The emptying process has to be made by opening the valve at the outlet. After opening the valve the tanks empty by gravity and the valve has to be closed after the emptying procedure.

The time for the emptying of the tank can be calculated as follows:

Minimal velocity occurs when the short-term storage tank (STTU) is nearly empty and the long-term storage tank (LTTU) is nearly full.

Length of the pipe from STTU to LTTU L = 271 m
Diameter of the pipe d = 110 mm

Water level Heights:
Bottom Level STTU H_1 = 1,483.46 m
Top Level LTTU H_2 = 1,476,67 m
$H = H_1 - H_2 = 1{,}483.46 - 1{,}476.67 = 6.79$ m

energy gradient $S = \frac{\Delta H}{L} = \frac{6.79\ m}{275\ m} = 0.0247 = 2.47\ \%$

lump-sum coefficient of operating roughness for pressure-pipe systems PVC-pipe k_b = 0.25 mm

$$\frac{k_b}{d} = \frac{0.25\ \text{mm}}{110\ \text{mm}} = 0.0023 = 2.3 * 10^{-3}$$

hydraulic losses

Inlet (pipe in tank)	ξ = 0.60
Valve (manhole near STTU)	ξ = 0.30
Bend 90° r/d = 3	ξ = 0.13
T (Bend 90° - manhole LTTU)	ξ = 1.30
Valve (manhole near LTTU)	ξ = 0.30
Bend 45° r/d = 3 2 * 0.3	ξ = 0.60
Inlet in LTTU	ξ = 1.00
	$\Sigma\ \xi$ = 4.23

1. Iteration

$k_b/d = 2.3*10^{-3}$ and Re = ∞

using the Nomogramm of Mock for the determination of λ: λ = 0.024 (in accordance to [3]

$$\text{velocity } v_1 = \sqrt{\frac{2*g*H}{\lambda*\frac{L}{d}+\Sigma\zeta}} = \sqrt{\frac{2*9.81*6.79}{0.024*\frac{271}{0.11}+4.23}} = 1.45\,m/s$$

viscosity ν at T = 20 °C: $\nu = 1.06*10^{-6}\ m^2/s$

$$Re_1 = \frac{v_1*d}{\nu} = \frac{1.45*0.11}{1.06}*10^6 = 1.5*10^5$$

2.Iteration

$k_b/d = 2.3*10^{-3}$ and Re = $1.5*10^5$

using the Nomogramm of Mock for the determination of λ: λ = 0.0255

$$\text{velocity } v_2 = \sqrt{\frac{2*9.81*6.79}{0.0255*\frac{271}{0.11}+4.23}} = 1.41\,m/s$$

$$Re_2 = \frac{v_2*d}{\nu} = \frac{1.41*0.11}{1.06}*10^6 = 1.46*10^5$$

3.Iteration

$k_b/d = 2.3*10^{-3}$ and Re = $1.46*10^5$

using the Nomogramm of Mock for the determination of λ: λ = 0.0255

$$\text{velocity } v_3 = \sqrt{\frac{2*9.81*6.79}{0.0255*\frac{271}{0.11}+4.23}} = 1.51\,m/s$$

$$Re_3 = \frac{v_3*d}{\nu} = \frac{1.51*0.1}{1.06}1*10^6 = 1.41*10^5$$

Iteration has no longer any change of λ and can be interrupted.

Flow during emptying:

$$Q = v*A = 1.41\,m/s*\frac{\pi*0.11^2}{4} = 0.0134\ m^3/s = 48\ m^3/h$$

Time for the emptying of both storage tanks V = 2.0 m³

$$t = \frac{V}{Q} = \frac{2.0\ m^3}{0.0134\ m^3/s} = 149\ s = 2.5\ minutes$$

It is assumed that a maximum opening time of the valves of 5 minutes is sufficient to empty the urine tanks.

The urine sewer is a 110 mm PVC pipe. The length and the elevation can be seen in the drawings. It runs from the UDDT building towards south and crosses the pipes of the wastewater treatment system as follows:

DA-T3-XX-035: sewer above the wastewater sewer

LA-T3-XX-308: sewer under the wastewater sewer (see master plan)

The urine sewer is parallel to the wastewater sewer and meets the main sewer at the road at the southern border of the buildings. Here, the urine sewer crosses the road **together** with the wastewater pipe. Both sewers have the same top elevation at the crossing and both will be covered by a concrete slab later on (see sanitary drawings).

Urine - Treatment

The treatment of the urine takes place in eight long-term storage tanks with a capacity of 5.0 m³ each and a total volume of

$$V_{urine\text{-}st} = 8 \times 5.0\ m^3 = 40.0\ m^3 > 33.6\ m^3/6\ months = V_{urine,0.5}$$

This volume is sufficient for the storage of the urine collected within half a year.

The maximum storage time can be calculated as

$$t_{urine-st} = \frac{V}{Q_{urine,week}} = \frac{40\ m^3}{1.4\ m^3/week} = 28.6\ weeks$$

With this volume the urine can be stored for approx. 28.6 weeks (7 months). This period of 7 months is the time between the two agricultural seasons (August – February). So the time of storage is sufficient to store the urine until the land will be prepared for sowing.

For the projects phases I and II half of the number of tanks are sufficient:

$$V_{urine\text{-}st,\ I\text{-}II} = 2 \times 2 \times 5.0\ m^3 = 20.0\ m^3 > 28.6\ weeks^* 0.49\ m^3/week = 14.0\ m^3 = V_{urine,0.5,\ I\text{-}II}$$

For the phase I – II only 4 tanks will be installed. With the extension of the project and the start of phase III the volume of the urine storage can be enhanced by four more additional tanks of 5 m³ each.

In accordance to the recommendations of the WHO [5] (Table 3) a storage time of 1 month is sufficient for the treatment of urine which shall be used for fertilizing crops that are to be processed.

Storage temperature (°C)	Storage time (months)	Possible pathogens in the urine mixture after storage	Recommended crops
4	≥1	Viruses, protozoa	Food and fodder crops that are to be processed
4	≥6	Viruses	Food crops that are to be processed, fodder crops[d]
20	≥1	Viruses	Food crops that are to be processed, fodder crops[d]
20	≥6	Probably none	All crops[e]

[a] Urine or urine and water. When diluted, it is assumed that the urine mixture has a pH of at least 8.8 and a nitrogen concentration of at least 1 g/l.
[b] Gram-positive bacteria and spore-forming bacteria are not included in the underlying risk assessments, but are not normally recognized as a cause of any infections of concern.
[c] A larger system in this case is a system where the urine mixture is used to fertilize crops that will be consumed by individuals other than members of the household from whom the urine was collected.
[d] Not grasslands for production of fodder.
[e] For food crops that are consumed raw, it is recommended that the urine be applied at least one month before harvesting and that it be incorporated into the ground if the edible parts grow above the soil surface.

Table 3: Recommended storage times for urine mixture[a] based on estimated pathogen content[b] and recommended crops for larger systems[c] [5]

Due to two seeding seasons in Ethiopia, the storage for a half year time is recommended.

The storage tanks are installed in two lines. After filling the first line the change to the second line can be made four weeks before application, thereby four weeks of exclusive storage time required for a safe application are fulfilled.

The long-term storage tanks (glass fibre tanks) are under the ground level in order to avoid any heating by the sun. The tanks have to be surrounded by sand for the protection against stones. All tanks of the line are connected among each other for level equalisation.

The storage tanks don't have any outlet and have to be emptied by pumps. In Ethiopia simple hand-pumps are only suitable for fuel or diesel and can't be used for water or urine. The price for handheld lift-pumps is similar to the costs for a benzene pump.

Benzene pumps are available for approx. 2,700 ETB with an capacity of 6.5 HP and 60 m³/h. Because of the higher flexibility the benzene pump is recommended for the use as an emptying pump for the urine tanks.

The pump will be only in use during the sowing season, while the farmers demand for fertiliser. This will include only a few days each season.

Faecal Matter - Collection

The faecal matter is collected in bins in the ground-floor of each toilet unit. The position of the bins and the bins themselves can be seen in Figure 3.

Figure 3: Position and dimension of the bin located in the ground-floor level

Before operation, a layer of organic material (paper, compost or similar) is put at the bottom of each bin for drainage of excess liquid.

When filled up, the bins have to be replaced by new ones.

Faecal Matter - Transport

The bins filled in the toilet building will be replaced by new ones from the rear access at the backside of each unit. Empty and clean bins are stored in the bin-store at the treatment site.

A barrow – modified for the conditions of the toilet house – is used for the transport of the filled bins from the building to the road. For this operation, the bins will be tightly closed with the lid. The transport from the road to the treatment site will be handled in the phase I – II by donkey chart which is hired for this purpose on hourly basis. Later on in phase III – IV the tractor of the wastewater treatment plant could maybe used.

Faecal Matter - Treatment

Human faeces have a moisture content of approx. 60 – 65 % and a C:N ratio between 5 and 10. Especially the nutrient ration (C:N) is unfavourable for composting processes, here a C:N ratio of 20 – 40 and a moisture level of 40 – 60 % is recommended for proper composting. In order to increase the C:N-ratio and to obtain a better structure which has a more favourable effect on the composting process a mixing with other organic wastes is recommended.

The adsorption of the liquid will mainly be done by adding of ash or sand into the toilet facilities. The increase of the nutrient ration has to take place before the treatment.

The university site has large areas with gardens and plants, which are in a very good condition due to regular maintenance. The residues from the cuttings of the shrubs, plants etc. can be used as an additional material for the composting process. On the base of

experience organic bio waste from the university kitchen can serve as another source for additional organic material.

The compost site has four open ditches, which will be loaded with material.

Each ditch has a dimension of:

Length	L = 6.00 m
Width	W = 1.00 m
Depth	D = 1.00 m
Volume	V = 6.0 m³

In total, all four ditches have a volume of 24.0 m³ for the treatment of the faecal matter of phases I – II. With this arrangement, the requirements of the WHO concerning the storage time of dry faecal matter can be fulfilled (Table 4). In accordance to the regulations of the WHO a storage time of 1 year is recommended for ambient temperatures > 20 C.

Treatment	Criteria	Comment
Storage; ambient temperature 2–20 °C	1.5–2 years	Will eliminate bacterial pathogens; regrowth of *E. coli* and *Salmonella* may need to be considered if rewetted; will reduce viruses and parasitic protozoa below risk levels. Some soil-borne ova may persist in low numbers.
Storage; ambient temperature >20–35 °C	>1 year	Substantial to total inactivation of viruses, bacteria and protozoa; inactivation of schistosome eggs (<1 month); inactivation of nematode (roundworm) eggs, e.g. hookworm (*Ancylostoma/ Necator*) and whipworm (*Trichuris*); survival of a certain percentage (10–30%) of *Ascaris* eggs (≥4 months), whereas a more or less complete inactivation of *Ascaris* eggs will occur within 1 year.
Alkaline treatment	pH >9 during >6 months	If temperature >35 °C and moisture <25%, lower pH and/or wetter material will prolong the time for absolute elimination.

[a] No addition of new material.

Table 4: Recommendations for storage treatment of dry excreta and faecal sludge before use at the household and municipal levels[a] [5]

The ditches are dug in the ground. The surrounded area is paved with cobblestones. At the top the frame of the ditches is paved with an L-shaped stone made of reinforced concrete. These stones keep the form of the ditches and are a barrier while emptying the bins into the ditch. The side walls of the ditches are made up of bricks.

The bins with the faecal matter (plus adsorption material) are emptied into the composting ditch. At the top of each layer of faeces (5 – 10 cm) the organic bio waste material is added as a layer as well. So the heap will increase until the chamber will be filled.

After the filling procedure the ditch is closed with a layer of soil and the material remains there for composting. After two months the composting material is turned to another empty ditch. This shifting supports the biological processes because of additional mixing and input of oxygen. This treatment step is repeated once again. To fulfil the storage criteria of the WHO the material is stored in the ditch for an additional period of 6 months. (Proposal for the several operation phases of the composting ditches, see Annex 01)

After one year, the material can be removed as compost and will be used on the fields or gardening areas on the campus of the university.

The expected volumes of the faecal matter and the bio waste are calculated in the table below (Table 5). Herein the same volume of bio waste is added to the faecal matter to increase the C:N ratio at least of 20. During the composting process volume and mass reduction down to 40 % occur.

Phase	Unit	I	II	III	IV
Students	[pers]	2,700	3,000	5,500	10,000
Capacity of UDD-Toilet	[%]	30	35	55	100
Volumes per year					
faecal matter	[m³/year]	5.1	6	9	17
addition of organic material (biowaste, grass etc.)	[m³/year]	5	6	9	20
total volume	[m³/year]	10	12	18	37
Compost per year (60 % degradation)	[m³/year]	4	5	7.2	15

Table 5: Estimation of the volumes of bio waste and compost

Grey water

Grey water contains water for hand washing, for anal cleansing and cleaning of the building. The treatment of the grey water takes place in a percolation area in the courtyard in-between the two toilet units. There are two stages of treatment:

1. Sedimentation
   In this stage the solid material such as sand, dust, hairs etc. which is transported by the grey water is removed by sedimentation or flotation.
2. Percolation in a gravel filter
   The pre-treated grey water is percolated in a gravel bed which is planted with reed. It will be treated by biological processes in the gravel filter as well as in the root zone of the plants. The treated grey water will either be taken up by the plants or infiltrated into the ground and enriches the groundwater.

<u>Grey water flow</u>

Daily grey water flow: $Q_{d,GW}$ = 976 l/d ≈ 1,0 m³/d

The largest grey water volume occurs when all facilities are in use. This means all toilet facilities and all hand-washings basins discharge at the same time.

Frequency of maximal use:

Toilets: 24 toilets * 30 persons / (toilet * h)	=	720 uses/h
Urinals: 6 urinals * 60 persons / (urinal * h)	=	360 uses/h
Total		1,080 uses/h

When all these users are using the hand-washing facilities, spending a volume of 0.5 l/pers there is a maximum grey water flow of:

$Q_{m,GW}$ = 1,080 users/h * 0.5 l/user / 3,600 s/h = 0.15 l/s

<u>Capacity of the inlet pipe:</u>

Pipe diameter: Ø 110 mm
Gradient I = 0,01 m/m
max. capacity of the pipe: $Q_{m,pipe}$ = 2.8 l/s ⇨ $Q_{m,GW} < Q_{m,pipe}$

<u>Volume of the sedimentation tank:</u>

$V_{Sed,GW} = t_{GW} * Q_m$ = 2.0 h * 0.15 l/s * 3,600 s/h / 1,000 l/m³= 1.08 m³

t_{GW} = retention time of the grey water [h]

For the storage of the settles material an addition to the volume of 50 % is made:

$V_{Sed,GW}$ = 1.5 * 1.08 m³ = 1.62 m³

The chosen sedimentation tank has the dimension

$V_{Sed,GW}$ = 1.2 m * 1.2 m * 1.2 m = 1.7 m³ > 1.62 m³

Surface load of the sedimentation tank:

$$q_A = \frac{Q_m}{A_{Sed}} = \frac{0.15\frac{l}{s} * 3.600\frac{s}{h}}{1.000\frac{l}{m^3} * 1.2m * 1.2m} = 0.38\frac{m}{h} < 0.8\frac{m}{h}$$

Also in times of a maximum input flow sand grains down to 0.01 mm can be separated by the sedimentation tank.

Percolation area

Although the percolation area will be planted and a loss of water by evaporation will occur the worst case of total infiltration (no evaporation) will be calculated as follows.

For the percolation area the infiltration capacity of the soil has to be known. This infiltration capacity test was made in accordance to the Ethiopian Building Standard Code [4].

The mean value of the infiltration rate of the two infiltration tests is calculated to $k_f = 7.5 * 10^{-6}$ m/s. Because of clogging and precipitation processes during the lifetime of the soil during the percolation the infiltration capacity is chosen to

$k_f = 1 * 10^{-6}$ m/s

During the rainy season hydraulic load of the percolation is the sum of the grey water input and the maximum daily rainfall.

The area necessary for the infiltration can be calculated as:

$$A_{PA} = \frac{Q_{d,GW}}{k_f} + \frac{A_{PA} * h_N}{k_f}$$

A_{PA} percolation area [m²]

h_N highest rainfall by day

For 2004 the highest rainfall per day occurred in August with h_{prec} = 43 mm/d.

Transforming the formula above results in:

$$A_{PA,n} = \frac{Q_d}{k_f * (1 - \frac{h_{prec}}{k_f})} = \frac{1.0\frac{m^3}{d} * \frac{1}{86,400}\frac{d}{s}}{1 * 10^{-6}\frac{m}{s} * (1 - \frac{0.043\frac{m}{d} * \frac{1}{86,400}\frac{d}{s}}{1 * 10^{-6}\frac{m}{s}})} = 23.0\,m^2$$

The two percolation areas on both sides of the sedimentation tank have the dimensions:
No of percolation beds: 2 items
Length: L = 5.60 m
Width: W = 2.25 m
Total depth: D = 1.50 m
Area of each percolation area: $A_{PA,1} = L * W = 5.60 * 2.25 = 12.6$ m²

Layer of the percolation areas:

Topsoil 0.20 m	
upper layer: gravel, grain size Ø 4 – 8 mm	0.50 m
distribution layer: gravel, grain size Ø 8 – 16 mm	0.50 m
infiltration layer: gravel, grain size Ø 4 – 8 mm	0.30 m

The infiltration area can be calculated to
A_{PA} = 2 * 5.60 m * 2.25 m = 2 * 2.60 m² = 25.2 m² > $A_{PA,n}$

The daily maximum infiltration load is the sum of grey-water percolation as well as precipitation:

$$A_{slits,total} = 3 * 51 * A \frac{\pi * d_{pipe}^2}{4} = \frac{\pi * 110^2}{4} = 9,503 \text{ mm}$$

The storage volume of the gravel bed (distribution layer) in the pore volume (approx. 20 % of total volume) is

$V_{PA,store}$ = 0.2 * 25.2 m² * 0.50 m = 2.5 m³ > $Q_{d,GW}$

More than a daily volume of the grey water can be stored in the pore volume of the gravel bed. This volume is able to equalize the daily fluctuations of the grey water inflow.

For the distribution of the grey water on the surface of the gravel bed a percolation pipe is installed. This percolation pipe is equipped with slits at its bottom size up to a third of the pipe height (37 mm of 110 mm total height). The width of the slits is 2 – 3 mm (detail see chapter B.4.)
The percolation area of these slits has to be larger than the cross section area of the inlet pipe:

$$A_{pipe} = \frac{\pi * d_{pipe}^2}{4} = \frac{\pi * 110^2}{4} = 9,503 \text{ mm}^2$$

Length of each slit	L_{Slit} = 140 mm
Minimum width of the slit	W_{Slit} = 2 mm
Area of the Slit	A_{Slit} = 140 * 2 = 280 mm²
Slits per percolation pipe (L = 5000 mm)	n_{Slit} = 50

Total percolation of all slits of one percolation bed:

$$A_{slits,total} = 3 * 50 * A_{Slit} = 3 * 50 * 280 \text{ mm}^2 = 42,000 \text{ mm}^2 >> A_{pipe} = 9,503 \text{ mm}^2$$

The percolation area of the pipes is approx. 4.4 times larger than the cross section area of the inlet pipe. In the case of clogging or growth of roots into the percolation pipe there is enough safety to avoid any backwater in the pipe or in the sedimentation tank.

The percolation pipes are coated with coconut or sisal fibres against the entrance of roots of the reed.

The gravel bed will be planted with reed in order to avoid clogging of the bed. The infiltration rate of the grey water will be reduced as the water will partly be taken by the plants and evaporate later.

C.3 Drawings

Drawings of the UDDT are shown in Annex 6.

Due to the limited size of this brochure only some selected drawings are inserted. All drawings are reduced from the original size of A1 to A4.

- Master plan - UDDT Building and Treatment Site
- Architectural ground floor plan
- Architectural first floor plan
- Architectural elevations
- Sanitary installations ground floor
- Sanitary installations section
- Treatment site: urine storage
- Treatment site: compost site
- Landscaping

D Operation and Maintenance (O&M) of UDDT

D.1 Operation and Maintenance Concept

∑ Operation	General characteristics of material
Faeces The faecal matter is collected in a bin system. Bins are replaced every week and transported to the treatment site, where the faecal matter will be co-composted with bio waste. The faecal material remains in the composting site for approximately 6-12 months.	• hygienically critical, potentially containing a series/array of pathogens, leading to water-borne diseases (e.g. bacteria, viruses, protozoa, nematodes, worm eggs) • consists of organics, nutrients and trace elements • improves soil quality and increase its water retention capacity • average production 0.4m3/week • consists mainly of organics submitted to decomposition processes and a minor proportion of nutrients
Urine The urine from the toilets is transported in pipes to two collection tanks near the toilet buildings which work as a short term storage for one week. From these tanks the urine is transported through pipe under gravity to a long term storage tank.	• hygienically uncritical • contains the largest proportion of nutrients available to plants • may contain hormones or medical residues • average production 1.4m3/week • consists mainly of nutrients available to plants and very little organics, therefore no need for stabilization
Grey water The grey water from the hand washing, anal cleansing and toilet cleaning is pre-treated in a sedimentation tank where solids settle down. The effluent from the sedimentation tank is percolated in a percolation bed planted with reeds.	• usually of no major hygienic concern • volumetrically the largest portion of wastewater • contains usually almost no nutrients (simplified treatment) • may contain a vast range of various substances • average production 7 m3/week

Diverting urine

There are a number of good reasons for not mixing urine and faeces:

- it keeps the volume of potentially dangerous material small;
- the urine remains relatively free from pathogenic organisms;
- urine and faeces require different treatments;
- it simplifies pathogen destruction in faeces;
- it reduces odour;
- it prevents excess humidity in the processing vault; and
- the uncontaminated urine is an excellent fertilizer.

D.2 Operating principles and methods

Operation in normal conditions

Vent Pipes

The vent pipe used in this project is a 110 mm PVC pipe which extends above the roof in the chamber for ventilation & aeration. The vent pipe draws out air from the vault, mostly by the action of air passing across the top of the pipe. The air that flows out of the pipe is replaced by air passing down the squat hole or pedestal. This is most efficient when the slab and UDDT pan are sealed and airtight and the head of the pipe is not surrounded by trees. Any foul odour from vault does not escape into the superstructure, but will be diluted by air and passes out of the pipe into the atmosphere. The effect is that the toilet becomes almost odourless. The vent also helps to remove moist air from the vault which helps to reduce the moisture content of the faecal matter.

To remove odours and drying contents the pipe shall be checked from time to time and be kept as straight as possible. The pipe shall also be covered with a suitable mosquito proof mesh at the top. It is important to thoroughly clean out the ventilation pipe from time to time to retain its efficiency. This is because spiders weave their webs inside the pipe and this seriously disrupts the air flow inside the pipe [9]. Efficient ventilation is important and helps to reduce odours and also maintains a constant flow of air through the vault which reduces moisture.

Dehydration, odor and fly control

The key operational factor for the successful operation of the UDDT is minimal moisture. A supply of ash should always be available in a suitable container, and this should be sprinkled over the faeces by the cleaning lady three times per day. A cupful (approximately 200 ml) should normally be sufficient per application, however the cleaning staff will quickly learn how much is required. The ash will absorb the inherent moisture in the faeces, thus aiding the dehydration process. Flies and odours are also controlled in this manner. Furthermore, ash, particularly wood ash, has a relatively high pH (approximately 10), which is useful in reducing pathogenic organisms in the faeces. The elimination of odours makes the toilet far more pleasant to use, and the control of insects, particularly flies, is important for health reasons. Too many flies are also a nuisance.

In these UDD toilets, since the faeces are deposited separately and covered with ash, flies do not breed well under these conditions. But if at any case fly breeding begins or when maggots are observed adding more ash will stop the breeding. It is essential that the faeces collection bin is not flooded with water or urine added. This will make things very messy.

Cleaning the toilet

As with any toilet, cleanliness is essential for good hygiene. The urine receptacle of the urine diversion pan, as well as the urinal, must be cleaned on a regular basis (daily). If the UDDT pan becomes soiled, it may be cleaned with a damp toilet brush or wet cloth. Water and disinfectant must be used to dip the cloth or brush in, but it should not be soaking wet. Water must be prevented from falling into the faeces receptacle as far as possible.

The great advantage of the urine-diverting system used in this project, where the faeces are contained in a removable bin and not a static vault is that the system can be washed down completely once the faeces collection bin has been removed. It is desirable that the UDDT pan is washed down and cleaned once per week. First the bin is removed and put outside the vault. The UDDT pan can then be thoroughly washed down and cleaned out with water

and detergents. The toilets floors and vault can also be washed down with water. The toilet and its parts are then allowed to dry out and are all put back together including the bin.

The urine pipe should also be flushed out with 1 litre water every week.

Disposal of anal cleansing material

Various methods are used for the disposal of anal cleansing material. The toilet paper can be deposited into the faeces container, as it decomposes when wetted afterwards. It should be noted that soft tissue paper or paper can be used.

It is also common practice in Ethiopia to use papers and tissue papers for anal cleansing. Anal cleansing with water is common, particularly among Muslims and increasingly these days also among some Non-Muslims. Six toilets in the female's unit and two units in the male's unit are provided with anal cleansing water drainage holes. Rooms having such facility are provided with a bucket of water and a jar. The water used for anal cleaning is collected and treated in the percolation area.

Co-Composting

The co-composting comprises various steps starting from waste sorting until the final bagging of the compost product. The carbon-nitrogen ratio in faeces is not viable for composting. Therefore additional carbon containing material, such as leaves plant matter and waste food has to be added to the mix. This will help promote composting which destroys the harmful pathogens, making humus which can safely be applied to fields.

The co-composting process is divided into nine steps which are shown in Figure 4. Faeces from the UDDT and the bio waste from the university campus arriving at the composting plant are sorted into several fractions. The organic fraction enters the composting process. It is then piled into the composting system.

The composting process has to be monitored by different parameters (temperature, moisture). Finally, the mature compost is screened and prepared for use or sale. Residues from sorting and screening are recycled or disposed of.

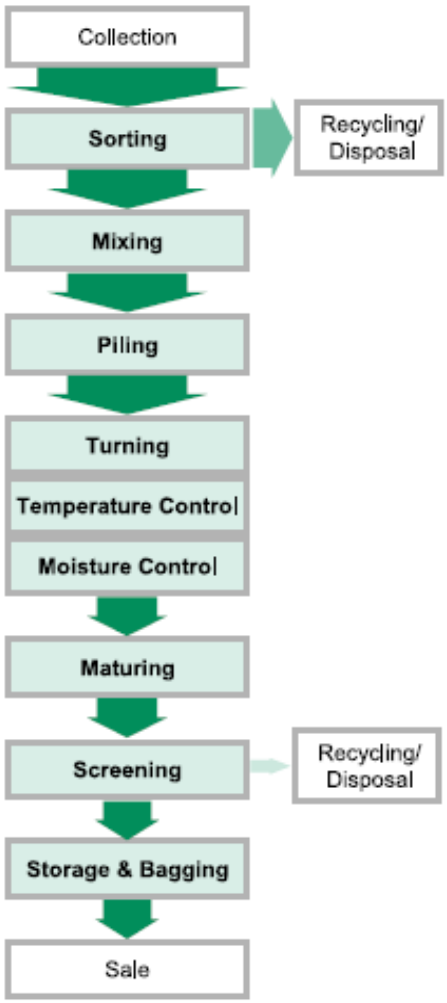

Figure 4:

Flow chart showing the co-composting process steps and material flow [10]

Composting materials that can be used to from the University campus are listed below

- Garden waste-leaves, wood chips, and branches
- Waste from cafeteria/kitchen(Both student and staff) – vegetables & fruit food waste
- Animal waste
- Straw from the farm lands
- Paper and small pieces of cardboard

Things to avoid in co-composting include

- Orange and lemon peels
- Meat and bones
- Animal products
- Plastic
- Metals

Removing composted material

When it is time to remove the composted material, it should not look or smell at all like the original waste material that went in. No faeces should be identifiable. Ideally, it should be dry, and look and smell like very rich garden soil [7].

Handling composted material

When handling composted material

- Use rubber (non-permeable) gloves
- Wash your hands thoroughly afterwards
- Keep tools used for working with the contents of the compost in a contained and out-of-the-way place.

Trouble Shooting

Bad smell occurs in the UDDT

When any bad smell occurs,

1. Check if ash was added in all faecal containers
   - If NO, add a cupful of ash in the faecal container
2. Check if urine diversion system is blocked.
   - If YES, unblock and flush water down the urine pipe
3. Check if the chamber content is damp/wet.
   - If YES, Inspect source of water and repair
4. Check if UDDT pan is unclean.
   - If YES, wipe with soapy and damp piece of cloth
5. Check if there is poor ventilation
   - If there is poor circulation; empty the content to create room for ventilation. In addition, ensure that the vent pipe is in the correct position and erect.
6. A check must always be done to assure that there are no leaks in the urine pipe.

Blockages in Urine Pipes

Most blockages that occur in urine-diverting dry toilets are “soft” blockages caused by precipitation on hair and paper fibre. The other type is “hard” blockages, caused by precipitation directly on the pipe wall. The blockages are removed either mechanically by a drain auger or chemically by use of strong solutions of caustic soda (2 parts of water to 1 part of soda) or acetic acid (>24%) [8]. The tools used for cleansing urine pipes are shown in Figure 5. These methods can also be used as prevention against blockages.

A suggested initial frequency for preventive cleaning is once in a month and then increasing the frequency if blockages still occur. Irrespective of the method used, it is important that the cleaning is followed by pouring 1–2 litres of water down the urine bowl as fast as possible, to flush away any material that might have come loose by the cleaning.

Figure 5: Cleansing tools for urine pipes [8]

Problems during Composting

Table 6Table 6 summarizes problems during composting and recommends solutions to solve them.

Problem	Cause	Solution
Vinegar or rotten eggs smell	Too wet, or compacted	Soak up excess moisture. If smell is too bad, add dry materials on top and wait until it dries out a bit before you mix the pile
Odor like ammonia	Not enough carbon	Add brown materials like leaves, straw, hay, shredded newspaper, etc
Attracts rodents, flies or other animals	Inappropriate materials (like meat, oil, bones), or the food-like material is too close to the surface of the pile	Bury kitchen scraps near the centre of the pile. Don't add inappropriate materials to compost. Switch to a rodent-proof closed bin
Attracts insects, millipedes, slugs, earthworms, etc	This is normal composting, and part of the natural process	Not a problem
Fire ant problems.	Pile could be too dry, not hot enough, or has kitchen scraps too close to the surface.	Make sure your pile has a good mix of materials to heat up, and keep it moist enough

Table 6: Possible problems during composting and recommended solution

D.3 Roles and Responsibilities

Tasks and Responsibilities of Adama University Management

An efficient and effective management of the systems is most essential for their proper functioning. The University management in general should aim in the following achievements:

- Proper collection, treatment and reuse of the wastes (faeces, urine and grey water)
- Safe and efficient operations and as far as possible self financing

Tasks and Responsibilities

The tasks and responsibilities of the University are listed as under

1. Recruit one man as caretaker and two women as cleaning staff
2. Supervise the staff above
3. Evaluate the works of caretaker and cleaners by a system of evaluation norms such as confidential reports, result oriented evaluation etc. The evaluation may refer to (i) Knowledge and skill, (ii) punctuality, (iii) Quality of operation and maintenance works, (iv) Dependability, (v) initiative and (vi) Tolerance to criticism
4. Ensure that the caretaker and cleaners have clear operating instructions and contact phone numbers
5. Share the experience of using UDDT and the treatment facilities to other universities whenever possible
6. Provide plot for UDDT building and treatment facilities.
7. Ensure and support the cooperation of stakeholders (Students, Agricultural research institute, regional and zonal agricultural bureaus, municipality, regional and zonal health bureaus, farmers, GTZ-IS etc.) for the sustainable operation of the scheme and reuse of the system products(urine and compost)
8. Provide training for users (students, farmers, agricultural field workers) in accordance and support of GTZ-IS.
9. Ensure the use of the system products (urine and compost) on the farm lands of the university and/or the university garden in accordance and support of GTZ-IS.
10. Identify potential users of the system products (Urine and compost)
11. Provide staff, the necessary equipment, tools and supplies for the O&M of the system.
12. Cover costs required for the transportation of faeces from the toilet building to the treatment site and the transportation of compost and urine to the users. In the future, it will be self financed when a market for the urine and compost is created.
13. Include the annual operation and maintenance program and budget of the system in the Universities annual plans
14. Keep records of the material and tools and money spent for the O&M. Similarly, keep records of any income obtained by the sale of the urine and compost.
15. Keep records of number and nature of complaints from caretaker and cleaners.
16. Make a document of how specific problems in O&M were over come. This will help in dissemination of the same to other universities.

In addition to the above tasks and responsibilities the responsible department/section of the university should look in to the following aspects:

1. That there are adequate maintenance facilities
2. That the operations are smooth
3. That the maintenance is efficient and economical
4. That the caretaker and cleaner are efficient and responsive
5. That the toilet units, tools and supplies are controlled properly
6. That good relations between the caretaker, cleaners and students are established

Effort of Operation

Effort of operation and maintenance of the sanitation system is show in the tables as follows:

Phase	Unit	I	II	III	IV
Students	[pers]	2,700	3,000	5,500	4,500
Capacity of UDD-Toilet	[%]	30	35	55	100
Cleaning					
Cleaning of the toilet	[h/week]	10	10	15	20
Adding of ash	[h/week]	2	2	3	4
Replacement of the bins	[h/week]	2	2	3	4
Transport of the bins	[h/week]	5	5	7	10
Urine – collection					
Time effort	[h/week]	0.25	0.25	0.25	0.25
Faecal matter and urine – treatment					
transport and disposal of bins	[h/week]	1.5	1.5	2	4
cleaning of bins	[h/week]	1	1	2	4
handling compost	[h/week]	2	2	4	8
pumping, distribution of urine	[h/week]	0.1	0.15	0.2	0.25
Total	[h/week]	24	24	37	55

Table 7: Estimation of the effort of operation for the UDD-Toilet and the treatment

Tasks of the operational staff	Beginning of operation		Later status of operation	
	I	II	III	IV
Around the building - Cleaning the toilets - Observation / training of students - Add ash into the bins	2 Ladies working half a day (focus: observation/ explaining tasks)		2 Ladies working half a day (focus: cleaning)	
Treatment of outlets - Replacement and transportation of bins - Emptying urine tanks - Filling composting ditches	1 Man working quarter of a day + transport facilities hired + daily labourer helping on composting field		1 Man working half a day + transport facilities hired + daily labourer helping on composting field	

Table 8: Tasks and staff for the operation for the UDD-Toilet and the treatment

Costs and Material required for routine O&M Works

The cost estimation and the material list for the routine operation and maintenance works are made for phase IV where all the UDDT and treatment facilities are in full operation. The cost and list of material is given below.

Labour cost

For the operation and maintenance of the system three persons, one man as caretaker & two women as cleaners need to be assigned / employed.

Transportation cost

The transportation of the faeces bins to and from the composting site and the transportation of the urine from the long term storage tank to the urine trial field/farm/users will be carried by a donkey/horse driven cart. These transportations can be made altogether with in one day per week. The donkey/horse driven cart can be hired at a cost of Birr 50.00 per day. Therefore the total amount of money required for transportation will be Birr 2600.00.

Material cost

A total of 30 items are required for the routine operation and maintenance of the whole system. The total cost of these items required for one year operation is Birr 2979.90.

Summary of costs

The summary of all costs for one year O&M are given in

Table 9.

S.No.	Item	Unit	Quantity	Unit Price	Total Price
1	Vim	pcs	52	12.00	624.00
2	Mop	"	4	30.00	120.00
3	Broom	"	4	6.00	24.00
4	Toilet soap	"	208	2.50	520.00
5	Powder soap	"	12	2.50	30.00
6	Tissue paper	"	20	3.00	60.00
7	Black pen	"	4	1.50	6.00
8	Registration book	"	2	18.00	36.00
9	Towel	"	4	10.00	40.00
10	Flit	pcs	8	25.00	200.00
11	Abu Jedi	Mt	12	10.00	120.00
12	Rag	Kg	1	7.00	7.00
13	Sponge	pcs	8	4.00	32.00
14	Gloves	pcs	4	7.00	28.00
15	Boots	"	1	60.00	60.00
16	Mask for nose and mouth	"	2	25.00	50.00
17	Uniform	"	3	120.00	360.00
18	Ash Bucket	"	2	25.00	50.00
19	Ash cup	"	2	2.00	4.00
20	Shovel	"	2	40.00	80.00
21	Spade	"	2	40.00	80.00
22	Hoe	"	1	40.00	40.00
23	Fork	"	1	40.00	40.00
24	Bucket for anal washers	"	2	25.00	50.00
25	Water jar for anal washers	"	2	2.50	5.00
26	Fibre Brush	"	4	12.00	48.00
27	Sanitary pad collecting basket	"	2	15.00	30.00
28	Spider removing mob	"	2	12.00	24.00
29	Wire brush	"	2	15.00	30.00
30	Plastic rope for tying bins	"	20	2.00	40.00
				Total	2,838.00
				Contingency (5%)	141.90
				Grand total	2,979.90
				Labor cost	9,600.00
				Transportation cost	2,600.00
				Total	**15,179.90**

Table 9: Material required per year for O&M

Instructions and Task List for Caretaker

Instruction for Caretaker (English)

- Your main tasks are:
  - Make sure that the toilet and the treatment facilities are working in a proper way.
  - Proper way is the separation of urine and faecal matter and the production of mineral fertilizer (from urine) and organic fertilizer (from faecal matter by composting)
- A monthly status report about the condition of the toilet and the treatment systems has to be given to the responsible official of the University.
- All damages and major maintenance works required have to be reported immediately to the responsible official of the University.
- Make sure that all bins are replaced properly before starting of toilet's operation again.
- Make sure that all doors for the bin access are closed and locked after replacement or inspection.
- The contact of the users with the faecal matter and the urine has to be avoided.
- Protective clothing have to be worn:
  handling with urine:
  - rubber gloves
  - goggles

  cleaning of urine tanks:
  - rubber gloves

  handling with faeces:
  - gloves
- Avoid the risks of infection and disease by proper handling of urine, faeces and grey water.
- Avoid the direct contact to the faecal matter, urine and grey water.
- Avoid spilling of urine and faecal matter during transportation
- Close the bins with a lid during transportation
- Be sure that all containers (bins, jerry cans) are closed properly before transportation
- Clean all tools and equipment after use
- Wash your hands with soap after handling with faecal matter and urine
- Additional material used for composting:
  - leaves
  - garden waste, wood ships and branches
  - Waste from cafeteria and kitchen, vegetables & fruit and food waste
  - Animal waste
  - Straw from the farm lands
  - Organic material from the farm lands
  - Paper and small pieces of cardboard
- Don't put these materials into the compost:
  - Orange and lemon peels
  - Meat and bones
  - Animal products
  - Plastic
  - Metals
- When the composted material will be removed, make sure that it looks and smells like soil. No faeces should be identifiable. It has to be dry and look like very rich garden soil.
- Be aware you are handling potentially infectious material. Take care of the instructions above. This secures a harmless handling without risks of contamination.

Instruction for Caretaker (Amharic)

2. የተንከባካቢ መመሪያ /Instruction for caretaker/

- የተንከባካቢው ዋና ሥራዎች የሚከተሉት ናቸው፡-
  - ሽንት ቤቱ፣የቆሻሻ ውሃ/ፍሳሽ ማጣሪያው እና የኮምፖስት ማዘጋጃዎች በትክክል እየሰሩ መሆኑን ማረጋገጥ፤
  - ትክክለኛው ሁኔታ፡- የሽንት እና የአይነምድር መለየት እና የተፈጥሮ ማፋበሪያ (ከሽንት) እና ኦርጋኒክ ማዳበሪያ (ዓይነምድርን ወደ ኮምፓስት በመቀየር) ማምረት ናቸው፡፡

- ስለ ሽንት ቤቱ፣ስለ ፍሳሽ ማጣሪያው እና ስለ ኮምፓስት ማዘጋጃዎች ሁኔታ ወርሃዊ ሪፖርት ለሚመለከው የዩንቨርስቲ ሠራተኛ ማቅረብ፤

- ሁሉም ጉዳቶች እና የሚያስፈልጉ ዋና ዋና የጥገና ሥራዎች ለሚመለከተው የዩንቨርስቲ ሠራተኛ ወዲያውኑ ሪፖርት ማድረግ አለባቸው፤

- ሽንት ቤቱ አገልግሎት መስጠት ከመጀመሩ በፊት ሁሉም የዓይነምድር ታንከሮች በሚገባ ሁኔታ መተካታቸው ማረጋገጥ፤

- የዓይነምድር ታንከሮች ከተተኩ ወይንም ከተቃኙ በኃላ የታንከሮቹ ማስገቢያ በሮች መዘጋታቸውን እና መቆለፋቸውን ማረጋገጥ፤

- ተጠቃሚዎች ከሽንት እና ከዓይነምድር ጋር አንዳይነካኩ ማድረግ፤

- የመከላከያ ልብሶች መልበስ አለባቸው
  1) ሽንትን ለማንጻጸዝ
     -የጎማ/ላስቲክ ጓንት
     -ጭንብል
  2) የሽንት ማጠራቀሚያ ታንከር ሲፀዳ
     - የጎማ/ላስቲክ ቢንቧ
  3) ዓይነ ምድር ለማንጻጸዝ
     - ጓንት

- የበሽታ እና የመበከል አደጋ እንዳይኖር ዓይነ ምድርን ሽንትን እና ቆሻሻ ውሃን በሚገባ ሁኔታ ይያዙ፤

- ከዓይነ ምድር ስሽንት እና ከቆሻሻ ውሃ ጋር በቀጥታ እንዳይነካኩሱ ይጠንቀቁ፤

- ሽንትም ሆነ ዓይነ ምድር ሲጓጓዝ እንዳይፈስ ያድርጉ፤

- የዓይ ምድር ተንከሮች ሲጓጓዙ ይከደኑ ፤

- ሁሉም እቃዎች (ታንከሮች ጀርካኖች) ከመጓጓዛቸው በፊት በሚገባ መከደናቸው ይረጋገጥ፤

- ከዓይነ ምድር እና ከሽንት ጋር የተያያዙ ስራዎችን ካከናወኑ በኃላ እጅዎን በሳሙና ይታጠቡ፤

- ለኮምፓስት ስራ የሚስተሉትን ነገሮች ይጠቀሙ፡-
  - ቅጥላ ቅጠሎች
  - የግቢ ውስጥ ቆሻሻ ፣የእንጨት ስርባሪ እና ቅርንጫፎች
  - የካፍቴሪያ እና የኩሽና ቆሻሻዎች፣ የአትክልት ፣ የፍራፍሬ እና የምግብ ትራፊዎች
  - የከብት እበት
  - ከአርሻ መሬት የሚገኙ ሳሮች
  - ከአርሻ መሬት የሚገኙ የሚሰበሰቡ ነገሮች
  - ወረቀቶች እና ቁርጥራጭ ክርታሶች

- ለኮምፓስት ስራ የሚከተሉትን ነገሮች አይጠቀሙ፡-
  - የብርቱካን እና የሎሚ ልጣጮች
  - ሥጋ እና አጥንት
  - የሥጋ ውጤቶች
  - ፕላስቲኮች
  - ብረታ ብረቶች

- ኮምፓስት ከጉድጓድ ሲወጣ የአፈር መልክ እና ሽታ እንዳለው ያረጋግጡ፡፡ዓይነ ምድር በኮምፓስቱ ውስጥ መታየት የለበትም ፡፡ኮምፓስቱ ደረቅ እና በጣም የላመ የጓሮ አፈርን መምሰል አለበት፤

- ለጤና ጠንቅ የሆኑ ነገሮችን እየነኩና እያጓጓዙ መሆኑን አይዘንጉ፡፡ከላይ የተዘረዘሩትን መመሪያዎች በሚገባ ይከተሉ፡፡ ይህም ከጉዳት እና ከመበከል አደጋ ያድንዎታል፤

Task List for Caretaker (English)

Period	Day	Task	Material
Weekly	Wed	▪ Inspect the toilet building - water taps - doors - floor drains - tiles - no. of lids - no. of waste bins - damage of moulds and urinals ▪ Report to the responsible person at University	Report paper
Weekly	Wed	▪ Inspect health of plants on percolation area	Report paper
Weekly	Wed	▪ Cleaning of the bins	Brush
Weekly	Wed	▪ Open valve of short term urine storage tank ▪ Close the valve after 15 minutes	Key
Weekly	Wed	▪ Transport of ash or compost to toilet building and filling up of storage buckets	Donkey cart
Weekly	Sat	▪ Prepare empty bins with a layer (10 cm) of organic material (ash, leaves, compost) at the bottom	Bins, organic material
Weekly	Sat	▪ Transport of empty bins from the compost site to the toilet building	Donkey cart
Weekly	Sat	▪ Replace faeces collection bin	Sack barrow
Weekly	Sat	▪ Transport of the full bins to the compost site	Donkey cart
Weekly	Sat	▪ Emptying of the bins	
Weekly	Sat	▪ Adding or organic bio waste	Shovel, spade, barrow
Weekly	Sat	▪ Measuring Temperature in the composting ditches in composting operation	Thermometer
Monthly	1st Wed	▪ Inspection of pipe connections (urine, grey water) on leakages, blockages and clogging and the ventilation pipes	
Monthly	1st Sat	▪ Turning of the compost	Shovel, spade
Semi-year	Jan, July 1st Sat	▪ Inspect urine tank (look inside, leakages, blockages etc.), report	Report paper
Semi-year	Jan, July 1st Sat	▪ Inspect grey water tank (look inside, leakages, blockages, sludge level etc.) – desludge if necessary (Sludge level < 0,6 m under water level), report	Stick, Report paper
Semi-year	Jan, July 1st Sat	▪ Removal of compost	Shovel, spade, barrow
Semi-year	Jan, July 1st Sat	▪ Screening of compost	Wire-mesh, barrow
Semi-year	Jan, July	▪ Emptying of the long-term urine storage tank (before and during the sowing season – according to the needs of the farmers)	Hand-pump, ben-zene-pump, hose, jerry can, funnel
Semi-year	Jan, July	▪ Cleaning long-term urine storage tank after emptying	Brush, can, water
Yearly	July 1st Sat	▪ Cleaning of short-term urine storage tank after emptying	Brush, can, water
Yearly	July 1st Sat	▪ Desludging of grey water sedimentation tank	Bucket

Table 10: Task List for Caretaker (English)

Task List for Caretaker (Amharic)

1. የተንከባካቢ የሥራ ዝርዝር /Tasks of caretaker/

ጊዜ	ቀን	የሥራ ዝርዝር	የሚያስፈልጉ ዕቃዎች
በየሳምንቱ	ዕሮብ	የሽንትቤቱን ህንጻ መቃኘት - የውሃ ቧንቧ እና ፎሌቶች - የወለል ፍሳሽ ማስወገጃ -የሽንት ቤት ክዳኖች ቁጥር -የሽንት ቤት መቀመጫዎች እና የቁም መሸኚያ ዕቃዎች ሁኔታ -በሮች -የወለል ንጣፎች -የመጸዳጃ ወረቀት ማስቀመጫ ቅርጫቶች ቁጥር	የሪፖርት ወረቀት
በየሳምንቱ	ዕሮብ	በፈሳሽ ማስረግያ ቦታ ላይ የተተከሉ አትክልቶችን ጤንነት መቃኘት	የሪፖርት ወረቀት
በየሳምንቱ	ዕሮብ	የዓይነምድር ታንክሮችን ማጽዳት	ብሩሽ
በየሳምንቱ	ዕሮብ	የአጭር ጊዜ የሽንት ማጠራቀሚያ ታንክር መክፈት እና ከ15 ደቂቃ በኃላ መዝጋት	መክፈቻ
በየሳምንቱ	ዕሮብ	አመድ ወይንም ኮምፓስት ወደ ሽንት ቤቱ ህንጻ ማጓጓዝ እና ለዚሁ በተዘጋጁ ባልዲዎች ውስጥ መሙላት	የአህያ ጋሪ
በየሳምንቱ	ቅዳሜ	በባዶ የዓይነምድር ታንክሮች ውስጥ የሚበሰብስ ነገር(አመድ፣ቅጠላቅጠል፣ኮምፓስት)ከታች እንደንጣፍ (10 ሣ.ሜትር)መጨመር	ታንክሮች የሚበሰብሱ ነገሮች
በየሳምንቱ	ቅዳሜ	ባዶ የዓይነምድር ታንክሮችን ከኮምፓስት ማዘጋጃ ቦታ ወደ ሽንት ቤቱ ህንጻ ማጓጓዝ	የአህያ ጋሪ
በየሳምንቱ	ቅዳሜ	የዓይነምድር ታንክሮችን መቀየር	የአጅ ጋሪ(ባለማንሻው)
በየሳምንቱ	ቅዳሜ	የሞሉ የዓይነምድር ታንክሮችን ወደ ኮምፓስት ማዘጋጃ ቦታ ማጓጓዝ	የአህያ ጋሪ
በየሳምንቱ	ቅዳሜ	ከሞሉ የዓይነምድር ታንክሮች ውስጥ ዓይነምድሩን በተዘጋጀው የኮምፓስት ማዘጋጃ ቦታ ላይ መድፋት	
በየሳምንቱ	ቅዳሜ	ሊበሰብሱ የሚችሉ ነገሮችን መጨመር	ዛቢያ፣አካፋ፣የአጅ ጋሪ
በየሳምንቱ	ቅዳሜ	በኮምፓስት ዝግጅት ሂደት ላይ በኮምፓስት ማዘጋጃ ጉድጓድ ውስጥ ያለውን የሙቀት መጠን መለካት	ቴርሞ ሜትር
በየወሩ	የመጀመሪያው ዕሮብ	-የቧንቧ መጋጠሚያዎችን (የሽንት እና የቆሻሻ ውሃ ፈሳሽ መስመሮች)መቃኘት እና የሚንጠባጠብ ፍሳሽ ካለ፣የተዘጉ እና የተደፈኑ መስመሮች ካሉ ማየት ፣ የማስተንፈሻ ቧንቧን(vent pipe) መቃኘት	
በየወሩ	የመጀመሪያው ቅዳሜ	ኮምፓስት መገልበጥ	አካፋ፣ዛቢያ
በየስድስት ወሩ	ጥር፣ሐምሌ የመጀመሪያው ቅዳሜ	የሽንት ማጠራቀሚያ ታንክሮችን መቃኘት -ውስጡን ማየት -ስንጥቅ ወይም ሌላ ጉዳት ካለ ማየት -ወጪና ገቢ የቧንቧ መስመሮችን ማየት -ግኝቶችን ሪፖርት ማድረግ	የሪፖርት ወረቀት
በየስድስት ወሩ	ጥር፣ሐምሌ የመጀመሪያው ቅዳሜ	የቆሻሻ ውሃ ፍሳሽ ማጠራቀሚያ ታንክሮች መቃኘት -ውስጡን ማየት -ስንጥቅ ወይም ሌላ ጉዳት ካለ ማየት -የዝቃጩን መጠን መለካት -የዝቃጩ ጠለል ከውሃው ጠለል በታች ከ60ሣ.ሜትር ካነሰ ዝቃጩን ማውጣት -ግኝቶችን ሪፖርት ማድረግ	ብትር፣ የሪፖርት ወረቀት
በየስድስት ወሩ	ጥር፣ሐምሌ የመጀመሪያው ቅዳሜ	ኮመወፖስት ከጉድጓድ ውስጥ ማውጣት	አካፍ፣ዛቢያ፣የአጅ ጋሪ
በየስድስት ወሩ	ጥር፣ሐምሌ የመጀመሪያው ቅዳሜ	ኮምፖስትን በወንፊት ማጣራት	የሸቦ ወንፊት፣ የአጅ ጋሪ
በየስድስት ወሩ	ጥር፣ሐምሌ	ከረጅም ጊዜ የሽንት ማጠራቀሚያ ታንክር ውስጥ ሽንቱን መቅዳት፡፡ ቅጂው የሚፈጸመው ከዘር መዝሪያ ጊዜ በፊት እና በዘር መዝርያ ወቅት ሆኖ በገበሬዎች ፍላጎት ላይ የተመሰረተ ይሆናል፡፡	የአጅ ፓምፕ፣ የሞተር ፓምፕ ቱቦ ፣ጀርካን፣ ጀግ፣ፋኔል
በየስድስት ወሩ	ጥር፣ሐምሌ	በረጅም ጊዜ የሽንት ማጠራቀሚያ ታንክር ውስጥ ያለው ሽንት ተቀድቶ ካለቀ በኃላ ታንክሩን ማጽዳጽ	ብሩሽ፣ጀግ፣ውሃ
በየአመቱ	ሐምሌ የመጀመሪያው ቅዳሜ	በአጭር ጊዜ የሽንት ማጠራቀሚያ ታንክር ውስጥ ያለው ሽንት ካለቀ በኃላ ታንክሩን ማጽዳት	ብሩሽ፣ጀግ፣ውሃ
በየአመቱ	ሐምሌ የመጀመሪያው ቅዳሜ	በቆሻሻ ውሃ/ፍሳሽ ማጠራቀሚያ ታንክሩ ውስጥ ያለውን ዝቃጭ ማውጣት	ባልዲ

Table 11: Task List for Caretaker (Amharic)

Instructions and Task List for Cleaning Staff

Instruction for Cleaning Staff (English)

- Your main tasks are:
  - Opening and locking the toilet cabins for the operation time
  - Keep the toilets tidy
  - Support the operation of the toilet in accordance to the task list
  - Inform the students about the proper use of the toilet
  - Teach the students to keep the toilet tidy
  - Teach the students to take their waste (cigarettes etc.) with them or dispose it in a proper way.
- Your attitude to the toilet may secure a proper sanitation system, which is preferred by the users.
- All damages and major maintenance works required have to be reported immediately to the responsible official of the University.
- The demand for soap and other supplies has to be reported to the caretaker in advance.
- Assure during your daily inspections:
  - the faecal holes have to be closed when not in use
  - the toilet rooms are clean
  - equipment like soap (hand wash basin) is available.
- The toilet pans, toilet rooms, corridors, hand wash basins and the surroundings have to be cleaned regularly according to the task list.
- Avoid any entrance of water into the faecal hole.
- For cleaning of the toilet mould don't use water. The cleaning has to be done dry by wipers or damp cloths.
- Cleaning of the toilet mould with water is only possible when the bin under the toilet is removed. The removal of the bin is caretaker's task. Coordinate your cleaning activities with the caretaker.
- The toilet room and the urinal bowl can be cleaned with water without any problems.
- The regular flushing of the urine bowl according to the task list reduces clogging and smell.
- Avoid the direct contact to the faecal matter, urine and Grey water.
- Protective clothing like gloves have to be worn during cleaning activities.
- Clean all tools and equipment after use
- Wash your hands with soap regularly after cleaning procedures
- Be aware you may have contact to potentially infectious material. Take care of the instructions above. This secures a harmless handling without risks of contamination.

- **Remember:**
  A dirty toilet is unpleasant to use. It stinks and attracts flies. A dirty toilet is a health hazard and may cause spreading diseases.
  A tidy toilet reduces your effort because it will be kept tidy by the users.

Instruction for Cleaning Staff (Amharic)

4. የፅዳት ሠራተኛ መመሪያ /Instruction for cleaning staff/

- የፅዳት ሠራተኛዋ ዋና ሥራዎች የሚስተሉት ናቸው፡-
  - ሽንት ቤቶችን መክፈትና መቆለፍ
  - ሽንት ቤቶች ፅዱ ሆነው እዲቆዩ ማድረግ
  - በተሠጠው የሥራ ዝርዝር መሰረት ሽንት ቤቱ ተገቢውን አገልግሎት እዲሰጥ ማድረግ
  - ተገቢውን የሽንት ቤት አጠቃቀም ለተማሪዎች ማሳወቅ
  - የሽንት ቤቱን ፅዳት እንዲጠብቁ ተማሪዎችን ማስተማር

- ተማሪዎች የራሳቸውን ቆሻሻ (ሲጃራንና የመሳሰሉትን) እራሳቸው በሚገባው ቦታ እና ሁኔታ እንዲያስወግዱ ማስተማር፤

- በሽንት ቤቱ ላይ ያልምት አመለካከት ሽንት ቤቱ በተጠቃሚዎች ተፈላጊነት ያለው እንዲሆንና ተገቢ የሆነ የንጽህና ሁኔታ እንዲኖር ሲያደርግ ይችላል፤

- ሁሉም ጉዳዮች እና የሚያስፈልጉ ዋና ዋና የጥገና ስራዎች ለሚመለከተው የዩኒቨርስቲ ሰራተኛ ወዲያውኑ ሪፖርት ማድረግ አለባቸው፤

- የሳሙናና ለሽንት ቤቱ የሚያስፈልጉ ሌሎች ግብአቶች ፍላጎት ለሚመለከተው የዩኒቨርስቲ ሠራተኛ በቅድሚያ ሪፖርት መደረግ አለበት፤

- በዕለት ተዕለት ተግባርዎ የማከተሉትን የረጋግጡ፡-
  - ተጠቃሚ በሌለ ወቅት የአይነ ምድር ቀዳዳዎች መከደናቸውን
  - ሽንት ቤቶቹ ንፁህ መሆናቸውን
  - በእድ መታጠቢያ ቦታዎች ላይ ሳሙና መኖሩን

- የሽንት ቤቶች፤ የሽንት ቤት መቀመጫዎች፤ ኮሪደሮች፤ የእጅ መታጠቢያ ገንዳዎች እና አክባቢያቸው በሚሠጠው የሥራ ዝርዝር መሰረት በየጊዜው መጸዳት አለባቸው፤

- ውሃ ለአይነ ምድር በተሠራው ቀዳዳ ፈጽሞ እንዳይገባ ይጠንቀቁ፤

- የሽንት ቤቱን መቀመጫ ለማጽዳት ውሃ አይጠቀሙ። ለማጽዳት ሲፈልጉ ደረቅ ባለ ሁኔታ በውሃ በረጠበ ጨርቅ ማጽዳት ይኖርብዎታል፤

- የሽንጽ ቤቱን መቀመጫ በውሃ ማጠብ የሚቻለው ሽንት ቤቱ ስር የሚገኘውን የዓይነ ምድር ተንከር ከተነሳ ብቻ ነው ።ታንከሩን ማንሳት የተንከባካቢው የስራ ድርሻ ነው።የሽንት ቤቱን መቀመጫ በውሃ ማጠብ ሲፈልጉ ከተንከባካቢው ጋር ይቀናጁ፤

- የሽንት ቤቱ ወለል እና የወንዶች የቁም ሽንት ዕቃዎች ያለምንም ችግር በውሃ ሲታጠቡ ይችላሉ፤

- በሥራ ዝርዝሩ መሰረት በየጊዜው የቁም ሽንት እቃዎችንና የሽንት ቤቱን የሽንት ቀዳዳዎች በውሃ ማጽዳት የሽንት ቧንቧዎች መዘጋትንና ሽታን ይቀንሳል፤

- ከዓይነ ምድር፤ ከሽንት እና ከቆሻሻ ውሃ ጋር በቀጥታ እንዳይነካኩ ይጠንቀቁ ፤

- እንደ ጓንት ያሉ የመከላከያ አልባሳት ፅዳት በሚከናወንበት ወቅት መለበስ አለባቸው፤

- ሁሉንም ዕቃዎችና መሣሪያዎች ከተጠቀሙ በኋላ ያፅዱአቸው ፤

- የጽዳት ሥራዎችን ካከናወኑ በኋላ በየጊዜው እጅዎን በሳሙና ይታጠቡ፤

- ለጤና ጠንቅ የሆኑ ነገሮችን እየነኩ መሆኑን አይዘንጉ ከላይ የተዘረዘሩትን መመሪያዎችን በሚገባ ይከተሉ ይህም ከጉዳት እና ከመለከል አደጋ ያድንዎታል።

ማስታወሻ

- የቆሸሸ ሽንት ቤትን መጠቀም አያስደስትም፤ ይሸታል ዝንቦችም ወደ ሽንት ቤቱ ይመጣሉ። የቆሸሸ ሽንት ቤት የጤና ጠንቅ ሲሆን ለበሽታ መሰራጨት መንስኤ ሊሆን ይችላል።

- ፅዱ ሽንት ቤት የእርስዎን ልፋት ይቀንሳል። ምክንያቱም ተጠቃሚዎችም የሽንት ቤቱን ጽዳት ስለሚጠብቁ ነው።

Task List for Cleaning Staff (English)

Period	Day	Task	Material
Daily		▪ Add ash to all faeces collection bins (1 cup per toilet per time) (3 times per day)	Ash bucket, ash cup
Daily		▪ Fill-up the water buckets in the toilet with anal cleansing facilities (2 times per day)	bucket
Daily		▪ Fill-up the soap at the hand wash basin (2 times per day)	soap
Daily		▪ Collect and empty the filled waste bins into the bucket (1 times per day)	Bucket
Daily		▪ Clean the toilet, the toilet room and hand wash basin (2 times per day)	Water, brush, soap, cloth, broom, bucket
Daily		▪ Clean the corridor (1 times per day) Clean the corridor (2 times per day in the rainy season)	Water, brush, soap, cloth, broom, bucket
Daily		▪ Check for odour in the toilet rooms or elsewhere give information to caretaker, if it occurs	
Daily		▪ Flush the pipe in all urinals and urine outlet of the toilets with 1 Litre of water	Bin

Table 12: Task List for Staff (English)

Remark: Keep the toilet tidy all over the day.

Toilet paper will be brought by the users; otherwise the cleaning staff may sell paper to the users.

Task List for Cleaning Staff (Amharic)

3. ጽዳት ሠራተኛ የሥራ ዝርዝር /Tasks for cleaning staff/

ጊዜ	የሥራ ዝርዝር	የሚያስፈልጉ ዕቃዎች
በየቀኑ	በሁሉም የዓይነምድር ታንከሮች አመድ ይጨምሩ (በአንድ ጊዜ በአንድ ታንከር አንድ ሲኒ አመድ ይጨመር) (በየቀኑ በአንድ ታንከር ሦስት ጊዜ ይጨመር)	የአመድ ባልዲ፣ አመድ፣ሲኒ
በየቀኑ	ለመፀዳዳት ውሃ ለሚጠቀሙት ተብሎ በተዘጋጀው ሽንት ቤት ውስጥ የውሃ ባልዲዎችን መሙላት (በቀን ሁለት ጊዜ)	ባልዲ
በየቀኑ	በእጅ መታጠቢያ ቦታ ላይ የእጅ መታጠቢያ ሳሙና ማኖር (በቀን ሁለት ጊዜ)	ሳሙና
በየቀኑ	የቆሻሻ መጣያ ቅርጫቶችን ስብስቦ በውስጣቸው የሚገኘውን ቆሻሻ ባልዲ ውስጥ መገልበጥ (በቀን ሁለት ጊዜ)	ባልዲ
በየቀኑ	ሽንት ቤቱን፣ የሽንት ቤቱን መቀመጫዎችን እና የእጅ መታጠቢያ ገንዳዎችን ማፅዳት (በቀን ሁለት ጊዜ)	ውሃ፣ብሩሽ፣ሳሙና፣ጨርቅ፣መጥረጊያ፣ባልዲ
በየቀኑ	ኮሪደሩን ማፅዳት (በቀን አንድ ጊዜ) ኮሪደሩን ማፅዳት (በክረምት ወቅት በቀን ሁለት ጊዜ)	ውሃ፣ብሩሽ፣ሳሙና፣ጨርቅ፣መጥረጊያ፣ባልዲ
በየቀኑ	በሽንት ቤቱ ውስጥ ወጪ እና በአከባቢው ሽታ መኖር አለመኖሩን ማረጋገጥ፡፡ ሽታ ካለ ለተንከባካቢው ማሳወቅ	
በየቀኑ	የቁም ሽንት መሸኛ ዕቃ ቀዳዳዎችንና የሽንት ቤቱ የሽንት ቀዳዳዎች አንድ ሊትር ውሃ በየቀዳዳው በመጨመር ማጠብ (በሳምንት አንድ ጊዜ)	ባልዲ

ማሳሳቢያ

- ሽንት ቤቱ ቀኑን ሙሉ ፅዱ እንዲሆን ያድርጉ፡፡
- ተጠቃሚዎች የሽንት ቤት ወረቀት ይዘው ይመጣሉ፣ ካልሆነ ግን የጽዳት ሠራተኛዋ ለተጠቃሚዎች የሽንት ቤት ወረቀት ልትሸጥ ትችላለች፡፡

Table 13: Task List for Cleaning Staff (Amharic)

Do's and Don'ts of UDDT users

DO'S

- Position yourself well on the toilet.
- Put material for anal cleansing (paper, soft paper, leaves...) in to the big hole.
- Always keep the toilet door closed.
- Wash your hands outside the toilet after using the toilet.
- Dispose of sanitary pads in the basket which is meant for its collection
- Close toilet hole after use
- Please share your knowledge on the use and operation of the UDD toilet with anyone else that does not know how to use the toilet.
- Put vegetable materials (if used as cleaning material) in the faecal container.
- For urination and anal washing use the respective holes.

DON'TS

- Do not mix urine with faeces
- Do not mix anal cleansing water with urine. Both have separate holes.
- Do not pour water or any liquid in the big hole
- Do not use the small hole for urinal when it is blocked
- Do not use detergents in the toilet
- Do not throw un degradable items like bottles, plastics, stones in the vaults
- Do not throw syringes, medicines, sanitary pads or any cosmetics down the toilet
- Do not throw trash, cigarettes, matches or burning material in to the toilet

Explanatory posters for students how to use the UDDT are attached in each toilet cabin. Posters see Annex 4.

D.4 Recommendations for agricultural use of the outlets

Urine

The major recommendations for urine are:

1. Storage should be made for larger systems (time and conditions, stated in Table 3, should be followed),
2. At least one month should apply between fertilization and harvest,
3. Additional stricter recommendations may apply on a local level, if frequent faecal cross contamination is envisaged. The recommendations for storage times are directly linked to agricultural use and choice of crop. Refer Table 3.

The Urine can be used as nitrogen and phosphorus fertilizer. The urine should only be applied on plants which products are not eaten raw. Cereals, maize etc. won't have any direct contact to the urine; therefore the risk of any contamination of the products is minimized.

For the first estimation the area required for the urine application is listed in the table below depending on the project phase:

Phase	Unit	I	II	III	IV
Students	[pers]	2,700	3,000	5,500	4,500
Capacity of UDD-Toilet	[%]	30	35	55	100
Volumes per 6 months Urine	[m³]	10	12	18	34
Approx. area for application (fertilizer dosage rate 100 kg N/ha and a concentration of 4 g/l N)	[ha]	4	4.8	7.2	13.6

Table 144: Estimation of the required field area for application

Details for the application of the urine have to be elaborated in cooperation with local authorities (agricultural research centre, agricultural department etc.) and basing on first analytical results of measuring the Nitrogen concentration in the urine. The expected results can be seen in Figure 6. This figure shows cereals (wheat grains) from a field in Wolayta Sodo area with different fertiliser application. The use of urine has shown approx. 38 % more yield than the use of artificial fertiliser.

Figure 6:

Result of urine application after harvesting cereals
left side: fertilising with Diammoniaphosphat (DAP)
right side: fertilising with urine

Regarding investigations concerning the use of urine and organic material from faecal matter the Awash Melkassa Agricultural Research Centre should be asked for cooperation.

Handling of Urine

Urine is generally considered safe for use, if it is kept free of faeces. Very few organisms are passed through the urine. Those that are passed in urine include *Salmonella typhi* (typhoid), *Salmonella paratyphi* (paratyphoid fever) and *Schistosoma haematobium* (biharzia). The first two do not survive long once outside the body and will be eliminated from urine after it has been stored for a couple of days. The bilharzias cycle is broken when the media (water, urine etc.) does not contain the intermediate host to complete transmission (usually snails). Therefore if urine is stored for a few days and the storage tank is drained at intervals recommended by the WHO-Guidelines the risk of contamination from one of the above organisms is minimal. If cross-contamination with faeces does occur, storage of urine for more than one or two months will render it safe.

HIV/AIDS virus also may not survive long time once outside the body and will not be active after the urine has been stored for a couple of days.

Recommendations for urine application

- Urine is unique and quick non-chemical fertilizer for Nitrogen-demanding crops.
- Apply natural or diluted, on soil & incorporate or water down, not on plant.
- Do not soak whole root; some plants (seedlings) are sensitive.
- Total amount applied is important; apply all at once or in parts.
- The recommended application rate and time for chemical nitrogen fertilizers (urea or ammonium if available) is the best starting point for developing local recommendations on application rate and time for urine. For translating such recommendations to urine, its nitrogen concentration can be estimated at 3-7 g per litre, if no better knowledge exists.
- Apply 1 litre urine to 1m² farm land or crop (~1 litre per meter row) and then increase, or better use recommendations for chemical N-fertilizers
- A total of 1 litre urine can be used per maize plant in smaller doses over the growing period. (Peter Morgan)
- As a rule of thumb, fertilization should stop after 2/3 or 3/4 of the time between sowing and harvest. Some vegetables, notably the leafy ones, are harvested before they reach their reproductive stage and therefore fertilizer applied closer to the time of harvest can be utilized. However, a waiting period of one month between fertilization and harvest is very advantageous from a hygiene point of view and recommended for all crops eaten raw [11].
- For best fertilizing effect and to avoid ammonia losses, the urine should be incorporated into the soil as soon as possible after the application, instantly if possible A shallow incorporation is enough, and different methods are possible. One is to apply urine in small furrows that are covered after application. Washing the nutrients into the soil with subsequent application of water is another option.
- When spreading urine, it should not be applied on leaves or other parts of the plants, as this can cause foliar burning due to high concentrations of salts when drying. Spraying urine in the air should also be avoided due to the risk of N loss through gaseous emissions of ammonia and the hygiene risk through aerosols.

Application of urine with out dilution (Recommended for Adama).

As indicated above, urine can be applied without dilution to the topsoil of vegetable beds during the preparation stage, before planting. Later, after several weeks the vegetables are planted and watered normally and their growth will be enhanced. During the months after urine application, soil bacteria convert the urea into ammonia, then into nitrite and finally into nitrate which the plant can absorb.

Note: Heavy rain can flush the nitrates away, a risk also with some potassium salts, although to a lesser extent. The far less soluble salts of phosphorus tend to hold their place in the soil far better.

Faecal Matter - Compost

The compost can be used for different purposes:

- For gardening as a soil conditioner
- At the farmlands of the University site to increase the soil fertility and the water holding capacity of the soil for the production of vegetables or cereals
- Sold as a product to farmers, which are cooperating with the university and supplying products (vegetables etc.).

Furthermore the composted material can be used as additive material for the toilet use and can replace the ash.

The agricultural use practices (and recommendations) will be dependent on the preceding treatment. Even if a treatment is aimed at elimination of the risk of pathogen transmission and its potential has been proven in laboratory and/or field experiments, process steps may malfunction, resulting in a fertilizer product that is not completely hygienically safe. Therefore additional measures should be taken in order to further minimize the risk for disease transmission. Thus:

- Equipment used for e.g. transportation of unsanitized faecal matter should not be used for the treated (sanitized) product.
- When applying faeces to soil, precautions related to the handling of potentially infectious material should be taken. These precautions should include personal protection and hygiene. Hand washing should naturally be done.
- Compost should be worked into the soil as soon as possible and not be left on the soil surface.
- Improperly sanitized faeces should not be used for vegetables, fruits or root crops that will be consumed raw, excluding fruit trees.

Working the compost into the soil will minimize further human or animal exposure except for some soil-borne helminthes, and will decrease the risk for pathogen run-off to nearby waters. A withholding period between fertilizing and harvest, as suggested for urine i.e. one month, is recommended also for faeces. This will allow further reduction of pathogens due to ambient factors such as microbial activity, UV-light and desiccation, thus adding another barrier against disease transmission. This withholding period should to be at least a month.

The faeces from the UUDT in Adama University are composted together with bio waste for 6-12 months and are stored for about 1Month. It is therefore safe and can be applied like animal manure.

Grey water

For the grey water the use is planned at the side for irrigation and infiltration purposes. Therefore an external use is not necessary. The grey water is used for irrigation of the reed plants and for infiltration at the toilet-site.

D.5 Health Protection Measures

General

In the use of treated excreta, urine or grey water, certain key risk points and exposure pathways need to be considered (Table 15).

Risk activity	Major exposure points	Risk management consideration
Emptying the faeces collection bin	Contact	▪ Provision of protective clothing and suitable equipment for persons involved ▪ Avoid spillage
Transportation	Contact	▪ Avoid spillage ▪ Equipment not used for other purposes without proper disinfection/cleaning
Composting activity	Contact	▪ Ensure treatment efficiency ▪ Protective clothing ▪ Facility should be fenced off ▪ Ensure no access for children
Application	Contact Inhalation	▪ Use "close to the ground application," work the material into the soil directly and cover ▪ Protective clothing for workers ▪ Minimum one month between application and harvest
Crops Harvest Processing and Sale	Consumption Handling	▪ Crops eaten raw pose the most risk; industrial crops, bio-fuels or crops eaten only after cooking pose less risk ▪ Adequate protective clothing (gloves, shoes) ▪ Provide safe water for washing and refreshing vegetables
Consumption	Consumption	▪ Practicing good personal, domestic and food hygiene ▪ Cooking food thoroughly

Table 15: Major exposure points for the reuse of excreta and grey water [5]

Exposure Scenarios to Urine

The main exposure scenarios to urine are given in Table 16.

Exposure	Risk
Cleaning of blocked pipes	Ingestion of pathogens
Accidental ingestion when handling unstored urine	Ingestion of pathogens
Accidental ingestion when handling stored urine	Ingestion of pathogens
Inhalation of aerosols created when applying urine	Inhalation of pathogens
Consumption of crops fertilized with urine	Ingestion of pathogens

Table 16: Exposure scenarios to Urine [6]

Practices to minimize the risks include the following:

- When applying the urine, precautions related to the handling of potentially infectious material should be taken. These precautions could include wearing gloves and thorough hand washing.
- The urine should be applied using fertilizing techniques close to the ground which avoid aerosol formation.
- The urine should be incorporated into the soil. This could in practice be done mechanically or by subsequent irrigation with water. A close to the ground application/fertilizing method is recommended to minimize aerosol formation. On a large scale this is often done by using special agricultural equipment, while on a smaller scale it is often applied manually. Handling smaller volumes is often safe, and the urine should preferably not be diluted before application [11].

Exposure Scenarios to Faecal Matter

The main exposure scenarios to faeces are the following

- Emptying of the toilet bin and transportation
- Cleaning of the toilet
- Working with the compost

Protective measures to be taken

- Use gloves for personal protection
- When finished wash hands, clean surfaces outside and equipment used.
- Well cleaned tools and equipment should be used for sanitized product

Exposure Control at Agricultural Sites

Exposure control related to the field and the use of products relates to (1) crop restriction, (2) application techniques, (3) fieldworkers, (4) the withholding period (period between fertilization and harvest) and (5) post harvest exposure control [5].

1. Crop restriction

Restricting crop selection does not normally need to be applied when treated urine and grey water are used due to the low degree of faecal contamination. The use of treated excreta or faecal sludge may be restricted to non-food crops (e.g. cotton and bioenergy crops such as rapeseed or fast-growing woods, like those used for biofuel). They may also be applied on crops processed before consumption (wheat) or crops that have to be cooked (potatoes). Crop restriction still requires that the excreta have been treated before use.

2. Application techniques

Urine should always be applied close to the ground and worked into the soil to minimize nitrogen losses; this also further reduces the risks.

Treated excreta or faecal sludge can essentially follow the local practices applied for animal manure. The material should, however, be worked into the topsoil, both as a benefit for plant uptake and to reduce direct contact with any remaining pathogens.

3. Fieldworkers

Agricultural fieldworkers/farmers are at high potential risk; especially for parasitic infections. Treated human excreta are often applied on a small scale, which should result in less risk than indiscriminate open-air defecation. In larger-sca1e applications, such as the use of treated faecal sludge exposure to helminthes eggs can be eliminated or reduced by appropriate treatment combined with the use of appropriate protective clothing (e.g. shoes or boots for fieldworkers).

Field workers should have access to adequate sanitation facilities and water for drinking and hygienic purposes.

4. Withholding period

It is always recommended that there be a period of at least one month between application of urine or treated excreta or faecal sludge and crop harvesting.

5. Post harvest exposure control

Wash salad crops and vegetables eaten uncooked vigorously in tap water.

Peel fruits and root vegetables before consumption as it reduces pathogens.

Cooking vegetables achieves an essentially complete reduction of pathogens.

D.6 Monitoring and Evaluation

Introduction

Efficient and effective management as well as correct use of the systems is most essential for their proper functioning and operation. Therefore ongoing monitoring & evaluation activities are extremely important in managing the systems. These should be performed throughout the entire process, beginning in the awareness raising phase before the operation started, and continued with monitoring activities and results being documented and evaluated. The results should be used to make necessary adjustments in the activities to ensure that the process continues as desired.

Recognized methods such as interviews, statistical evaluation, questionnaires or observations, should be used to collect the necessary information within reasonable and appropriate limits. Energy should not be wasted collecting information which will serve no practical purpose.

Monitoring and evaluation remains important in all other steps of the project, right through to implementation for both the documentation of the change in the original situation for research and development purposes (with respect to the environment, hygiene, user satisfaction, costs, profits, resource use, productivity, increase in harvests, job creation etc.) as well as for long-term quality assurance of the end-product.

As monitoring and evaluation is a comprehensive process itself, again a careful plan of activity should be set up in discussion with all stakeholders.

The monitoring and evaluation of the systems should consist of:

1. Awareness Rising

Initiatives to be undertaken before the construction of UDDT is finalized and the operation can start in order to ensure that all involved parties are aware of a proper use and proper operation:

- Awareness rising trainings, lectures
- Target groups: users, operators of building, operators of treatment, farmers
- Before construction is finalized
- For details see separate awareness rising overview (Table 17)

2. Monitoring

Monitoring activities of the systems should be performed throughout the entire process. They aim to ensure (i) the proper and hygienic use and operation, (ii) the long-term quality assurance of the end-product and iii. the documentation of the change in the original situation for research and development purposes (with respect to the environment, hygiene, user satisfaction, costs, profits, resource use, productivity, increase in harvests, job creation etc.). Monitoring activities can be divided into 2 parts and should consist:

#

<u>a. Technical monitoring</u>

- Convenience for users, convenience to maintain; blockages in pipes, vaults, odour, flies, and insects; toilet unit use, cleaning, resistance against urine, spillages
- Carried out by University (maintenance department / care taker)
- From the beginning of operation as a permanent and dynamic process
- For details see separate monitoring sheet (Annex 5)

b. Social monitoring

- Health impact: less diseases in the University?
- Reuse: urine and faeces, treatment, application
- Perception: students, caretaker, cleaners, visitors
- Problem analysis: improvements, comfort, convenience
- Carried out by University (health faculty / agricultural faculty / faculty of social sciences)
- After 6 months of operation
- Details to be decided by responsible faculties

3. Evaluation

External evaluations should take place in order to evaluate whether optimization and fundamental adjustments of operation activities and construction works should be done. It also focuses on best practice made.

- Carried out by an external expert (health- , agricultural expert)
- After 6 months of operation (constructive adjustments if necessary, identification of best practices) and after 12 months of operation
- Details to be developed by assigned evaluation expert.

Recommendation

The Monitoring and Evaluation should focus on whether the EcoSan facilities are being used and managed accurately. Problems should be identified and then should be reflected in the future plans along with technology modification and hygiene education. Ultimately the results from the monitoring and evaluation both the communication process and the information will improve the system operations and in this way allow a decision whether this type and technology is suitable for other similar projects on institutional level.

Table 17: Awareness rising for different target groups

	Target Groups			
	Users (students)	**Operation of UDDT building (care taker & cleaning lady)**	**Operation of treatment (care taker/maintenance staff)**	**Use of products (farmers)**
Objective	Proper use of UDDT	Clean toilet, clean building, proper cleaning measures	Proper operation: emptying the bins, composting, transport urine, storage urine	Proper and safe application of products (compost and urine)
Start of involvement	Before finishing of construction	Before finishing of construction	Before finishing of construction	After ½ year of operation
Action to be taken	Introduction lecture of the beginning of the semester	Introduction of proper cleaning measures	Introduction of proper operation	Application of products
Initial actor	Health instructor (belongs to health faculty)	Manager of maintenance department	Manager of maintenance department	Farmers, tenants
Responsibility	Health faculty	Maintenance department	Maintenance department	University management
Frequency	1 per semester (acc. to needs)	1 per year (acc. to needs)	1 per year (acc. to needs)	
Focus of lecture	Personal hygiene, health of target group, comfort	Practical demonstration	Practical demonstration	Practical demonstration, exchange of information with other farmers (Sodo, Arba Minch)
Trainer	Consultant to student representatives and health faculty	Consultant to cleaning staff, care taker and maintenance department	Expert for compost (Arba Minch University) to care taker and maintenance department	Agricultural experts (Agricultural colleges Sodo, Arba Minch) to farmers
Dissemination	Student representatives to students, “health club”			Information visits of others farmers
Materials used	Practical lessons, posters, “drama”	Instruction papers, checklist	Instruction papers, checklist	Demonstration lots
Other stakeholders / consultants	Clinic staff, medicines		Agricultural department, research institutes, Arba Minch University	Agricultural department, research institutes, other farmers (Sodo, Arba Minch)

E Construction of the UDDT

[Pictures of construction to be inserted]

F Frequently Asked Questions (FAQ)

The use of products from human excreta is one of the benefits of source orientated sanitation also named as ecological sanitation. Surprisingly people are very open minded towards the idea especially when an agricultural background is there. Because of the difference to traditional or conventional sanitation systems a lot of question raise up on different levels. The most relevant questions will be answered by this document. The questions are grouped on different topics.

General questions

1. In which locations in Ethiopia have ecological sanitation systems been implemented?

SUDEA (Society for Urban Development in East Africa) was the first promoter of Ecological Sanitation (EcoSan) in Ethiopia. Since 1998 a number of pilot projects, responsible for over 300 urine diversion dry toilets, have been undertaken in partnership with local NGOs in Addis Ababa, Jimma, Bahir Dar, Hamusit and Harar. A public private partnership called Ecological Sanitation Ethiopia (ESE) which is partly funded by GTZ, has also been working on urine diverting dry toilets in Ethiopia since 2006. This project has the focus on the implementation in multi-storey buildings. The project constructed urine diversion toilets in Wolayta Soda and Arba Minch and has got convincing results in the use of urine as fertilizer. Another EU funded project called ROSA (Resource Oriented Sanitation concepts in peri-urban areas of Africa) is working in Arba Minch since 2006 on ecological sanitation systems. The project has carried out various activities which include construction of about 6 urine diverting dry toilets at the moment (more are planned) and researches on the reuse of feaces and urine. The results found from the researches are encouraging and promising.

2. In which other countries have ecological sanitation systems been implemented?

In many countries; EcoSan initiatives are currently operating in developing and developed countries, including: Austria, Bangladesh, Benin, Bolivia, Bulgaria, Burkina Faso, China, Côte d'Ivoire, Denmark, El Salvador, Ethiopia, Germany, Guinea, India, Kenya, Mali, Mexico, Mongolia, Mozambique, Nepal, Netherlands, Norway, Palestinian Territories, Peru, Romania, Senegal, South Africa, Sri Lanka, Sweden, Switzerland, Tanzania, Togo, Uganda, Ukraine, Vietnam, and Zimbabwe. Evaluations reveal considerable achievements and demonstrate that EcoSan is viable as an infrastructure application in diverse socio-economic locations in both rural and urban contexts, enabling equitable services for men, women, children, and the elderly.

3. In which countries the use of urine as fertilizer is common?

In many parts of the world it was a tradition to keep the urine and faeces apart. The old Japanese and Chinese practice of night soil recovery from urban areas separated urine and faeces, with the urine regarded as a valuable. In many European countries, urine was historically often collected separately. Mainly due to practical reasons, it was poured into the drain to avoid smells and to prevent the latrine from filling too quickly.

4. Why should I consider Urine Diverting Dry (UDD) Toilets for the Universities?

In most of the universities in Ethiopia is a lack of water because of the insufficient water supply and missing facilities and pressure. Urine diversion toilets are best solutions in such situations because such toilets do not need water for flushing and can be efficiently used with out water. Water is only required for hand washing, anal cleansing and cleaning toilet floors. In addition urine diversion toilets produce valuable products (urine and faeces) that can be used as mineral fertilizer and organic fertilizer (soil conditioner).

5. Is ecological sanitation an appropriate technology for urban areas?

Most definitely! In fact, it is the most logical option where population densities are high. VIP toilets are a problem in confined spaces because one can't simply move them when the pits become full, and they are difficult and expensive to empty. A large number of pit toilets in a densely populated area can lead to foul odours hanging around and may also pollute groundwater resources with organic matter and nutrients. Septic tanks with soakaways represent a similar problem, as the soil may eventually become unable to absorb all the effluent and the groundwater becomes polluted with nutrients, which may be taken up by wells probably. Ecological sanitation technology avoids these problems - there are no odours if the systems are managed properly, no danger of groundwater pollution, maintenance is easy and, best of all, the toilets can be installed inside the house.

6. Is it possible to use UDD-Toilets in high-raised buildings (e.g. dormitories)?

Yes. In China the Sweden Erdos Eco-town Project (EETP) has installed urine-diversion seating toilets in forty-two 4-5 storey buildings. The 5 year implementation of EETP proved that EcoSan is feasible both technically and economically. In Germany and Sweden also there are high rise buildings equipped with dry and urine-diversion toilets. Urine-diversion toilets are also going to be installed by Ecological Sanitation Ethiopia (ESE) in G+2 condominium houses in Awassa.

7. Are there any success stories in the use of urine?

Extensive trials have been performed on various crops in different countries all over the world. These trials show nearly the same results. In Africa in Mali, Burkina Faso, Malawi, Uganda and Zimbabwe these trials were made. Herein urine is a quick-acting fertilizer that can be used for most vegetables and the fertilizing conditions are at least similar to conventional mineral fertilizer. Trials made by ESE in Sodo Wolayta on maize and wheat using urine as fertilizer also revealed that the production of urine fertilized ones is very high when compared to those fertilized with chemical fertilizer.

8. Can children use UDD-Toilets as well?

The usual designs of the toilets are only suitable for children when squatting toilets are in use. For sitting type urine diversion toilets special seats are manufactured e.g. in South Africa to put on the bigger toilet seats when children use the toilet.

9. Can disabled persons use UDD-Toilets?

The usual UDD-Toilets constructed up to now are not accessible for wheel chair users. However the following provisions will make the use possible.

The rooms for disabled persons using wheel chairs should be larger to accommodate the wheel chair and there should be no steps in the gate instead a sloping riser should be made for access by disabled users. In South Africa attempts are made to make the toilets suitable for disabled persons.

Hygienic risks

10. Is the UDD-Toilet less hygienic than water flush systems?

UDD-Toilets are not less hygienic than conventional water flush toilets. For both misuse/abuse leads to unhygienic conditions. In the case of water shortages water flush toilets become unhygienic very fast, in opposite dry toilets can be operated also without water very hygienically.

11. What do I have to do to minimize the hygienic risks for me and other users?

I have to be aware of the use of the toilets. Furthermore I have to leave the toilet in a clean condition.

12. Is urine hygienically safe to use as fertilizer?

Urine is hygienically safe to use as fertilizer, if it is kept free of faeces and regulations and recommendations for its use are taken into consideration (i.e. WHO guidelines).

13. What kind of diseases may be transferred by use and handling of urine (HIV, Bilharzias, worms, etc.)?

Those that are passed in urine include Salmonella typhi (typhoid), Salmonella paratyphi (paratyphoid fever) and Schistosoma haematobium (bilharzias). The first two do not survive long once outside the body and will be eliminated from urine after it has been stored for a couple of days. The bilharzias cycle is broken when the media (water, urine etc.) does not contain the intermediate host to complete transmission (usually snails). Therefore if urine is stored for a few days and the storage tank is drained at intervals recommended by the WHO-Guidelines the risk of contamination from one of the above organisms is minimal. If cross-contamination with faeces does occur, storage of urine for more than one or two months will render it safe.

HIV AIDS virus also may not survive long once outside the body and will not be active after the urine has been stored for a couple of days.

14. What kind of diseases may be transferred by use and handling of treated faecal matter (HIV, Bilharzias, worms, etc.)?

Pathogenic species of bacteria, virus and parasitic protozoa will be eliminated by treating faeces. In accordance to the WHO- Guidelines treatment means storage for specific time or composting with an increase of temperature. However there is a minimal risk that eggs (ova) of helimenths especially ascaries and tape worm may

persist in low numbers after treatment. Therefore, personal protection equipment should be used while handling and applying the treated faeces and it should additionally be mixed into the soil in such a way that it is well covered.

Operation and maintenance

15. What are the operation and maintenance requirements of UDD-Toilets?

The special construction of urine diversion toilets keeps urine and faeces separate. Ash or other additives like dry soil (or a mixture of the two), which is kept in a container next to the toilet, is sprinkled on the faeces. This absorbs the inherent moisture, covers the faeces and assists dehydration. The dehydrated faeces can be easily collected (the collection chamber is generally on ground level) and may be reused as soil conditioner after treatment. If this is not desired, it may simply be bagged and collected by entrepreneurs as a paid service.

16. Does the system have high operation and maintenance efforts and costs?

The answer to this question depends on the design of the system. In many cases, there will be two, or in some cases three fractions to handle instead of one or two, which in itself may entail more practical aspects since both the urine and faeces should be re-circulated to agriculture. Regarding the toilets, the experience is that the piping for urine needs more maintenance than the conventional piping, in order to avoid blockages. However, with improved design this need may diminish.

If the urine and faeces are to be used locally, operation and maintenance will be geared towards the piping system and collection tanks. If the urine and faeces are to be used in agriculture, operation and maintenance include transportation, storage and use of the products. The costs of maintenance can be covered by selling the products.

17. Which equipment and tools are necessary for a proper operation?

The following are required for the proper operation of UDD-Toilets and the treatment of the toilet products:

Only additives like ash, sawdust, soil, sand or compost are necessary for the proper operation of the toilets. The regular replacement of the bins under the toilet is a prerequisite for the proper operation. Regular cleaning and a proper condition support the O&M of the toilet.

18. What happens, if the caretaker doesn't work properly?

Spillage of faeces from faeces container, overflow of urine collection tanks, and leakages in the urine pipes may occur if the caretaker doesn't work properly. This will make things very messy. The result will be unhygienic conditions for the users. Furthermore odour and flies will occur.

19. What happens, if the cleaning staff doesn't appear to work?

The toilet will become dirty and unpleasant to use. It may stink and attract flies and the users won't be willing to use the toilets and to keep the toilets clean from their side.

20. What happens, if water enters the urine outlet?

This doesn't affect the proper operation of the toilets. Only the volume for liquid matter will increase and more effort for its transport is necessary.

21. What do I do, when faecal matter enters the urine outlet?

If a system is clearly mismanaged (i.e. faeces can be seen in the urine bowl or other routes of cross-contamination are observed), prolonged storage of greater than 6 months should be applied before urine is used as fertilizer.

22. What do I do, if urine pipes are clogged?

The blockages are removed either mechanically by a drain auger or chemically by use of strong solutions of caustic soda (2 parts of water to 1 part of soda) or acetic acid (>24%). For prevention of blockages the pipe should be flushed with water once per week.

23. What happens, if water or urine enters the faecal outlet?

If water or urine enters the faecal outlet, the faecal matter becomes too wet and the drying process will be disturbed. When faecal matter are too wet this results in development of bad smell and maggots & flies will occur. Therefore entering of water, urine or any other liquid has to be avoided.

In the case that water or urine enters the faecal outlet, ash in a larger amount has to be added to the bins to absorb the moisture. If this fails or is not possible the bins have to be replaced immediately.

24. What do I do, when water or urine enters the faecal outlet?

One should add a lot of ash to absorb the moisture if water enters the faecal outlet. If this fails or is not possible the bins have to be replaced immediately.

25. Are there any flies or other insects during the operation of the UDD-Toilet?

If properly used and operated there will be no flies in UDD-Toilet. However, during the wet season those Culicine mosquitoes, which do not carry malaria, can hide in the vault and emerge up the faecal hole during use. The mosquitoes look for dark places to hide but they do not breed there as there is no water.

26. Can any animals (rats, spiders etc.) affect the operation of the UDD-Toilet?

Spider webs, if found inside the vent pipe, seriously disrupts the air flow inside the pipe. Efficient ventilation is important and helps to reduce odours and also maintains a constant flow of air through the vault which reduces moisture.

Rats and lizards may enter into the faecal container/chamber and may carry disease causing pathogens on their feet and spread these pathogens elsewhere. Therefore the access doors have to be closed during all times of operation.

27. Are cockroaches a problem during the operation of a UDD-Toilet?

Cockroaches are not reported in proper working UDD-Toilets. They may only occur when the faecal matter becomes too wet. Nevertheless they will not create any problem during the operation of the toilets.

28. Is there any smell?

Properly used and operated UDD-Toilets do not smell as the faecal matter in the container/chamber is semi-dry and any odours are carried out by the vent pipes. For the avoidance of smell by urine remaining on the toilet's surface the urine bowl has to be flushed daily with approx. 0.5 – 1.0 Litres of water.

29. What do I do, when smell arises (odour problem)?

Odour may have different reasons:

Urine:
- Leakage of the pipes
- Blocking of urine pipes
- Insufficient cleaning of the toilet (urine part)

Odour from urine can be reduced by a simple smell trap (rubber sheet or perforated condom) at the outlet of the urine part of the toilet.

Faecal matter:
- Insufficient cleaning of the toilet
- Faecal matter is too wet (liquid has entered the bin)
- Poor ventilation

Planning and design

30. What do I have to consider for planning of urine-diverting systems?

Urine diversion, with subsequent collection and reuse of the urine, is one way to collect nutrients from the wastewater fraction for use in agriculture or the home garden. Urine diversion should be considered among different options. Urine diversion will emerge as the best solution when aspects such as protecting the environment, generating fertilizers and recycling on the small scale are prioritized. Cases where urine-diverted dry systems have been promoted are where the wastewater treatment plant has limited capacity, where the surface and ground waters need to be protected, where there are problems with pit latrines or VIP-latrines, and where there is a demand for urine and faeces as fertilizers.

31. Does the planning of UDD-Toilets need more effort than conventional toilets (VIP-latrines, Pit-latrines)?

Yes. In opposite to flush systems working as an end-of-pipe technology the treatment is nearby the source – by these short cycles may be achieved. The planning of a urine-diverting system takes into account various issues such as improved environment, food security for households and safer handling of a waste flow from the household. The planning includes not only the design of the toilets and pipes but also the transportation, storage and treatment of the toilet products (urine and faeces).

32. Is urine diversion equipment (moulds etc.) available in Ethiopia?

Currently there are different options available in Ethiopia:

1. Awassa Tabor ceramic factory ceramics starts the production of a squatting type toilet (Turkish toilet).

2. One Fibreglass factory in Addis Ababa is offering toilet seats both sitting and squatting types made of glass fibre

3. AquaSanTec in Addis Ababa imports squatting type toilet pans made of plastics (Polyethylen) which are produced in Kenya.

33. What do construction companies need to consider when constructing a urine diversion system?

Since urine-diverting systems are seldom included in building codes, special care needs to be taken by the builders to ensure proper running of the system. The sizing and inclination of pipes, documentation and accessibility, are some of the aspects where mistakes can lead to failure of the system.

Users should be supplied with a simple manual that explains the concept, as well as operation and maintenance routines. If there is a choice between suppliers, take care to choose a supplier where spare parts and support can be given. If there is no municipal collection of urine, you must plan for an adequate space where the urine can be used for crop production, and establish routines in order to put the urine to use.

The construction should cater for appropriate collection and storage capacity for the urine.

User's behaviour

34. Can one use a UDD-Toilet where people are not interested in reusing excreta?

Yes. While reuse of sanitized excreta for agricultural purposes should be encouraged, it is not a precondition for implementing this technology. Human excreta represent a valuable resource, but can also be regarded as an "optional extra" available for free. Dehydrated faeces can easily be disposed or incinerated, while urine can also be led into a shallow soakpit if reuse of these products is not desired. Urine is generally fairly sterile but can harm the groundwater when the distance to the groundwater level or the distance between different toilets infiltrating urine is too small. In an urban area, collection and disposal of dehydrated faeces can also be seen as an entrepreneurial opportunity, and need not be an expensive service.

35. Can I put items used for cleaning (toilet-paper, stones etc.) into the faecal-outlet?

Yes. Anal cleaning material like tissue paper, paper, and leaves can be deposed into the vault, because they decompose when wetted afterwards in the composting process. Stones can't be decomposed and won't affect the composting process. Other non decomposable material like plastics should not be put in the faecal chamber but may be deposed into the waste bin nearby.

36. Can I put sanitary pads into the faecal-outlet?

No. Sanitary pad should be put in a basket which is meant for collecting it.

37. Does menstruation blood affect the operation of the UDD- Toilets and the use of the outputs?

It does not affect the operation of the toilets and the use of the outputs. If there are some remains of blood on the urine bowl, rinsing it with small amount of water or wiping it with tissue paper is necessary for cleanliness.

38. Is the use of ash (dry bulking material) obligatory?

Adding dry bulking material is obligatory; otherwise, any excreta will be too wet. This may attract insects for breeding and odour may occur. The bulking material also helps to cover the fresh faeces and thus lower the potential for fly contact and breeding, reducing the risk of disease transmission.

As adding dry bulking material can be use: ash, sand, soil, sawdust, compost.

39. Do I have to add ash after each use of the toilet?

It is not compulsory to add ash after each use. However it can be applied two or three times per day. At the universities this will be done by the caretaker.

40. What shall I do, when no ash is available?

If ash is not available the following material can be used: Saw dust, wood chips, dry soil, sand, compost, etc.

Cost aspects

41. How does the investment-, operation- and maintenance costs of a UDD-Toilet compare with other toilets (VIP-toilet, water flush toilets)?

There is no reason for a urine diversion toilet to cost any more than a VIP toilet, as far as capital expenditure is concerned. Space requirements are similar, while the pedestals can be produced quite cheaply. Even though the toilet needs to be raised slightly above ground level in order to provide access to the collection chamber, which represents an additional expense, no pit is required, which can be a substantial saving. The superstructures of the two types of toilet may be identical. In actual fact, because urine diversion toilets can be installed inside a dwelling, and not constructed separately outside, savings may be realized on walls and roof. Of course, if one compares O&M costs, the urine diversion toilet wins by a wide margin. So if one compares lifecycle costs, a urine diversion toilet is actually more economical.

Since water flush toilets require expensive wastewater treatment facilities and water supply of ample amount and adequate pressure, the investment cost will be greater than that of urine diversion system.

42. Is the operation and maintenance more costly than the traditional pit-toilets?

Yes. In most parts of the world, basically two options to tackle sanitation problems are applied which can be described as "drop and store" and "flush and forget". These conventional forms of wastewater management and sanitation systems are based on the perception of faecal material, which is considered as repulsive and not to be touched. In the case of the UDD-Toilets the urine and the faecal matter are checked, stored, treated and transported regularly increasing the O&M costs when compared to the traditional toilets.

However, sanitation systems should not be chosen only on economic criteria. Health and risk of disease transmission, short and long term environmental and resource aspects are essential for the long term sustainability, as are institutional and socioeconomic factors. And all of these should be evaluated for the whole systems, including sustainable treatment.

Reuse of output products (irrigation & agriculture)

43. Are there any restrictions concerning the application of urine?

When spreading urine, it should not be applied on leaves or other parts of the plants, as this can cause foliar burning due to high concentrations of salts when drying. Spraying urine in the air should also be avoided due to the risk of Nitrogen loss through gaseous emissions of ammonia and the hygiene risk through aerosols.

44. Are there any harmful substances in the urine?

In excreta the content of heavy metals and other contaminating substances such as pesticide residues is generally low or very low, and depends on the amounts present in consumed products. Faeces contain a greater amount of these substances than urine does. Even so, the concentrations of contaminating substances in faeces are usually lower than in chemical fertilizers (e.g. cadmium) and farmyard manure (eg. chromium and lead).

A large proportion of the hormones produced by our bodies and the pharmaceuticals that we consume are excreted with the urine. It is reasonable to believe that the risk for negative effects on crop quality and quantity from hormones is negligible. All mammals produce hormones and the vegetation and soil microbes are adapted to, and can degrade, these hormones. Thus, both fertilizer experiments and evolutionary history strongly indicate that there is no real risk.

45. Is there any risk associated with pharmaceuticals from using the urine as fertilizer?

Different research projects have or are investigating the affects of pharmaceutical residues. These substances are excreted by the human beings via the urine as well as via the faecal matter. Their concentrations depend on the amount uptaken by the human beings.

The degradation of these substances depends on the environment and the concentration of microorganisms.

Urine and faecal fertilizers are mixed into the active topsoil, which has a microbial community just as diverse and active as that in wastewater treatment plants, and the

substances are retained for months in the topsoil. This means that there is plenty of time for the microbes to degrade any pharmaceutical substances and that risks associated with them are small.

Concerning both hormones and pharmaceutical substances, it thus seems far better to recycle urine and faeces to arable land than to flush them into recipient waters, where the concentration of microorganisms is very low.

There are many indications that the possible risk from pharmaceutical substances in the agricultural system is small and far smaller than the risks associated with the present system. Furthermore, the human use of pharmaceutical substances is small compared to the amount of pesticides (insecticides, fungicides, bactericides and herbicides) used in agriculture, which are just as biologically active as pharmaceutical substances.

46. How and when do I apply urine to my plants?

The urine should be incorporated into the soil. This could in practice be done mechanically or by subsequent irrigation with water. A close to the ground application/fertilizing method is recommended to minimize aerosol formation. On a large scale this is often done by using special agricultural equipment, while on a smaller scale it is often applied manually.

Urine can be applied on arable land without any dilution before seeding. After seeding dilution of urine with water (approx. 1:4) is recommended.

Urine can be applied in the same period as chemical fertilizers are applied. As a rule of thumb, fertilization should stop after between 2/3 and 3/4 of the time between sowing and harvest. Some vegetables, notably the leafy ones, are harvested before they reach their reproductive stage and therefore fertilizer applied closer to the time of harvest can be utilized. However, a waiting period of one month between fertilization and harvest is very advantageous from a hygiene point of view and recommended for all crops eaten raw.

47. Is Urine acidic and will hurt my plants?

In general an application of too much urine will affect the plants because of the addition of too many salts to the plants. Urine will hurt some sensitive plants (seedlings) when the leaves will have contact with urine. Before application to plants, urine should be diluted with water (ration 1: 3 – 1:5) for the protection of the roots.

48. How can I convince farmers to use urine and faecal matter as fertilizer?

One can convince farmers to use these products as fertilizer by showing them farms where the use of urine and faecal matter as a fertilizer is successful or by doing a crop trial with and without the use of urine and faecal matter as fertilizer on one or two of selected farmers' plots. There have been many trials worldwide, including many African countries.

49. How do I know, when the composting process is finished and the compost can be used?

We know that the composting process is finished and the compost can be used if the compost is dry, and looks and smells like very rich garden soil. When it is time to

remove the composted material, it should not look or smells at all like the original waste material that went in. No faecal matter should also be identifiable.

50. What do I do with the other outputs like grey water?

The grey water can be treated by simple treatment techniques such as soil infiltration, gravel filters, constructed wetlands or ponds. More complex methods, such as activated sludge, rotating biological contactors or membrane filtration, may also be used.

51. Can I use the grey water?

The treated grey water can be used for irrigation of agricultural crops in water-scarce regions. It can also be used for groundwater recharge or industrial or urban reuse or discharged into surrounding watercourse.

52. May detergents (e.g. from soaps and cleaning substances) affect the grey water treatment and pollute the groundwater?

Detergents will not affect the grey water treatment. They will also not pollute the groundwater as they are trapped in the treatment unit and degraded by the microorganisms.

Cultural, religious and gender aspects

53. Does the toilet fit for both genders?

Yes. The toilet units which are available in the market are designed in a way that urine is collected in an appropriate way from both women and men using the toilet.

54. Where do anal washers do their washing procedure after the use of the toilet?

The UDD-Toilet has three holes for faecal matter, urine and anal washing use. So, anal washers can use the respective hole for anal cleansing in front of the toilet.

55. Does the anal cleansing affect the operation of the UDD Toilet?

It will not affect the operation as long as the hole meant for anal washing use is used. A problem will arise if and only if the anal washing water gets mixed with the faecal matter or urine.

Muslims can make their cleansings in UDD-toilets which are having facilities for anal washing. They should not splash water in the faecal chamber while doing their cleanings.

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H Annex

Annex 1: Operation plan of the compost site

Period [month]	Ditch I	Ditch II	Ditch III	Ditch IV
0 - 2	F			
2 - 4	F			
4 - 6	F			
6 - 8	C	E	F	
8 - 10	E	C	F	
10 - 12	C	E	F	
12 - 14	St	F	C	E
14 - 16	St	F	E	C
16 - 18	St	F	C	E
18 - 20	E	C	St	F
20 - 22	C	E	St	F
22 - 24	E	C	St	F
24 - 26	F	St	E	C
26 - 28	F	St	C	E
28 - 30	F	St	E	C
30 - 32	C	E	F	St
32 - 34	E	C	F	St
34 - 36	C	E	F	St
36 - 38	St	F	C	E
38 - 40	St	F	E	C
40 - 42	St	F	C	E
42 - 44	E	C	St	F
44 - 46	C	E	St	F
46 - 48	E	C	St	F

Legend

	Empty - not in use yet
F	Filling
C	Composting
E	Currently empty - for shifting of compost needed
St	Storage of compost

Annex 2: Temporary Solutions for Treatment until Treatment Plant is built

In case the UDDT building will be build before the construction of the treatment plant and the Lot 2b buildings, following temporary actions should be taken in order not to demolish the urine pipe or to disturb the construction process of the treatment plant:

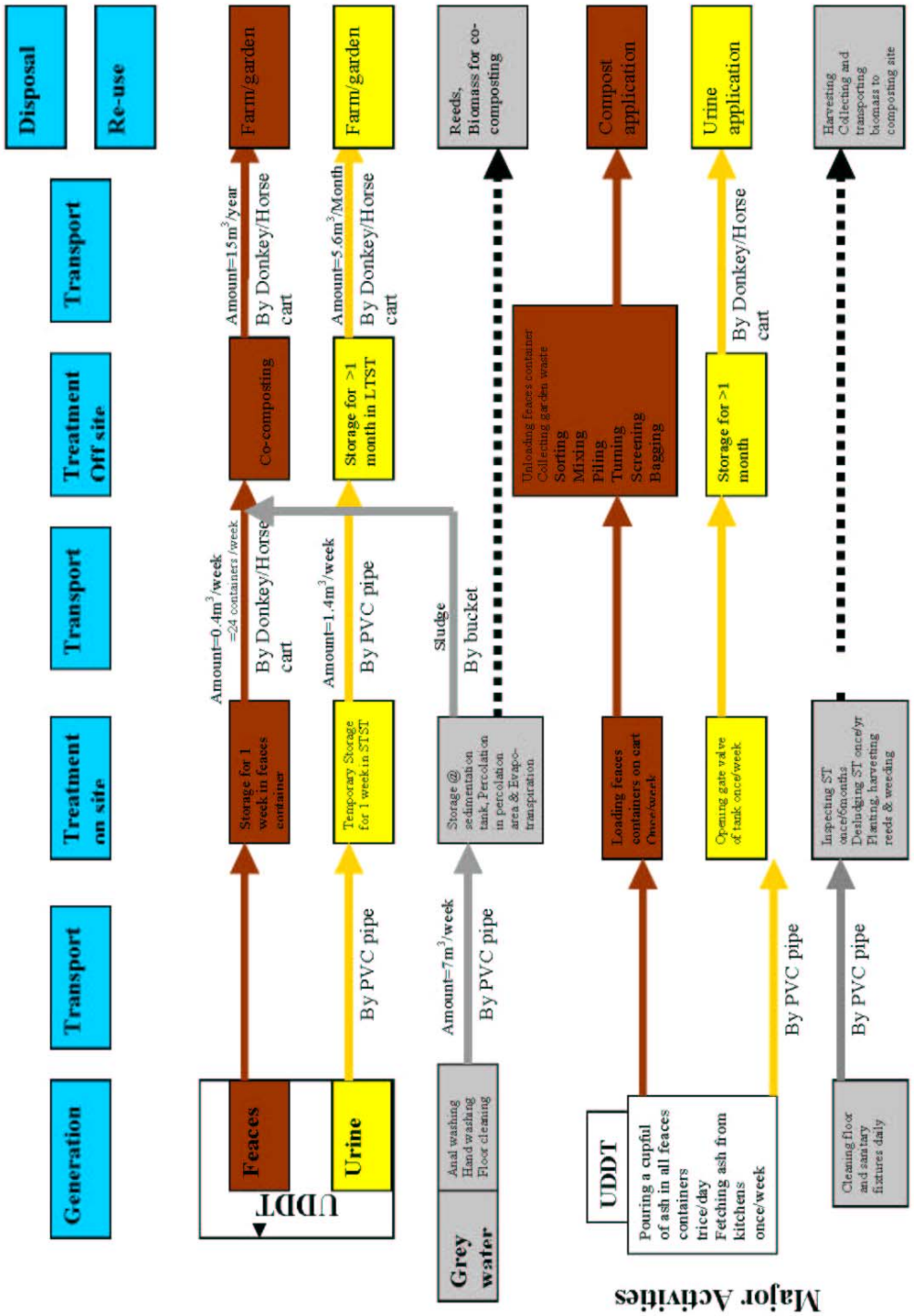
For the time being, the transport of the urine from the short-term to the long term storage will not occur by pipe, but will be made by hand pump and canisters on donkey chart. The canisters will be emptied into two of the long term tanks (2 x 5m³) that will be installed temporarily near the existing waste ponds in the south of the campus. Furthermore, a simple temporary composting ditch will be dug for the treatment of the faeces.

The short term tanks as well as the manholes next to the toilet building will be constructed right from the beginning, the same for the urine pipe up to UMH-3.

After finalization of the Lot 2b buildings and the treatment plant the permanent solution (see 0 Urine - Transport) will be implemented and used.

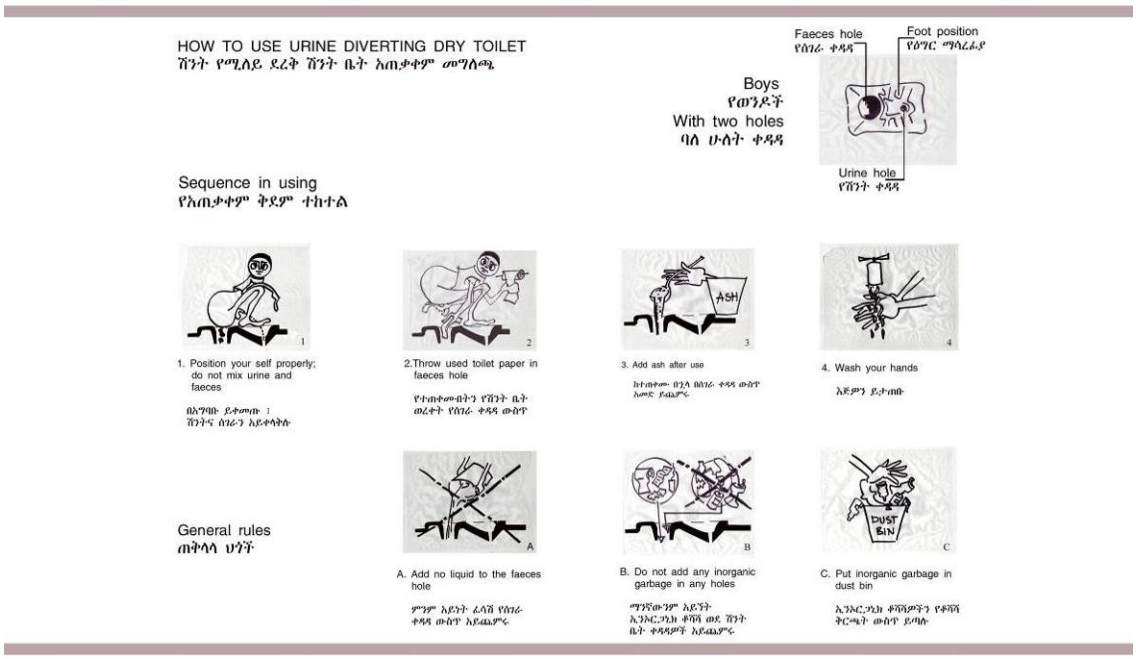
Annex 3: Operation Activities and Material Flow Chart

The material flow and the activities carried out in the operation of the system are presented below:

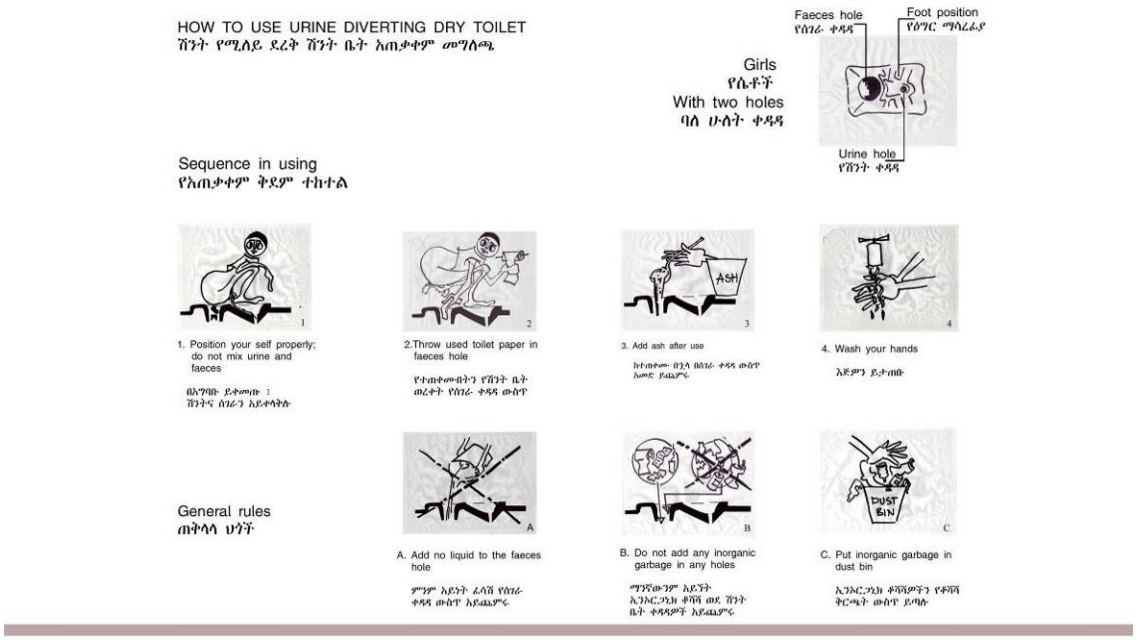


Annex 4: Student Posters

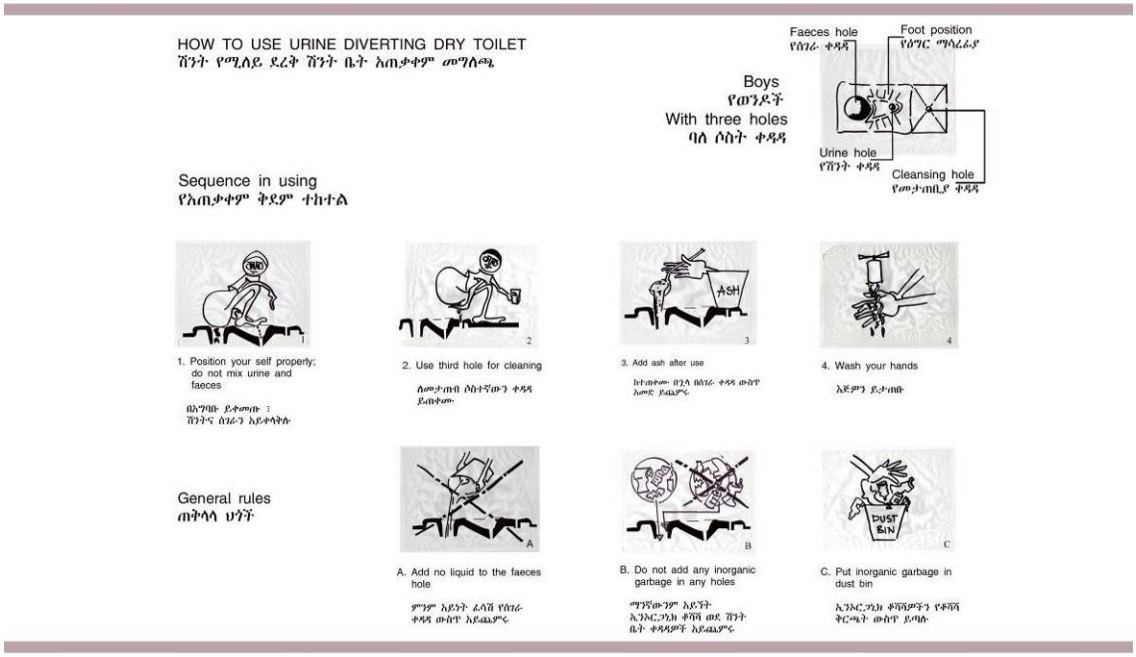
Male's unit



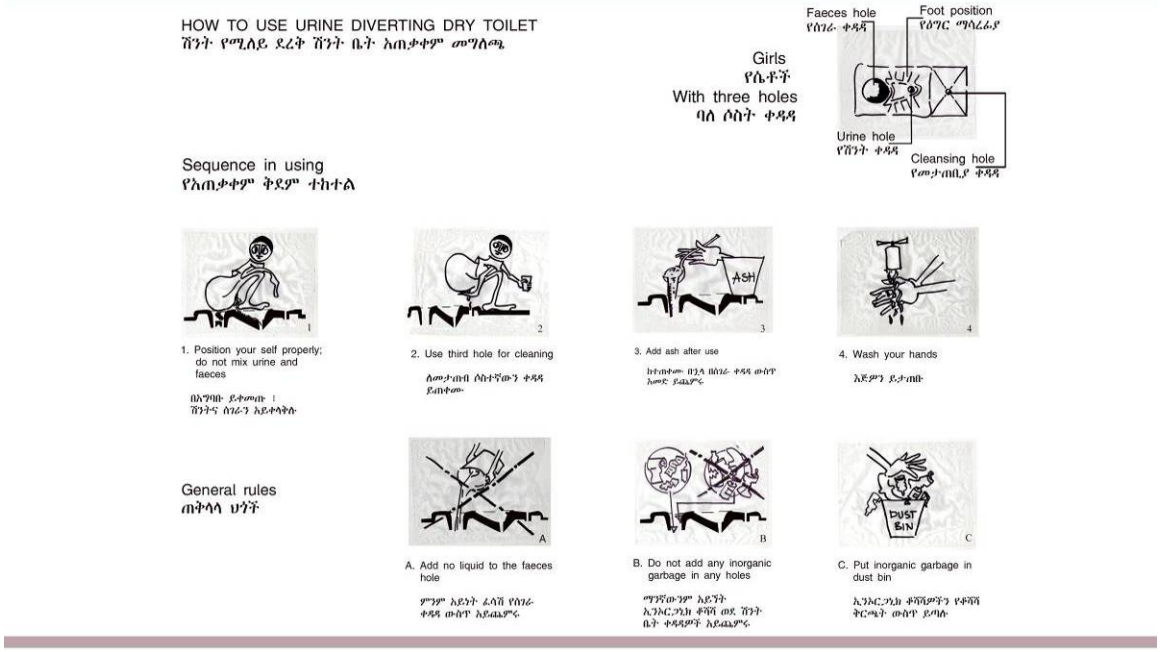
Female's unit



Male's unit for washer

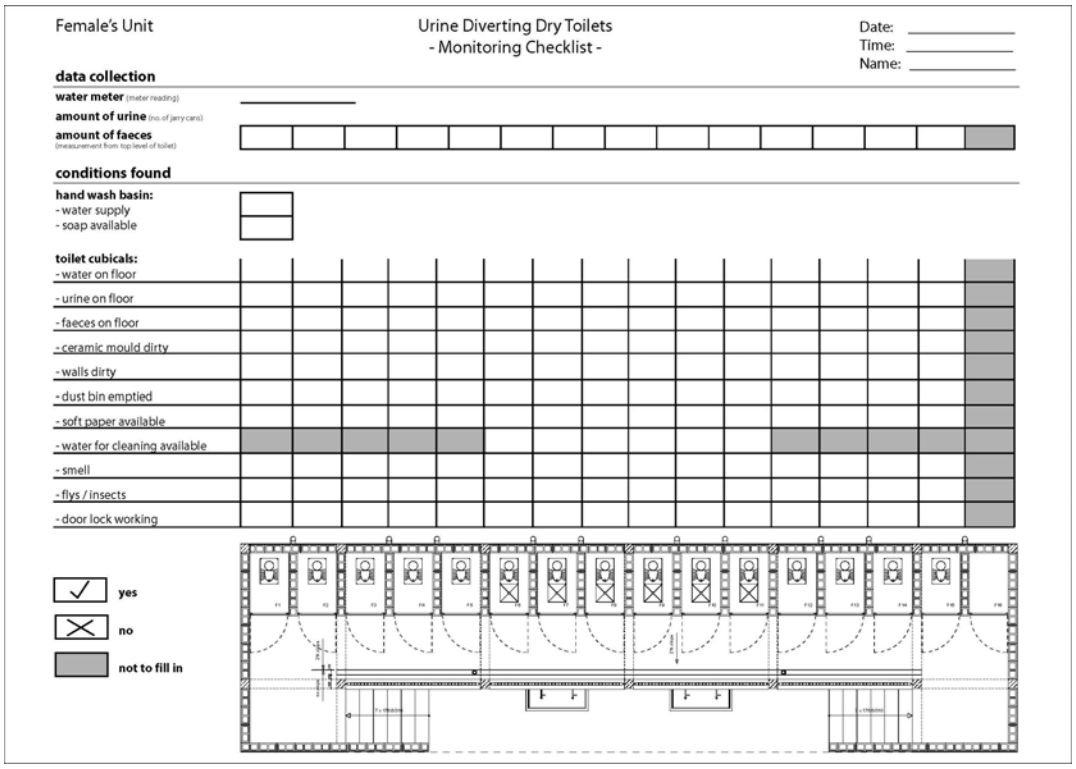


Female's unit for washer

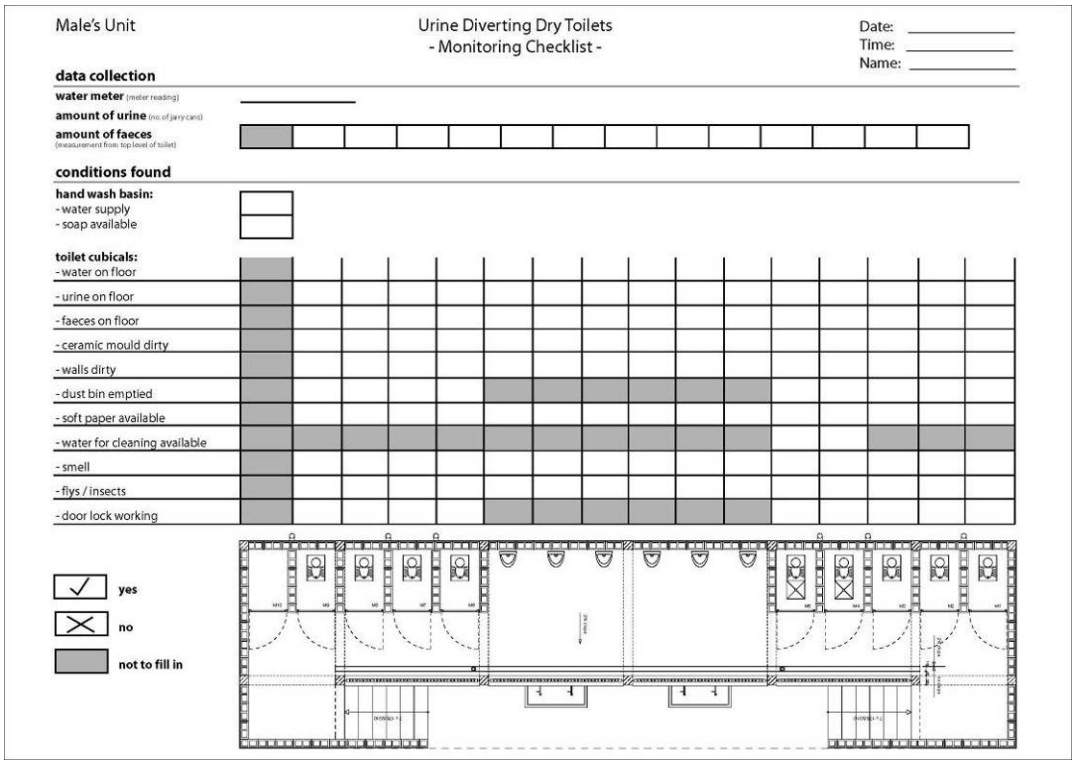


Annex 5: Monitoring Sheets

Monitoring sheet for female's unit



Monitoring sheet for male's unit



Annex 6: Drawings

- Master plan - UDDT Building and Treatment Site
- Architectural ground floor plan
- Architectural first floor plan
- Architectural elevations
- Sanitary installations ground floor
- Sanitary installations section
- Treatment site: urine storage
- Treatment site: compost site
- Landscaping