Features of water supply and sanitation in developing countries

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Introduction

1. Meeting basic needs in water supply and waste disposal is the daily provision of between 20 and 50 litres per person of safe and convenient water for drinking, food preparation and personal hygiene, together with adequate and safe means of excreta and personal hygiene, together with adequate and safe means of excreta and wastewater disposal. There are some 1 500 million people (the urban and rural poor) in developing countries (excluding China) whose basic needs are not met. The UN General Assembly has declared the 1980s as a decade during which a real and substantial effort should be made to meet these needs.

2. In 1976 the World Bank, aware that the benefits of its lending program in the water supply and sanitation sectors were not reaching the urban and rural poor, undertook a two year research program into appropriate technologies for low cost water supply and sanitation in developing countries. The results of this research program (Ref. 9) show that low cost technically viable alternative technologies to conventional water supply and sewerage do exist and that these technologies can have a public health impact similar to that of conventional approaches.

3. Following this research program, the United Nations Development Program (UNDP), as part of its preparations for the International Drinking Water Supply and Sanitation Decade (1981-1990), has sponsored a global project of demonstration programs in low cost water supply and sanitation in developing countries. Under this project, which the World Bank is executing, the Bank established a Technology Advisory Group (TAG) in late 1978 to facilitate the design, implementation and monitoring of these demonstration programs in selected parts of the developing world.

4. This paper summarizes the sector background, highlighting some of the current TAG sector thinking and highlights areas of further applied investigation which have been identified by TAG.

BACKGROUND

5. Sanitation and water supply planning and development work in developing countries is set in a range of social, economic, demographic and climatic situations, wide variation in some aspects is contrasted by remarkable similarities in other aspects. These are highlighted in Table I, which shows for example Sudan with an area of 2,5 million km^2 and a population density of 7 persons per km^2 contrasted with Lesotho with an area of 30 000 km^2 and a population density of 43 persons per km^2 (the U.K. has an area of 244 000 km^2 and a population density of some 246 persons per km^2). The countries have largely rural populations (generally over 85 % rural) and a low per capita Gross National Product (GNP) of under US $ 500 per capita (the U.K. per capita GNP was US $ 5 000 in 1978).

6. Life expectancy is generally under 50 years with much of the population undernourished, and generally with poor curative and preventive medical facilities. The infant mortality rate is generally greater than 120 per thousand live births and in a few countries greater than 180 per 1 000. This human misery and sadness which this brings has a serious debilitating effect on society as well as on individual families. Between 40 % and 50 % of the population is under 14 years of age, with fewer than 5 % at primary school; adult literacy is low (generally under 40 % literate). The position is summarized in Table II.

7. Existing service levels of safe drinking water and adequate excreta disposal are variable but not particularly good as shown in Table III. Rural areas in particular have very poor water service levels and almost negligible excreta disposal facilities. In urban areas, service levels are highly skewed in favour of high income households who consume well above basic need levels and in many cases receive free, services for which the poor have either to pay or do not receive at all.

8. The countries are all low income countries. The outlook for improvement in per capita GNP, particularly when compared with the industrialised countries such as USA or the United Kingdom is poor, due to slow economic growth combined with high population growth; Figure I highlights this, showing the present and projected continued vast gap in GNP per capita between nations, while Figure II shows the considerable past and projected growth in population. A major feature of this growth has been the trend towards increased urbanisation as shown in Figure III; this trend is projected to continue such that typically in sub-Saharan Africa the estimated 1975 urban population of 80 million (about 21 % of total population) is expected to grow to over 259 million (about 40 % of total population) by 2000. The countries also have a variety of different religions, political, economic and socio-cultural environments which affect planning and implementation of water supply and sanitation programs.

DEVELOPMENT REQUIREMENTS

9. To overcome the existing very poor levels of water supply and sanitation services in the developing countries a range of technologies and "service delivery models" have been identified by the two World Bank executed programs discussed previously (Ref. 9, 13, 14, 15) which have been fairly widely reviewed; the major findings of these reviews are that there is a wide range of affordable, appropriate and acceptable technologies available (but in many cases poorly developed) which can give adequate levels of service.

10. Water supply technologies include not only individual piped and metered house connections (costing typically $ 120 per capita) but also

- yard taps,
- communal stand posts (Figures IV & V)
- deep well and shallow well hand pumps (costing typically $ 25 per capita - Figures VI and VII) and
- wells.

11. Sanitation technologies (for excreta disposal) do not, as is still widely believed by the professions, consist of either waterborne sewerage, bucket latrines or nothing; a range of other sound systems is available including

- Ventilated Improved Pit Latrines (VIP latrines - See Figure VIII)
- Pour Flus (P.F.) latrines (See Figure IX)
- Sewered Pour Flush latrines
- Communal latrines
- Septic tanks
- Aquaprivies and
- Waterborne sewerage.

12. Figure X shows a generic classification of Sanitation Systems, and Table IV shows a detailed cost comparison of the technologies which highlights the high per-capita cost of waterborne sewerage compared with other options, and emphasizes the importance of affordability.

LIKELY SANITATION OPTIONS

13. Excreta disposal systems need to be technically appropriate, financially affordable and socially acceptable. From the work done on recent program development, there are two particularly attractive solutions to excreta disposal which meet this criteria: These are the VIP latrine and the PF latrine, both using alternative pit technology (see Figures VIII and IX). They are suitable for both urban and rural developments; when the first pit is filled, it is rested to allow for pathogen decay (see Ref. 9) while the second pit is used. When the latter is full, the first pit is emptied (after a period of at least 2 years) and the resulting humus (which has been formed by microbial action) can be safely removed and used for soil conditioning or agricultural fertilizer. The first pit is then used while the second pit rests and the contents biograde. The cycle continues. No further treatment of the humus is required; and the systems can be used in high density situations; pits are not continually excavated and reexcavated, which would be both expensive and cause household decommitment.

14. Both systems use the soil as a receiving body for liquids; P.F. are latrines which have twin leaching pits, are particularly suitable where personal ablution is with water as is done in Muslim and Hindu cultures (typically 4 to 6 l.c.d is generated) and VIP latrines where dry materials are used for cleansing. This implies (particularly for the PF latrine) that the soil must have leaching capacity.

15. In parallel with excreta disposal, provision must be made for sullage disposal; this would be to either a soakway disposed of in the yard, to a stormwater drain or into gardens. (Sullage management is often overlooked in development projects; it can cause major health problems by providing insect vector breeding sites).

16. In situations of very high density, poor soil absorption capacity or once water consumption rises (with income level) to exceed soil absorption capacity an alternative system is the piped PF latrine; liquids (from excreta, ablutions, flushing and sullage) which would normally leach into the soil are carried to treatment in shallow flat sewers which have widely spaced manholes.

17. The order of magnitude of investment required to meet the current broad service goals in developing countries is considerable; estimates vary widely and depend on the technical and institutional models adopted. The table below gives an indication of the required investment.

TABLE 17.1

1/&2/

Estimates of Investments Required to Meet Current Service Deficits of Water Supply and Sanitation in Developing Countries

			CASE 1			CASE 2		
		Unit Cost $/cap.	Pop. Served %	No. (mill.)	Cost $ US (bill.)	Pop. Served %	No. (mill.)	Cost $ US (bill.)
Urban Water Supply	hc	120	70	447	53.6	40	255	30.6
	stp	40	30	191	7.6	40	255	10.2
Sanitation	sew.	250	40	260	65.0	25	163	40.0
	sept.	100	40	260	26.0	15	98	9.8
	Lat.	30	20	131	3.9	40	260	7.8
Sub Total Urban					156.1			98,4
Rural Water Supply	hc	150	20	313	46.9	10	157	23.6
	stp	40	40	628	25.1	30	471	18.8
	hc	25	40	628	15.7	40	628	15.7
Sanitation	sew.	250	20	335	83.8	10	167	39.2
	Lat.	20	80	1338	26.8	70	1171	23.4
					198.3			120.7
TOTAL URBAN AND RURAL					354.4			219.1

1/ It should be noted that 100 % urban coverage using water supply house connections and sewerage only (i.e. no appropriate technology) would cost $ 329.4 billion rather than the $ 156.1 billion calculated with a mix of technologies.

2/ Software costs are not included in these estimates.

3/ SOURCE: Ref. 16.

4/ hc. = house connection
sew. = sewered
lat. = latrine
stp. = standpipe

18. It should be noted that these estimates exclude both sullage disposal and the "software" required to ensure sound program delivery and development together with long term maintenance; the investment implication of these inputs are considerable. They also exclude the capitalized value of operations and maintenance costs. Annex I shows details of these estimates.

19. Work undertaken in the water and sanitaion sector over the past 18 month has raised a number of issues of note and identified areas in which further applied reaserch is required.

ISSUES OF NOTE

Manpower development and training

20. Sound manpower development and training programs have long been recognized as crucial for economic growth and development in developing countries. Low cost sanitation developments are still in the formative stages; training and information dissemination is therefore essential at all levels. Decision makers, planners and engineers need orientation, technicians and operators need to be trained and householders need orientation, technicians and operators need to be trained and householders need to be informed; the impact of this on project costs is substantial however and could often best be borne by central government.

Self-Help

21. "Self-help" 1/ which (together with "community participation") has tended to become the development planner's surrogate for sound programme design has a major role in sanitation programme development. The two major objectives of self-help are:

- to reduce system costs by having the householder undertake part of system construction, operation and maintenance; and part of system construction, operation and maintenance; and

- to achieve householder commitment through involvement, thereby improving the chances of adequate system usage and maintenance, thereby realising investment benefits.

22. Numerous self-help orientated programmes have experienced implementation problems principially due to insufficient technical support thereby stretching householders beyond their capability. In these situation the waste of resources and squandring of householder goodwill will have a long term detrimental impact on sector development.

23. In many countries the traditional method of trying to improve low cost sanitation has been for the Health Ministry to verbally exhort householders to build latrines; in a few countries, sketches are provided (generally very poorly ' engineered ' structures) after which the householder is left to his own devices with no access to technical backing, materials purchasing or financing. Latrines, when built, often collapse; in some cases children fall into the pits.
What is needed in reality is sound, well-illustrated designs (bearing in mind adult literacy rates) preferably modelled in 3 dimensions, together with access to building materials, tools, low level technical assistance, finance and supervision. The level of input required will clearly vary in each country and programme. It is crucial to seccessful program development that self-help is not stretched beyond its capability, and that the correct level og resource support is provide to assist participants.

1/ Self-help inputs to sanitation programs in the context of this paper are defined as inputs by beneficiaries in the form of householder labour and materials in the construction operation and maintenance phases.

Socio-cultural aspects of sanitation

24. A sound understanding of socio-cultural aspects of sanitation at community, household and individual level is essential to ensure effective program design and subsequent successful implementation; this implies working in multi-diciplinary terms, and program design must include socio-cultural inputs throughout project life to enable sound implementation.

Communal Sanitation Facilities

25. Consideration has been given in many countries over the years to the construction of communal or shared facilities. With the exception of the well documented and unique "Comfort Stations" program in Ibadan, Nigeria and a number of Indian programs, communal facilities have either been a failure or have been rejected by the community. However since community facilities are substantially more cost effektive than individual household facilities, it is felt that their development should be explored further in African programs, such as programs in which each household has a private room with it maintains.

Beneficary Oriented Information Systems

26. The development of beneficiary and community oriented information systems is crucial to program success. It is generally agreed that health education is an essential complementary input to water and sanitation investments; emphasis is now placed on the development of broad-based information systems which will include health education and will:

- introduce the program to the community
- stimulate interest and encourage participation
- provide technical information and identify benefits
- identify financing mechanisms and sources of materials
- promote continuing facility use by all the family

A range of communication media are available for this including radio, cassette tapes, pamphlets and posters. Urban authorities, and "hardware" oriented authorities (Ministries of Works) have limited experience in this area; project design in future will need to strengthen these functions.

Cost Recovery

27. Policy and mechanisms for effective administration of water supply and sanitation cost recovery are in the formative stages in many countries. A common decision criteria has been that the monthly household financial cost of water supply and sanitation services should not exceed 5% of monthly household income. Low cost projects aim to deliver services to the rural and urban poor and by implication are aimed at households near of often below the poverty treshold; cost recovery policies for this population group are intrinsically difficult to develop and administer. There is little point in developing a cost recovery policy which requires effective institutions for implementation if these institutions do not exist; therefore, institution strengthening is considered a major project objective concurrent with the development of cost recovery policies.

Typical Program Components

28. From the work undertaken in the various countries, and experience to date in the sector it is concluded that a general structure for water supply and sanitation program development should include the following key elements:

- a central steering committee comprising the ministries of departments responsible for finance and planning, health, urban and rural development, water supply and sewerage;
- sound project management, technical assistance and site investigations,
- preinvestment assessment of socio-cultural factors, and beneficiary preference;
- information systems development and community dialogue;
- access to and delivery of building materials and mass produced components, combined with financing mechanisms;
- integration of design with sanitation related physical infrastructure development (particularly water supply, storm water drainage, and housing layouts),
- integration of program management with existing administrative structures (such as village or town councils),

- a monitoring and evaluation program,

- a program for briefing central government personnel, and training engineers, technicians, artisans and extension workers.

AREAS OF APPLIED RESEARCH

29. Applied research is needed in a number of areas, in both water supply and sanitation; significantly less has been done in sanitation than water hence the need is greater in this area. Some of the more significant areas which must be investigated if low cost sanitation programs are to proceed with confidence are discussed below:

Latrine Emptying

30. Latrine emptying is largely unresolved; there is no recent experience of emptying well engineered latrines and the recently developed twin pit latrines have yet to handle excreta (fully decomposed or otherwise) and in investigations done by the IDRC Research Project 1/ into the accetability of alternate sanitation systems, composting was rejected as being unacceptable due mainly to a reluctance to handle fresh or decomposed excreta.

31. In both urban and rural areas, latrines are currently moved when they are full; this is clearly uneconomic when they are well built, and also unacceptable to householders who have put substantial effort and finance into latrine construction . As urban plot sizes reduce 2/ it becomes both technically difficult and expensive to re-excavate pits and move superstructures. The development of twin-pit latrines will overcome the problem. The BRE (UK) is planning to evaluate pit emtying methods in Botswana, and TAG is planning to investigate this elsewhere; this work is crucial to the development of low cost sanitation.

Environmental Pollution Hazards

32. Extensive improvements of service levels of water supply and sanitation in developing countries can be undertaken if groundwater sources are substantially developed and low cost on-site systems of excreta disposal adopted. These two strategies are in conflict in that on-site excreta disposal will in many cicumstanced pollute groundwater sources. Insufficient is known at present about these potential hazards in developing countries, and consideration is beeing given in a number of countries to assessing the impact of on-site systems on the environment in general and groundwater in particular. The recent improvements in membrane filtration techniques (making them simple, inexpensive, reliable and rugged) together with more reliable methods of sampling (such as the Water Research Centre UK in-situ sampling device) has meant that the rigorous monitoring programmes needed can be relatively easily ndertaken. TAG is working with various governments in adressing this issue but much work still needs to be undertaken.

Small Bore Sewer Design

33. Small bore shallow flat sewers are a cost-effective solution to the removal of liquids from pour flush latrines and to carry sullage in areas with high water tables or impermeable soils. Little is known about their long term performance nor have firm design criteria been established and proven.

Ventilation of Pit Latrines

34. Ventilation dramatically reduces odour and insect problems usually associated with pit latrines, but the vent pipe is expensive. Field trials are required to optimize configuration, diameter, height and material and to test and verify theoretical models, establishing clear design criteria and confidence limits.

1/ The International Development and Research Centre of Canada undertook a Research Project into low cost Sanitation in a number of countires in 1976 to 1978.

2/ Site and serivce plots sizes in low income urban Africa have reduced from over 100 sq m in the early 1970's to currently under 200 sq m.

Pit Desludging Techniques

35. Double pit systems are preferable as they avoid the need to handle fresh excreta. However there may be many situations where single pits have to be used (in dense urban areas), where vault toilets have to be emptied frequently (in areas where on-site disposal of excreta is not possible) and where double pits need to be emptied mechanically (in areas of high groundwater). Many current pit desludging methods are unhygienic or damage the pit substructure. There is a need to test and evaluate a range of existing equipment and methods for pitemptying in a number of developing countries (cost-effective and acceptable technologies are likely to be highly country spesific).

Evaluation of Pour Flush Latrines

36. Pour flush latrines with either twin or single soakage pits have been found to be a socially acceptable and financially affordable form of sanitation; it is expected that a large scale sanitation projects using this technology will be developed over the next decade.
Technical and sociological performance data as a basis for planning these investments is very limited; this

data can be obtained however by rigorously evaluating a number of large scale sanitation projects in India which use pour flush/soakage pit technology.

Sanitation Entomology

37. Most of the technologies being proposed or implemented as appropriate low cost sanitation pose a definite risk of increased fly or mosquito breeding. Pit latrines of any kind (including VIP latrines) which have squat holes rather than a water seal are prone to massive fly breeding if the pit contents are dry and mosquito breeding if the pit contents are wet. Septic tanks and soakage pits are also major mosquito breeding sites. It is essential to know to what degree various designs of latrine (especially VIP and PF latrines) promote major fly or mosquito breeding and how such breeding may be controlled or eliminated at reasonable cost.

Septic Tanks

38. To permit lower cost solutions in higher density areas septic tanks should probably be multicompartmental, accept sullage and sewage in different compartments and possibly used in conjunction with upflow anaerobic filters. There are no rigourously tested design criteria for multi compartmental tanks. Little is known about the long term absorbtion capacity of drainfields in different soil types, for accepting either sullage or septic tank effluent.

Nightsoil Treatment Ponds

39. Performance data on waste stabilization ponds used for the treatment of nightsoil is limited. Reliable design data is essential for areas where a vault toilet system is likely to be extensively used or where sludge from VIP, PF or other on-site system needs further treatment.[1]

1. Twin pit technology will obviate this need.

"Palafitic" Area Sanitation

40. Many developing countries have extensive low income housing areas built on stilts over waterlogged ground. Excreta disposal is a formidable problem, and there is a need to develop and evaluate workable cost effective services for these areas.

Water Demand Management

41. The range of low-water usage plumbing hardware and relevant information on it which is available to developing countries is very limited. Current designs and design methodologies are based on high-income and hence high usage needs. More effective water usage through improved hardware (with possibly user education) will both make water more affordable and service a far larger portion of the community. Rigourous analytical data is required on low volume flush cisterns and pans, drain performance problems, flow limiting devices, simple taps and stop cocks, P and Strap design optimisation together with data on appropriate manufacturing methods with appropriate quality control.

CONCLUSION

42. While the need for improved sanitation and water supply in the developing countries is substantial, many Governments have a commitment to develop programs to meet these needs. Although sanitation developments are still in the formative stage, institutional structures and technical options are emerging which it is anticipated will prove successful.
Crucial to success in this new area of development will be continued high government commitment combined with sound planning, sensitive implementation and considerable support by mulitlateral and bilateral agencies. These efforts will produce effective programmes only if sustained householder commitment to programme development is achieved by culturally responsive design and implementation.

43. Recent work has highlighted specific areas where further applied research is needed in order to build on exiisting experience. The water supply and sanitation industry in Europe, both public and private sector is in a unique position to be able to contribute to this having a wide range of skills and experience readily available. Undertaking this work would represent a major contribution to the massive effort being planned by developing countries to meet the basic water supply and sanitation needs of their low income population.

Acknowledgements

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FIGURE I

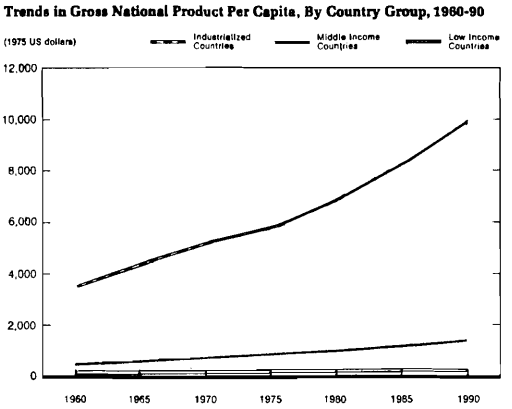


FIGURE II

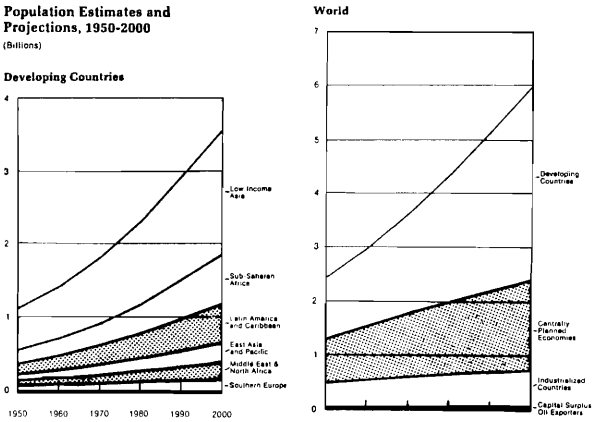


FIGURE III

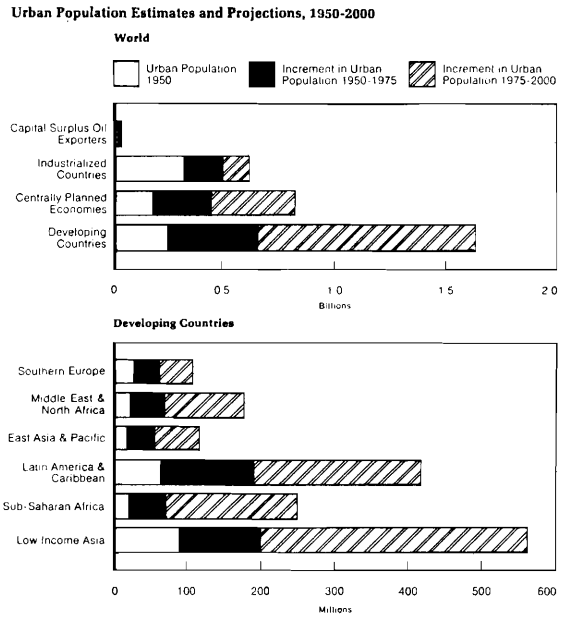
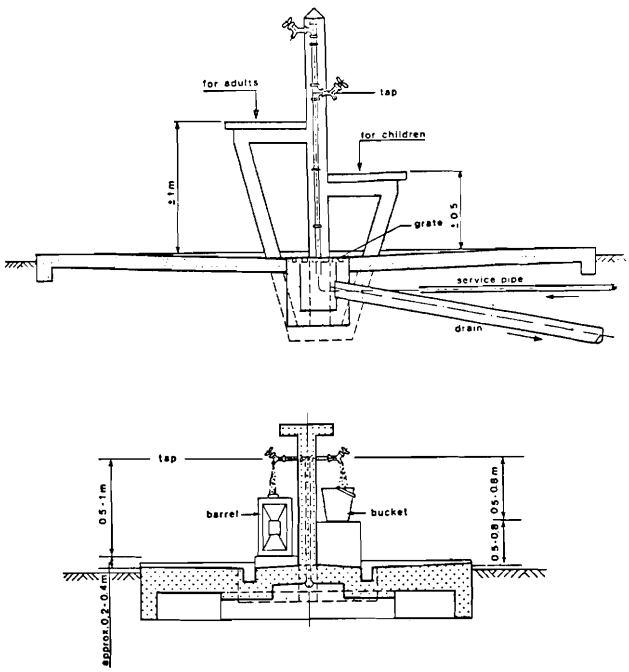
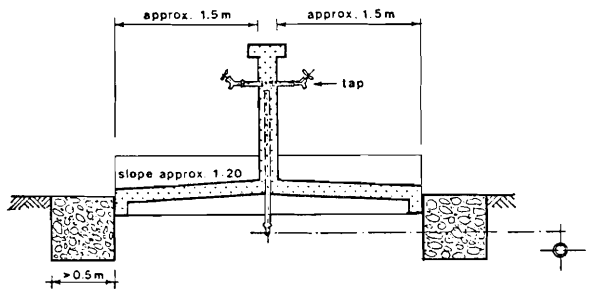


FIGURE IV

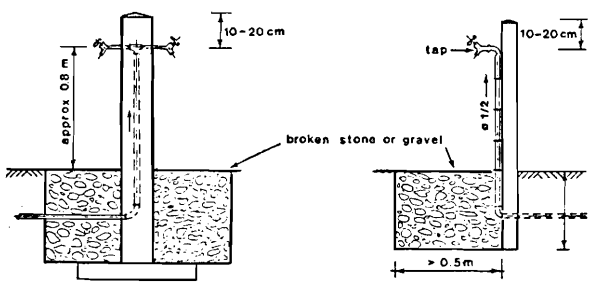


STANDPOSTS WITH RAISED PLATFORM
(a) to accommodate different categories of users
(b) to allow containers of different sizes to be used.

FIGURE V



A: CROSS-SECTION OF STANDPOST WITH TWO SCREW TAPS AND A CONCRETE PLATFORM

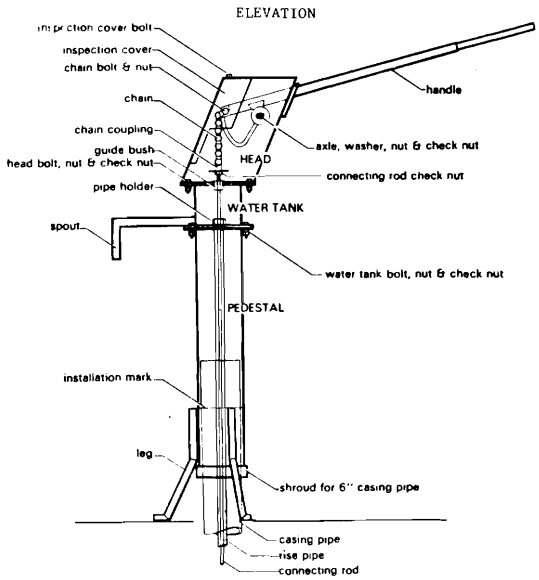


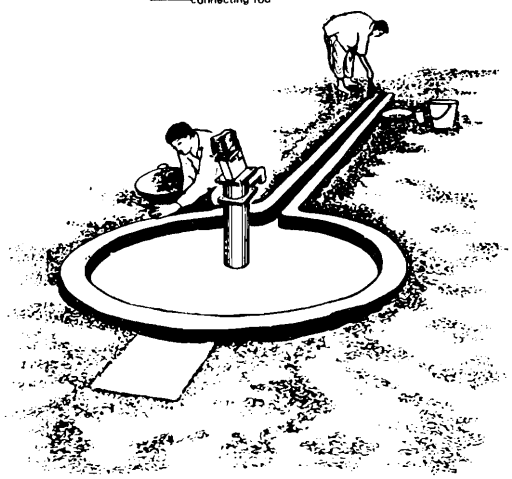
B: CROSS-SECTIONS OF SIMPLE STANDPOSTS TYPICAL OF RURAL WATER SUPPLIES

FIGURE VI

INDIA MARK-II HANDPUMP

TYPICAL DEEPWELL HANDPUMP



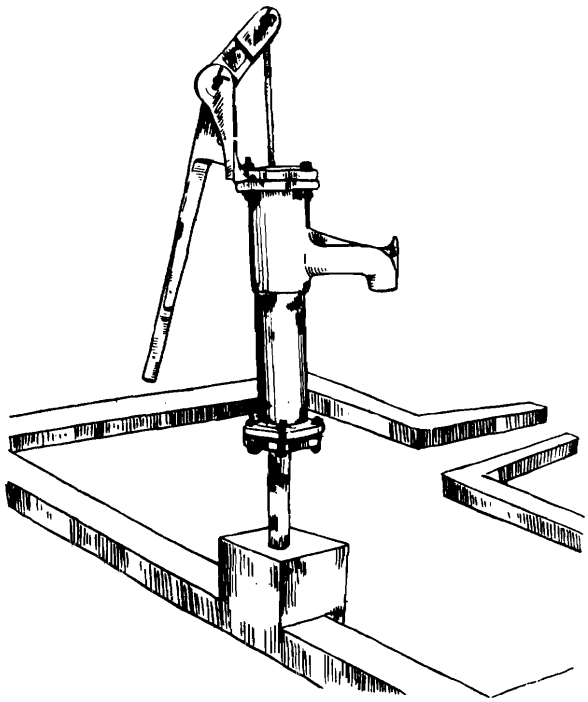


PLATFORM AND DRAIN

FIGURE VII

SHALLOW WELL HANDPUMP No.6

নলকূপের পাম্প মেরামত সম্বন্ধে জানবার বিষয়



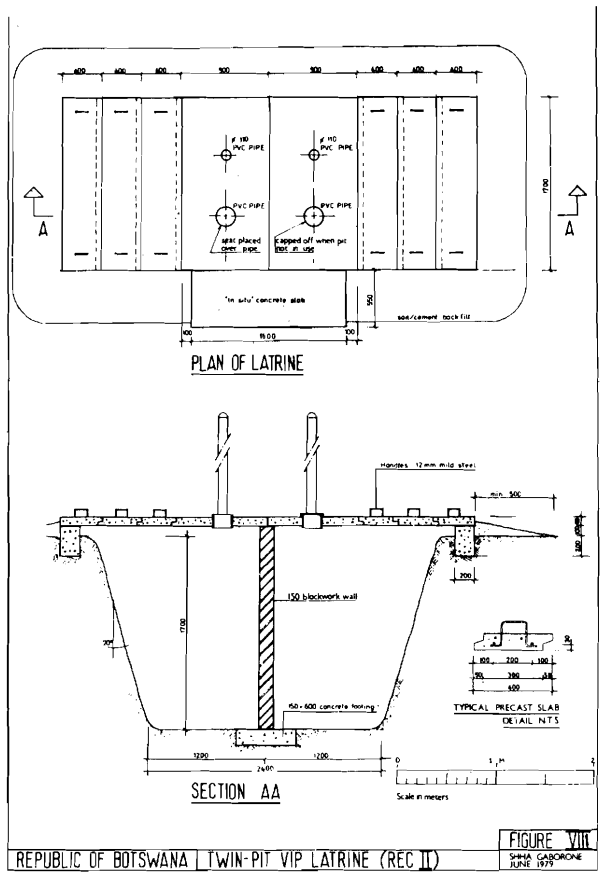


TABLE I

BACKGROUND DATA I

GEOGRAPHIC, DEMOGRAPHIC, AND ECONOMIC DATA

Country	Area square km	Population mid 1978	Population density Persons per sq km	% of Population that is rural	GNP per capita US $-1978
Botswana	570 000	0,7 m	1,23	85 %	620
Egypt	1 001 000	38,7 m	38,7	58 %	400
Lesotho	30 000	1,3 m	43,3	90 %	360
Nigeria	924 000	81,0 m	87,7	77 %	560
Ghana	239 000	11,0 m	46,0	n.a.	390
Sudan	2 506 000	17,4 m	6,9	85 %	320
Tanzania	945 000	16,9 m	17,9	88 %	230
India	3 288 000	643,9 m	195,8	80 %	180
Bangladesh	144 000	83,6 m	580,6	94 %	90
USA	9 363 000	218,4 m	23,3	-	9 700
United Kingdom	244 000	60,0 m	245,9	-	5 030
China	9 597 000	914,0 m	95,2	n.a.	460

Source: REF. 1, 2, 3, 4 and 7.

TABLE II

BACKGROUND DATA II

DEMOGRAPHIC, HEALTH AND SOCIOLOGICAL

Country	Life expectancy at birth-1977 (years)	Daily Per Capita Calorie Supply as % of Requirement 1974	Population per Nursing Person 1976 No.	% of children 0-14 years in total population 1975 %	2000 %	% of Age Group enrolled in Primary School 1976 %	Adult Literary Rate 1975 %
Botswana	44 (1975)	n.a.	n.a.	46	44	n.a.	n.a.
Egypt	54	113	1 150	41	34	72	44
Lesotho	50	99	3 780	38	39	100	40
Nigeria	48	88	3 210	45	46	49	15 (1960)
Ghana	48	101	860	48	45	44	30
Sudan	46	88	1 260	46	42	39	20
Tanzania	51	86	3 300	47	46	70	66
India	51	89	6 320	42	35	79	36
Bangladesh	47	92	53 700	47	42	83	22
USA	73	133	150	25	22	100	99
UK	73	133	180	24	23	100	99
China	64	99	n.a.	34	25	n.a.	n.a.

Source: Ref. 1, 2, 3 and 4.

TABLE III

LATEST ESTIMATES OF LEVELS OF SERVICE OF POTABLE WATER SUPPLY AND SANITATION IN VARIOUS COUNTRIES

Country[1]	% of Population with Safe Potable Water Urban	Rural	% of Population with[2] Adequate Sanitation Urban	Rural
Botswana (Ref.7)	90 %	28 %	30 % to 50 %	less than 25 %
Egypt	80 %	50 %	n.a.	n.a.
Lesotho (Ref.7)	65 %	14 %	51 %	2 % to 17 %
Nigeria	n.a.	n.a.	n.a.	n.a.
Ghana (Ref. 6)	86 %	14 %	95 %	40 %
Sudan	40 %	45 %	less than 10 % (Ref.5)	less than 30% (Ref. 5)
Tanzania (Ref.2)	88 %	36 %	n.a.	40 %
India	83 % (Ref.7)	20 % (Ref.7)	87 %	2 %
Bangladesh	15 % (Ref.7)	55 % (Ref.7)	40 %	5 %
USA	100 %	100 %	100 %	less than 100%
United Kingdom	100 %	100 %	100 %	100 %
China	n.a.	n.a.	n.a.	n.a.

Note:

1) Unless indicated otherwise, source is Ref. 8.

2) "Adequate" is the definition used in compliation of official statistics. It does not imply that the sanitation facility is sufficient in terms of current TAG thinking.

2. Population to be served 1/

	Population Without Service (millions) 1975 Water	Sanitation	1990 Water	Sanitation
Urban	127	144	638	651
Rural	1 106	1 210	1 569	1 673
Total	1 223	1 354	2 207	2 334

3. Investments Required 2/

		Unit Cost $/cap.	CASE 1 Pop. %	Served No. (mill.)	Cost $ US (bill.)	CASE 2 Pop. %	Served No. (mill.)	Cost $US (bill.)
Urban Water Supply	hc	120	70	447	53,6	40	255	30,6
	stp	40	30	191	7,6	40	255	10,2
Sanitation	sew.	250	40	260	65,0	25	163	40,0
	sept.	100	40	260	26,0	15	98	9,8
	Lat.	30	20	131	3,9	40	260	7,8
					156,1			98,4
Rural Water Supply	hc	150	20	313	46,9	10	157	23,6
	stp	40	40	628	25,1	30	471	18,8
	hc	25	40	628	15,7	40	628	15,7
Sanitation	sew.	250	20	335	83,8	10	167	39,2
	Lat.	20	80	1338	26,8	70	1171	23,4
Sub Total Rural					198,3			120,7
TOTAL URBAN AND RURAL					354,4			219,1

1/ Calculated from information contained in UN Document E/CONF. 70/14 "Report on Community Water Supplies".

2/ It should be noted that 100 % urban coverage using water supply house connections and sewerage only (i.e. no appropriate technology) would cost $ 329.4 billion rather than the $ 156.1 billion calculated with a mix of technologies.

TABLE IV

ALTERNATIVE SANITATION TECHNOLOGIES

Financial Requirements for Investment and Recurrent Cost per Household

(1978 $)

	Total Investment Cost [a]	Monthly Investment Cost [b]	Monthly Recurrent Cost	Monthly Water Cost	Hypothetical Total Monthly Cost [b]	Percent of Income of Average low Income Household
	(1)	(2)	(3)	(4)	(5)	(6)
Low Cost						
Pour flush toilet	70	1,5	0,2	0,3	2,0	2
Pit latrine	125	2,6	-	-	2,6	3
Communal toilet [d]	355	7,4	0,3	0,6	8,3	9
Vacuum truck cartage	105	2,2	1,6	-	3,8	4
Low cost septic tanks	205	4,3	0,4	0,5	5,2	6
Composting toilet	400	8,3	0,4	-	8,7	10
Bucket cartage [d]	190	4,0	2,3	-	6,3	7
Medium Cost						
Sewered aquaprivy	570	7,1	2,0	0,9	10,0	11
Aquaprivy	1 100	13,1	0,3	0,2	14,2	16
Japanese vacuum truck cartage	710	8,8	5,0	-	13,8	15
High Cost						
Septic tanks	1 645	14,0	5,9	5,9	25,8	29
Sewerage	1 480	12,6	5,1	5,7	23,4	26

SOURCE: Ref. 13

a/ Including household plumbing as well as all other on- and off-site system costs.

b/ Assuming investment cost is financed by loans at 8 % over 5 years for the Low Cost systems, 10 years for the Medium Cost Systems and 20 years for the High Cost Systems.

c/ Assuming average annual income per capita of $ 180 and 6 persons per household.

d/ Based on per capita costs scaled up to household costs to account for multiple-household use in some of the case studies.

Investments Needed to Achieve
Drinking Water and Sanitation Decade Targets

1. Assumption

(a) Unit Costs

Water Supply,
- Piped System with House Connccetions (Hc) 120$/cap
- Piped System with Standpipes (stp) 40$/cap
- Rural Piped Water Supply with hc 150$/cap
- Rural Piped Water Supply with stp 40$/cap
- Rural Handpumps Water Supply hp 25$/cap

Sanitation,
- Urban Waterborne Sewerage (sew) hc 250$/cap
- Urban onsite with (i) Septic Tanks (sept) 100$/cap
  (ii) Pourflush latrine or Communal Latrine (lat) 30$/cap
- Rural Waterborne with hc (sew) 250$/cap
- Rural Onsite with lat 20$/cap

(b) Service Levels

Case 1 (100 % coverage using 1980 WHO Target Urban Service Standard Distribution)

Urban — Water Supply: 70% hc, 30% stp

Urban — Sanitation: 40% sew, 40% sept. tanks, 20% lat. & communal lat

Rural — Water Supply: 20% hc, 40% stp, 40% hp

Rural — Sanitation: 80% sew, 20% lat

Case 2 (80% coverage with service standard as suggested)

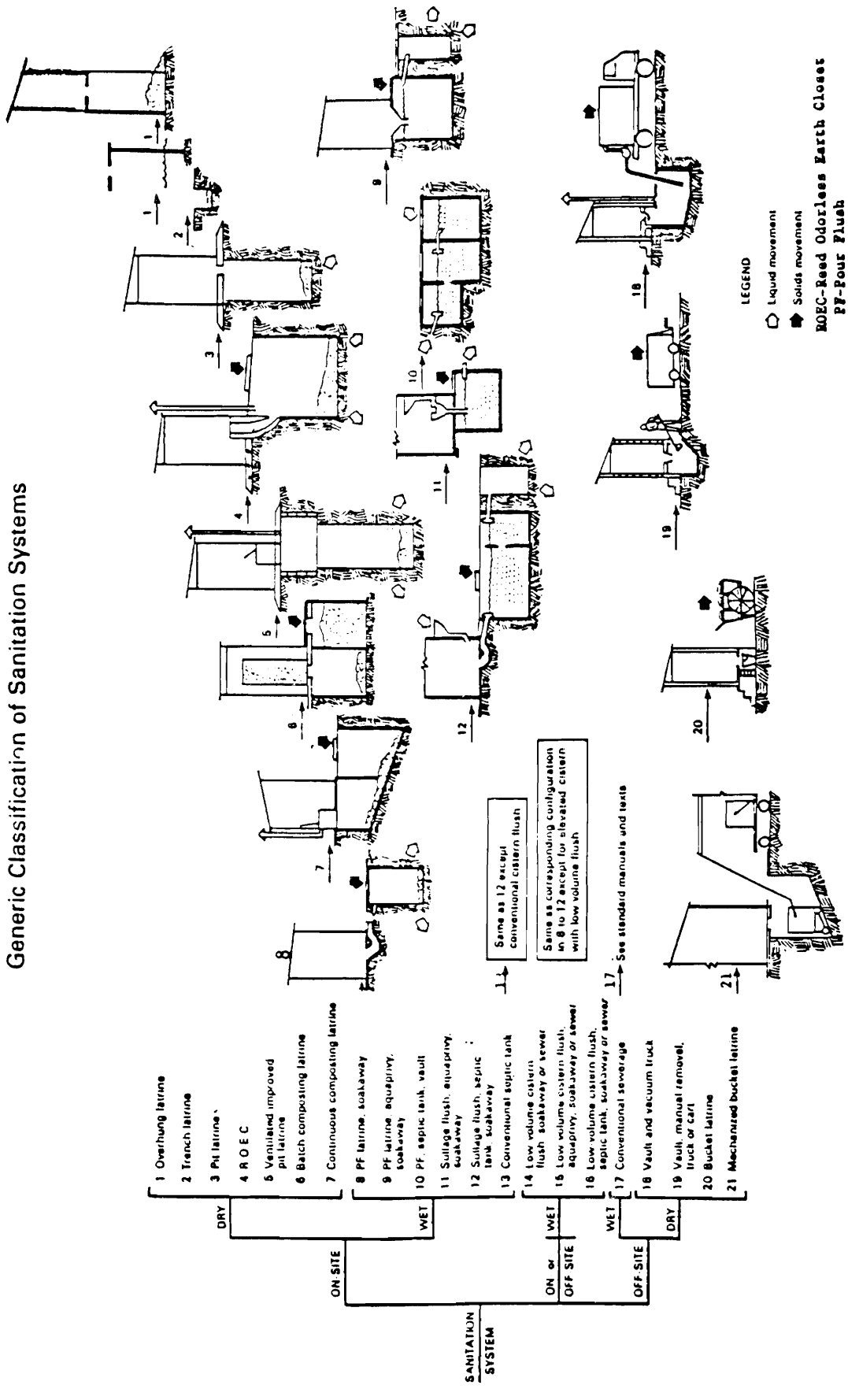
Urban — Water Supply: 40% hc, 40% stp

Urban — Sanitation: 25% sew, 15% sept. tank, 40% lat & communal lat

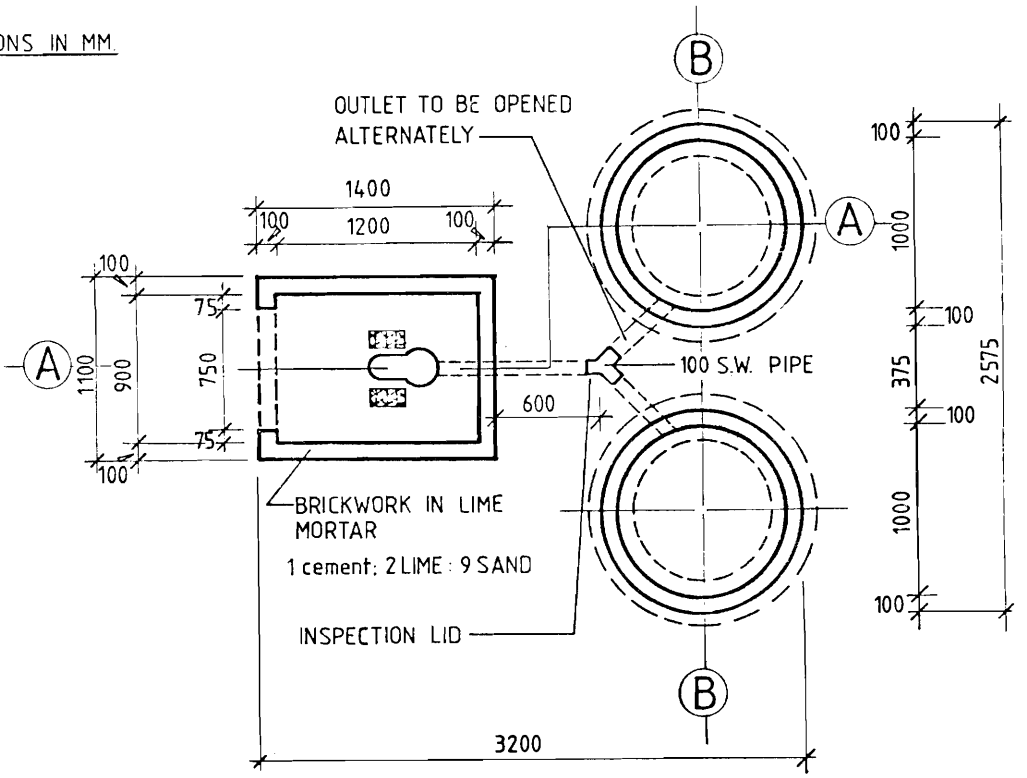
Rural — Water Supply: 10 % hc, 30 % stp, 40 % hp

Rural — Sanitation: 10 % sew, 70 % lat

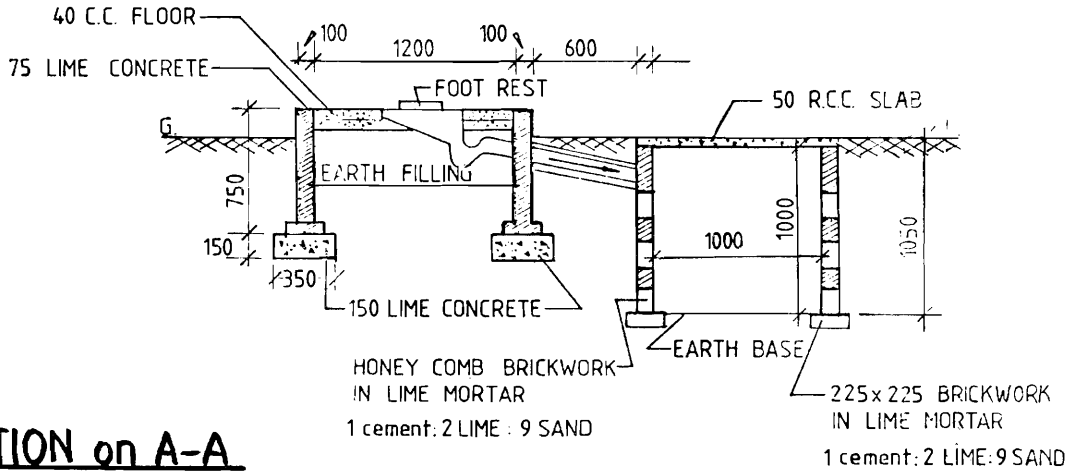
FIGURE X


Generic Classification of Sanitation Systems
SANITATION SYSTEM
ON SITE
OFF SITE
ON or OFF SITE
DRY
WET
1 Overhung latrine
2 Trench latrine
3 Pit latrine
4 ROEC
5 Ventilated improved pit latrine
6 Batch composting latrine
7 Continuous composting latrine
8 PF latrine, soakaway
9 PF latrine aquaprivy, soakaway
10 PF, septic tank, vault
11 Sullage flush, aquaprivy, soakaway
12 Sullage flush, septic tank soakaway
13 Conventional septic tank
14 Low volume cistern flush soakaway or sewer
15 Low volume cistern flush, aquaprivy, soakaway or sewer
16 Low volume cistern flush, septic tank, soakaway or sewer
17 Conventional sewerage
18 Vault and vacuum truck
19 Vault, manual removal, truck or cart
20 Bucket latrine
21 Mechanized bucket latrine
Same as 12 except conventional cistern flush
Same as corresponding configuration in 8 to 12 except for elevated cistern with low volume flush
See standard manuals and texts
LEGEND
Liquid movement
Solids movement
ROEC-Read Odorless Earth Closet
PF-Pour Flush

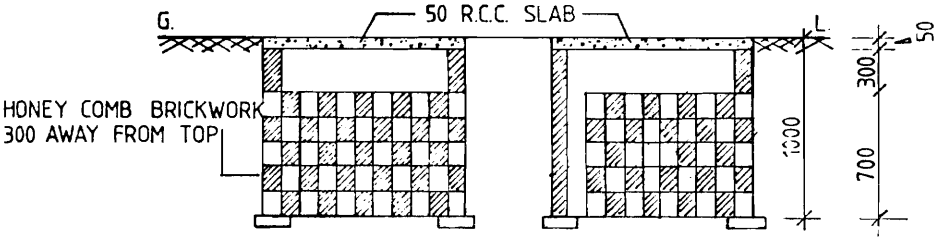
ALL DIMENSIONS IN MM.



PLAN



SECTION on A-A



SECTION on B-B

POUR-FLUSH LATRINE FIG. IX

TAG / UNDP / INDIA FEB 1980