

Appendices

Appendix A: Introduction to technical aspects of groundwater development for rural water supply

Groundwater development requires input from many disciplines: economists, sociologists, planners and administrators as well as specialists to address the technical aspects of resource evaluation, water supply design and resources management.

Groundwater development is different in nature to many engineering projects. Data are always incomplete and progress must be cautious and controlled. This Appendix describes the processes involved in developing a groundwater resource and how knowledge of the behaviour of a groundwater system can be improved through sensible management. It is intended to provide only sufficient information for the non-specialist to be able to appreciate the technical input of the hydrogeologist within the Preparation Project. Good groundwater development measures include:

- good, careful management;
- good practices for design and management of work;
- monitoring and databasing; and
- maintenance.

The stages of development

During the early stages of development, groundwater is frequently used in an *ad hoc* way. Depending on location and need, holes are dug in the ground, springs are exploited, even horizontal drains (used for many centuries by the Arabs, Romans and South American Indians) as well as manually drilled boreholes (as in China and India) may be constructed.

As needs expand, a more detailed investigation or feasibility study of the groundwater system is required before further development can sensibly take place. Estimates are made of the rate at which the aquifer system is replenished by rainfall, and further drilling, perhaps controlled centrally, then proceeds. In due course further development may place the level of extraction close to the replenishable limit of the aquifer and shallower more vulnerable sources may start to dry up seasonally. Artificial recharge, perhaps from rivers, may help alleviate the situation, but this respite may only be temporary. At this stage degradation of the aquifer may progressively occur. Unless extreme care is taken, over-exploitation, often accompanied by deteriorating water quality and pollution of the resource, will begin to take place.

A main objective of the Programme is to avoid placing the available water resources in jeopardy and to avoid degradation of the resource. This will assist the likelihood of developing a sustainable rural water supply system. It can be accomplished through careful planning and assessment.

Some hydrogeological concepts

Aquifers are reservoirs, and can act as buffers to variations in rainfall and recharge from rainfall, so they are capable of maintaining supply through prolonged dry periods. Groundwater moves through pore spaces or fissures within the saturated part of the aquifer. The aquifer can thus act as a filter to solid material such as waste, but water is also a solvent and it can take some material into solution. A hydrogeologist is able to quantify some of these characteristics. A glossary of technical terms is provided to help in understanding.

Groundwater hydraulics

Groundwater derives from recharge by rainfall percolating vertically downwards under gravity through the soil zone to reach the water table. In this state the groundwater is unconfined, and once it has reached the water table it may flow laterally according to the prevailing head difference or hydraulic gradient on the water table. It may flow down the hydraulic gradient beneath an impermeable cover, at which point the aquifer becomes confined.

What happens at any one point in a groundwater system may affect what happens at other points. Whether these need to be considered in the ultimate management of the aquifer depend on the distances and time scales involved. If a distance is fixed, such as that between two village wells, then it is the time for a significant effect to propagate across that distance which is important. Conversely if the time scale is fixed, such as the duration of a drought, then the distance that is affected by pumping a source or group of sources becomes significant.

Groundwater chemistry

Groundwater chemistry is controlled by atmospheric inputs within the rainfall, biological activity mainly within the soil zone, water-rock interaction and human impacts.

Rain is a source of a number of solutes in small quantities and is also a weak acid. Acidity is enhanced in the soil zone where microbial activity promotes production of carbon dioxide (CO_2). This acidity in turn drives the weathering and dissolution process at the base of the soil where water and rock interaction and ion exchange are greatest. The presence of carbonate minerals such as calcite either as a sandstone cement, fracture infill or as limestone cause hard, carbonate rich groundwater, whereas silica rich rocks such as granite and silica cemented sandstones cause relatively soft and sometimes slightly acid groundwater.

The percolating groundwater may take only a few hours to pass down a fissure to the water table or it may proceed at a rate of up to 1 metre per year in a porous stratum such as alluvium. Once at the water table it can flow down the hydraulic gradient towards a natural point of discharge (a spring or baseflow discharge to a river or a stream). Depending on the distances, hydraulic gradient and transmissivities involved, this may take between a few tens of years to many thousands of years. The older the groundwater the greater the opportunity for it to reach chemical stability with the solid rock and generally this also means the more mineralised or more saline it can become. Older waters may be zoned with increasing depth, and it is not uncommon to find younger fresher groundwater over older saline (and, therefore, more dense) water.

The presence of oxygen in an unconfined aquifer, or reducing anoxic conditions which may be generated in an unconfined aquifer, dictate the chemical process that may occur within a given rock type. Extreme reducing conditions promote the uptake of metals in solution. These are commonly manifested as ochreous iron-stained deposits derived from the water once it is pumped up and left in contact with the air. Other metals may also be present, notably manganese, and sometimes lead and zinc. World Health Organisation suggests maximum desirable potable levels for various elements in *Guidelines for drinking-water quality: Volume 1 Recommendations* (WHO, 1993).

The main factor affecting transport of pollution through aquifers is the flow rate, which depends on the transmissivity and thickness of the aquifer, and the hydraulic gradient. Other factors to pollutant transport are adsorption on to the mineral grains and biological activity in the soil zone. Some organic pollutants also tend to break down through a process known as biodegradation, and with time change into new, sometimes less harmful products, in terms of water potability. Pollutant transport also affects dilution according to diffusivity within the aquifer. All these factors tend to produce an overestimation of groundwater pollution from point sources. Nevertheless protection of groundwater sources from contamination, particularly from nearby waste disposal facilities, is an important design consideration particularly for shallow and vulnerable unconfined aquifers.

Hydrogeological glossary

<i>adsorption</i>	the process by which a thin layer of a substance accumulates on the surface of a solid substance
<i>aerobic</i>	in the presence of the atmosphere and free oxygen.
<i>aquifer</i>	a rock formation which is sufficiently permeable to yield a usable quantity of water to a borehole, well or spring
<i>baseflow</i>	the sustained flow of a stream, provided from stored sources (principally groundwater). The flow is unrelated to a specific rainfall event
<i>biodegradation</i>	microbial breakdown of a compound
<i>bedrock</i>	the unweathered rock beneath the saprolite, regolith and/or alluvium
<i>confined aquifer</i>	an aquifer overlain by less permeable strata in which groundwater is under pressure
<i>crystalline basement</i>	non-sedimentary rocks which yield water from the regolith or aquifer weathered surface and fractures at depth
<i>drawdown</i>	the difference between the rest water level (or piezometric head) and the water level caused by pumping a borehole
<i>electrical resistivity depth sounding</i>	a geophysical survey technique by which an electrical current is passed through the ground between electrodes, and measured via another pair of electrodes. Electrode separation reflects the depth of observation. Interpretation is by mean of analogue
<i>evapotranspiration</i>	water returned from plants to the atmosphere
<i>fissures / fractures</i>	the preferential storage and transport of groundwater in fresh bedrock may best occur in dilated cracks or joints. Water may be fed to the fractures from the granular regolith above, provided that the saprolite is saturated
<i>gravel pack</i>	rounded granular material (typically 1 to 3mm in diameter) placed in the annulus behind slotted borehole casing or screen. It acts as a borehole stabiliser and as a means of promoting water flow into the borehole
<i>groundwater system</i>	qualitative description of the flow of groundwater in an aquifer and how it is affected by the prevailing geology
<i>head</i>	the height to which water rises above a set datum (often sea level) in a well or borehole
<i>hydraulic gradient</i>	the prevailing inclination of the water table which provides the driving force to transmit groundwater through an aquifer
<i>igneous</i>	rocks formed by solidification from a molten state; includes intrusive (e.g. granites) and extrusive rocks (e.g. lavas)
<i>ion exchange</i>	the exchange of ions between different colloids
<i>lithology</i>	a term referring to the general characteristics of a sedimentary rock
<i>metamorphic</i>	a rock derived from a pre-existing rock by mineralogical, chemical or structural change (e.g. pressure, heat), the process being sufficiently complete to form a well-defined new rock type
<i>permeability</i>	the ability of a material (e.g. rock) to allow fluid to pass through it under the pressure of a hydraulic gradient
<i>piezometric level</i>	the level to which water will rise in a borehole which penetrates groundwater confined in a fracture or beneath a confining layer such as clay
<i>porosity</i>	the ratio of the volume of the voids in a rock to the total volume of the rock
<i>precipitation</i>	rainfall or snowfall
<i>recovery</i>	the process which occurs when a pump is stopped and the water level in the borehole is allowed to rise back towards its static pre-pumping level. Incomplete recovery at an elapsed time greater than the total duration of the pumping phase may indicate over pumping
<i>regolith</i>	the weathering product that may be present over crystalline basement rocks. It may have a clay-rich upper part which inhibits downward percolation of rainwater, and is generally granular, progressing to blocky with depth. It may be a few metres to a few tens of metres thick
<i>salinity</i>	the concentration of salts and chemicals within water
<i>sedimentary</i>	a rock that has been laid down under the action of water, wind or ice from the detritus of existing rock material
<i>storativity</i>	the volume of water that can be removed under gravity from a saturated rock mass
<i>specific capacity</i>	the yield of a borehole divided by the respective drawdown. For inter-borehole comparison the pumping elapsed time should always be the same (e.g. 240 minutes)

<i>specific electrical conductivity</i>	the unit electrical conductivity of a fluid, which in the case of groundwater reflects the salinity of the water
<i>storativity</i>	the volume of water that can be released from or taken into storage per unit surface area of the aquifer for each unit change of head
<i>transmissivity</i>	a measure of the ability of an aquifer to transmit groundwater, being the product of aquifer thickness and aquifer hydraulic conductivity
<i>unconfined aquifer</i>	an aquifer in which the saturated zone meets the unsaturated zone at the water table, the latter maintained at atmospheric pressure

Bibliography for Water Resources Assessment

- American Society of Civil Engineers (1996)
- Bureau of Reclamation (1997)
- Calow *et al.* (1997)
- Freeze and Cherry (1979)
- Gunston (1998)
- Hamill and Bell (1986)
- Lerner *et al.* (1990)
- Linsley (1981)
- Struckmeier and Margat (1995)
- Todd (1980)
- Twort *et al.* (1985)
- Walton (1970)
- Wilson (1990)
- World Meteorological Organisation (1994)

Appendix B: Implementor or Facilitator? Achieving Community Management in Nepal²⁷

Jeremy Ockelford and Vijaya Shrestha

In a paper written for WHO, IRC states that ‘governments have a vital *facilitating* role to play in fostering local management and control of community water sources and supplies’ [emphasis added]. It goes on to emphasise partnership with local communities, and the type of decisions communities should be making with support of government agencies (IRC International Water & Sanitation Centre, 1995). But how are government agencies to achieve this? In many places government departments implement projects and programmes with community participation, but this can mean many different things.

The transformation from implementor to facilitator is much more difficult. This paper looks at a case in Nepal where His Majesty’s Government’s Department of Water Supply & Sewerage (DWSS) is making major efforts to achieve this transformation. The start of the process of changing this technical department to undertake the social and community components of rural water supply and sanitation were described by Shrestha and Pyakural (1996).

During the preparation of a major rural water supply and sanitation sector loan project with DWSS and the Asian Development Bank in early 1996, there was a debate in the water and sanitation sector about the respective roles of implementor and facilitator. These terms were not clearly defined but there was an assumption that the DWSS was an implementor, which was a bad thing, and that other groups, particularly NGOs, were facilitators, which was a good thing. Implementor and facilitator were seen in black and white terms, with an organisation being either one or the other. In fact, further discussion revealed that in many cases, NGOs had taken over the role of implementor instead of facilitating communities to manage the construction, operation and maintenance of their own water supply systems (Asian Development Bank and Department of Water Supply and Sewerage 1996).

This view of implementor and facilitator is rather simplistic and limiting. There are many steps in a project and in any one of these an agency may be an implementor or a facilitator, or part way between the extremes. To assist the DWSS in its efforts to change its way of working the team of consultants and staff preparing the project developed a table of the extreme definitions for implementor and facilitator in each step of the project, together with the changes needed to move from one to the other. A modified version of this is shown in Table 1 (Asian Development Bank and Department of Water Supply and Sewerage 1996).

The Table does not define the position of any particular agency, but it can be applied to any agency, including NGOs. An agency can be located anywhere at or between the extremes, so it may be a facilitator in some activities and an implementor in others. The DWSS itself was already a facilitator in several of the steps of a project, and was making progress in other steps.

²⁷ Paper reproduced from Ockelford and Shrestha (1998) in Pickford (1998)

Table 1: Definitions of Facilitator and Implementor

	Activity	Implementor	Facilitator	Changes needed
1	Community Water Supply and Sanitation Awareness Campaign	<ul style="list-style-type: none"> Telling people about water supply and sanitation 	<ul style="list-style-type: none"> Participatory discussion, with broad range of people in communities, about water supplies, hygiene and sanitation, drawing out people's own interests, practices and concerns. Explanation of how people will be involved with and make decisions in sub-projects. 	<ul style="list-style-type: none"> Staff orientation Training in PRA techniques Clear methodology for campaign meetings
2	Request from community	<ul style="list-style-type: none"> Request from small group only Political requests 	<ul style="list-style-type: none"> Broad based request from many (majority) members of community 	<ul style="list-style-type: none"> Orientation to DDC Council and Assembly
3	VDC and DDC Request Approval	<ul style="list-style-type: none"> Decisions made without information, transparency or accountability 	<ul style="list-style-type: none"> Formal approval by VDCs Prioritisation by DDCs in accordance with published criteria Communities informed of prioritisation 	<ul style="list-style-type: none"> Criteria published Priority criteria explained to communities Transparent decision making
4	Pre-feasibility study	<ul style="list-style-type: none"> Study directed by overseer with support of community 	<ul style="list-style-type: none"> Use of PRA techniques Mass meetings to provide orientation on project activities and procedures Verifications of need for water and interest of communities Data gathering by and with community members Water source identification Preliminary layout of system by community with technical explanation and advice by overseer 	<ul style="list-style-type: none"> Training in PRA and community approaches Training in facilitation of meetings Adequate time for processes
5	DDC and DWSS prioritisation	<ul style="list-style-type: none"> Decisions made without information, transparency or accountability 	<ul style="list-style-type: none"> Prioritisation by DDC/DWSO in accordance with published guidelines and criteria Communities informed of prioritisation and decision 	<ul style="list-style-type: none"> Clear simple guidelines and criteria openly available Transparent decision making
6	User need survey & feasibility study – socio-cultural, economic, health, technical	<ul style="list-style-type: none"> Survey staff carry out survey asking community for information Technical survey by technician/overseer with help from villagers 	<ul style="list-style-type: none"> Mass meetings to discuss feasibility study and explain techniques Use of PRA techniques Data gathering by community members Preliminary layout of system by community with technical explanation and advice by overseer 	<ul style="list-style-type: none"> Training in PRA Survey methodology based on PRA Development of methods and teaching materials to explain technology Change in attitude of technical staff to share and explain engineering knowledge Sufficient time for process to be conducted at villagers' pace
7	Appraisal of Feasibility Study Report	<ul style="list-style-type: none"> Appraisal by agency 	<ul style="list-style-type: none"> Appraisal by agency and community 	<ul style="list-style-type: none"> Sufficient time Feasibility report in Nepali and English

	Activity	Implementor	Facilitator	Changes needed
8	Social preparation process	<ul style="list-style-type: none"> Communities told about processes and processes imposed 	<ul style="list-style-type: none"> The following conducted using participatory methodologies: WUSC formed Health workers and teachers identified VMW appointed Volunteers selected O&M systems discussed and developed, including payment to VMW and O&M fund 	<ul style="list-style-type: none"> Sufficient time Technicians and overseers with community development skills Participatory methodologies for WUSC formation, VMW appointment, volunteer selection, etc. Linkage with and support to health posts
9	Agreement signed WUSC - Agency	<ul style="list-style-type: none"> Takes place between WUSC Chair and DE at DWSO, or at Agency's office 	<ul style="list-style-type: none"> Mass meeting to explain details of agreement Provision for modification of terms of the Agreement Agreement signed in the community at a mass meeting 	<ul style="list-style-type: none"> Flexibility in terms of Agreement
10	Preparation of detailed design, materials requirement, cost estimate	<ul style="list-style-type: none"> Done by Agency staff (or consultants) in office using standard procedures 	<ul style="list-style-type: none"> Design according to standards, but with drawings and explanation that can be understood by community Transparent materials estimation Transparent costs estimation 	<ul style="list-style-type: none"> Methods for presenting engineering design concepts in simple terms Transparent materials and costs estimating formats
11	Presentation of designs and cost estimates to communities	<ul style="list-style-type: none"> Not done 	<ul style="list-style-type: none"> Presented, explained and discussed Adjustments made by community Copy of design, materials quantities and cost estimates given to community 	<ul style="list-style-type: none"> Additional step Change in attitude of technical staff to share and explain engineering knowledge Adequate time
12	Training to WUSC in management of construction	<ul style="list-style-type: none"> Not done (Agency manages construction) 	<ul style="list-style-type: none"> Management training given to all members of WUSC on site 	<ul style="list-style-type: none"> Participatory training techniques
13	Procurement of materials	<ul style="list-style-type: none"> Central or regional procurement 	<ul style="list-style-type: none"> Procurement as close as possible to point of use WUSC involved in tender appraisal Purchase accounts open to community 	<ul style="list-style-type: none"> Decentralised procurement Procedures to allow WUSC to appraise tenders Transparent accounting
14	Construction	<ul style="list-style-type: none"> By contractor supervised by Agency staff 	<ul style="list-style-type: none"> By community with technical guidance and support from technical facilitator (WST) 	<ul style="list-style-type: none"> Abolition of contracting system Materials and financial advances to community for construction materials Training in management of construction WST full-time on site
15	Hygiene and water use education	<ul style="list-style-type: none"> Lecturing style of teaching Limited target group (WUSC only) 	<ul style="list-style-type: none"> Participatory teaching materials and training methods Targeting effective motivators in village (village health volunteers, women's groups, youth volunteers, WUSC, etc.) Follow-up trainings 	<ul style="list-style-type: none"> Participatory training materials and methods Trained trainers Adequate time

	Activity	Implementor	Facilitator	Changes needed
16	Sanitation	<ul style="list-style-type: none"> Insisting that people (WUSC members) build latrines 	<ul style="list-style-type: none"> Latrines built as a result of genuine understanding and demand 	<ul style="list-style-type: none"> Hygiene and water use education Latrines not used as only targets and indicators of hygiene and sanitation coverage
17	Training of VMW	<ul style="list-style-type: none"> Lecturing style of teaching 	<ul style="list-style-type: none"> Participatory training 	<ul style="list-style-type: none"> Participatory training materials and methods
18	Training of WUSC for management of O&M	<ul style="list-style-type: none"> Lecturing style of teaching 	<ul style="list-style-type: none"> Participatory training 	<ul style="list-style-type: none"> Participatory training materials and methods
19	Completion ceremony	<ul style="list-style-type: none"> 'Hand-over' of scheme to users 	<ul style="list-style-type: none"> Celebration of community's achievement in constructing their own system 	<ul style="list-style-type: none"> Reorientation of concept of 'ownership'
20	O&M monitoring and follow-up support	<ul style="list-style-type: none"> By DWSO Not done until repair required 	<ul style="list-style-type: none"> Regular visits by MST to ensure that WUSC and VMW are confident and functioning 	<ul style="list-style-type: none"> Application of 1993 O&M Policy Budget allocation and staff

Abbreviations

Abbreviations:	
DDC	District Development Committee (appointed by elected District Assembly)
DE	District Engineer (employed by DWSO)
DWSS	Department of Water Supply & Sewerage
DWSO	District Water Supply Office (responsible to DWSS)
MST	Maintenance & Sanitation Technician (employed by DWSO)
O&M	Operation and maintenance
PRA	Participatory rural appraisal
VMW	Village Maintenance Worker (responsible to WUSC)
WST	Water & Sanitation Technician (employed by DWSO)
WUSC	Water User & Sanitation Committee (elected by community)

Progress

The Fourth Loan Project was agreed between the ADB and the Government of Nepal in November 1996, and work started in January 1997. The project is due for completion by mid-2001, with a mid-term review scheduled for the end of 1998.

Progress in the transition by the DWSS from implementor to facilitator includes the appointment of sociologists, the training of technical staff (engineers, overseers and technicians) in PRA methodologies and social preparation, and development of new procedures with information sheets in Nepali for distribution in villages. In addition DWSS has issued a directive that construction cannot be started until the preparation phase is completed. About four months is allowed for this phase, covered by Activities 8 to 12 in Table 1. DWSS has developed a strong support and monitoring programme to ensure that the facilitation process is followed. For the first time a budget allocation for social preparation work is included in the new Ninth Five Year Plan of His Majesty's Government of Nepal.

References

- Asian Development Bank, and Department of Water Supply and Sewerage (1996), *Fourth Rural Water Supply and Sanitation Sector Project: Final Report of the Project Preparation Technical Assistance*, ADB/DWSS (unpublished), Kathmandu.
- IRC International Water & Sanitation Centre (1995), 'The Influence of Technology on Operation and Maintenance of Rural Water Supply Projects', in *Integrated Rural Water Management*, ed. WHO, Geneva.
- Shrestha V.L. and Pyakural D.C. (1996), 'Community management and socialising engineers', in *Reaching the Unreached: Challenges for the 21st Century*, Proceedings of the 22nd WEDC Conference, J. Pickford *et al.* (eds), WEDC, Loughborough.

Appendix C: References and Bibliography

- African Development Bank, 1990, *Environmental Sector Policy Paper*, African Development Bank.
- Almedom, A., Blumenthal, U. and Manderson, L., 1997. *Hygiene Evaluation Procedures*. International Nutrition Foundation for Developing Countries, London.
- American Society of Civil Engineers, 1996. *Hydrology Handbook* (2nd edition). ASCE Manuals and Reports on Engineering Practice, No.28. American Society of Civil Engineers, New York.
- Asian Development Bank, 1992. *Guidelines for The Health Impact Assessment of Development Projects*, Office of the Environment, Asian Development Bank, Manila.
- Asian Development Bank, 1993. *Environmental Assessment Requirements and Environmental Review Procedures of the Asian Development Bank*. Asian Development Bank, Manila.
- Asian Development Bank, 1994. *Handbook for Incorporation of Social Dimensions in Projects*. Asian Development Bank, Manila.
- Asian Development Bank, 1998. *Guidelines on the Use of Consultants by Asian Development Bank and its Borrowers*. Asian Development Bank, Manila
- Banez-Ockelford, J., 1995. *Partners in Creative Training*. PACT/JSI, Phnom Penh, Cambodia.
- Bolt, E. (Editor), 1994. *Together for Water and Sanitation: Tools to Apply a Gender Approach - The Asian Experience*. Occasional Paper Series No.24. IRC International Water and Sanitation Centre, The Hague.
- Boot M.T., 1990. *Making the Links: Guidelines for Hygiene Education in Community Water Supply and Sanitation*, Occasional Paper Series Nos. 5. IRC International Water and Sanitation Centre, The Hague.
- Boot, M.T., 1991. *Just Stir Gently: The way to mix hygiene education with water supply and sanitation*. Technical Paper Series No. 29. IRC International Water and Sanitation Centre, The Hague.
- Boot, M.T. and Cairncross, S. (Editors), 1993. *Actions Speak: The study of hygiene behaviour in water and sanitation projects*. London School of Hygiene and Tropical Medicine and IRC International Water and Sanitation Centre, The Hague. .
- Brassington, R., 1988. *Field Hydrogeology*. Geological Society of London Professional Handbook. Open University Press, Milton Keynes, UK.
- Bureau of Reclamation, U.S.A., 1997. *Water Measurement Manual* (Third Edition). Bureau of Reclamation, United States Department of the Interior, in co-operation with the U S Department of Agriculture. United States Government Printing Office, Pittsburgh, USA
- Cairncross, S. Carruthers I., Curtis D., Feachem R., Bradley D., Baldwin G., 1980. *Evaluation for Village Water Supply Planning*. John Wiley & Sons, Chichester.
- Cairncross, S. and Feachem, R., 1986. *Small Water Supplies*. Ross Bulletin No.10. The Ross Institute of Tropical Hygiene, London.
- Cairncross, S. and Feachem, R., 1993. *Environmental Health Engineering in the Tropics*. John Wiley & Sons, Chichester, UK.
- Cairncross S., and Kochar V., 1994. *Studying Hygiene Behaviour. Methods, Issues and Experiences*. Sage Publications, London.
- Calow R.C., Robins N.S., MacDonald A.M., Macdonald D.M.J., Gibbs B.R., Orpen W.R.G., Mtembezeka P., Andrews A.J. and Appiah S.O., 1997. 'Groundwater management in drought prone areas of Africa', *International Journal of Water Resources Development*, 13, 2, pp.241-261
- Chambers, R., 1993. *Challenging the Professions*. IT Publications, London.
- Chandler, C.G., 1985. *Achieving Success in Community Water Supply and Sanitation Projects*. SEARO Regional Health Papers No.9. WHO, New Delhi.
- Colin, J., 1999. *VLOM for Rural Water Supply: Lessons from Experience*. Task No.162, WELL, London and Loughborough.
- Cotton, A., Pintelon, L., Janssens, J. and Gelders, L., 1994. *Tools for the Assessment of Operation and Maintenance Status of Water Supplies*. WHO, Geneva.
- Cullivan, D., Tippet, B., Edwards, D.B., Rosenweig, F. and McCaffery, J., 1988. *Guidelines for*

- Institutional Assessment: Water and Wastewater Institutions*. WASH Technical Report No.37. WASH, Washington D.C.
- Davis, J. and Brikke, F., 1995. *Making your water supply work: Operation and maintenance of small water supply systems*. Occasional Paper Series No. 29. IRC International Water and Sanitation Centre, The Hague.
- Davis, J., Garvey, G. and Wood, M., 1993. *Developing and Managing Community Water Supplies*. Oxfam Development Guidelines No.8. Oxfam, Oxford.
- Dublin (1992) *The Dublin Statement and Report of the Conference*, International Conference on Water and the Environment: Development issues for the 21st Century, 26-31 January 1992, Dublin, Ireland.
- Eade, D. and Williams, S. (Editors), 1995. *The Oxfam Handbook of Development and Relief*, Oxfam, Oxford.
- Edwards, D.B., Salt, E. and Rosenweig, F., 1992. *Making Choices for Sectoral Organization in Water and Sanitation*. WASH Reprint: Technical Report No. 74. Environmental Health Project (formerly WASH), Washington D.C.
- Edwards, D.B., Rosenweig, F. and Salt, E., 1993. *Designing and Implementing Decentralisation Programs in the Water and Sanitation Sector*. WASH Technical Report No.89. WASH, Washington D.C.
- Environmental Health Project, 1997. *Better Sanitation Programming: A UNICEF Handbook*. EHP Applied Study No.5. Environmental Health Project, Washington D.C.
- Evans, P., 1992. *Paying the Piper: An overview of community financing of water and sanitation*. Occasional Paper Series. IRC International Water and Sanitation Centre, The Hague,.
- FAO, 1995. *Water sector policy review and strategy formulation: A general framework*. FAO Land and Water Bulletin No.3. FAO, Rome.
- Freeze R.A. and Cherry J. A., 1979. *Groundwater*. Prentice Hall, New Jersey.
- Frelick, G., and Fry, S., 1990. *Training on Hygiene Education*. WASH Reprint: Technical Report No 60. Environmental Health Project (formerly WASH), Washington D.C.
- Gajanayake, S. and Gajanayake, J., 1993. *Community Empowerment: A Participatory Training Manual on Community Project Development*. PACT Publications, New York.
- Good, A., 1996. 'Social Issues in NGO Water Projects' in I. Smout (Editor), *Water and NGOs: Proceedings of an ODA workshop*. WEDC, Loughborough University, Loughborough.
- Gosling, L. and Edwards, W.M., 1995. *Toolkits: A Practical Guide to Assessment, Monitoring, Review and Evaluation*. Save the Children Development Manual No.5. Save the Children, London.
- Gunston, H.M., 1998. *Field Hydrology in Tropical Countries*. IT Publications, London.
- Hamill L. and Bell F.G., 1986. *Groundwater Resource Development*. Butterworths, Sevenoaks, UK.
- Hamilton, D. and Gaertner, U., 1991. *Goal Oriented Project Planning: An Introduction to the Methodology*. UNDP Office for Project Services, GTZ, Manila.
- Handy, C., 1993. *Understanding Organizations*. Penguin Books, London.
- International Labour Office, 1993. *How to select and use consultants: A client's guide*. ILO, Geneva.
- IRC and NETWAS (Editors), 1994. *Working with Women and Men on Water and Sanitation: An African Field Guide*. Occasional Paper Series. IRC International Water and Sanitation Centre, The Hague.
- Jordan, T., 1984. *A Handbook of Gravity-Flow Water Systems*. Intermediate Technology Publications, London.
- Kamminga, E., 1991. *Economic Benefits from Improved Rural Water Supply: A review with a focus on women*. IRC Occasional Paper. IRC International Water and Sanitation Centre, The Hague.
- Kjellerup, B. and Ockelford, J., 1993. 'Handpump standardization in Cambodia' in *Waterlines* 12 (No.1), IT Publications, London.
- Lerner D.N., Issar A.S. and Simmers I., 1990. *Groundwater recharge*. International Contributions to Hydrogeology No.8. International Association of Hydrogeologists, Kenilworth, UK.

- Linney, B., 1995. *People, Pictures and Power: People-centred visual aids for development*. MacMillan and TALC, London.
- Linsley, R.K., 1981. *Hydrology for Engineers* (3rd edition). McGraw Hill, New York.
- Listorti J.A., *Environmental Health Components for Water Supply, Sanitation, and Urban Projects*. World Bank Technical Paper Number 121. The World Bank, Washington, D.C.
- Lutz W., Chalmers, Hepburn and Lockerbie, 1992. *Health & Community Surveys*. Volumes I & II. Macmillan, London.
- Mbewe, I.J. and Sutton, S., 1999. 'Under-estimated potential of traditional water sources?' in J. Pickford (Editor), *Integrated development for water supply and sanitation*. Proceedings of 25th WEDC Conference, Addis Ababa. WEDC, Loughborough.
- Miloradov, M. and Marjanovic, P., 1998. *Guidelines for conducting water resources assessment*. Studies and reports in hydrology. UNESCO Publishing, Paris.
- Morgan D.L., 1988. *Focus Groups as Qualitative Research*. Sage Publications, Newbury Park, CA, USA.
- Morgan, P., 1990. *Rural Water Supplies and Sanitation*. MacMillan Education Ltd, London.
- Mpumalanga Workshop, 1999. *Financing of Community Water and Sanitation Services: The Mpumalanga Statement*. DWAF, Mvula Trust, WSP-ESA, UNICEF, DFID. http://www.africanwater.org/mpumalanga_statement.htm
- Narayan, D., 1993. *Participatory Evaluation: Tools for managing change in water and sanitation*. World Bank Technical Paper No.207. World Bank, Washington D.C.
- Narayan, D. and Srinivasan, L., 1994. *Participatory Development Toolkit: Training materials for agencies and communities*. World Bank, Washington D.C.
- Noppen, D. (Editor), 1996. *Village Level Operation and Maintenance of Handpumps: Experiences from Karonga, Malawi*. Project and Programme Papers. IRC International Water and Sanitation Centre, The Hague.
- Ockelford, J., 1996. 'Technical and Management Issues' in I. Smout (Editor) *Water and NGOs: Proceedings of an ODA Workshop*. Loughborough University, Loughborough.
- Ockelford, J. and Shrestha, V., 1998. Implementor or Facilitator? Achieving Community Management in Nepal. In: J. Pickford (Editor), 24th WEDC Conference: Sanitation and Water for All. WEDC, Islamabad, pp. 110-113.
- Pickford, J., 1995. *Low-Cost Sanitation: A survey of practical experience*. IT Publications, London.
- Pickford, J. (Editor), 1998. *Sanitation and Water for All: Proceedings of the 24th WEDC Conference*. WEDC, Loughborough.
- Reinke, W.A., Stanton, B.F., Roberts, L. and Newman, J., 1993. *Rapid Assessment for Decision Making: Efficient Methods for Data Collection and Analysis*. WASH Field Report No.391. WASH, Washington D.C.
- Roark, P., Hodgkin, J. and Wyatt, A., 1993. *Models of Management Systems for the Operation and Maintenance of Rural Water Supply and Sanitation Facilities*. Environmental Health Project/WHO, Washington D.C.
- Saywell, D., 1999. 'Pollution from on-site sanitation - the risk? What risks?' *Waterlines*, 17, No.4. IT Publications, London.
- Schaefer M., 1993, *Health, Environment and Development: Approaches to Drafting County-Level Strategies for Human Well Being under Agenda 21*. WHO, Geneva.
- Slocum, R., Wichhart, L., Rocheleau, D. and Thomas-Slayter, B. (Editors), 1995. *Power, Process and Participation: Tools for Change*. IT Publications, London.
- Struckmeier W. F. and Margat J., 1995. *Hydrogeological maps: A guide and a standard legend*. International Contributions to Hydrogeology No.17. International Association of Hydrogeologists, Kenilworth, UK.
- Therkildsen, O., 1988. *Watering White Elephants?* Scandinavian Institute of African Studies, Uppsala.
- Thomas-Slayter B., Esser A.L. and Shields M.D., 1993. *Tools of Gender Analysis: A Guide to Field Methods for Bringing Gender into Sustainable Resource Management*, ECOGEN Research Project, International Development Program, Clark University, Worcester, MA, USA.

- Todd, D.K., 1980. *Groundwater Hydrology* (2nd edition). John Wiley, New York.
- Tomaro, J.B. and Wall, R.E., 1991. *Technical Assistance to the African Development Bank: Development of Guidelines for Project Preparation and Appraisal in Water Supply and Sanitation*. WASH Field Report No. 333. WASH, Washington D.C.
- Twort A.C., Law F.M. and Crowley F.W., 1985. *Water Supply*. Edward Arnold, London
- Wakeman, W., 1995. *Gender Issues Sourcebook for Water and Sanitation Projects*. UNDP-World Bank Water & Sanitation Program, Washington D.C.
- Walton W.C., 1970. *Groundwater Resource Evaluation*. McGraw-Hill, New York.
- WASH, 1987. *Guidelines for Designing a Hygiene Education Programme in Water Supply and Sanitation for Regional/District Level Personnel*. WASH Field Report 218. Washington D.C.
- Water Supply & Sanitation Collaborative Council, 2000. *Vision 21: A Shared Vision for Hygiene, Sanitation and Water Supply and a Framework for Action*. WSSCC, Geneva.
- Watt S.B. and Wood W.E., 1979. *Hand Dug Wells and Their Construction*. IT Publications, London.
- WELL for DFID, 1998. *Guidance Manual on Water Supply and Sanitation Programmes*. WEDC, Loughborough.
- Werner, D. and Bower, B., 1982. *Helping Health Workers Learn*. The Hesperian Foundation, Palo Alto, California.
- Whyte, A., 1986. *Guidelines for planning community participation activities in water supply and sanitation projects*. WHO Offset Publication No.96. WHO, Geneva.
- Wijk-Sijbesma, C. van, 1985. *Participation of Women in Water Supply and Sanitation*. Technical Paper No. 22, 22. International Reference Centre for Community Water Supply and Sanitation, The Hague.
- Wijk-Sijbesma, C. van, 1998. *Gender in Water Resources Management, Water Supply and Sanitation*. Technical Paper Series. IRC International Water and Sanitation Centre, The Hague.
- Wilson, E.M., 1990. *Engineering hydrology* (4th edition). Macmillan, Basingstoke, UK.
- Wood, S., Sawyer, R. and Simpson-Hebert, M., 1998. *PHAST Step-by-step Guide: A participatory approach for the control of diarrhoeal disease*. WHO, Geneva.
- World Health Organisation, 1985. *Guidelines for Drinking-Water Quality: Vol.3 Drinking-water quality control in small-community supplies*. WHO, Geneva.
- World Health Organisation, 1993. *Guidelines for drinking-water quality: Volume 1 Recommendations*. WHO, Geneva.
- World Health Organisation, 1994. *Financial management of water supply and sanitation*. WHO, Geneva.
- World Health Organisation and UNICEF, 1998. *Water Supply and Sanitation Sector Monitoring Report*, World Health Organisation, Geneva.
- World Meteorological Organisation, 1994. *Guide to Hydrological Practices: Data acquisition and processing, analysis, forecasting and other applications* (5th edition). WMO No.68. World Meteorological Organisation, Geneva.