Part 2

Section 2A
Supporting evidence

Section 2B
Sample characteristics (by technology)

Section 2C
Database listing

Section 2D
Bibliography

Section 2E
Annex

Section 2A
Supporting evidence

Absence of household sanitation

Key findings

- Lack of space is not the primary determinant for absence of household sanitation. Poverty, and/or the inability to save funds to invest in longer term sanitation facilities are key constraints (poverty may force householders to prioritise use of space to other functions)
- Significant family indebtedness, often due to payment of medical fees through illness, constrain ability to save or invest in sanitation
- In cases where plot size was mentioned as the key factor explaining absence, these cases were spread across a range of plot size categories, rather than being exclusively linked to the smallest group
- Plot sizes amongst households without sanitation are not on average smaller than those houses where latrines are present

Survey sample

A total of 540 cases (29% of full sample) were found to be lacking any domestic sanitation facilities within the confines of the household plot. The majority of these cases were drawn from Ghana (84%), with India and Mozambique accounting for 14% and 2% of all cases respectively. (*For details, see Sample Characteristics*).

Reasons for absence of household latrines

- In answering the question, '*Why is there no household toilet?*', the largest responses noted 'high cost' (22%); 'use public latrines' (17%); 'lack space' (16%); 'difficult to operate and maintain' (8%); or that 'no facility provided' (6%). **[ref.: absence:1]**
- The response 'lack of space' was not found to be associated exclusively with relatively small plot sizes. Crosstabulations between reason for absence of household latrine and recorded plot size indicate that this factor was evenly represented across all plot size categories, from the

smallest grouping 11-220m^2 (5%), through to the largest grouping 630-2700m^2 (4%). **[ref.: absence:2]**

- In the majority of cases (86%), the lack of household sanitation facilities was, unsurprisingly, felt to be unsatisfactory. When asked '*What is preferred toilet choice?*', 28% chose WC to septic tank; 18% VIP; 17% simple pit types; 10% WC to sewer; and 8% pour-flush with twin soakpit. A significant minority (5%) expressed that 'any' toilet would be preferred. **[ref.:absence:3]**

Simple pit latrines

Key findings

- Few cases of problems with simple pit latrines recorded, reinforced by high levels of user satisfaction
- User satisfaction levels most significantly affected by smell, emptying and insects
- A quarter of all simple pit latrines had been in use for more than five years
- Only 6% of pit latrines been emptied, most on one occasion only. Re-emptying periods were greater than three years in most cases

Description

For a description of simple pit latrines, please refer to section B.

Survey sample

A total of 396 cases (21% of full sample) were found to have a simple pit toilet within the confines of their household plot. The majority of these cases are drawn from Mozambique (86%), with Ghana accounting for the remaining 14%. (*For details, see Sample Characteristics*).

Reasons for construction

- In general, socio-economic factors dictate reasons for construction of simple pits, above purely technical considerations. 'Low cost' (29%) and 'comfort and convenience' (28%) form the two largest responses to the question, '*Why did you build the toilet like this?*'. Other significant minorities included 'easy to clean' (11%), 'simple to use and maintain' (8%) and 'no choice' (6%). **[ref.:simpit:1]**

Problems with simple pit latrines

- Notably, just under three-quarters of all cases (73%) indicated that householders had experienced 'no' problems with their simple pit latrine. Where problems were identified, they included 'frequent repairs' (7%); 'smell' (7%); 'smell and insects' (5%); and insects (2%). 'Emptying' ranked as the sixth most important factor with only 1.3%. **[ref.:simpit:2]**

Repairs

- In the majority of cases (85%), users were responsible for repairing their latrine; in 12% of cases, users replied that the latrine had not required repairs to date. **[ref.:simpit:3]**

Cleanliness of latrine

- Surveyors were asked to record the level of cleanliness found in the latrine superstructure (against pre-determined scales). In 86% of cases, latrines were identified as 'very clean' or 'clean', while only 12% were identified as 'not clean' and 2% 'very unclean'. In just under half of the cases sampled, the users claimed to have cleaned the latrine 'today'; just over a third (34%) cleaned 'yesterday' and 17% 'more than 2 days ago'. **[refs.:simpit:4-5]**

Plot size

- Household plot size (m^2) varied in range from a minimum of $28m^2$ to a maximum of $3300m^2$. The arithmetic mean stood at $403m^2$, with a median plot size figure of $306m^2$ and a mode of $375m^2$.

Cost of latrine

- In 98% of all cases, the facility was paid for by the users themselves from their own resources. Monthly operation and maintenance costs ranged from US$ 0 - US$ 5 **[ref.:simpit:6-7]**

Years in use

- In the majority of cases sampled (57%), households had been using their latrine for between 1-5 years (of which the majority fall within years 1-3); 18% had been in use for less than 1 year. Notably, a cumulative total of 26% of all cases recorded latrines in use for between 6-31 years (15% between 6-10 years, with the remaining 10% in use between 11-31 years. 80% of this figure was found in years 11-14). **[ref.:simpit:8]**

Pit emptying

- In the majority of cases (94%), simple pits had not been emptied during their lifetime. 2% of the sample showed pits had been emptied once and 1.5% on three occasions. Crosstabulations between years in use against number of times emptied showed that in cases where pits had not been emptied, 59% had been in use for between 1-5 years; 12% for 6-10 years and the remainder (9%) for 11-20 years. **[ref.:simpit:9-10]**

- When asked to judge the volume of sludge removed during emptying, 91% had 'all' pit sludge removed; 4% 'half'; and 2% respectively for both 'quarter' and 'three quarters'. 79% of households maintained that their pit was not yet full. **[ref.:simpit:11]**

- In 58% of all cases the period between pits being emptied lasted for more than 3 years. A re-emptying period of between 5-7 years accounted for the single largest proportion in this grouping (19%). A significant minority of all cases (12%) accounted for re-emptying every six months. **[ref.:simpit:12]**

- Responsibility for emptying simple pit latrines was generally considered to be the householder's (67% of all cases), though significant minorities employed contractors (19%) or perceived the Municipality (14%) to be responsible. **[ref.:simpit:13]**

- The method for emptying simple pit latrines relies to a large extent (61% of cases) on manual action (either by hand or with hand tools). In 30% of cases, a vacuum tanker was used for this purpose. **[ref.:simpit:14]**

- Cost of emptying ranged between US$ 5 to US$ 40 per emptying incident. **[ref.:simpit:15]**

- After emptying, the majority of households reported that pit contents were buried on-plot (60%); 24% stated that hygienic disposal off-site occurred, and 11% that indiscriminate dumping away from the plot was the main practice. **[ref.:simpit:16]**

- Of those households which identified emptying as a problem, 28% noted 'high cost', and 17% 'frequency' of emptying. 50% claimed 'no' problems with the process. **[ref.:simpit:17]**

Anal cleansing

- In the majority of cases, 'newspaper' was used as anal cleansing material (65%); toilet paper by 20% and 7% a combination of both. **[ref.:simpit:18]** Following defecation, the majority of users placed their cleansing materials either into a receptacle inside the latrine shelter (58%); outside the shelter (21%) or in the pit itself (21%). **[ref.:simpit:19]** In those cases where the material did not end up in the pit or receptacle inside/outside the shelter, it was burnt. **[ref.:simpit:20]**

Odour and insect nuisance

- Simple pit latrines recorded little or moderate odour and insect nuisance levels. When users were asked to express on a pre-determined scale the extent to which the pit smelt, 54% of households recorded 'no smell'; 37% 'slight smell'; and 9% 'strong smell' **[ref.:simpit:21]** A similar question relating to insect nuisance (flies) found that 91% of householders considered there to be either 'no' or 'tens' of flies; 8% 'hundreds' and 1% 'thousands'. **[ref.:simpit:22]**

User satisfaction

- High degrees of user satisfaction were expressed with simple pit latrines. 90% of all householders responded that they were either 'satisfied' or 'very satisfied' with their pit latrine. Of the remainder, 6% recorded being 'unsatisfied', and only 1% 'very unsatisfied'. **[ref.:simpit:23]**
- User satisfaction levels were not significantly affected by the incidence of either smell or odour nuisance in percentage terms. **[ref.:simpit:25-26]** However, of all the problems identified with simple pit latrines, 'smell', 'emptying' and a combination of smell and insects were found to have the greatest impact on these satisfaction levels. **[ref.:simpit:27]**

Identified problems and their perceived impact

- Critically, of those users who identified that there were problems with their simple pit, very few considered this to have more than a 'moderate impact' on their ability to use the facility (5%). The majority (84%) felt that the problem(s) identified had 'no impact'. **[ref.:simpit:24]** It was found that the factors which would most help to relieve the identified problems recorded included 'lower cost' (41%); 'easier to operate and maintain' (35%) and 'not require regular emptying' (10%) **[ref.:simpit:28]**

Ventilated Improved Pit (VIP) latrines

Key findings

- Insect and odour nuisance recorded as common problems with the VIP latrine
- A third of all VIP latrines had been in use for more than five years
- A significant proportion of VIP latrines required emptying every six months
- High levels of user satisfaction expressed, but satisfaction levels affected most by incidence of smell, insects and emptying problems

Description

For a description of ventilated improved pit latrines, please refer to section B.

Survey sample

A total of 52 cases (3% of full sample) were found to have a VIP toilet within the confines of their household plot. All of these cases were drawn from Ghana. (*For details, see Sample Characteristics*).

Reasons for construction

- Social reasons act as the primary reason for construction of VIP latrines, with 'comfort and convenience' (34%) ranking as the largest response to the question, '*Why did you build the toilet like this?*'. Other significant minorities included 'low cost' (12%), 'no choice' (12%), 'simple to use and maintain' (8%), 'lack water' (8%) and a combination of 'comfort and convenience' and 'health and hygiene' (8%) **[ref.:vip:1]**

Problems with VIP latrines

- 52% of all cases indicated that householders have experienced 'no' problems with their VIP latrines. Ironically for a latrine designed to reduce insect and odour nuisance these factors figured prominently amongst responses. A combination of 'smell and insects' (10%); 'emptying' (8%); 'insects' (6%); and 'smell' (4%) ranking as the most common problems noted **[ref.:vip:2]**

Repairs

- In the majority of cases (94%), the householder was responsible for repairing the latrine. **[ref.:vip:3]**

Cleanliness of latrine

- Surveyors were asked to record the level of cleanliness found in the latrine superstructure (against pre-determined scales); 23% of cases were identified as 'very clean'; 65% as 'clean'; and 13% as 'not clean'. In just over three-quarters (77%) of the cases sampled, the users claimed to have cleaned the latrine 'today'; 10% cleaned 'yesterday' and 13% 'more than 2 days ago'. **[refs.:vip:4-5]**

Plot size

- Household plot size (m^2) varied in range from a minimum of $60m^2$ to a maximum of $4500m^2$. The arithmetic mean stood at $825m^2$, with a median plot size figure of $630m^2$ and a mode of $630m^2$.

Cost

- In 52% of all cases, the facility was paid for by the users themselves from their own resources, with loans accounting for an additional 13%. A third of households spent nothing on monthly maintenance; 25% spending 5000 cedis (US$2.4); 12% 4000 cedis (US$1.9). **[ref.:vip:6]**

Years in use

- In the majority of cases sampled (59%), households had been using their VIP latrine for between 1-5 years; 9% for less than 1 year; and 33% for between 6-10 years. **[ref.:vip:7]**

Pit emptying

- In 46% of cases, VIP latrines had not been emptied during their lifetime. 22% of the sample showed latrines had been emptied once and 16% twice. Crosstabulations between years in use against number of times emptied showed that in cases where VIP latrines had not been emptied, 31% had been in use for between 1-5 years; and 6% for 6-10 years. **[ref.:vip:8-9]**

- When asked to judge the volume of sludge removed during emptying, 57% of householders had 'all' pit sludge removed; 6% respectively for both 'half' and 'three quarters' and 3% for 'quarter'. 29% of households claimed that the pits were not yet full. **[ref.:vip:10]**

- In 17% of all cases the period between pits being emptied lasted for more than 3 years. Re-emptying periods of 1 and 2 years accounted for 21% respectively. Significantly, 42% of all cases accounted for re-emptying every 6 months. **[ref.:vip:11]**

- Responsibility for emptying VIP latrines was generally perceived to be that of the municipality (54%), though significant minorities employed contractors for emptying (26%) or undertook emptying themselves (20%). **[ref.:vip:12]**

- The method for emptying VIP latrines relies on heavily on vacuum tankers (53%) or manually with hand tools (38%). **[ref.:vip:13]**

- In cases where householders possessed knowledge about the cost of emptying (n=16), values ranged widely from between 4000 to 50,000 cedis (US$2-24). The most common cost figure noted for emptying was 30,000 cedis, or US$15 **[ref:vip:14]**

- Following emptying, 89% of households report that pit contents were disposed hygienically off-site; 7% dumped indiscriminately away from the plot; and 4% buried on-plot; **[ref.:vip:15]**

- Of those households which identified emptying as a problem, 45% noted 'high cost', and 5% respectively for combinations of 'high cost and frequency' and 'high cost and hygiene'. 45% claimed 'no' problems with the process. **[ref.:vip:16]**

Anal cleansing

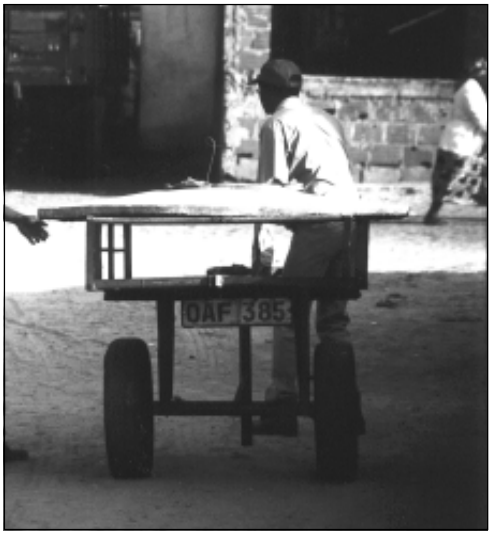
- 'Newspaper' was used as anal cleansing material in 51% of cases; toilet paper by 16% and 31% a combination of both. **[ref.:vip:17]** Following defecation, the majority of users placed their cleansing materials either into a receptacle inside the latrine shelter (96%); or outside the shelter (4%). **[ref.:vip:18]** In those cases where the material did not end up in the pit or receptacle inside/outside the shelter, it was burnt. **[ref.:vip:19]**

Odour and insect nuisance

- VIP latrines recorded relatively high degrees of odour nuisance levels. When asked to express on a pre-determined scale to what extent the VIP latrine smelt, 40% of households recorded 'no smell'; 54% 'slight smell'; and 6% 'strong smell' **[ref.:vip:20]** A similar question relating to insect nuisance (flies) showed that for 90% of householders there was either 'no' or 'tens' of flies. However, for categories acting as indicators of higher levels of nuisance, VIP latrines performed poorly, with 3% and 7% of all cases recording 'hundreds' and 'thousands' of flies respectively. **[ref.:vip:21]**

Photograph 1:
Typical latrine superstructure (made from reeds) used in Mozambique, where it is customary for latrine shelters to be built without a roof

Photograph 2:
Transportation of completed slabs from production unit to household plot, Maputo, Mozambique



Photograph 3:
Production of popular unreinforced domed slabs used for low cost simple pit latrines in peri-urban areas of Mozambique

Photograph 4:
Pour flush latrine in improved urban slum, Vijayawada, India. Operational sanitation facilities were found to be commonplace on the smallest of plot sizes (as small as 14m^2)

User satisfaction

- Relatively high degrees of user satisfaction were expressed. 83% of all householders responded that they were either 'satisfied' or 'very satisfied' with their VIP latrine. Of the remainder, 8% recorded being 'unsatisfied', and only 2% 'very unsatisfied'. **[ref.:vip:22]**
- User satisfaction does not seem to be significantly affected by the incidence of either smell or odour in percentage terms **[ref.:vip:23-24]**, but 'smell', 'insects' and a combination of smell, insects and emptying do make the most prominent impact of all identified problems to satisfaction levels **[ref.:vip:25]**

Identified problems and their perceived impact

- Notably, of those users who identified that there were problems with their VIP latrines, few considered this to have more than a 'moderate impact' on their ability to use the facility (18%). The majority (61%) felt that the problem(s) identified had 'no impact', with 21% recording 'slight impact'. **[ref.:vip:26]** It was found that the factors which would most help to relieve the identified problems recorded included 'lower cost' (36%); 'easier to operate and maintain' (41%) and 'not require regular emptying' (9%) **[ref.:vip:27]**

Pour-flush latrines

Key findings

- Pour flush latrines have been constructed on plots as small as 14m^2
- Just under two-thirds of all households using pour-flush latrines had used them for more than five years
- Two-thirds of all latrines had not been emptied, and half of these had been in use for between 6-10 years
- For 60% of all latrines the period between being emptied exceeded three years. In just over a quarter latrines, this period lasted for five years or more
- User satisfaction levels are most significantly affected by smell, blockage and frequent repairs

Description

For a description of pour-flush pit latrines, please refer to section B.

Survey sample

A total of 394 cases (21% of full sample) were found to have a pour flush toilet within the confines of their household plot. All of these cases are drawn from India. (*For details, see Sample Characteristics*).

Reasons for construction

- Socio-economic factors tend to determine the reasons for construction of pour-flush latrines. 'Comfort and convenience' (34%), 'Low cost' (21%); 'no choice' (15%) and 'easy to clean' (11%) form the largest responses to the question, '*Why did you build the toilet like this?*'. **[ref.:pf:1]**

Problems with pour-flush latrines

- 59% of all cases indicated that householders had experienced 'no' problems with their pour-flush latrines. Where problems were identified, they included 'smell' (12%); 'insects' (8%); 'blockage' (5%) and 'emptying' (4%) **[ref.:pf:2]**

Repairs

- In the majority of cases (95%), users were responsible for repairing their latrine, the remainder being split between the Municipality (3%) and 'other agency' (1%). **[ref.:pf:3]**

Cleanliness of latrine

- Surveyors were asked to record the level of cleanliness found in the latrine superstructure (against pre-determined scales). 87% of cases were identified as 'very clean' or 'clean'; with 8% as 'not clean' and 4% 'very unclean'. In 39% of the cases sampled, the users claimed to have cleaned the latrine 'today'; 11% cleaned 'yesterday' and 50% 'more than 2 days ago'. **[refs.:pf:4-5]**

Plot size

- Household plot size (m^2) varied in range from a minimum of $14m^2$ to a maximum of $3374m^2$. The arithmetic mean stood at $146m^2$, the median plot size figure of $90m^2$ and a mode of $54m^2$.

Cost

- In 43% of all cases, the facility was paid for by the users themselves from their own resources, with 'loan and subsidy' accounting for 47%. **[ref.:pf6]** Of those who knew how many months of their loan were left to repay

(n=75), 17% of households had 20 months to repay; 9% had eight months left to pay; and 33% had between 2-6 months left to complete. **[ref.:pf:7]** Monthly maintenance costs were low (ranging between Rs10-Rs100 (US$0.30-US$2.8), with most households spending either Rs10-20 per month (25% and 27% of all cases respectively). 9% of households spent nothing on maintenance. **[ref.:pf:8]**

Years in use

- In 36% of cases, households had been using their pour-flush latrines for between 1-5 years; 47% for between 6-10 years; 12% between 11-20 years and 3% for longer. Only 3% of cases had used their latrine for less than 1 year. **[ref.:pf:9]**

Pit emptying

- In 66% of cases, pour flush latrines had not been emptied during their lifetime. 20% of the sample showed latrines had been emptied once and 8% twice. Crosstabulations between years in use against number of times emptied show that in cases where pour-flush latrines had not been emptied, 41% had been in use for between 1-5 years; and 47% for 6-10 years. Where latrines had been emptied once, 64% had been in use for 6-10 years **[ref.:pf:10-11]**

- When asked to judge the volume of sludge removed during emptying, 64% of householders responded that pits were not yet full. Where emptying had occurred (n=101) 78% of households had 'all' pit sludge removed; 15%'half'; 6% 'quarter' and 1% 'three-quarters'. **[ref.:pf:12-13]**

- In 59% of all cases the period between pits being emptied lasted for 3 years or more (with 27% of cases falling in the 'more than 5 years' category). A two year re-emptying period accounted for 21% of cases and one year, 10%. **[ref.:pf:14]**

- Responsibility for emptying pour flush latrines was generally perceived to be that of the user (81%). **[ref.:pf:15]**

- The method for emptying pour flush latrines relies exclusively on manual techniques, either by hand (41%) or with hand tools (59%) **[ref.:pf:16]**

- In cases where householders possessed knowledge about the cost of emptying (n=98), values ranged from between Rs150-1500 (US$4.0-42.0). The most common figure noted was Rs500 (US$14). **[ref:pf:17]**
- Following emptying, 75% of households reported that pit contents were dumped off-site; in 15% of cases pit excreta was disposed hygienically off-site and in 8% of cases it was composted **[ref.:pf:18]**
- Of those households which identified emptying as a problem, 29% noted 'high cost', and 14 'hygiene'. 46% claimed 'no' problems with the process. 'Frequency' and 'access to plot' accounted for only 5% and 4% respectively. **[ref.:pf:19]**

Odour and insect nuisance

- Pour-flush latrines recorded little odour and insect nuisance. Users were asked to express on a pre-determined scale to what extent the pour flush latrine smelt. 63% of cases recorded 'no smell'; 30% 'slight smell'; and 6% 'strong smell' **[ref.:pf:20]** A similar question relating to insect nuisance (flies) found that 95% of householders considered there to be either 'no' or 'tens' of flies; with the remaining 5% noting 'hundreds'. **[ref.:pf:21]**

User satisfaction

- High degrees of user satisfaction were expressed with pour-flush latrines. 83% of all householders responded that they were either 'satisfied' or 'very satisfied' with their latrine. **[ref.:pf:22]**
- User satisfaction does not seem to be significantly affected by the incidence of either smell or odour in percentage terms **[ref.:pf:23-24]**, but 'smell', 'blockage' and 'frequent repairs' make the most prominent impact of all identified problems to satisfaction levels **[ref.:pf:25]**

Identified problems and their perceived impact

- Where users identified that there were problems with their latrines, few considered this to have more than a 'moderate impact' on their ability to use the facility (11%). The majority (69%) felt that the problem(s) identified had 'no impact', with 20% recording 'slight impact'. **[ref.:pf:26]** It was found that the factors which would most help to relieve the identified problems recorded included 'easier to operate and maintain' (43%); 'lower cost' (27%); and 'not require regular emptying' (17%) **[ref.:pf:27]**

WC to septic tank

Key findings

- The most common problems noted with septic tanks include 'lack of water' and 'emptying'. These two issues most significantly impact on user satisfaction levels
- 58% of all households had used septic tanks for more than three years. 36% of these had used the facility for more than 11 years
- Just under half of all septic tanks had not been emptied during their lifetime
- In just over one third of all cases, the period between emptying the tanks exceeded three years. Interestingly, a significant proportion complained of the need to empty every six months
- High degrees of user satisfaction expressed

Description

For a description of septic tanks, please refer to section B.

Survey sample

A total of 159 cases (9% of full sample) were found to have a WC to septic tank within their household plot. 82% of these cases are drawn from Ghana, the remainder from India. (*For details, see Sample Characteristics*).

Reasons for construction

- Social factors tend to determine reasons for construction of septic tanks. 'Comfort and convenience' (48%), and a combination of 'comfort and convenience' and 'health and hygiene' (6%) form the largest positive responses to the question, '*Why did you build the toilet like this?*'. 22% of households indicate that they had 'no choice' in building septic tanks, which may refer to users buying plots on which this type of facility was already provided. The relative expense of septic tanks is indicated by the low response to 'low cost' (2%) **[ref.:wcsep:1]**

Problems with septic tanks

- 54% of all cases indicated that householders had experienced 'no' problems with their septic tanks. Where problems were identified, they included 'lack water' (12%); 'emptying' (12%); 'insects' (5%) and 'blockage' (5%) **[ref.:wcsep:2]**

Repairs

- In most cases (82%), the householder was responsible for repairing their toilet. Other significant minorities including 'contractor' (8%), and in 8% of all cases responded the septic tank had 'not needed repair' **[ref.:wcsep:3]**

Cleanliness of latrine

- Surveyors were asked to record the level of cleanliness found in the latrine superstructure (against pre-determined scales). In19% of cases, latrines were identified as 'very clean'; with 72% as 'clean'. In 44% of the cases sampled, the users claimed to have cleaned the latrine 'today'; 8% cleaned 'yesterday' and 48% 'more than 2 days ago'. **[refs.:wcsep:4-5]**

Plot size

- Household plot size (m^2) varied in range from a minimum of $27m^2$ to a maximum of $4500m^2$. The arithmetic mean stood at $650m^2$, the median plot size figure of $576m^2$ and a mode of $900m^2$.

Cost

- In 71% of all cases, the facility was paid for by the users themselves from their own resources. **[ref.:wcsep:6]** Monthly maintenance costs ranged from US$ 0.30 to US$ 10 **[ref.:wcsep:7]**

Years in use

- In 36% of cases, households had been using their septic tanks for between 1-5 years; 22% for between 6-10 years; 18% between 11-20 years and 18% for longer. 6% of cases had used their latrine for less than 1 year **[ref.:wcsep:8]**

Emptying

- In 48% of cases, septic tanks had not been emptied during their lifetime. 12% of the sample showed tanks had been emptied once and 8% twice. Crosstabulations between years in use and number of times emptied show that in cases where septic tanks had not been emptied, 80% had been in use for between 0-5 years; and 12% for 6-10 years. Where tanks had been emptied once, 36% had been in use for 0-5 years and 27% for 6-10 years **[ref.:wcsep:9-10]**

- When asked to judge the volume of sludge removed during emptying, 35% of householders responded that the tank was not yet full. Where emptying had occurred (n=80) 85% of households had 'all' tank sludge removed; 7%'half'; and 6% 'three-quarters'. **[ref.:wcsep:11-12]**

- In 34% of all cases the period between tanks being emptied lasted for 3 years or more (with 21% of cases being accounted by the 3-5 years category). Other significant responses include 'every 6 months' (23%); 'every 2 years' (18%) and 'every year' (13%). **[ref.:wcsep:13]**
- In response to the question *Who is responsible for emptying the pit/tank/ toilet?,* 51% accounted responsibility to the Municipality; 29% to the user and 19% to contractors. **[ref.:wcsep:14]**
- The method for emptying septic tanks relies predominantly the use of vacuum tankers (80%). Manual emptying accounts for the remaining 20%, by hand recording 11% and with machinery 8%**[ref.:wcsep:15]**
- Cost of emptying ranged from US$ 8 to US$18 **[ref:wcsep:16]**
- Following emptying, just under half (49%) of all households report that tank contents are dumped off-site; 45% claim hygienic disposal off-site and 4% buried on plot **[ref.:wcsep:17]**
- Of those households which identified emptying as a problem, 12% noted 'high cost', and 10% 'access to plot'. 60% claimed 'no' problems with the process. **[ref.:wcsep:18]**

Odour and insect nuisance

- Users were asked to express on a pre-determined scale to what extent the septic tanks smelt. 67% of cases recorded 'no smell'; 32% 'slight smell'; and 1% 'strong smell' **[ref.:wcsep:19]** A similar question relating to insect nuisance (flies) found that 79% of householders considered there to be 'no', and the remaining 21% 'tens' of flies. **[ref.:wcsep:20]**

User satisfaction

- High degrees of user satisfaction were expressed. 90% of all householders responded that they were either 'satisfied' or 'very satisfied' with their septic tank. **[ref.:wcsep:21]**
- User satisfaction does not seem to be significantly affected by the incidence of either insects or odour in percentage terms **[ref.:wcsep:22-23]**, but 'lack of water', and 'emptying' make the most prominent impact of all identified problems to satisfaction levels **[ref.:wcsep:24]**

Identified problems and their perceived impact

- Where users identified that there were problems with their latrines, few considered this to have more than a 'moderate impact' on their ability to

use the facility (14%). The majority (86%) felt that the problem(s) identified had either 'no impact' or 'slight impact', **[ref.:wcsep:25]**

- It was found that the factors which would most help to relieve the identified problems recorded included 'easier to operate and maintain' (46%); 'regular water supply' (13%), 'not require regular emptying' (11%), and 'lower cost' (10%); **[ref.:wcsep:26]**

Bucket/pan latrines

Key findings

- Emptying is the most commonly noted problem with bucket/pan latrines, especially the frequency and cost elements. Smell and insect nuisance are of secondary importance
- A quarter of all bucket/pan latrines have been in use for between 21-30 years
- Bucket/pan latrines record the highest levels of insect and odour nuisance of all latrine types
- Users expressed a high degree of dissatisfaction with bucket/pan latrines. Satisfaction is significantly affected by smell, insects and emptying practices

Description

For a description of bucket/pan latrines, please refer to section B.

Survey sample

A total of 264 cases (14% of full sample) were found to have a bucket/pan latrine within the confines of their household plot. All of these cases are drawn from Ghana. (*For details, see Sample Characteristics*).

Reasons for construction

- In general, factors beyond user control and cost considerations determine the main reasons for construction of bucket/pan latrines. 'No choice' accounts for 39% of cases, reflecting the fact that many bucket/pan latrines were built with the house, and 'low cost' accounts for 28% of responses. Other significant minorities included 'comfort and convenience' (12%), and 'simple to use and maintain' (8%). **[ref.:bucket:1]**

Problems with bucket/pan latrines

- 'Emptying' represents the single most common problem with bucket/pan latrines (accounting for 42% of all responses), followed by a combination of smell and emptying (9%); smell, insects and emptying (6%) and emptying and expense (5%). 'Smell' and 'insects', problems which are typically associated with bucket/pan latrines, accounted for only 4% and 0.4% respectively **[ref.:bucket:2]**

Repairs

- For the majority of cases (96%), users were responsible for repairing their latrine; in 2% of cases, users replied that the latrine had not required repairs to date. **[ref.:bucket:3]**

Cleanliness of latrine

- Surveyors were asked to record the level of cleanliness found in the latrine superstructure (against pre-determined scales). In roughly half of all cases, bucket/pan latrines were identified as 'clean', with a slightly smaller figure (43%) recorded as 'not clean'. In 39% of the cases sampled, users claimed to have cleaned the latrine 'today'; 21% cleaned 'yesterday' and 40% 'more than 2 days ago'. **[refs.:bucket:4-5]**

Plot size

- Household plot size (m^2) varied in range from a minimum of $70m^2$ to a maximum of $5772m^2$. The arithmetic mean stood at $695m^2$, the median plot size figure of $600m^2$ and a mode of $630m^2$.

Cost of latrine

- In 74% of all cases, the facility was paid by the users from their own resources, and in 4% the cost was met through a subsidy. The 20% 'not known' figure reflects the number of bucket/pan latrines originally built with the house **[ref.:bucket:6]** Monthly operation and maintenance costs ranged from 0 to 40,000 cedis (US$ 0-US$ 20), with a mean figure of 5346 cedis (US$ 3). **[ref.:bucket:7]**

Years in use

- With the history of bucket/pan latrine use in Ghana, the figures for years in use reflect an older age range than other latrine types. In 25% of cases, households had been using their latrine for between 21-30 years; 22% of

cases for between 11-20 years; and 23% of cases for between 1-10 years. **[ref.:bucket:8]**

Emptying

- For bucket/pan latrines, the most common interval for emptying is between two and three days (19% and 42% respectively). Other significant minorities include 'weekly' (14%) and 'every 4 days' (8%). **[ref.:bucket:9]**

- Responsibility for emptying bucket/pans was seen to be the responsibility of 'contractors' (63%), though 29% saw this as the users duty and 8% perceived the Municipality to be responsible. **[ref.:bucket:10]**

- In 99% of all cases, users were responsible for paying for emptying services. **[ref:bucket:11]**

- After emptying, 41% of households claimed that bucket/pan contents were dumped indiscriminately off-site; 25% claimed hygienic disposal off-site, and 3% buried on-plot. 31% householders responded 'not known'. **[ref.:bucket:12]**

- Of those households which identified emptying as a problem, 'frequency' of emptying was the single most important factor (46%); 9% of households recorded 'high cost' as a problem. 38% claimed 'no' problems with emptying. **[ref.:bucket:13]**

Anal cleansing

- In 49% of cases, 'newspaper' was used as anal cleansing material; 29% a combination of both newspaper and toilet paper; and 'toilet paper' alone accounted for 8%. **[ref.:bucket:14]** Following defecation, the majority of users placed their cleansing material either into a receptacle inside the latrine shelter (91%); or in the bucket/pan itself (5%), or outside the shelter (1%). **[ref.:bucket:15]** In those cases where the material did not end up in the bucket/pan or receptacle inside/outside the shelter, it was burnt (92%) or put on a rubbish dump (8%). **[ref.:bucket:16]**

Odour and insect nuisance

- Bucket/pan latrines were found to suffer from significant insect and odour nuisance, as measured by the users themselves. Householders were asked

to express on a pre-determined scale to what extent the bucket/pan smelt. Only 10% of cases recorded 'no smell'; the majority (70%) noting 'slight smell'; and 20% 'strong smell' **[ref.:bucket:17]** A similar question relating to insect nuisance (flies) found that 20% of householders considered there to be 'no' flies; 68% 'tens' of flies; 10% 'hundreds' and 3% 'thousands'. **[ref.:bucket:18]** In cases where households responded to questions about presence of cockroaches (n=122), 60% indicated 'tens' of cockroaches in the latrine shelter, the remainder reporting 'none'. **[ref:bucket:19]**

User satisfaction

- Relatively high degrees of user dissatisfaction were expressed about bucket/pan latrines. 48% of all householders responded that they were either 'very unsatisfied' or 'unsatisfied' with their bucket/pan latrine. Of the remainder, 29% recorded being 'satisfied', and only 4% 'very satisfied'. **[ref.:bucket:20]**

- Although smell and odour were recorded as problems of secondary importance to emptying, user satisfaction levels were significantly affected by them. Crosstabulations for satisfaction against smell indicate that 47% of all cases correspond with the variables 'very unsatisfied / unsatisfied' and 'slight/strong smell'. Similarly, 44% of all cases correspond with the variables 'very unsatisfied / unsatisfied' and 'tens, hundreds and thousands' of flies. **[ref.:bucket:21-22]**

- 'Emptying' (21%), 'smell' (2.3%) and a combination of 'smell and emptying' (7%) and 'smell, insects and emptying' (4%) have the most prominent impacts of all identified problems to user satisfaction levels **[ref.:bucket:23]**

Identified problems and their perceived impact

- Of those users who identified that there were problems with their bucket/pan, only 16% considered that the problem(s) had no impact. A large proportion (49%) felt that the problem(s) identified were of 'moderate impact' or higher. **[ref.:bucket:24]** It was found that the factors which would most help to relieve these problems included 'not require regular emptying' (32%); 'simpler toilet design' (26%); 'easier to operate and maintain' (17%); and 'lower cost' (9%). **[ref.:bucket:25]**

Plot size

Key findings

- Operational sanitation facilities were found to be commonplace on the smallest of plot sizes
- Levels of user satisfaction were not significantly affected by the incidence of small plot size
- There is little indication that plot size determines technology choice. No definitive grouping or concentration of technology types was observed by recorded size categories
- There is little indication that plot size is associated with particular operational problems. Where the most common latrine problems were noted, they were spread across all size categories
- The absence of household sanitation is not exclusive to the smallest plot sizes

Background

Critics of pit latrines often claim they are unsuitable for small plots in urban areas. In Jamaica, regulations prohibited pit latrine construction in areas where the density was higher than ten houses per acre (23 houses per hectare); in Indonesia, regulations state that areas with over 250 persons per hectare shall be classified as densely populated and shall not use on-plot excreta disposal (Alaerts and others, 1991). In a manual prepared for Habitat it was stated that the pit latrine system (except VIP's) is 'unsuitable for use in even low density urban developments' (Roberts, 1987). The smallest plot size recommended for twin pit pour flush latrines in India is 26 square metres (Riberio, 1985). None of the criteria used appear to be based on reasoned argument or on evidence of performance.

Household survey results and lessons

On-plot sanitation unsuitable for small plot sizes?

Significant proportions of sample households **with** operational sanitation facilities were found on relatively small plot sizes: one third of all such cases were measured with plot areas of up to 150m^2; just over 10 per cent on plots with an area not greater than 54m^2 **[ref:all:1]**. Although this indicates the coincidence of domestic sanitation on relatively small plots, it fails to say anything about the performance or suitability of the facilities. Although not a perfect measure of 'suitability', levels of user satisfaction are indicative. When asked to express degrees of (dis)satisfaction with their facility, those

households with the smallest plot sizes (defined here as in the range 13-110m^2) expressed high levels of satisfaction, 83% being either 'satisfied' or 'very satisfied' with their facility, with13% either 'unsatisfied' or 'very unsatisfied'. **[ref:all:2]** Importantly, in crosstabulations between satisfaction levels and recorded problems with latrines, lack of space does not feature amongst the most commonly noted problems **[ref:all:3].**

Plot size determines technology choice?

Table 2 below shows the incidence of selected technology types against their respective plot size categories. Critically, it indicates that technology choice is not exclusively matched to a single plot size category. Although some technology types have higher concentrations within a specific plot size range (i.e., pour flush latrines and the 13-100m^2 range), significant minorities also fall within other size categories.

Table 2: Incidence of technology type against plot size category

	Plot size category			
Count **Row %**	**13-110m^2**	**111-300m^2**	**301-598m^2**	**599m^2-highest**
Bucket/pan	*2* **0.8**	*22* **8.5**	*101* **39.0**	*134* **51.7**
Simple pit		*15* **21.4**	*18* **25.7**	*37* **52.9**
VIP	*1* **4.0**	*1* **4.0**	*6* **24.0**	*17* **68.0**
Double pit			*5* **20.0**	*20* **80.0**
WC - sewer	*15* **50.0**	*7* **23.3**	*3* **10.0**	*5* **16.7**
WC - septic tank	*22* **14.2**	*12* **7.7**	*44* **28.4**	*77* **49.7**
Pour flush x 2	*185* **71.7**	*59* **22.9**	*7* **2.7**	*7* **2.7**
Pour flush x 1	*84* **70.0**	*30* **25.0**		*6* **5.0**
Improved latrine	*7* **2.2**	*167* **54.2**	*122* **39.6**	*12* **3.8**

Key: *Count*: number of cases in each category
Row %: cell percentage as an expression of row total

Operational problems associated with small plot sizes?
The findings indicate that problems associated with low cost sanitation in urban areas are common across different plot size categories. Where problems were noted, the incidence of the three most important, 'emptying', 'smell' and 'insects', were found to be dispersed across all four size categories **[ref.: all:3]**

Absence of household latrines a function of small plot size?
Households **without** sanitation facilities are not exclusively concentrated on the smallest plot sizes. A median plot size figure of 432m^2 (table 3 below) indicates that 50 per cent of these cases are found above this mid-point in plot size categories (up to a maximum of 2700m^2). Furthermore, the distribution of plot sizes for households without sanitation tends to be skewed towards larger plot categories, as the mode figure of 630m^2 indicates. Mean, median and modal plot sizes for households without sanitation are larger than in cases where either a simple pit or pour-flush latrine is in use.

Postal survey results and lessons

The responses obtained from sector professionals through the postal survey in large part confirm the findings from the household survey. The postal survey was based on a sample of 57.

Role of planning regulations and minimum plot size
Respondents to the postal survey were asked to estimate the minimum plot sizes in their city as specified in planning regulations. As to be expected, this

Table 3: Plot size calculations for selected technology types

	Plot sizes (m^2)				
Type	*Mean*	*Median*	*Mode*	*Minimum*	*Maximum*
Pour flush	146	90	54	14	3374
Simple pit	403	306	375	28	3300
None	466	432	630	11	2700
WC septic tank	650	576	900	27	4500
Bucket	695	600	630	70	5772
VIP	825	630	630	60	4500

Table 4: Comparison between minimum plot sizes laid down in planning regulation and average plot sizes in informally developed urban districts

	Plot sizes (m^2)				
	Mean	*Median*	*Mode*	*Minimum*	*Maximum*
Minimum plot size*	500	387	150	36	2500
Average plot size	419	220	150	35	3600

*As laid down in planning regulations

figure was found to be consistently larger than average plot sizes in informally planned urban districts, as table 4 above indicates.

Variations in systems used according to formal/informal development
Comparisons between technology types most commonly used in planned and unplanned urban areas confirms what is previously known. In more formally planned and better serviced districts there is a tendency towards use of WC toilets (either to sewers or septic tanks), whilst in more informally and haphazardly planned districts, non-flush systems such as simple pit latrines, VIP's, or no facility are common. For both formally and informally planned districts however, a diversity of technology types in use was noted. **[ref.:post:1-2]**

Odour and insect nuisance

Key findings

- Only small percentages of households perceive odour and insect nuisance to be a common problem with their latrine (although nuisance of this kind does have a significant impact on satisfaction levels)
- Bucket/pan latrines register the highest nuisance levels of all latrine types
- Relative to other latrine types VIP's record higher than anticipated levels of odour and insect nuisance. There is little conclusive evidence to suggest a link between odour and insect nuisance and: height of vent above roof line, presence of fly screens, vent pipe colour and diameter of pipe
- Quantitative test results for insect nuisance indicate low absolute numbers of insects observed across a range of latrine types
- Anecdotal evidence raises doubts about domestic latrines as the primary source of insect nuisance on-plot

Background

Complaints about pit latrines most frequently mention odours and insect nuisance, yet there are few specific references to overcoming these nuisances in urban areas. Flies are a serious problem because they spread disease through feeding and breeding on faeces. Some types of mosquitoes (the *Culex* variety) breed in polluted water such as in wet latrines and may carry the disease filariasis. Reduction of smells, flies and mosquitoes are therefore of the greatest importance to reducing household and environmental health hazards.

General incidence of insects and odour nuisance

Odour and insect nuisance are the second and third most commonly noted problems mentioned by users of latrines in urban areas. However, percentages in both cases are small (accounting for only 7% and 4% of cases for 'smell' and 'insects' respectively), with 'emptying' being the single most frequently noted problem (12%) **[ref:all:4]**

Incidence of odour nuisance by latrine type

Table 5 below compares householder responses by latrine type for the question *'Does the toilet smell? How bad is this smell?*' It is important to note how few of the responses fall under the 'strong smell' category. What is unusual are the responses for both simple pits and VIP latrines; with the former registering larger percentages under 'no smell' and smaller percentages under the 'slight smell' categories than the VIP latrine type. Previous assumptions about simple pit vis-à-vis VIP latrines would tend to question

Table 5: User perception of the incidence of odour nuisance, by latrine type

	Odour nuisance (% of cases)			
Latrine type	*Cases*	*No smell*	*Slight smell*	*Strong smell*
Bucket/pan	253	10	70	20
Simple pits	388	54	37	9
VIP	48	40	54	6
Pour flush	391	63	30	6
WC to septic tank	152	67	32	1
All latrine types		49	42	9

such a finding especially given that VIP latrines had been designed specifically to address the problem of odour nuisance. One possible explanation may be that the odour problems in VIP latrines are exacerbated by increased fouling around the squat hole due to the dark interior of the latrine.

Use of vent pipes

The study looked at VIP latrines with vent pipes in order to assess their effectiveness in controlling insect and odour nuisance. In general, the statements already made concerning user perception of odours and insects to some extent answer this question. Incorrect siting of the vent pipe below the roof level is assumed to reduce the efficacy of the vent. However, this research found no significant relationship between vent pipe height above (or below) existing roof level and perceived odour nuisance. **[ref:vip:28]** Similarly, crosstabulations between the incidence of insects in the latrine and the presence and condition of a fly screen failed to show trends which might indicate some relationship between the two variables. **[ref:vip:29]** Further analysis on odour nuisance based on vent pipe colour and diameter of vent pipe proved equally inconclusive. **[ref:vip:30-31]**

However, the sample size involved with VIP latrines was small (n=52) and the results must be interpreted with caution.

Tight fitting lids covering squat holes

It is difficult to suggest a causal link between the presence of lids and insect/odour nuisance given the multitude of variables which may affect user perception of nuisance (for example, the fact that in Mozambique there is no containment of insects / odour because the superstructures are not enclosed). However, where lids were recorded (in 345 cases), the trend is towards few cases of either 'strong' smell or large numbers of insects (either hundred or thousands) being reported. By contrast, where lids were absent (n=39) it was found that just over half of all latrine users recorded 'strong smell', and a quarter recorded 'hundreds' of insects. **[ref:simpit:29-32]** Just under two thirds of all cases reported lids 'not damaged' (61%); 37% 'partly chipped' and 2% 'badly broken'. For cases where lids were 'not damaged' or 'partly chipped', the largest percentages were found amongst those categories indicating no or low insect and odour nuisance levels (for example, 'no' or 'slight' smell, 'none' or 'tens' of insects). **[ref:simpit:33-34]**

Table 6: Incidence of insect nuisance by latrine type					
	Insect nuisance (% of cases)				
Latrine type	*Cases*	*None*	*Tens*	*Hundreds*	*Thousands*
Bucket/pan	194	20	68	10	3
Simple pits	378	46	46	8	1
VIP	30	40	50	3	7
Pour flush	386	71	24	5	0
WC to septic tank	127	79	21	0	0
All latrine types		54	38	6	1

Incidence of insect nuisance by latrine type

The figures for insect nuisance largely mirror those for odour. Again, the majority of cases are registered within the 'none' or 'tens' categories (92% of all cases); bucket/pan latrines show the highest nuisance scores, while water seal latrine types show the lowest nuisance scores (see table 6 above). VIP latrines record the highest rating amongst all latrine types in the 'thousands' category. Factors leading to increased light levels within the VIP latrine superstructure (such as small windows) may help to explain this poor rating.

The findings from the quantitative testing for numbers of insects contained with latrine superstructures tend to reinforce the results from the household survey about insect nuisance **[ref:insect:1]**. Just over two thirds of all cases sampled (n=71) recorded 0-5 insects, a further 27% cases recorded 6-50 flies, and only 7% recorded 51-100+ insects.

Latrines the primary source of insect nuisance on the household plot?

Anecdotal evidence from interviews with householders about the source of insect nuisance, especially with regard to flies, indicates that the latrine structure is not necessarily the primary source of insect nuisance on the plot. Other important sources include solid waste pits and lane side drains, which when full or blocked, quickly attract flies.

Absence of household latrines

Key findings

- A key reason for the lack of household latrines is poverty, rather than lack of available space on-plot. Poverty, and/or the inability to save funds to invest in longer term sanitation facilities are key constraints
- The relationship between cost, technology choice and income level is a complex one, which defies simple categorisation. There is some evidence to suggest grouping of unskilled employment for those households without sanitation, although this does not remain consistent for lower cost latrine types. Similarly, skilled sources of employment are not the sole source of employment with higher cost latrine types. Choices about sanitary technology are based on a variety of factors, of which cost is just one (important) consideration

Background

In the urban context, the factors which determine whether sanitation facilities are present or absent from the household plot are diverse, including issues such as poverty, cost of technology, available space, indebtedness and problems with operation and maintenance. Available literature emphasises the importance of the lack of space in the urban environment as a key feature explaining absence of household sanitation.

Plot size a determinant of absence of household latrine

As mentioned on page 82, criticism of pit latrines focuses on their supposed inappropriateness for small plot sizes. Results from the household survey indicate that for the users, absence of a household latrine is more a function of poverty than available space on the plot. When answering the question, '*Why is there no household toilet?*', the single largest responses from users recorded 'high cost'; and 'use public latrines', factors directly or indirectly linked to income. 'Lack of space' figured only as the third most important response. Poverty may lead householders to prioritise the use of what space they have on plot to other functions, not consistent with sanitation.

Figures from the postal survey of sector professionals tend to reinforce these findings, with cost being cited as the single most significant factor. Combinations of cost and lack of space are also frequently noted. **[ref:post:4]**

Relationship between cost, technology choice and income level

Table 7 shows the outcome when sources of household income are disaggre-

Table 7: Rank order of main household source of income, by technology type

	Latrine type					
Rank	*Septic tank*	*VIP*	*Pour flush*	*Simple pit*	*Bucket*	*Absent*
1	Trader	Trader	Labourer	Labourer	Trader	Trader
2	Labourer	Clerk	Mechanic	Trader	Unemployed	Labourer
3	Retired	Retired	Trader	Clerk	Retired	Fisherman
4	Civil servant Clerk Mechanic	Civil servant	Civil servant	Civil servant	Clerk	Unemployed
5	Unemployed	Student	Rail employee	Mechanic	Seamstress	Mechanic

gated by technology type and ranked in order of sample size. Rather than asking the monetary value of a householders income, which would have introduced sampling bias to the results, proxy indicators of income levels were used, in this case, the main source (or profession) which accounted for household income. It is possible to group these professions by type, such as unskilled, semi-skilled and skilled and in this way reach a better idea of the relationship between cost, technology choice and income. Intuitively, it could be argued that given the higher capital costs of particular latrines types (i.e., septic tanks and VIP's), there will be a general trend towards higher income sources of employment being associated with those technology types. Conversely, those households without latrines, or latrines with lowest capital costs, would be assumed to draw on unskilled sources of employment.

What the figures above show is that the situation is much more complex than anticipated. What is observable is that for those households which have no sanitation facility, there is a significant grouping of unskilled jobs which form the basis of household income. This tends to reinforce the findings from the household survey that poverty is one of the key reasons for absence of domestic sanitation. However, the same cannot be said for lower cost types such as bucket/pan latrines or simple pits which have a mix of both unskilled, and skilled sources of employment. Although some grouping of employment types can be identified amongst septic tanks and VIP latrines, the mix of sources is clearly apparent.

This would tend to indicate that there is no strong relationship between cost, technology choice and income, and that technology choice is influenced much more by other factors, such as socio-cultural features. It is also implicit that the householders were able to exercise a choice over their technology, which previous sections (Section B) have shown not necessarily to be the case.

Unsupported initiatives

Examples of households which have provided sanitation facilities outside of existing latrine building programmes are informative in that they may indicate reasons for failure to adopt the programme or highlight particular constraints to potential users of those systems. Householders perceptions about sanitation programmes are critical factors to note. Case study work points to the importance that householders attach to maintaining choice and quality of the latrine type they use (see case study 14 below), despite additional cost considerations to the householder.

Case study 14: Example of unsupported initiative for sanitation provision

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District: *Ranigaratoth*
City: *Vijayawada, India*
Family size: *4 adults, 2 children*
Income earners: *3 (Husband Rs. 50- per day)*
Occupation: *Labourer/vegetable vendor*

Notes: This family had been previously relocated from an old bustan site to this district. They had built their own home and provided many of their own services with only limited government assistance. They decided to construct their own latrine (outside of the Municipality's low cost sanitation programme) because they perceived problems with the programme's toilets, and did not want to wait for a new latrine construction programme before being able to use their own facility.

The family perceived that the key disadvantage with the programme's toilets was the need for regular pit emptying, so they constructed a [deep] pour-flush single pit. This facility was built at a time when other construction work was on-going, so exact costs were unavailable - however, in conversation with the householders it was estimated that the total cost (including labour) was Rs 5000. A small contractor was employed to build the latrine, and the family

saved money from their joint incomes to build the facility. For ten years prior to having a household toilet, the family had resorted to open defecation at a point approximately 200 metres distant. The principal catalyst for latrine construction had been the comfort and convenience it would provide for the users.

User satisfaction

Key findings

- Householders decisions to invest in domestic sanitation are typically driven by socio-cultural rather than health factors
- In all but one case, users express high degrees of satisfaction with their latrine (in excess of 80% recording 'satisfied' or 'very satisfied'). Bucket/pan latrines record by far the highest levels of dissatisfaction
- Many users do not perceive there to be a problem with their latrine. Where problems are recorded, the most common include 'emptying', 'smell' and 'insects', although absolute figures are low
- Of these three problems, 'emptying' and 'smell' have the most impact on satisfaction levels and ability for the user to use the latrine

Background

There is little available literature on user perceptions of latrine operation in urban areas, or on changes in attitude caused by problems with operation and maintenance.

Perceived user benefits of sanitation

As a proxy indicator of perceived benefits of sanitation, the household survey asked each family, '*Why did you build a toilet on your plot?*'. The results tend to reinforce the finding that socio-cultural, rather than health factors dominate user decisions to invest in domestic sanitation facilities. Factors including 'comfort and convenience' and 'privacy' account for just under half of all responses (48%). 'Health' accounts for 11%, and other significant minorities include 'government sponsored' (8%), 'no/poor public facilities' (5%) and a combination of comfort/convenience and privacy (5%) **[ref:all:5]**

Expressed levels of user satisfaction

Table 8 shows the aggregated responses to the question, '*How satisfied are*

Table 8: Levels of expressed user satisfaction by technology type					
	Levels of user satisfaction (% of cases)				
Type	*Very satisfied*	*Satisfied*	*Neither*	*Unsatisfied*	*Very unsatisfied*
Bucket/pan	4	29	19	44	4
Simple pit	22	68	3	6	1
VIP	17	67	6	8	2
Pour flush	10	73	4	8	5
WC septic tank	22	68	3	4	3

you with your toilet?'. The results indicate high levels of expressed satisfaction (83% or more recording 'very satisfied' or 'satisfied') for five of the six latrine types listed. Only bucket/pan latrines show significant levels of dissatisfaction, with just under half of all cases listed as 'unsatisfied' or 'very dissatisfied'.

Problems with operation and maintenance of latrines
In response to the question, '*What problems do you have with your toilet?*', it was significant that in over half of all cases (54%) there were 'no' problems with the latrine. Where problems were recorded, difficulties with 'emptying' were the most commonly noted minority (12%), with 'smell' and 'insects' recording 7% and 4% respectively. **[ref:all:4]**

Table 9: Most commonly noted problems with latrine by technology type							
	Problems with latrine (% cases)						
Type	*None*	*Smell*	*Insects*	*Emptying*	*Repairs*	*Blockage*	*Lack water*
Bucket/pan	20	4	1	42	–	–	–
Simple pit	73	7	2	1	7	–	–
VIP	52	4	6	8	–	4	–
Pour flush	59	12	8	4	2	5	–
WC septic tank	54	3	5	12	1	5	12
All	54	7	4	12	3	3	2

Table 9 carries a comparison of the most frequently noted problems by technology type. This table reflects the overall picture noted above. An important aspect to note is the high percentages recorded under 'none' for five of the six latrine types tested, with only bucket/pan latrine types recording less than 50% in this category. Additionally, the percentages recorded for smell and insects are relatively small, as compared against those recorded for emptying.

When examining individual technology types several points of interest are observable:

- Simple pit latrines record the highest percentage figures of all types under the 'none' category; and VIP latrines record the second lowest;
- That pour-flush latrines, even with their waterseal, record insects and odours as amongst the most commonly noted problems. However, only 36% of users perceive this odour nuisance to be greater than 'slight';
- Bucket/pan latrine users frequently record 'emptying' problems;
- 'Lack of water' is only mentioned in relation to WC to septic tanks.

What the above comparison does provide is an indication of the relative problems experienced by users of individual technology types, but what is not clear is the impact that these problems have on the user's satisfaction of their latrines. Crosstabulations between these two variables are informative in that they indicate which of the above problems have the strongest impact on satisfaction levels. Examining the percentage of cases that fall in the two most dissatisfied categories (see Table 10) indicates that of the six most

Table 10: Crosstabulations between recorded problems and user satisfaction

	% of all cases				
Problem	*Very unsatisfied*	*Unsatisfied*	*Neither*	*Satisfied*	*Very satisfied*
Smell	0.3	1.6	0.6	4.5	0.2
Insects	0.1	0.1	0.1	3.7	0.3
Emptying	0.1	4.6	2.1	4.6	0.6
Repairs	0.1	0.3	0.1	1.8	0.5
Blockage	0.1	0.4	0.4	1.5	0.3
Lack water	0.2	0.5	0	0.9	0.3

Table 11: Crosstabulations between recorded problems and perceived impact on use of latrine

	Impact on use of latrine (% of all cases)				
Problem	*No impact*	*Slight impact*	*Moderate impact*	*Strong impact*	*Cannot continue to use*
Smell	3.7	2.5	0.4	0.5	0.4
Insects	3.7	0.5	0.2	0	0.1
Emptying	1.8	5.4	2.1	2.1	0.6
Repairs	0.7	1.7	0.4	0.1	0.1
Blockage	0.3	1.6	0.1	0.1	0.7
Lack water	0.1	1.3	0.3	0.2	0

prominent problems listed in Table 9, only 'emptying' and 'smell' impact significantly on dissatisfaction levels (defined here as larger than 1.0% of all cases).

Crosstabulations between recorded problems and their perceived impact on continued use of the household latrine reinforces this point. Of the problems identified, only 'emptying' and 'smell' account for a cumulative figure of more than 1% of all cases in the three categories indicating more than a moderate impact on continued use of the latrine, as table 11 illustrates.

Latrine emptying

Key findings

- Manual methods of emptying dominate, and are especially commonplace for simple pit and pour flush latrines. As expected, mechanical emptying tends to be associated with VIP and septic tank latrines
- The responsibility for emptying latrines is normally either that of the users, or contractors. Contractors are of particular importance in the emptying of bucket/pan and pour flush latrines
- For those latrines which had been emptied, most had been used for 6, 7, or 8 years. Typically, these latrines had been emptied either once or twice
- Rates for re-filling of previously emptied latrines indicate that the majority fill over 3-6 years
- Where users expressed a problem with emptying, frequency, cost and hygiene were ranked as the three most important issues
- In the majority of cases, the final disposal site for collected excreta was either unknown or indiscriminate dumping

Background

When pit latrines or septic tanks become full, they must be either taken out of use and a new pit dug, or the pit/tank emptied. The practice of emptying pits by hand can present serious health hazards if the faecal matter has not been rested for at least two years. Where suitable equipment is available, lined pits can be mechanically emptied, although there are serious limitations presented by densely crowded urban areas and access to plots and the cost involved in using vacuum tankers.

How latrines are emptied

Results from the household survey indicate that where latrines are emptied, the most common practice is for manual emptying either by hand or with handtools. In response to the question, *'How is the pit / tank emptied?'*, just over one third (37%) of all households employed manual forms of emptying, with only 9% favouring vacuum tankers. Significantly, just over half of all responses (53%) replied that the household latrine had not been emptied. **[ref:all:6]**

Which types of latrines are emptied by what method?

Table 12 compares latrine type by emptying method. The results tend to confirm that for bucket/pan, simple pit and pour-flush latrine types that

Table 12: Comparison of latrine types and emptying method					
	Emptying method (% of cases)				
Type	*Manually by hand*	*Manually with handtools*	*Vacuum tanker*	*Other methods*	*Not emptied*
Bucket/pan	100	–	–	–	–
Simple pit	6	1	4	1	87
VIP	2	25	35	4	35
Pour flush	14	21	–	–	64
WC septic tank	7	5	50	–	37

manual emptying methods dominate. The large percentage figure recorded for vacuum tankers under WC to septic tanks is to be expected. Interestingly, the relatively low percentage figures for 'not emptied' suggest a more frequent emptying rate for VIP's and WC's to septic tanks as compared to other latrine types, a fact borne out in the analysis of re-emptying rates.

Who does the emptying?

If manual methods tend to dominate latrine emptying, who actually empties the pit/tank, and who pays? The household survey asked the question, *'Who is responsible for emptying the pit/tank?'* and the general findings show that users were normally those responsible for this process (45%), with contractors and the municipality recording 35% and 18% respectively. **[ref:all:7]**

There is significant variation by type however, as table 13 below illustrates. Unsurprisingly, the bucket/pan system records the highest figures for the use of a contractor, normally an individual drawn from the informal sector. The use of contractors for emptying in this case may be a legacy of the era in which a formalised system of emptying was in place with conservancy labourers removing nightsoil daily.

Two points of clarification are required in explaining table 13. Although a high percentage figure was recorded for 'user' in relation to emptying of pour-flush latrines, experience from India suggests that given the prevailing cultural taboo associated with handling faecal matter, almost all responsibility for emptying is that of contractors, typically 'scavengers'. Such a discrepancy may have arisen from the local translation of 'responsibility'

Table 13: Responsibility for emptying by latrine type

	% of all cases		
Type	*User*	*Contractor*	*Municipality*
Bucket/pan	29	63	8
Simple pit	67	19	14
VIP	20	26	54
Pour flush	81	12	8
WC septic tank	29	19	51

into Telegu. Secondly, to some extent this table may reflect the perceptions of householders as to who is responsible, rather than who actually performs the task of emptying. For instance, the responses for 'municipality' in relation to simple pit latrines and pour-flush latrines are not consistent with actual practice.

Length of time latrine in use

The length of time a latrine has been used by a household and the frequency with which it has been emptied is an important indicator of its performance and sustainability. For those latrines which were recorded as 'not emptied' from the household survey, breakdown of figures reveals that just under 60% had been used for between 1-10 years (with 40% falling in the 1-5 year category; 18% in the 6-10 year category).

Selected year by year breakdown is shown in table 14, and indicates a significant skewing towards years 1-3.

In those cases where latrines had been emptied, the majority (88%) had been emptied between 1-6 times. Of these, most latrines had been emptied either

Table 14: Breakdown of number of years latrine in use recorded as not emptied (selected years: 1-10; excluding bucket/pan latrine)

	Years in use (% of all cases)									
	1	2	3	4	5	6	7	8	9	10
Not emptied	11.8	9.8	8.9	5.3	4.1	4.9	5.4	2.8	1.8	3.2

Table 15: Breakdown of years latrines used by number of times emptied (excluding bucket/pan latrines)

	Years in use (% of all cases)										
Times emptied	1	2	3	4	5	6	7	8	9	10	Total
1	1.5	3.0	1.5	2.0	3.0	4.5	6.5	6.0	1.5	5.0	34.5
2			1.0	2.0	2.0	2.5	2.0	2.0		1.0	12.5
3	0.5		1.5	1.0	0.5	0.5	1.0	1.5		0.5	7.0
4			0.5	0.5		1.0	0.5				2.5
5			0.5								0.5
6		0.5	0.5			1.0			0.5	0.5	3.0
Total	2.0	3.5	5.5	5.5	5.5	9.5	10	9.5	2.0	7.0	

once or twice, with most being used for between 6-8 years (see table 15 above). These figures question the assumptions made about the high frequency of latrine emptying in low income urban areas and the short time period between initial use and first emptying.

Re-emptying periods

Householders were asked, '*How long does it take for the pit/tank to require emptying again?*'. The responses are indicative of the rate at which a recently emptied pit/tank fills again. Professionals assumptions in this area tend towards short re-emptying periods. However, this research indicates that for both simple pit and pour-flush latrine types longer refilling periods (typically

Table 16: Breakdown of re-emptying period by latrine type (excluding bucket/pan latrines)

	Time taken for pit to refill (m = months / y = years) % of cases								
	3m	4m	6m	1 yr	2 yr	3-4 yr	5-6 yr	7-9 yr	10-11 yr
Simple pit	3	6	12	13	7	22	19	4	8
VIP	–	–	42	21	21	8	4	–	4
Pour flush	–	–	1	10	21	32	27	–	–
WC septic tank	9	3	23	13	19	30	4	–	–
All	3	2	7	6	8	12	8	1	2

3-4 and 5-6 years) are commonplace, whereas VIP and WC to septic tank types record larger percentages in the 6 months, 1 and 2 year categories (See table 16).

When examining the combined figures for all latrines, there are two points to note: the 20% of all latrines emptied with refill periods of between 3-6 years, and the relatively high proportion of all latrines recording refill rates of every 6 months, 1 or 2 years (21%). These latter figures may well be skewed by the impact of both VIP and WC to septic tank latrine types recording relatively large percentages between the 6 months - 2 years categories.

Problems with emptying

An earlier section of this report has already noted that 'emptying' constituted the single most common problem noted with all latrine types (see page 92and table 9) and was one issue which significantly affected user satisfaction of latrines (see page 92 and table 8). Paradoxically, when householders were asked, *'What problems do you have with pit/tank emptying?'*, 45% of all cases recorded 'none'. Where problems were noted, the most significant issues included 'frequency', 'high cost' and 'hygiene'. Other factors which might have been assumed to have been of importance, such as 'access to plot' or 'odour', recorded only 3% and 0.5% of all cases respectively.

A clearer picture of why 'frequency' heads this list is seen in the table below, comparing latrine type with emptying problem. The frequency of emptying for bucket/pan latrines is clearly the most significant factor for this type and skews the overall figures as a result. It is clear that the cost of emptying is a

Table 17: Type of emptying problem by latrine type

	% of all cases					
	High cost	*Frequency*	*Hygiene*	*Access*	*None*	*Others*
Bucket/pan	9	46	3	–	38	5
Simple pit	28	17	–	3	50	2
VIP	45	–	–	–	45	10
Pour flush	29	5	14	4	46	2
WC septic tank	12	5	1	11	60	11
All	19	21	6	3	45	

key problem more consistently noted by all latrine types, particularly with regard to the VIP, pour flush and simple pit latrines.

Disposal of pit contents following emptying

The final destination of emptied pit excreta and its disposal method is critical to maintenance of a community's health. As a means to establishing emptying outcomes, the household survey asked, *'What happens to the contents of the pit/tank after emptying?'*. The figures tend to show that in the majority of cases the final destination of pit excreta is 'indiscriminate dumping' or 'unknown' (accounting for 34% and 33% of all cases respectively). A significant minority (24%) reported that pit contents were disposed of hygienically off-site (though few householders could say where these site were), and only 8% replied that contents were buried on-plot. **[ref:all:7]**

Double pit latrines

Key findings

- Need for more frequent user support and education activities to be made available
- Construction related problems were infrequently noted by users. Of greater concern were correct operation and maintenance of twin and double pit latrines

Background

There are occasions when two shallow pits may be more appropriate than a single deep pit, such as in cases where the underlying geology of an area is difficult to excavate, or where groundwater levels are within one or two metres of the surface. In alternating double pits, accumulated solids in one pit are left for a 'safe' period until the excreta has decomposed and can be handled without health risk. During the resting period, the alternative pit is used by the household. Where separate twin pits are used as with pour-flush latrines, a Y-junction and access chamber are constructed to allow the users to direct excreta from one pit to another.

Concern about twin and double pits has focused on construction related and operational problems. For correct operation of double pit offset pour-flush

latrines, for example, particular care has to be taken with the construction of the Y-junction, and the user must be made aware of how the latrine should be operated. Longer term support facilities, training and demonstration of operation are key elements to operational success.

Construction related problems

This research indicates the primacy of operation and maintenance, over construction related problems with this latrine type. The household survey found that users of twin or double pit latrines did not rank construction related problems as a key concern. The most relevant construction related problem, 'blockages', accounted for only a minority of cases for both pour-flush twin pit latrines (5%) and double VIP latrines (4%).

Although drawn from an admittedly small sample (n=57), postal survey results tend to confirm this point, showing that 'construction related' problems accounted for only 3% of all problems found amongst double pits. Of much greater significance were factors relating to the correct operation and maintenance of double pits, including both pits being used at the same time / pits not rested (28% of all problems). **[ref.:post:3]**

Some anecdotal evidence during fieldwork indicated that the blockages recorded in some double pit latrines were attributable to the use of high density plastic (HDP) pans which were not as efficient at transporting flushed excreta as ceramic pans.

Inadequacy of education and support for users

The key position of operation and maintenance related problems points to the need for a more effective and sustained procedure of user education and support. Although in the programmes studied for this research, householders were given a practical demonstration of how the pour-flush latrine works, how to recognise when a pit is full and the method to alternate from one pit to another, this failed to address a wider problem that the existing procedure of demonstrating latrine operation had been tied to the masons who originally constructed the latrines. When new owners or tenants moved onto the plot, no framework for provision of guidance was available. Training and support for scavengers on latrine use may help to mitigate this problem.

Groundwater pollution

Key findings

- Determining the movement of viruses and bacteria in soils is extremely difficult, and involves a complex interaction of soil profile and hydraulic conductivity parameters, temperature, soil pH, moisture retention capacity. The clay content of the unsaturated zone is amongst the single most important indicator of the likely mobility of contaminants and its subsequent impact on groundwater pollution
- Larger sized contaminants (helminths and protozoa) are normally effectively removed by physical filtration; bacteria are normally filtered by clayey soils. Of most concern are waterborne viruses which are too small for even fine grained clays to filter
- Viruses *normally* die-off within three metres of the pollution source, irrespective of soil type. Bacterial contamination is *normally* removed given sufficient depth of unsaturated soil (at least 2 metres) between the pollution source and water point. A minimum distance of 15 metres between a pollution source and a downstream water point is sufficient for removal of all contaminants
- Health risks associated with groundwater pollution should be set against the much greater hazard of open defecation. The potential for groundwater pollution from pit latrine systems should not be used as the sole argument for not installing these systems

Background

A problem that is noted in relation to on-plot sanitation is the potential for pollution of groundwater that is associated with these systems. Contamination from on-plot systems can be categorised as follows:

Microbiological contaminants: liquids percolating into the soil from latrine pits or septic tanks contain large numbers of micro-organisms of faecal origin, including viruses, bacteria, protozoa and helminths.

Chemical contaminants: including nitrogen and phosphorus. Chemical pollution extends much further than pollution by micro-organisms. In areas with high pit latrine densities, nitrate concentrations may build up to in excess of World Health Organisation (WHO) drinking water guidelines. The main health hazard in such an event is 'blue baby syndrome' or methaemoglobinaemia, when milk powder is mixed with contaminated water and fed to young infants. If left untreated, this can prove fatal.

Thus, groundwater under or near pit latrines may become polluted which can

be a serious problem when it affects the quality of drinking water drawn from wells and boreholes. Water in leaky pipes may also be contaminated if the pressure drops and polluted groundwater levels are above the pipes.

A particular problem in densely populated urban areas is the possible proximity of latrine pits and shallow wells on neighbouring plots. Whilst the levels of service for water supply remain poor, many urban dwellers are likely to use a nearby shallow well if the groundwater table is sufficiently high. The lack of effective urban development planning control means that it is very difficult to regulate and enforce the relative location of latrines and wells on plots, even in formally developed areas.

All types of sanitation pose a pollution threat of some kind. Fourie and Ryneveld (1995) argue that when considering pollution from on-plot sanitation, there are three primary aspects to consider:

1. That human excreta contains a number of different possible contaminants
2. That at sufficiently high doses, these contaminants are potentially hazardous to human health and or the natural environment
3. In order for a dose to be transmitted to a host, the contaminants must be sent by one route or another from the source to individuals or to the environment

A key route to transmission is the subsurface, hence a clear understanding of contaminant movement and the factors which affect it is critical to the development of guidelines for minimising pollution risk to groundwater sources from these sanitation systems.

Literature review: key points

General contaminant movement

- On reaching the groundwater table, the rate of contaminant movement will be much greater than in the unsaturated zone, and this movement will be in the direction of the regional groundwater flow;
- The presence of macropores in the soil (caused by channels formed from decomposed roots, or rock fissures) may significantly increase contaminant movement;
- Studies by Sengupta (1996) indicate that contaminant travel is higher in sandy soils than in clayey silt or silty clay soils;
- An understanding of the physical and chemical processes that remove

contaminants from water during movement through the subsurface is important in understanding whether influent from a particular latrine will pollute a drinking water source;
- The movement of contaminants through the subsurface is affected by processes which may affect the concentration and composition of the contaminants;
- It is unclear to what extent nitrate can be denitrified in the soil to produce nitrogen gas which will escape into the atmosphere.

Microbiological contamination

- The mobility of the four principal microbiological organisms (viruses, bacteria, protozoa and helminths) is affected by both their physical size and chemical/other processes.
- Larger sized contaminants (helminths and protozoa) are normally effectively removed by physical filtration by soil adjacent and below the pollution source; bacteria are normally filtered by clayey soils. Of most concern are waterborne viruses which are too small for even fine grained clays to filter. Effective physical filtration is highly dependent on the particle size of the soil, with well-graded soil being the most effective filter.
- Chemical processes such as adsorption (whereby foreign bodies become attached to the surface of the soil, thus reducing the free energy of the surface) are critical to effective virus removal in the subsurface region, and tends to be most effective where pH levels are low (Stumm & Morgan, 1981). Since adsorption is unlikely in already saturated soils, maximising residence times in unsaturated zones is a key factor to removal and elimination of these viruses.
- Adsorption of viruses is considered most effective in clayey soils (Drewry and Eliassen, 1968; Tim and Mostaghimi, 1991).

Chemical contamination

The contaminants of most importance in this category are nitrates and phosphates. The latter are removed by adsorption by almost all soil types (excluding coarse, clean gravels) within a short distance from the pollution source.

- The removal of nitrates in the subsurface is dependent primarily on microbiological rather than physical processes.

Hydrogeological factors affecting movement of contaminants

- The permeability of a soil between a pit and the groundwater level is a key factor in determining the possible contamination of groundwater from such sources.
- Not all soil profiles are uniform; most are heterogeneous, and may have different hydraulic conductivities in both vertical and horizontal directions.
- There is significant difference of opinion between sector professionals as to what constitutes the ideal soil for minimising contamination from on-plot sanitation facilities. Some (Romero, 1972; Fekpe et al, 1992) express a preference for free-draining soils (such as coarse sands). This conflicts with other researchers (Taussig and Connelly, 1991; Lewis et al, 1980) who argue that fine, graded soils, with a thickness of 2-3 metres, and clays, are more suitable.
- Subsurface flow of water is significantly affected by the presence of macropores in the soil profiles. Highly fractured bedrock close to, or at the soil surface, for instance, will facilitate contaminant movement to groundwater levels.

Movement of viruses, bacteria and nitrates

- For viruses, the bulk of existing literature indicates almost complete die-off within three metres of the pollution source, irrespective of soil type. In a study by Gerba et al, 1975, all but one virus type indicated travel distances for viruses of less than one metre. Lower rates of virus removal are achieved in coarser soils. In fast flowing groundwater conditions however, pollution may travel up to 25 metres (Caldwell, 1937).
- With bacterial contamination, existing literature indicates that given sufficient depth of intact, unsaturated soil between the source of contamination and the groundwater, virtually all bacterial pollution should be removed. There is general consensus that 'sufficient depth' implies two metres, as long as the rate of effluent application does not exceed 50mm/day. In locations with intense rainfall, this distance may need to be increased as higher infiltration rates may carry polluted water further through the subsurface.
- It is generally agreed that a minimum distance of 15 metres between a pollution source and a downstream water point is satisfactory for the removal of contaminants.
- Determination of nitrate pollution should proceed from an initial assessment of background nitrate levels, since contamination can be derived

from a number of sources other than on-plot sanitation systems.

- Literature indicates that the key condition for minimising nitrate contamination of groundwater is to maximise its residence time in the unsaturated zone, which has a smaller hydraulic conductivity than the saturated zone and hence delays the time at which nitrates enter the saturated zone. Studies by Cochet et al, 1990 and Sikora and Keeney, 1976, suggest that it may be possible to alter the conditions of the unsaturated zone to some extent, increasing denitrification processes by adding carbon either to the soil surrounding the pit or soakaway, or the influent itself.

Relative health risks

The issue of groundwater pollution is essentially one of weighing relative health risks. The contamination of the surface environment through open defecation is the primary environmental concern since this has the greatest potential to transmit health hazards to the wider community. There are obviously health risks associated with groundwater pollution when communities are abstracting water from nearby shallow wells for domestic consumption, but these risks need to be viewed in perspective to the risks from faecal contamination at the ground surface.

Local solutions

Cotton (1997) argues that groundwater pollution can be dealt with in two ways: modifications to the sanitation system (i.e., soakpit surrounded by sand envelope), or through changes to the water supply system (i.e., establishing a reticulation system with standposts to reduce the need for using groundwater for domestic consumption). Other options for consideration include extracting water from a lower level in the aquifer, which is acceptable assuming low extraction rates and proper sealing of well casings as it passes through the pollution zone.

Section 2B
Sample characteristics (by technology type)

Absence of household latrine

Main points include:

- With regard to tenure status, there was an even split between tenants (45%) and landlords (52%). 3% of all cases defined as 'caretaker'.
- The number of people on-plot ranged between a minimum of 1, and a maximum of 94, the latter accounting for cases where several families reside within the same plot, typically in compound housing. The arithmetic mean figured at 17, the median figure is 14 and the mode 10.
- Of those cases where a response was provided (in 57% of cases), the majority (97%) claimed that no members of the household currently had diarrhoea.
- In just under one third of all cases (32%), no consumer items (defined as television, radio, iron, refrigerator, or other electrical goods) were identified by surveyors. The single most popular item, a radio, was found in 15% of cases, and in 27% both a radio and television were recorded. Households in which three or more consumer items were identified accounted for 21% of all cases.
- Household plot size (m^2) varied in range from a minimum of $11m^2$ to a maximum of $2700m^2$. The arithmetic mean figured at $466m^2$, with a median figure of $432m^2$ and a mode of $630m^2$.

Bucket/pan latrine

Main points include:

- Tenure status of households with bucket/pan latrines indicates that 46% are tenants and 53% are owners. 1% of all cases defined as 'caretaker'.
- Number of people on-plot ranges from a minimum of 1, to a maximum of 300. The mean number of individuals on-plot is 19, the median figure is 16 and the mode 15.
- In those cases where a response was provided (61%), 95% claimed that no members of the household currently had diarrhoea; 3% of cases recorded one individual with diarrhoea; 2% with two household members.
- The mean number of adults using bucket/pan latrines is 11; the maximum 38. Largest percentages were recorded amongst households with 8, 9 or

10 adults.

- In only 9% of all cases were households found to have no consumer items. A radio and television were the single most commonly recorded item (37%); a radio was identified in 13% of cases. Households in which 3 or more consumer items were identified accounted for 38% of all cases.
- 89% of all cases indicate a lid to bucket/pan is present (as a way of reducing odour and insect nuisance). In 91% of cases this lid was undamaged, forming a sound seal; the remaining 9% of cases were partly damaged, or chipped.
- Mean latrine superstructure size (m^2) is $2.5m^2$; median - $2.0m^2$ and mode, $2.0m^2$

Simple pit latrines

- Tenure status of households with simple pit latrines indicate that 31% are tenants and 64% are owners. 4% of all cases defined as 'caretaker'.
- Number of people on-plot ranges from a minimum of 1, to a maximum of 100. The mean number of individuals on-plot is 8, the median figure is 7 and the mode 6.
- In those cases where a response was provided (23%), 80% claimed that no members of the household currently had diarrhoea; 18% of cases recorded one individual with diarrhoea.
- The mean number of adults using simple pit latrines is 5; the maximum 33. Largest percentages found amongst households with 3, 4 or 5 adults.
- In one-third of all cases, households were found to have no consumer items. Radios were the single most commonly recorded item (47%); a radio and television were recorded in 17% of cases. Households in which three or more consumer items were identified accounted for 19% of all cases.
- 85% of all simple pits were estimated to have pit depth of between 3-6 feet; 11% 7-10 feet and 4% 11feet and deeper. The deepest pit recorded was 23 feet. Crosstabulations between depth of pit and users perception of smell failed to prove any statistically significant relationship between the two variables.
- 90% of all cases indicate a lid to the pit is present (as a way of reducing odour and insect nuisance). In just under two-thirds of all cases, this lid was undamaged, forming a sound seal; in 37% of cases the lid was partly damaged, or chipped, and in 1.5% the lid was badly broken. Crosstabulations between presence of lids to toilets and users perception of odour indicate a fall in cases between 'no smell' (52%) and 'strong smell' (4%).
- Mean shelter size (m^2) is $6.6m^2$; median - $6.0m^2$ and mode, $6.0m^2$.

Ventilated Improved Pit (VIP) latrines

- Tenure status of households with ventilated improved pit latrines indicate that 33% are tenants and 67% are owners.
- Number of people on-plot ranges from a minimum of 1, to a maximum of 120. The mean number of individuals on-plot is 19, the median 15 and the mode 10.
- In those cases where a response was provided (57%), all claimed that no members of the household currently had diarrhoea.
- The mean number of adults using VIP latrines is 11; the maximum 90. Largest percentages found amongst households with 5, 6, 7 or 10 adults.
- 15% of households were found to have no consumer items. 66% of households possessed both radio and television. Households in which 3 or more consumer items were identified accounted for 9% of all cases.
- 24% of all VIP latrines were estimated to have pit depth of between 4-6 feet; 68% 7-10 feet and 8% 11 feet and deeper. The deepest pit recorded was 28 feet.
- Mean shelter size (m^2) is $3.3m^2$; median - $2.3m^2$ and mode, $1.8m^2$.

Pour-flush latrines

- The sample shows that 95% of households were identified as owners, with only 5% tenants.
- Number of people on-plot ranges from a minimum of 2, to a maximum of 20. The mean number of individuals on-plot is 8, the median 7 and the mode 5.
- In those cases where a response was provided (68%), 99% claimed that no members of the household currently had diarrhoea.
- The mean number of adults using pour flush latrines is 5; the maximum 20. Largest percentages found amongst households with 2-6 adults.
- 38% of households were found to have no consumer items. 28% of households possessed a television, 23% both radio and television and 10% a radio.
- 73% of all pour flush latrines were estimated to have pit depth of between 4-6 feet; 20% 7-10 feet and 5% 11 feet and deeper. The deepest pit recorded was 13 feet.
- Mean shelter size (m^2) is $1.5m^2$; median - $1.0m^2$ and mode, $1.0\ m^2$.

WC to septic tanks

- The sample shows that 54% of households were identified as owners, 44% as tenants and 1% as caretaker.
- Number of people on-plot ranges from a minimum of 1, to a maximum of

80. The mean number of individuals on-plot is 12, the median 9 and the mode 4.

- In those cases where a response was provided (57%), 99% claimed that no members of the household currently had diarrhoea.
- The mean number of adults using WC to septic tanks is 9; the maximum 65. Largest percentages found amongst households with 3, 4, 5 and 6 adults.
- A relatively small 15% of households were found to have no consumer items. 28% of households possessed a television and radio; and households in which 3 or more consumer items were identified accounted for 43% of all cases.
- Mean shelter size (m^2) is 2.1m^2; median - 2.1m^2 and mode, 1.8 m^2.

Section 2C
Database listing

Full copies of all data output referenced in this report can be obtained from the project authors.

This includes:

- Data output based on household surveys, postal surveys and field tests. This information is broken down by latrine type and country;

- Full text versions of semi-structured interviews. These include interview with:

  - MATTHEW ADOMBIRE; Acting Director (Planning and Development), GWSC; Ghana.
  - MARIA DOS ANJOS; Head of WSS department for MoH; Mozambique.
  - F N ARKO; Executive Secretary/Programme Manager, CEDECOM, Cape Coast, Ghana.
  - N A ARMAH; Chief Mechanical Engineer, Waste Management Department, Accra Metropolitan Assembly, Ghana.
  - FRANCIS AWINDAOGO; Regional co-ordinator GWSC, Tamale, Ghana.
  - DAN AYIVIE; Project Manager, Accra Sustainable Programme, Town & Country Planning Dept, Accra, Ghana.
  - EMMANUAL BAWA; Water and Sanitation Officer, UNICEF, Ghana.
  - BEN DOE; Project Manager, Accra Sustainable Programme, Town & Country Planning Dept, Accra, Ghana.
  - ODOUROI DONKOR; Project Officer, ProNet, Accra, Ghana.
  - LUIS ELIAS; Head of National Water Directorate, Maputo, Mozambique.
  - TAMALE SANITARY COMMITTEE OFFICIALS; Tamale, Ghana.
  - JOSE NAENE and HELENA COVANE; animators for Jorge Dimitrov and Urbanicazao districts, Maputo, Mozambique.
  - K RAJENDRA PRASAD; Deputy Executive Engineer, Vijayawada Slum Improvement Project, Vijayawada, India.

  - GANGADHARARAO MEKA; Assistant City Planner, Vijayawada Slum Improvement Project, Vijayawada, India.

- Video film of low income urban conditions in Ghana, Mozambique and India;

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Section 2D
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Section 2E
Annex

Total Annual Cost per Household

An extension of the least cost analysis approach is to consider the total annual cost per household (TACH) (Kalbermatten et al, 1982). TACH is calculated by considering the total present value (PV) of the life-cycle cash flow as the equivalent of a loan which has to be paid back over the design life of the system at constant, non-inflated prices. The value of yearly repayments, including interest, is obtained by mulitiplying the present value by a capital recovery factor. This factor is taken from capital recovery factor tables which are based on the equation:

Capital recovery factor

$$= \frac{r(1 + r)^t}{(1 + r)^t - 1}$$

where

r = discount rate

t = design life in years