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Family scale rural water treatment plant: intermittent slow sand filtration

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Table 2. Inorganic constituents of health significance

Constituent	Unit	Guideline value	Remarks
arsenic	mg/l	0.05	
asbestos	—	no guideline value set	
barium	—	no guideline value set	
beryllium	—	no guideline value set	
cadmium	mg/l	0.005	
chromium	mg/l	0.05	
cyanide	mg/l	0.1	
fluoride	mg/l	1.5	natural or deliberately added; local or climatic conditions may necessitate adaptation
hardness	—	no health-related guideline value set	
lead	mg/l	0.05	
mercury	mg/l	0.001	
nickel	—	no guideline value set	
nitrate	mg/l (N)	10	
nitrite	—	no guideline value set	
selenium	mg/l	0.01	
silver	—	no guideline value set	
sodium	—	no guideline value set	

Table 3. Organic constituents of health significance

Constituent	Unit	Guideline value	Remarks
aldrin and dieldrin	µg/l	0.03	
benzene	µg/l	10[a]	
benzo[*a*]pyrene	µg/l	0.01[a]	
carbon tetrachloride	µg/l	3[a]	tentative guideline value[b]
chlordane	µg/l	0.3	
chlorobenzenes	µg/l	no health-related guideline value set	odour threshold concentration between 0.1 and 3 µg/l
chloroform	µg/l	30[a]	disinfection efficiency must not be compromised when controlling chloroform content
chlorophenols	µg/l	no health-related guideline value set	odour threshold concentration 0.1 µg/l
2,4-D	µg/l	100[c]	
DDT	µg/l	1	
1,2-dichloroethane	µg/l	10[a]	
1,1-dichloroethene[d]	µg/l	0.3[a]	
heptachlor and heptachlor epoxide	µg/l	0.1	
hexachlorobenzene	µg/l	0.01[a]	
gamma-HCH (lindane)	µg/l	3	
methoxychlor	µg/l	30	
pentachlorophenol	µg/l	10	
tetrachloroethene[d]	µg/l	10[a]	tentative guideline value[b]
trichloroethene[d]	µg/l	30[a]	tentative guideline value[b]
2,4,6-trichlorophenol	µg/l	10[a,c]	odour threshold concentration, 0.1 µg/l
trihalomethanes		no guideline value set	see chloroform

[a] These guideline values were computed from a conservative hypothetical mathematical model which cannot be experimentally verified and values should therefore be interpreted differently. Uncertainties involved may amount to two orders of magnitude (i.e., from 0.1 to 10 times the number).

[b] When the available carcinogenicity data did not support a guideline value, but the compounds were judged to be of importance in drinking water and guidance was considered essential, a tentative guideline value was set on the basis of the available health-related data.

[c] May be detectable by taste and odour at lower concentrations.

[d] These compounds were previously known as 1,1-dichloroethylene, tetrachloroethylene, and trichloroethylene, respectively.

Table 4. Aesthetic quality

Constituent or characteristic	Unit	Guideline value	Remarks
aluminium	mg/l	0.2	
chloride	mg/l	250	
chlorobenzenes and chlorophenols	—	no guideline value set	these compounds may affect taste and odour
colour	true colour units (TCU)	15	
copper	mg/l	1.0	
detergents	—	no guideline value set	there should not be any foaming or taste and odour problems
hardness	mg/l (as $CaCO_3$)	500	
hydrogen sulfide	—	not detectable by consumers	
iron	mg/l	0.3	
manganese	mg/l	0.1	
oxygen—dissolved	—	no guideline value set	
pH	—	6.5–8.5	
sodium	mg/l	200	
solids—total dissolved	mg/l	1000	
sulfate	mg/l	400	
taste and odour	—	inoffensive to most consumers	
temperature	—	no guideline value set	
turbidity	nephelometric turbidity units (NTU)	5	preferably <1 for disinfection efficiency
zinc	mg/l	5.0	

Table 5. Radioactive constituents

Constituent	Unit	Guideline value	Remarks
gross alpha activity	Bq/l	0.1	(*a*) If the levels are exceeded more detailed radionuclide analysis may be necessary. (*b*) Higher levels do not necessarily imply that the water is unsuitable for human consumption
gross beta activity	Bq/l	1	

REFERENCES

References
L.J. Abraas

Author	Year	Title	Affiliation	Publishers
Akintola F.O., Areola O., & Faniran A.	1980	THE ELEMENTS OF QUALITY AND SOCIAL COSTS IN RURAL WATER SUPPLY AND UTILIZATION	Dept of Geography, Univ. of Ibadan, Nigeria	Water Supply and Management Vol 4
Alcock P.	1986	AN EXAMINATION OF HOUSEHOLD WATER CONSUMPTION IN THE INADI WARD, KWAZULU		Technical Paper, The Civil Eng. in S.A., November 1986
Annon	1986	FIVE-POINT PLAN FOR AFRICA AGREED BY 30 COUNTRIES AT ABIDJAN	All-Africa Seminar on Low cost Rural and urban-fringe water supply.	World Water, November 1986
Clark J.W., Viessan W, and Hanser M.J.	1965	WATER SUPPLY AND POLLUTION CONTROL 2nd edition		
Corbetis S.	1984	COMPARISON OF RAPID GRAVITY AND UPFLOW FILTRATION FOR MINE WATER	Water Systems Research Programme, Univ. of Wits., Dept of Civil Eng	Unpublished Report No W14, August 1984
Huisman L.L.	1978	DEVELOPMENTS OF VILLAGE-SCALE SLOW SAND FILTRATION	University of Technology, Delft	Progess in Water Technology (Oxford) Vol. 11:Iss.1/2
IDRC	1981	RURAL WATER SUPPLY IN CHINA, Potable Water	International Development Research Centre	Report NO. IDRC-TS25E, Chapter 1
Kerkhoven P.	1979	THIRD WORLD TESTS FOR SAND FILTERS	World Water, September 1979	
Milne D.P., Curran J.C. and Wilson L.	1986	EFFECTS OF SEDIMENTATION ON REMOVAL OF FAECAL COLIFORM FROM EFFLUENTS IN ESTUARINE WATER	Pergamon Journals Ltd., Great Britian	Water Research Vol. 20, No. 12, pp.1493-1496
Paramasivam R. et al	1979	SLOW SAND FILTERS FOR RURAL WATER SUPPLIES IN DEVELOPING COUNTRIES	National Environ Eng Research Inst, Nagpur, INDIA	Internat. Water Supply Assoc. Singapore Conference, 13-15 February 1979
Sibony J.	1981	DISINFECTION OF DRINKING WATER IN DEVELOPING COUNTRIES		Aqua (London) Vol 5
Van der Veen C.	1980	HYGIENE OF DRINKING WATER IN DEVELOPING COUNTRIES	Pro Aqua - Pro Vita Fachtagung IV WASSER (1980)	Aqua NO. 5
WHO	1984	GUIDELINES FOR DRINKING-WATER QUALITY - Recommendations	World Health Organisation	WHO Guidelines for drinking-water quality, Vol.1
Wegelin M	1984	HORIZONTAL-FLOW ROUGHING FILTRATION: AN APPROPRIATE PRETREATMENT FOR SLOW SAND FILTRATION IN DEVELOPING COUNTRIES	WHO Int. Ref. Centre for Waste Disposal	IRCWS News No. 20 (August)
Williams P.G.	1984	FIRST REPORT ON SLOW SAND FILTER INVESTIGATION	National Inst. for Water Research, S.A.	Presented at Purification and Distribution of Water Symposium, Pretoria, S.A., 18 October 1984
Windle-Taylor E.	1980	WATER RELATED DISEASES AND THE BROAD PRINCIPLES OF WATER TREATMENT APPLICABLE TO THE THIRD WORLD	WHO	Aqua (London) 1980 NO.2

BIBLIOGRAPHY

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Literature Survey
L.J. Abraas

Author		Title	Affiliation	Publishers	Description
Akintola F.O., Areola O., & Faniran A.	1980	THE ELEMENTS OF QUALITY AND SOCIAL COSTS IN RURAL WATER SUPPLY AND UTILIZATION	Dept of Geography, Univ. of Ibadan, Nigeria	Water Supply and Management Vol 4	Provides useful social water costs data for Oyo State, Nigeria.
Al Azharia Jahn, S	1980	TRADITIONAL PRACTICES OF HANDLING DRINKING WATER IN DEVELOPING COUNTRIES	Water purification project, Khartoum, Sudan	Aqua Vol 9, NO. 10	A modernised water supply system does not necessarily change old water related customs, many of which may re-contaminate the water.
Alajarsamy S.R., Chandhirajan M.	1981	PACKAGE WATER TREATMENT PLANTS FOR RURAL AND ISOLATED COMMUNITIES		Journal of the Indian Waterworks Assoc. Vol 13: No 1	Small packaged units for the removal of fluoride and iron are described.
Alcock P.	1986	AN EXAMINATION OF HOUSEHOLD WATER CONSUMPTION IN THE INADI WARD, KWAZULU		Technical Paper, The Civil Eng. in S.A., November 1986	A survey of domestic water usage provides consumption information, including components of consumption and re-use of water.
Annon	1986	FIVE-POINT PLAN FOR AFRICA AGREED BY 30 COUNTRIES AT ABIDJAN	All-Africa Seminar on Low cost Rural and urban-fringe water supply.	World Water, November 1986	Report on the conference includes trends in low cost water supply in Africa. Also included is the five point plan adopted at the conference.
Annon	1979	APPROPRIATE TECHNOLOGY FOR WATER SUPPLY AND WASTE DISPOSAL IN DEVELOPING COUNTRIES	International Water Supply Assoc., Singapore		An examination of the relationship between low cost water supply and sanitation. Because of the high cost of waste disposal it is often neglected which results in the deterioration of the quality of water scources.
Bedard G.J., Heinjen H.A.		SLOW SAND FILTRATION - APPROPRIATE TECHNOLOGY FOR SAFE WATER	International Reference Centre (WHO)		A pamphlet giving photos and details of SSF used in various countries as part of the World Water and Sanitation Decade.
Bhole A.G.	1981	DESIGN AND FABRICATION OF A LOW COST PACKAGE WATER TREATMENT PLANT FOR RURAL AREAS IN INDIA		Aqua (London) Vol 5	A low cost packaged water treatment unit is described, using a tapered pebble-bed flocculator, a plate settler and a filter unit.
Clark A.	1982	LESOTHO MAKES STRIDES IN RURAL WATER SUPPLY		Waterlines (London) Vol. 1: No 2: August 1982	The Lesotho Village Water Supply (VWS) project is described in some detail.
Clark J.W., Viessman, and Hasser M.J.	1965	WATER SUPPLY AND POLLUTION CONTROL 2nd edition			Filtration hydraulics (pp. 366 - 372) and micro biological descriptions.
Corbetin S.	1984	COMPARISON OF RAPID GRAVITY AND UPFLOW FILTRATION FOR MINE WATER	Water Systems Research Programme, Univ. of Wits., Dept of Civil Eng	Unpublished Report No WI4, August 1984	The report contains a useful chapter on Filtration Theory which includes filtration mechanisms and mathematical models.
Dissent B.T.	1980	THE APPROPRIATE TECHNOLOGY OF PROMOTING SAFE WATER SUPPLY IN AFRICA		Aqua (London) Vol 3	A general discussion of appropriate water supply methods with a plea to address the problem on a large scale.
Faniran A.	1983	NEW APPROACH TO WATER SUPPLY IN DEVELOPING COUNTRIES, Examples from the Nigerian situation.	Natural Resources Forum	NRF Vol 7, NO. 3	The paper argues for governments to undertake small schemes with local participation rather than large water schemes, citing Nigerian examples.
Feachem R.	1980	BACTERIAL STANDARDS FOR DRINKING WATER QUALITY IN DEVELOPING COUNTRIES	London School of Hygiene & Tropical Medicine	Lancet (London), Vol 8188, No. ?	High standards set for water supplies requiring chlorination are questioned in favour of low or no-treatment solutions which are more easily maintained and hence more reliable.
Frankel R.J.	1979	OPERATION OF THE COCONUT FIBER/BURNT RICE HUSKS FILTER FOR SUPPLYING DRINKING WATER TO RURAL COMMUNITIES IN SOUTHEAST ASIA	Seatec Int, Bangkok	American Journal of Public Health. Vol 69	A two stage filtration process was applied in Southeast Asia where SSF was inapropriate because of high turbidity. The first "roughing" phase used shredded coconut husks and the second "polishing" phase used burnt rice husks.

Literature Survey
L.J. Abrams

Author	Title	Affiliation	Publishers	Description
Gecaga J.	1980 SIMPLE WATER TREATMENT METHODS	International Development Research Centre	Rural Water Supplies in Developing Countries, Conference proc., Zomba, Malawi 5-12 August, 1980	The paper discusses briefly different water treatment methods including plain sedimentation, aeration, SSF, rapid sand filtration, disinfection, and others.
Glennie C	1982 A MODEL FOR THE DEVELOPMENT OF A SELF-HELP WATER SUPPLY PROGRAM	Technology Advisory Group to the World Bank	World Bank Technical Paper NO. 2	A working paper which considers the manpower, training and institutional requirements of self-help water supply and sanitation programmes.
Gray D., Keen J., & Reynolds J.	1987 UN HANDPUMP PROJECT REPORT DISPOSES OF MANY MYTHS	UNDP/World Bank Hand pump project	World Water, May 1987	Preliminary report on the findings of the hand pump testing programme.
Huijkens J., Turrell R.P.J.	1978 SPECIAL (TRAINING) PROBLEMS IN RURAL WATER SUPPLY PROJECTS IN DEVELOPING COUNTRIES	International Water Supply Assoc. Kyoto		An examination of training priorities and needs for rural water development.
Haile T.	1980 COMMUNITY PARTICIPATION IN RURAL WATER SUPPLY DEVELOPMENT	Ethiopia water resource authority	Rural Water Supplies in Developing Countries, Conference proc., Zomba, Malawi 5-12 August, 1980	Issues relating to the role of women in water supply are discussed, together with water consumption patterns.
Helvetas (Editor)	1985 MANUAL FOR RURAL WATER SUPPLY	Swiss Cooperation for Development, Zurich & Yaounde, Cameroon.	SKAT, Swiss Centre for Appropriate Technology, 5th edition.	175 pages of information including design tables and detailed drawings covering most methods required in the field.
Huisman L.L.	1978 DEVELOPMENTS OF VILLAGE-SCALE SLOW SAND FILTRATION	University of Technology, Delft	Progess in Water Technology (Oxford) Vol. 11:Iss.1/2	A standard reference on the subject - Huisman covers most elements of the process including an introduction to bacteriological action.
IDRC	1981 RURAL WATER SUPPLY IN CHINA, Potable Water	International Development Research Centre	Report NO. IDRC-TS25E, Chapter 1	A useful and comprehensive discussion on the health related aspects of water quality, including standards, organic and inorganic pollutants, and micro-biological contamination.
Kawamura S.	1981 DESIGN OF WATER TREATMENT PLANTS IN DEVELOPING COUNTRIES		Aqua (London) Vol 1	A concise description of unit processes and water treatment alternatives.
Kerkhoven P.	1979 THIRD WORLD TESTS FOR SAND FILTERS	World Water, September 1979		General discussion of SSF including rates of filtration, shading of filters, operation & maintenance, and community support.
LeChevallier M.W. & Seidler R.J.	1980 Staphylococcus aureus IN RURAL DRINKING WATER	Oregon State University	Applied and Environmental Microbiology, Vol 30, NO. 4	Staphylococcus aureus is a common agent in food poisoning. Water in rural USA is tested.
Magid I.N.	1984 WATER TREATMENT FOR RURAL AREAS WITH EMPHASIS ON SUDAN	Faculty of Eng. & Arch., University of Khartoum, Sudan	Water International (Lausanne) Vol. 9: No. 3	General information is given on water quality and different treatment methods in Sudan.
Mann H.T. & Williamson D.	1973 WATER TREATMENT AND SANITATION, Simple methods for rural areas.	Intermediate Technology Development Group	ITDG (London)	A compendium of simple methods drawn from field experience with simple design criteria and illustrations.
Mbwette T.S.A.	1985 EXPERIENCES WITH SLOW SAND FILTERS IN TANZANIA	WEDC	11th Conference : Water and sanitation in Africa: Dar es Salaam	Brief paper describing research and practice of SSF in Tanzania, with consideration given to pretreatment using horizontal roughing filtration.
Milne D.P., Curran J.C. and Wilson L.	1986 EFFECTS OF SEDIMENTATION ON REMOVAL OF FAECAL COLIFORM FROM EFFLUENTS IN ESTUARINE WATER	Pergamon Journals Ltd., Great Britian	Water Research Vol. 20, No. 12, pp.1493-1496	The paper examines the adsorption of bacteria (faecal coliform) to suspended solids and the consequent removal of bacteria through sedimentation.

Literature Survey
L.J. Abraas

Author		Title	Affiliation	Publishers	Description
Myhrstad J.A. & Huldorsen O.	1983	DRINKING WATER IN DEVELOPING COUNTRIES - THE MINIMUM TREATMENT PHILOSOPHY	Norconsult A.S. Sandvika, Norway	*Aqua No. 2 (London)*	Based on the Kigoma region in Tanzania, the paper advocates and discusses low technology methods of reducing microbiological contamination and turbidity as the "minimum treatment philosophy".
Paramasivam R. et al	1981	SLOW SAND FILTER DESIGN AND CONSTRUCTION IN DEVELOPING COUNTRIES		Journal of the American Water Works Association (New York)Vol 73 Iss 4.	A useful paper giving SSF design guide lines, together with economics of SSF variables and optimal filter dimensions. Economy of scale study indicates that provision for frequent expansion is preferable to large initial plants.
Paramasivam R. et al	1979	SLOW SAND FILTERS FOR RURAL WATER SUPPLIES IN DEVELOPING COUNTRIES	National Environ Eng Research Inst, Nagpur, INDIA	Internat. Water Supply Assoc. Singapore Conference, 13-15 February 1979	The paper presents & discusses results of 30 months of SSF tests. Factors discussed are different filtration rates, shading, intermittant operation, high raw water organic levels and the use of builders grade sand.
Sibony J.	1981	DISINFECTION OF DRINKING WATER IN DEVELOPING COUNTRIES		Aqua (London) Vol 5	Describes the most important waterborne biological diseases and their causes, together with details of several treatment methods.
Sundaresan B.B.,Paramasivan R.,Sadkari S.K.	1977	PART 3 - SLOW SAND FILTERS SERVING RURAL AREAS AND SMALL COMMUNITIES IN INDIA - AN INVENTORY	National Environ Eng Research Inst, Nagpur, INDIA	Slow sand filtration - Project report, Phase I	The use of SSF in India is researched by questionnaire. Problems experienced are noted together with details such as rate of flow.
Supik A.	1982	RURAL WATER SUPPLY FOR THE MASAI COMMUNITY AROUND MOUNT SUSWA		1st African water technology Conference, Nairobi	A piped water supply scheme is discussed together with numerous problems which arose with construction and maintenance.
Tjiook T.K.	1976	COMMUNITY WATERSUPPLY AND SANITATION: BASIS TO RURAL DEVELOPMENT		International Conference on Transfer of Technology, November 1976	The role of community water and sanitation projects in national development programmes.
Van Wijkslijbesma C.A.	1980	DE AANVAARDING VAN DRINKWATERVOORZIENINGEN DOOR DE GEBRUIKERS IN ONTWIKKELINGSLANDEN	WHO International Reference Centre for Community Water Supply	H2O Vol 13:, No. 13	User perceptions of water supply in developing countries.
Van der Veen C.	1980	HYGIENE OF DRINKING WATER IN DEVELOPING COUNTRIES	Pro Aqua - Pro Vita Fachtagung IV WASSER (1980)	Aqua NO. 5	A very comprehensive paper on hygiene and disease, the technology of water supply in developing countries, the human environment, costs and water charges, and an overview of the developing world water supply situation.
WHO	1984	GUIDELINES FOR DRINKING-WATER QUALITY - Recommendations	World Health Organisation	WHO Guidelines for drinking-water quality, Vol.I	The publication includes a useful introduction to the concepts of water quality, and guidelines to cover the following aspects: microbiological, biological, chemical and physical, and radioactive contaminants.
WHO	1977	SLOW SAND FILTRATION FOR COMMUNITY WATER SUPPLY IN DEVELOPING COUNTRIES - A selected and annotated bibliography.	World Health Organization	WHO IRC, Bulletin NO. 9, May 1977	A 50 page annotated reference list with indexes of authors and key words, and a list of reference institutions.
WHO	1980	DISINFECTION OF DRINKING WATER IN DEVELOPING COUNTRIES - REFERENCE LIST NO. 14	WHO International Ref. Centre for community water supply info.		A four page reference list.
WHO	1980	QUALITY OF DRINKING WATER IN DEVELOPING COUNTRIES	World Health Organization	WHO IRC, ref. list NO.18	An eight page reference list.

Literature Survey
L.J. Abraas

Author	Title	Affiliation	Publishers	Description
WHO	1980 HEALTH ASPECTS OF COMMUNITY WATER SUPPLY IN DEVELOPING COUNTRIES	World Health Organization	WHO IRC, ref list NO.5	A six page reference list.
Cleasby J.L.	1983 SIMPLIFYING DESIGN OF WATER TREATMENT PLANTS FOR DEVELOPING COUNTRIES	Water Air Resources Inc. Gainesville	Journal of the American Water Works Association (New York)Vol 75 iss 5.	Engineering objectives of packaged units are presented together with brief discussion on unit processes.
Wegelin M	1984 HORIZONTAL-FLOW ROUGHING FILTRATION: AN APPROPRIATE PRETREATMENT FOR SLOW SAND FILTRATION IN DEVELOPING COUNTRIES	WHO Int. Ref. Centre for Waste Disposal	IRCWD News No. 20 (August)	Different SSF pretreatment methods are discussed. HRF is discribed together with practical experience in Europe and Tanzania.
White G.F.	1978 DOMESTIC WATER SUPPLY IN THE THIRD WORLD	Univ Colorado Boulder	Progress in Water Technology (Oxford) Vol 111 No 1/2	The paper discusses different methods and their shortcomings of establishing national water usage patterns.
Williams P.E.	1984a A STUDY OF BACTERIA REDUCTION BY SLOW SAND FILTRATION	National Inst. for Water Research, S.A.	Unpublished paper	The paper discribes the results of a research programme into the effectiveness of faecal coliform bacteria removal through SSF. The influences of selected process variables are discussed.
Williams P.E.	1984b FIRST REPORT ON SLOW SAND FILTER INVESTIGATION	National Inst. for Water Research, S.A.	Presented at Purification and Distribution of Water Symposium, Pretoria, S.A., 18 October 1984	Preliminary results of the research programme are presented, describing the pilot plant and indicating the effects of some process variables.
Windle-Taylor E.	1980 WATER RELATED DISEASES AND THE BROAD PRINCIPLES OF WATER TREATMENT APPLICABLE TO THE THIRD WORLD	WHO	Aqua (London) 1980 NO.2	Classification of diseases and biological organisms. Grouping of water related diseases and discussion of water treatment and prevention methods in the context of general public health.

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