5

EQUIPMENT AND ADDRESSES

5

Glossary

The following definitions are those used within these documents but may not be dictionary definitions.

For definitions of the following words refer to the section *Background to groundwater and aquifers pp230-5*:

aquiclude; aquifer; aquitard; artesian borehole; basement complex confined aquifer; consolidated sediments; desalination; dyke; evaporation; fault; fissure; fracture; fractures; ground water; hydraulic conductivity; igneous; infiltration; joint; laterite; loam; loess; metamorphic; mineral; perched aquifer; percolation; permeability; pores; porosity; precipitation; rock; saturated zone; sedimentary; sill; soil; specific yield; sub-soil; sub-surface water; surface water; transmissivity; transpiration; unconfined aquifer; unconsolidated sediments; unsaturated zone; voids; water table; weathering.

Accessibility — How easy something is to access or approach.

Affected population — Refugees, internally displaced persons and populations not displaced but still affected by an emergency. Where a displacement has occurred a differentiation has been made between the displaced and non-displaced or 'local population'.

Aggessivity — The carbon dioxide level in the water. Aggressive waters tend to be corrosive and hence can damage supply systems.

Agrochemical pollution — Pollution resulting from agriculture including chemicals used therein.

Assessment — Evaluation. Process of identifying and understanding a situation.

Assisted sedimentation — Sedimentation speeded up with the addition of chemicals such as alum, ferric chloride or other. Includes the processes of flocculation, coagulation and sedimentation.

Biological survey — A study of the water based biological life in an area e.g. small water animals, plants, algae, invertebrates etc.

Birka — An uncovered rainwater catchment pond / tank found in Southern Sudan and Ethiopia. Often lined with vertical concrete walls.

BOD_5 or BOD — The five day biochemical oxygen demand is defined as the amount of oxygen required by bacteria while stabilising decomposable organic matter under aerobic conditions (Sawyer and McCarty, 1978).

Borehole	A hole drilled to give access to an underground water source. Other names include tubewell or drilled well.
Catchment map	A diagrammatic representation of a catchment area i.e. an area of land where the natural slope of the ground leads water to be drained into a river basin or reservoir. Map should include potential sources of pollution.
Disaster	'A 'disaster' results in serious disruption of society, causing widespread human suffering and physical loss or damage, and stretches the community's normal coping mechanisms to breaking point' (Davis and Lambert, 1995).
E.coli	*Esherichia coli*, thermotolerant coliform organisms used as indicator organisms to identify the likelihood of faecal pollution.
EBCT	Empty Bed Contact Time. Calculation of time for a volume of water to pass through a filter with media, calculated ignoring the volume of the media i.e. as though the filter bed was empty.
Emergency	'A crisis that arises when a community has great difficulty in coping with a disaster. External assistance is needed, sometimes lasting for many months, perhaps years' (Davis and Lambert, 1995).
Evaluation	'An assessment at one point of time of the impact of a piece of work and the extent to which the objectives have been achieved' (Gosling and Edwards, 1995 p98).
Geomorphological analysis	The analysis, description and interpretation of landforms.
Global Positioning System (GPS)	Devise used for locating positions in the world using information from American military satellites.
***Hafir* dam**	A constructed rainwater catchment pond with a settlement basin at the inlet and a separate outlet for abstraction. Found in Southern Sudan and Ethiopia.
Hydroclimatic monitoring	Monitoring of climatic changes and the effects on the hydrology of the area.
Hydrogeology	The study of geology and water in the ground.
Industrial pollution	Pollution from industrial or agricultural sources.
Internally displaced person	A person displaced within the boundary of their own country.

Invertebrates	Any animal lacking a backbone.
Landsat images	Satellite images showing thermal signatures of the ground.
Local population	Population living near to the displaced population who were there prior to the emergency or disaster.
Logistics	Planning and organisation of the provision of resources.
Morbidity data	Data relating to diseases.
Mortality data	Data relating to death.
National and local government	Central, regional and local government and, although not strictly true, authorities concerned with the supply and management of utilities.
Natural threats	Natural phenomenon which causes danger to people, facilities and the environment. May include earthquakes, volcanic eruptions, hurricanes and others.
Operation and maintenance	The activities undertaken to ensure the continued running of a process such as chemical dosing and structural repair.
Organisation	Used in this document to cover NGOs and international agencies.
Refugee	Person who has crossed an international border in genuine fear of persecution (refer to the Geneva Conventions for complete definitions).
Sanitary investigation	Survey of the sanitary or hygienic conditions of a water source.
Schmutzdecke	A layer of sediment and microbiological growth which forms on the top of a slow sand filter and breaks down pathogens by biological and chemical processes.
Seasonal yield	Volume of water obtainable from a water source during a particular season of the year.
Sedimentation	The settlement of solid matter to the bottom of a liquid.
Small water animals	Small invertebrates living in surface water, visible with the naked eye.
Socio-political consideration	A consideration related to the social or political environment.

Spring	Natural outflow of groundwater which often forms the starting point of a stream.
Survey	To look at and take a general view of.
Tankering / trucking	The transportation of water by vehicular means.
Treatability	How easy a water is to treat/ clean/ improve to a required level.
Turbidity	The murkiness of water caused by suspended materials.
Upgrading approach	Where systems are designed at a specified level of service and then subsequently improved to higher levels of service.
Water quality analysis	Evaluation of water quality using laboratory or field water testing equipment.
Water quality assessment	Evaluation of water quality using one or more of a range of methods (including water quality analysis, catchment mapping and others).
Water quality parameter	A characteristic of water quality, either chemical, physical or biological.
Water source	A water body from which water may be abstracted or obtained. Can be groundwater, surface water or rainwater. It could also be a point on an existing supply system.
Water supply	Where water is provided. It may be from a groundwater source via a borehole, shallow well or spring or from a surface water source via direct abstraction or pumped, or from rainwater collected in tanks, in ponds in the ground or sub-surface dams. Supply may be simple where the user abstracts straight from a source or it may be a complex arrangement of pumps, pipes and taps.
Well	A hole or shaft bored or dug into the earth to allow abstraction of supply of water, oil, gas etc.

Water quality analysis and surveying equipment

The types of equipment required to assess water sources in an emergency situation can be split into the following groups:
- general (including surveying, flow measurement and other); and
- water quality analysis.

Brand names and suppliers have been noted in the following listings for convenience but this does not imply endorsement by WEDC or DFID. Other brands may be just as suitable.

General equipment (surveying, yield measurement etc.) ■

General items include equipment for surveying, yield measurement, sample collection, storage, and treatability testing.

The most important items of equipment for each activity are as follows:
- **surveying** (compass; clinometer / Abney level; 3m tape; line level; altimeter / aneroid barometer; global positioning system)
- **yield measurement** (stop watch; 3m tape)
- **sample collection and storage** (sample bottles; syringes for dilutions or measurement of small volumes; sampling container and string)
- **treatability testing** (beakers (1-litre if possible); spatula / spoon; chemicals)
- **other** (sampling net for biological survey; workplace mat; tissues; marker pen; Swiss Army Knife or equivalent; torch / flashlight; survey or record book)

See the tables, pp281–2 for a detailed list of equipment.

Makes and suppliers of general equipment ■

Clinometer or Abney level

Makes and Suppliers
Clinometers and altimeters can both be purchased from surveying equipment suppliers. Their prices range from £85 (including sales tax) to several hundred pounds.

Makes (1996; Abney level):	Abney level (5.25 inch; 6.5 inch)
Makes (1996; Clinometer):	Suunto Clinometer (aluminium body with or without light illumination); Suunto Compass / Clinometers; Silva Compass / Clinometers
Example supplier:	GeoSupplies Ltd.

Altimeter or aneroid barometer

Makes and Suppliers
Altimeters are supplied by outdoor specialists and possibly surveying equipment suppliers. Their prices can range from around £100 to several hundred pounds.

Makes (1996):	Thommen Altitronic Traveller (range -500 to +6000m +/- 10m); Thommen Altitrek Altimeter (range 0 to + 5000m +/- 30m); Avocet Vertech; Silva;
Example suppliers:	Field & Trek Ltd.; Cotswolds

Global positioning system (GPS)

Makes and Suppliers
There are many suppliers and makes of GPS receivers and prices range from approximately £130 (including sales tax) to thousands of pounds. Following are a few of the makes at the lower price range and their suppliers:

Makes (1996):	Garmin (GPS 38, GPS 40, GPS 45XL); Magellan (GPS 2000, GPS 300, GPS 4000, Meridian XL, Trailblazer XL); Trimble (Scout Master (tm) GPS); Silva (GPS XL1000)
Example suppliers:	Business on the Move Ltd.; Field & Trek Ltd.; Cotswolds; Silva (UK)Ltd.

See *Catchment mapping: surveying*, pp161-8 which discusses each item of equipment and its applicability to the assessment of water sources. Also see *Useful addresses*, pp286–8 for suppliers' details.

Water quality analysis equipment ■

A range of equipment types are available for the measurement of each water quality parameter.

Physical and chemical testing equipment

The following list is a selection of equipment types.

Comparator with discs
Colorimetric method. Tablets are dissolved in the sample in a small tube. The sample in the tube is viewed in the comparator versus a graded colour on an interchangeable disc. The colour intensity / shade indicates the concentration of the parameter being tested.

Checkits / pool-testers or pocket kits
Colorimetric method. Tablets are dissolved in the sample and the resulting colour compared to a scale which is either on the sample container (checkit or pool-tester) or on a separate card (pocket kits).

Papers
Colorimetric method. Test paper strips have reactive test zones which produce colours relative to the concentration of the parameter under test. The strip is dipped into the sample and after the colour change has occurred it is compared to a scale.

Photometer
Colorimetric method. The photometer is an electronic instrument which has built in filters and a digital display. Tablets are dissolved in the sample and then the concentration of colour is measured electronically. Calibration has to be undertaken against a blank of the sample.

Electronic stick meters
Small electronic stick meters which read digitally when the enclosed electrode is submerged. They require calibrating against a standard solution periodically.

Tablet count
Titrimetric method. Tablets are dissolved one by one into a sample of known volume until a prescribed colour change takes place. The concentration of the parameter is determined from the number of tablets and the size of the sample.

Shelf-life and storage conditions for consumables:

- The **foil-wrapped tablets** (for photometer, comparator with discs and checkits) should be stored in a cool, dry place out of direct sunlight to maintain their maximum shelf-life of five years. If stored in other conditions the shelf-life reduces to two years maximum. They should always be stored out of direct sunlight.
- The **bottled tablets** (tablet count method) have a shelf-life of nine months when the seal is broken if stored in cool, dry conditions. If the seal has not been broken then they last much longer. If the seal is broken and they are stored in hot, humid conditions then the shelf-life will be six months at a maximum. They should be stored out of direct sunlight.
- The **paper strips** (as in the Merckoquant strips) will last for five years if unopened and stored in a cool, dry place (room temperature is acceptable). If opened or stored in hot and humid conditions then the manufacturer would not state time scales. They should be stored out of direct sunlight.

Microbiological testing equipment:

Several methods for the quantitative determination of indicator bacteria in a water sample are noted below with their major advantages and disadvantages.

Multiple tube (or Most probable number (MPN))
This method involves the addition of measured volumes of the sample to sets of sterile tubes or bottles each holding a suitable liquid medium (containing lactose). Thermotolerant coliform organisms (*E.coli*) produce acid and gas when incubated at 44°C for 48 hours. They then need to be incubated for a longer period for confirmative tests. This method is often used in laboratories in developing countries but is not suitable for field analysis.

Advantages:
- can be used for turbid water
- good for the detection of a small number of organisms

Disadvantages:
- result take a long time
- large volume of consumables
- training is required to carry out the test

Membrane filtration
This method involves filtering a measured volume of the sample through a membrane filter with a pore size of 45μm. Micro-organisms are retained on the surface of the filter. The filter is then placed on an absorbent pad which has been soaked in a suitable selective growth medium (containing lactose) in a petri dish and then incubated at 44°C for 24 hours. Bacteria grow into colonies on the filter paper and can be counted visually.

Advantages:
- results are quicker than from multiple tube method
- uses less consumables than the multiple tube method

Disadvantages:
- it is unsuitable for use with turbid waters or waters containing small numbers of desired organisms, as they and the undesirable bacteria grow on the same medium
- training is required to carry out the test
- there are many opportunities for contamination

Colilert / MUG

A known volume of the sample is added to pre-prepared test tubes which have then been sealed. In each tube is a mixture containing salts, nitrogen and carbon sources and a specific indicator for *E.coli* and total coliform (MUG and ONPG). Non-coliform bacteria are chemically suppressed. The tubes are incubated at 37°C. In less than 24 hours positive tubes containing total coliform turn yellow and positive tubes containing *E.coli* fluoresce in the dark. The test is confirmatory.

Advantages:
- the short time required to produce confirmed results (less than 24 hours)
- it is a simple test to undertake and does not require lengthy training
- sterilization is not necessary
- additional pieces of equipment are not needed except for an incubator, a fluorescent light (and sterile, bacteria free water and syringes if required)
- the tubes can be stored at room temperature
- the tubes can be incubated against the body in an emergency

Disadvantages:
- a large number of consumables are required
- a five tube test will only indicate up to >16 per 100ml. To determine higher levels dilution is required with bacteria-free water

Dipslides

A pre-prepared sampler, consisting of a plastic handle with a 0.45μm filter and an absorbent pad containing dehydrated nutrient medium, is immersed in the sample. 1 ml of the sample is drawn through the filter and the resulting sampler is incubated at 44 °C for 24 hours. Each colony represents 1 organism per 1ml (100 per 100ml).

Advantages:
- simple to use and no training needed
- sterilization is not required
- additional equipment is not required except an incubator

Disadvantages:
- the method is not recommended for counts of less than 10 colonies per 1ml (manufacturer's literature)
- the dipslides need to be stored at 0-2°C

Other methods:

Studies have been undertaken into alternative, non-traditional, procedures for estimating water quality. Four simple tests were studied (IDRC / CRDI / CIID, 1990) to try and overcome the problems of the present bacteriological tests. Problems with current tests are that:
- the tests are not easily portable;
- they require trained personnel; and
- they use expensive supplies;
- a long time is required to obtain the results.

Water quality analysis: General equipment

Survey equipment

Left to right: line level, global positioning system receiver, compass / clinometer, altimeter and stopwatch

Other equipment

Left to right: 1 litre beaker, autoclavable sample containers, marker pen, spatula / spoon, tissues, 10 ml and 1 ml syringes

De-ionisation pack

Water quality analysis: Physical / chemical test equipment

Comparator with disks

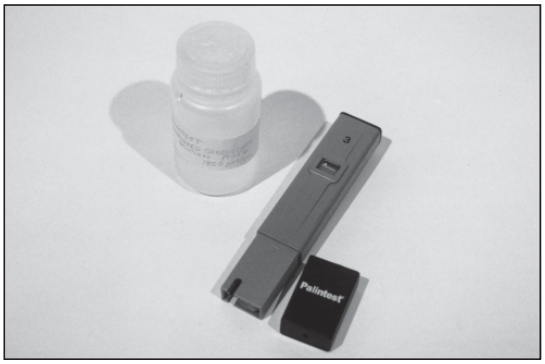
Checklists / pool testers and pocket kits

Paper strips

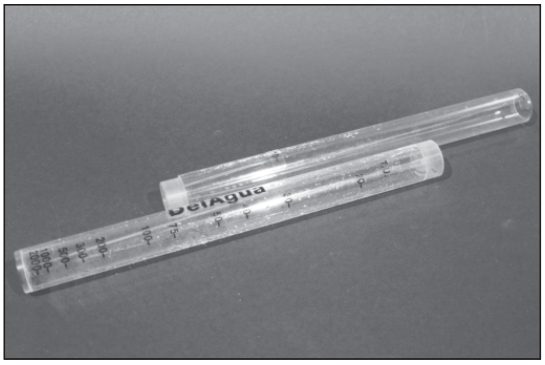
Photometer

Water quality analysis: Physical / chemical test equipment

Electric stick meters



Turbidity tube



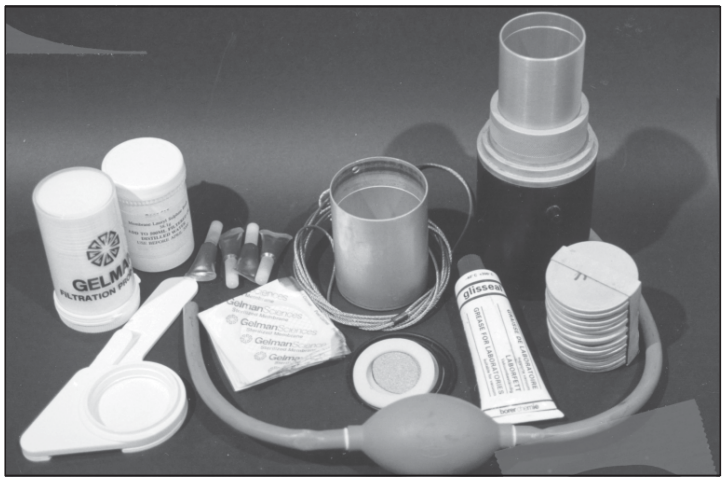
Test kits

Tablet count

Water quality analysis: General equipment

Sampling net

Water quality analysis: Microbiological test equipment



Membrane filtration apparatus (minus incubator)

Left to right: filter pads and dispenser, membrane lauryl sulphate broth and MFC broth, filter papers, sampling cup and line, spares for filtration unit, filter suction pump, grease, filter unit and petri dishes)

Colilert test, H_2S strip and dipslides

Left to right: Colilert test tubes, fluorescent light, H_2S strip tube and dipslides

The four tests studied were:
- Bacteriophages
- A-1 broth
- H_2S paper strip
- Presence / absence tests

The tests are not all quantitative. Further research needs to be undertaken but the tests look promising and may overcome some of the problems mentioned above. Some of the above tests are available commercially: the H_2S paper strip test is supplied as part of the All India Institute of Hygiene & Public Health and UNICEF Water Quality Field Test supplied in India. It is also supplied by the Fundaçion Zumaque in Venezuela and Premier Health Care Products in India.

Makes and suppliers of water quality testing equipment ■

See table p270 for a selection of 'ready-made' test kits as provided by suppliers which include a microbiological component. Also see the tables pp271–276 which identify alternative items of field equipment for a range of chemical, physical and microbiological parameters and *Useful addresses,* pp286–288 for suppliers' addresses.

Notes accompanying tables pp271–276:

(i) Prices quoted are as of June 1997 and do not include sales tax or postage and packaging.

(ii) PT= Palintest; WT= Wagtech; CAM = Camlab; ELE= ELE; DEL= Delagua; MER= Merck; TINT= Tintometer

(iii) Items marked with a ✣ have chemicals which are restricted for transport by IATA regulations. Note that other items in tables pp271–276 may also be restricted in the same way. Confirmation should be sought prior to purchase.

(iv) Tables pp272–276 do not include capital costs or details for the photometer or the Lovibond or Palintest disc comparators. The basic costs for these items can be found in table p271 and should be added where necessary.

'Ready-made' test kits (including microbiological components)

Parameter	Delagua/ Oxfam	ELE '50'	ELE '25'	ELE '25I'	Wagtech 'potalab'	Wagtech 'potakit'	CAMLAB HACH, MEL presence/ absence safe drinking water lab
E.coli (includes lighter, tweezers, silicone grease, etc.)	membrane filtration - 16 test 44°C aluminum dishes {lauryl sulphate broth (lsb)} (incubator in kit box)	membrane filtration - 50 test 37 or 44°C aluminum dishes (50) or plastic dishes (16) {lsb} (incubator in kit box)	membrane filtration - 25 test 37 or 44°C aluminum dishes (25) or plastic dishes (8) {lsb} (incubator in kit box)	membrane filtration - 25 test 37 or 44 °C aluminum dishes (25) or plastic dishes (8) {lsb} (incubator in kit box)	membrane filtration - 50 / 16 test 37 or 44°C aluminum dishes (50) or plastic dishes (16) {lsb} (incubator in kit box)	membrane filtration - adjustable 25 to 50°C plastic dishes {lsb} (incubator not in kit box)	MUG reagents in disposable test tubes and fluorescent lamp (incubator included which fits in kit box)
sampling cup	yes	yes	yes	yes	yes	yes	-
turbidity	tube 5-2000 TU	meter 0-50 NTU	meter 0-50 NTU	tube 5-500 JTU	tube 5-500 JTU	tube 5-500 JTU	-
pH	comparator {phenol red 6.8-8.2}	meter 0-14	meter 0-14	photometer {phenol red 6.8-8.4}	meter 0-14	comparator 4-11{universal} ✻{other indicators available}	pH stick probe
conductivity	meter	meter 0-2000 µS/cm (temperature compensation)	meter 0-2000 µS/cm (temp. comp.)	meter 0-2000µS/cm (temp. comp.)	meter 0-1999µS/cm	pocket meter 0-199µS/cm	TDS probe
temperature	meter	meter -30 to- +150°C	meter -30 to +150°C	meter -30 to +150°C	meter 0-100°C	thermometer	thermometer
redox	-	meter 0-1999 mV	meter 0-1999mV	meter 0-1999 mV	meter 0-1999 mV	-	-
nitrates	-	photometer 0-1.0mg/l (as NO_3-)	photometer 0-1.0mg/l as NO_3-)	✻ photometer 0-1.0mg/l	photometer 0-20 (as N)mg/l	✻ comparator 0- 15 (as N)mg/l	comparator 0-50mg/l as ?
nitrites	-	photometer 0-0.5 (as N) mg/l	photometer 0-0.5 (as N)mg/l	✻ photometer 0-0.5 (as N)mg/l	photometer 0-0.5 (as N)mg/l	✻ comparator 0-0.4 (as N)mg/l	-
ammonia	-	photometer 0-1.0mg/l	photometer 0-1.0mg/l	✻ photometer 0-1.0mg/l	photometer 0-1.0mg/l	✻ comparator 0-1.0mg/l	-
aluminium	-	✻ photometer 0-0.5mg/l	✻ photometer 0-0.5mg/l	✻ photometer 0-0.5mg/l	✻ photometer 0-0.5mg/l	✻ comparator 0-0.5mg/l	-
fluoride	-	✻ photometer 0-1.5mg/l	✻ photometer 0-0.5mg/l	✻ photometer 0-0.5mg/l	✻ photometer 0-1.5mg/l	✻ comparator 0-1.5mg/l	-
iron	-	✻ photometer 0-10mg/l	✻ photometer 0-10mg/l	✻ photometer 0-10mg/l	✻ photometer 0-1.0 / 10mg/l	✻ comparator 0-1.0 / 10mg/l	-
manganese	-	✻ photometer 0-0.03 mg/l	✻ photometer 0-0.03mg/l	✻ photometer 0-0.03mg/l	✻ photometer 0-0.03mg/l	✻ comparator 0-0.03mg/l	-
chlorine	comparator {DPD1 & DPD3}	photometer 0-5.0mg/l	photometer 0-5.0mg/l	photometer 0-5.0mg/l	photometer {DPD} 0-5mg/l	comparator {DPD} 0 to 1, 2, or 5mg/l	comparator 0-3.5mg/l
case supplied	yes	yes	yes	no (carrying bag can be bought)	yes	no	yes
weight	6 kg	20kg	16kg	9kg			
Notes: (✻indicates optional extra)		28 parameters can be tested with the photometer	as ELE 50	as ELE 50	36 parameters can be tested with the photometer Also stopwatch and deionised water pack	19 parameters can be tested with the comparator Also stopwatch and deionised water pack	Only indicates presence/ absence of *E.coli*. It is not quantitative

Microbiological tests — field equipment alternative

	Equipment / consumable	Supplier	Code	Capital cost (£)	Consumables cost (£)
Dipslides	Incubator	WAG	WAG8000	603.98	-
	Dipslides	PT (or Millipore)	PT 710	-	16.40 for 10
	Consumable cost per test = £1.648 (for 100 when purchasing more than 100)				
Colilerts	Incubator	WAG	WAG8000	603.98	-
	Colilert tubes	PT	CT010	-	45.25 for 50 tubes
for dilutions:	Plastic syringes (1ml and 10ml)	BDH / Merck	-	-	19.86 & 16.19 per 100
	UV lamp	PT	CT102	25.25	-
	Consumable cost per test = £13.95 (for 15 tubes and count to >1600 / 100ml)				
Membrane filtration	Delagua kit includes filtration unit, incubator, physical / chemical test equipment (pH, chlorine and turbidity) and consumables for 200 tests	DEL	-	1050	-
	MLS broth	DEL	-	-	3.00 for 38.1g tub (200 tests)
	Pads and filter papers	DEL	-	-	20.00 for 200
	Pad dispenser	DEL	-	-	6.11
	Consumable cost per test = £0.15 for one filtration without wastage (for 6 filtrations using syringes for dilutions then cost = £1.23 without wastage)				

Photometer and Comparator costs

Equipment	Code (✻ ,✻✻, or ✻✻✻ are highlighted in tables pp272–276 when appropriate)	Supplier	Capital cost (£)
Photometer (as Palintest but also supplied by others)	PT250 ✻	PT (also supplied by ELE and WT)	480.00
Disc comparator (as Lovibond but also supplied by others)	142000 ✻✻	TINT (also supplied by ELE and WT)	31.50
Set of five No. 13.5mm cells (10ml) cells for Lovibond disc comparator	354243 ✻✻	TINT (also supplied by ELE and PT)	16.00
Disc comparator 'standard kit' includes comparator, cells, dilution tube, case (Palintest)	PT220 ✻✻✻	PT	54.60

Core water quality parameters — field equipment alternatives

Parameters	Range and accuracy required	Field equipment available	Range and accuracy of equipment	Supplier	Code capital equip.	Capital cost (£)	Code consumables	Consumables cost (£)
Turbidity	< 5, 5, 10, 20, 50, 100, 200 NTU	Turbidity tube	5-500 TU	DEL	-	36.28	-	-
		Photometer	5-400TU	PT (or ELE, WT)	*	*	-	-
pH	4-10 +/- 0.5	pH sensor		PT	PT151	39.30	PT105/S	16.20 Buffer pack for pH 4,7,10
		pH sensor (self-calibrating)	-2 to 16 +/- 0.1	MER	309/0178/03	40.75	-	-
		Papers	1-12 +/- 1 Pehanon indicator papers	CAM	-	-	mn/90401	10.80 for 200
		Papers	4-9 +/- 0.5 Pehanon indicator papers	CAM	-	-	mn/90424	9.30 for 200
		Papers	4-7 +/- 0.2 non-bleeding stips	MER	-	-	315022D	10.40 for 100
		Papers	6.5-10 +/- 0.2 non-bleeding strips	MER	-	-	315062L	10.40 for 100
		Papers	0-14 non-bleeding strips	MER	-	-	315082P	10.40 for 100
		Checkit	6.0-9.2 +/- 0.4	TINT	155280	19.95	-	6.30 for 100
		Checkit	6.0-8.2	DEL	-	10.50	-	9.00 for 250 phenol red
		Pocket kit	4-10	PT	-	-	PK136	14 for 50
		Disc comparator	4-10	PT	CD136	28.25	AK136	11.95 for 200 universal
		Disc comparator	6.8-8.4 +/- 0.2	TINT	** 2/1J	** 36.50	511750	5.20 for 100 phenol red
Odour	not objectionable to consumers	Sample containers with lids	-	see general equipment	-	-	-	-
Conductivity	Conductivity < 450, 450 to > 1300µS/cm +/- 100µS/cm	Conductivity meter / TDS sensor		PT	PT159 cond PT152 TDS	46.55	PT156 cond PT155 TDS	7.85 standard conductivity solution 7.85 standard TDS solution
	TDS < 300, 300 up to 1000mg/l +/- 100mg/l	Conductivity meter / TDS sensor	0-1990 µS/cm +/- 10 0-1990mg/l +/- 10	MER	309/0782/ 01 or 03	40.00	309/0741/14 cond	10.50 standard conductivity solution
		Portable conductivity meter	0-1990µS/cm +/- 10 0-1990mg/l +/- 10	DEL	-	220.50	-	-

Secondary water quality parameters — field equipment alternatives

Parameter	Range and accuracy required	Field equipment available	Range and accuracy of equipment	Supplier	Code capital equipment	Capital cost (£)	Code consumables	Consumables cost (£)
Chloride	100, **250**, 500 +/- 50	Tablet count	0-1000	PT	-	-	AS079	7.55 for 50
		Tablet count	0-5000	TINT	-	-	414180	17.50 for av 40
		Pocket kit	0-1000	PT	-	-	PK079	14 for 50
		✣Drop count titration	20-400	CAM	-	-	HH/01440-01	39.30 for 100
		Disc comp (LB)	0-200	TINT	✻✻ 3/71	✻✻ 60.00	464801	5.75 for 100ml reagent
		Photometer	0-50 to 0-50,000	PT	✻	✻	PM268	13.50 for 50
Flouride	0.5, **1.5**, 3.0 +/- 0.5	✣Disc comp. (LB) + Nessler attachment	0-1.6	TINT		too bulky and fragile		
		Photometer	0-1.5	PT	✻	✻	PM179	14.05 for 50
		Disc comp (PT) + Nessler attachment	0-1.5	PT		too bulky and fragile		
		✣Colorimeter	0-2	CAM	HH/46700-05	350.00 (includes 50 tests)	-	-
Iron	0.1, **0.3**, 1.0 +/-0.1	Aquaquant, simple	0-1.0	MER	-	-	166052D	25.00 for 50
		Checkit	0-10.0 +/- 0.2 up to 1.0 +/- 2.0 up to 10	TINT	155240	19.95	515370	16.80 for 100
		Cube comparator	0-5.0 +/-1	CAM	HH/14008-00	18.60 (inc l50 tests)	-	-
		Pocket kit	0-1.0	PT	-	-	PK155	14 for 50
		Disc comp (LB)	0.1-1.0 +/-0.1	TINT	✻✻ 3/116	✻✻ 36.65	NOL 515370	16.80 for 100
		Disc comp (PT)	0-1.0	PT	✻✻✻ CD155	✻✻✻ 28.25	AK155	32.40 for 250
		Photometer	0-1.0	PT	✻	✻	PM155	11.90 for 50
Manganese	0.05, **0.1**, 0.3 +/-0.05	Disc comp (LB) + Nessler attachment	0.0025-0.5	TINT		too bulky and fragile		
		Photometer	0-0.03	PT	✻	✻	PM173	11.90 for 50
		✣Disc comp (HACH)	0-0.7 +/-0.05	CAM	HH/23508-00	160 (includes 50 tests)	-	-
		Disc comp (PT)	0-0.03	PT	✻✻✻ CD173	✻✻✻ 28.50	AK173	26.90 for 250
		Aquaquant	0-0.5	MER	-	-	165442J	88.26 for 110

Parameter	Range and accuracy required	Field equipment available	Range and accuracy of equipment	Supplier	Code capital equipment	Capital cost (£)	Code consumables	Consumables cost (£)
Nitrates	30, **50**, 80, 100 as NO_3^- +/-20 (6.8, **11.4**, 18.8, 22.8 as N)	✣Disc comp (LB)	0-100 as NO_3^-	TINT	✻✻ 3/142	✻✻ 36.65	513111 & 513121	15 for 250 (x2)
		✣Pocket kit	0-75 as NO_3^-	PT	-	-	PK184	14 for 50
		✣Photometer	0-20 as N	PT	✻	✻	PM163	17.05 for 50
		Disc comp (HACH)	0-50 +/- 1 as N	CAM	HH/01468.03	63.20 (includes 100 tests)	-	-
		Cube comp	0-50 +/- 10 as N	CAM	HH/14037.00	18.60 (includes 50 tests)	-	-
		Merckoquant strips	0-10-30-60-100-250-500 as NO_3^-	MER	-		315244P	16.60 for 100
		✣Checkit	(0.2-20mg/l as N)	TINT	155250	44.90	513111 & 513121	15.00 & 12.50 for 250
		Nitrate test tube	required with LB disc comparator and photometer	TINT	366220	1.35 (x2)	-	-
Nitrites	1, 2, **3**, 5 as NO_2^- +/- 1 (0.3, 0.7, **0.9**, 1.5 as N)	Disc comp (LB)	0-0.5 as N	TINT	✻✻ 3/103	✻✻ 36.50	512310	7.75 for 100
		Pocket kit	0-2.0 as NO_2^-	PT	-	-	PK109	14 for 50
		Photometer	0-0.5 as N	PT	✻	✻	PM109	6.25 for 50
		Disc comp (HACH)	0-0.5 as N	CAM	HH/21820-00	63.20 (includes 100 tests)	-	-
		Cube comp	0-1.0 +/- 0.2 as N	CAM	HH/20596-00	18.60 (includes 50 tests)	-	-
		Merckoquant strips	0-1-5-10-40-80 as NO_2^-	MER	-	-	315202F	23.40 for 100
		Checkit	0-1.6 as NO_2^-	TINT	155260	19.95	512310	7.75 for 100
		Disc comp (PT)	0-15 as N	PT	✻✻✻ CD109	✻✻✻ 28.25	AL109	15.05 for 200
Sulphates	100, **400**, 600 as SO_4 +/- 50	Photometer	0-200	PT	✻	✻	PM154	5.15 for 50
		Tablet count	0-200	TINT	-	-	414320	20.50 for av. 40
		✣Turbidimetric	50-200 +/-50	CAM	HH/02251.00	53.90 (includes 100 tests)	-	-
		Merckoquant strips	200-300, 400-500, 800-900, 1400-1600	MER	-	-	315212H	23.40 for 100
Taste	local reports	local reports	-	-	-	-	-	-
Temp	e.g. -10 to 100°C	Thermometer in brass case	-10 to 50°C	PT	PT684	17.10	-	
		Pocket thermometer in aluminium case	-10 to 250°C	PT	PT689	11.55	-	-

Treatability tests - field equipment alternatives

Parameter	Range and accuracy required	Field equipment available	Range and accuracy of equipment	Supplier	Code capital equipment	Capital cost (£)	Code consumables	Consumables cost (£)
Chlorine residual	0, 1, 2 +/- 0.2	Checkit	0.2-8.0 +/- 0.2 to 1.0 then various to 8.0	TINT	155300	19.95	511310 & 511290	5.10 for 100 (x2) rapid dissolving
		Disc comp (LB)	0.1-2.0	TINT	3/40J	30.30	511310 & 511290	5.10 for 100 (x2) rapid dissolving
		Disc comp (PT)	0-2.0 free combined and total	PT	CD011/5	28.25	AK031	17.60 for 200
		Photometer	0-5.0 free combined and total	PT	✻	✻	AP031	20.30 for 200
		Pocket kit	0-2.0	PT	-	-	PK011	14 for 50
		Disc comp (HACH)	0-3.5 +/- 0.1 (free and total)	CAM	HH/02231-01	48.30 (includes 50 tests)	-	-

Industrial / agrochemical — field equipment alternatives

Parameter	Range and accuracy required	Field equipment available	Range and accuracy of equipment	Supplier	Code capital equipment	Capital cost (£)	Code consumables	Consumables cost (£)
Aluminium	0.1, **0.2**, 0.5	Disc comp (LB)	0-0.5 +/-0.5	TINT	✻✻ 3/127	✻✻ 36.50	515461 & 515471	13.40 for 250 (x2)
		Photometer	0-0.5	PT	✻	✻	PM166	10.55 for 50
		Pocket kit	0-0.5	PT	-	-	PK166	14 for 50
		Aquaquant	0-0.8	MER	-	-	165562Q	94.70 for 185
		Checkit	0-0.5	TINT	155200	19.95	515461 & 515471	13.40 for 100 (x2)
		Disc comp (PT)	0-0.5	PT	✻✻✻ CD166	✻✻✻ 36.55	AK166	7 for 250
Arsenic	0.005, **0.01**, 0.03	Merckoquant strips	0-0.1-0.5-1.0-1.7-3.0	MER	-	-	315292A	76.20 for 100
Cadmium	0.001, **0.003**, 0.005	none	-	-	-	-	-	-
Chromium	0.01, **0.05**, 0.1	Disc comp kit (LB)	0.01-0.1	TINT	413630	260.00	-	-
		Photometer	0-1.0 (vi & iii)	PT	✻	✻	PM281 (vi) & PM281S (iii)	17.05 for 50 & 47.35 for 50
		✣Colorimeter	0-0.5 (vi)	CAM	HH/41100-03	450.00 (includes 100 tests)	HH/25050-25	19.50 for 25
		✣HACH cube	0-1.0 +/- 0.2 (iv)	CAM	HH/12527-00	18.60 (includes 50 tests)	-	-
Copper	1, **2**, 5 +/- 1	✣Disc comp	0.5-5.0 +/-0.5	TINT	✻✻ 3/149	✻✻ 30.80	513550 & 513560	21.90 & 10.00 for 100
		Photometer	0-5.0	PT	✻	✻	PM186	16.25 for 50
		Aquaquant	0-5.0	MER	-	-	165281K	88.26 for 100
		✣Disc comp (HACH)	0-5.0 (free & total)	CAM	HH/21941.00	66.80 (includes 50 tests)	-	-
		Disc comp (PT)	0-5.0	PT	✻✻✻ CD186	28.25	AK186	39.75 for 50
		Pocket kit	0-5.0	PT	-	-	PK186	14 for 50
		Checkit	0-5.0 (free & total)	TINT	155420	19.95	513550 & 513560	21.90 & 10.00 for 100
Detergents	visual, odour	visual, odour	-	-	-	-	-	-
Lead	0.005, **0.01**, 0.03	✣Colorimeter	0-0.15	CAM	HH/41100-48	570 (includes 20 tests)	-	-
Mercury	0.005, **0.01**, 0.03	none	-	-	-	-	-	-
Pesticides	varies	none	-	-	-	-	-	-
Petroleum products	visual and odour	none	-	-	-	-	-	-

Equipment selection

The ideal equipment requirements for assessing emergency water sources are:

Individual items:
- easy to use with simple instructions
- small and easily transportable
- no restrictions on air transport
- fast and easy to produce results
- covers range and is accurate enough
- limited requirement for distilled / deionized water
- dilutions not necessary
- does not require calibration (or then calibration to itself, or then calibration to deionized water)
- robust — limited effects from: U.V.light; shock; humidity; temperature
- can test several parameters
- easy to repair or replace
- limited consumables or consumables easy to obtain
- reasonable cost of equipment and consumables
- microbiological test equipment - limited need for sterilization

Whole kit:
- can be packed into a durable case; and
- possible to carry the kit over long distances by hand or using a shoulder strap.

There are very few items of equipment which are perfect for the task as most items have both positive and negative features. Examples of negative features of the equipment include:
- the ranges measured by the equipment are not appropriate and hence dilutions are required to measure the parameter to the World Health Organisation guideline value;
- the equipment is bulky, heavy, expensive or fragile; or
- some of the test reagents are restricted for air transportation by IATA regulations.

Example total kit list

The following kit has been identified as suitable for **assessing emergency water sources and treatment processes in the field**. *Modifications to this kit list would be required for a monitoring programme.*

The kit has been divided into three sections:
- Core tests
- Secondary tests
- General and treatability tests

When packaging the kit it can be divided into the following parts:
1. The Delagua kit has all of the equipment to undertake the core tests (including microbiological analysis) if the conductivity stick / sensor, standard solution for calibration and the pH non-bleeding sticks (to widen the pH measurement range of the pool-tester included in the kit) are added.
2. The secondary tests would need to be packed separately to the core tests if the Delagua kit is used. They include paper strips, a photometer, and tablet count methods. A deionized water

pack would be required to provide dilution water for the manganese test as the photometer measures a range below the WHO guideline level. It can also be used to provide dilution water when one of the parameters is found to be unusually high. The general items for survey and yield measurement, sample collection and storage, and treatability can be packed with the secondary test equipment.

Alternatively, if the Delagua kit is not selected and an alternative incubator is used then the whole kit could be packed into a single case.

Reasons for choice

When identifying suitable physical / chemical test equipment the aim was to identify a single, simple, small but robust item of equipment covering the required range for measurement without the need for dilution. The ideal requirements for equipment have been noted earlier on p227. Laboratory trials, field trials and personnel preferences were also used to assess the alternative options.

The final choice of equipment was partially directed by the difficulty of measuring fluoride in the field. The photometer has been included in this kit list to measure several of the parameters simply due to its ability to measure fluoride to WHO guideline levels. The only other simple item of equipment identified as potentially suitable for field analysis of fluoride was the disc comparator. However Nessler attachments are required for the measurement of fluoride, and this consists of long glass tubes which are not suitable for a portable field kit. Although the photometer can measure several parameters and, therefore, is favorable in this way, it is electronic and hence not always trusted by fieldworkers. Some of the reagents required to measure the secondary parameters (e.g. nitrates and nitrites) are also restricted by IATA transport regulations. Some of the parameters require dilution to measure at WHO guideline levels (e.g. manganese).

Should fluoride measurement not be required the following items of equipment can be interchanged with the photometer:

- Iron: - Lovibond checkit
- Manganese: - Aquaquant manganese kit (easy to use and samples do not require dilution but it has liquid reagents and is bulky)
- Aluminum: - Lovibond checkit
- Chlorine: - Checkit

The photometer would not be suitable for daily monitoring of chlorine or aluminium residual on site. The checkits are much more suitable for this purpose.

Simple field equipment for the measurement of arsenic to WHO guideline levels was not identified.

The next best alternative to the membrane filtration test (for a quantitative measurement of *E.coli*) was found to be the Colilert test. The main problem with this test is the volume of consumables it requires, it's cost, and the need for sterile dilution water. However the test is simpler to undertake and incubates at 37°C which is advantageous in the field. The main disadvantage of the Delagua kit is its weight.

Core tests — example field kit list

Parameter / purpose	Equipment type / method	Supplier	Order number capital	Capital cost (£)	Order number consumables	Consumables cost (£)	Total kit	Total cost (£)
Turbidity	Turbidity tube (5-500 TU)	DEL	-	36.28	-	-	In Delagua kit	-
pH	BDH non-bleeding strips	MER	-	-	315022D (4-7 pH) & 315062L (6.5-10 pH)	10.40 for 100 (x2)	2 con	20.80
Conductivity	Conductivity / TDSsensor	PT	PT159	46.55	PT156	7.85 standard solution	1 cap 1 con	46.55 7.85
E.coli (Sterilisation)	✜Methanol / ethanol / alcohol	buy in field	-	-	-		-	
E.coli (Stabilisation of chlorinated samples)	Sodium thiosulphate (hydrated)		-	-	-		-	
E.coli (Incubator)	Delagua kit (includes items below)	Del			-		1 cap & cons	1050.00
	Charging unit, leads, battery							
	Filter unit including funnel and collar, vacuum cup, vacuum pump, sample cup, cable for sample cup, bronze disc, sealing gasket and rubber o-ring							
	Petri dishes x 16							
	MLS broth (38.1g)	Del	-	-	-	3.00	4 con	12.00
	Pad dispenser	Del	-	6.11	-	-	1 cap	6.11
	Pads and filter papers (200)	Del	-	-	-	20.00	1 con	20.00
	Tweezers							
	Screwdriver							
	Lighter							
	Lubricating grease							

Secondary tests — example field kit list

Parameter / purpose	Equipment type / method	Supplier	Order number capital item	Capital cost (£)	Order number consumables	Consumables cost (£)	Total kit	Total cost (£)
Chloride	Tablet count	PT	-	-	PK079	7.55 for 50	1con	7.55
Fluoride	Photometer	PT	PT250	480.00	pm179	14.05 for 50	1 cap 1 con	480.00 14.05
Iron	Photometer	PT	PT250	included in fluoride price	pm155	11.90 for 50	1 cap 1 con	- 11.90
Manganese	Photometer	PT	PT250	included in fluoride price	pm173	11.90 for 50	1 cap 1 con	- 11.90
Nitrates	Merckoquant strips	MER	-	-	315244P	16.60 for 100	1 con	16.60
Sulphates	Merckoquant strips	MER	-	-	315212H	23.40 for 100	1 con	23.40
Permanganate value	Tablet count	PT	-	-	CP113	33.55 (inl. 50 tests)	1 con	33.55
Deionized water packs	water pack	PT	PT500		-	8.15	2con	16.30

General and treatability tests — example field kit list

Parameter / purpose	Equipment type /method	Supplier	Order number capital item	Capital cost (£)	Order number consumables	Consumables cost (£)	Total kit	Total cost (£)
Yield measurement and survey								
Measurement	stop watch						1 cap	
	GPS (Garmin 38)	Internet - Business on the move	-	126.80	-	-	1 cap	126.80
	compass	Geo Supplies	SV15TDCL	44.95	-	-	1 cap	44.95
	altimeter	Field & Trek	25075	119.11	-	-	1 cap	129.00
	float and weight	Use 110 ml bottles + sand					1 cap	
	calculator						1 cap	
	Swiss Army-type pen knife		1-09-01	19.92	-	-	1 cap	19.92
	pencil, pen and ruler						1 cap	
	paper						1 con	
	3m tape		-	2.99	-	-	1 cap	2.99
	torch	PT	CT102	25.25	-	-	1 cap	24.25
	batteries						2 cons	
	geo lens	Geo Supplies	GLx10	2.50	-	-	1 cap	2.09
	line level		-	1.39	-	-	2 cap	2.78
	survey book	Geo supplies	CW2256	7.36	-	-	1 cap	7.36
	electrical tape						1 con	
Other								
Sample collection and storage	sample bottles 60ml x 12	MER	215/0399/02	5.88	-	-	1cap	5.82
	sample bottles 110ml x 12	MER	215/0399/04	9.12	-	-	1cap	9.73
	bottles 500ml x 12	MER	215/0399/16	20.37	-	-	1 cap	21.75
	syringes 1ml	MER	-	-	406/0375/11	19.86 for 100	1 cons	36.18
	syringes 10ml	MER	-	-	406/0375/14	16.19 for 100	1 cons	16.00
	sampling cup	included with filtration kit						
	sampling line	included with filtration kit						
	biological sampling net (1 mm mesh bag for 200mm frame)	GB nets		6.85	-	-	1 cap	6.85
Cleaning	glassware wipes (or tissues)	PT	-	-	PT619	2.00	1con	2.10

Parameter / purpose	Equipment type /method	Supplier	Order number capital item	Capital cost (£)	Order number consumables	Consumables cost (£)	Total kit	Total cost (£)
Working surface	workplace mat	PT	PT525	5.25	-	-	1 cap	5.25
Marker	marker pen						1 cap	
Treatability	spatula/spoon (120ml)	MER	260/0140/01	5.76	-	-	2 cap	11.52
	beakers 1l x 5	MER	209/0730/39	10.97	-	-	1 cap	12.48
(Alkalinity)	Tablet count (Total, M or T) (Caustic, P)	TINT	-	-	 414130 414140	(for 20-100 tests) 14.10 15.40	1 cap 1 cap	29.50
(Temperature)	Thermometer in case	PT	PT684	17.10	-	-	1 cap	17.10
(Aluminium)	Photometer	PT	PT250	included in fluoride price	PM 166	10.55 for 50	1 cap	-
(Residual chlorine)	Photometer	PT	PT250	included in fluoride price	PM 031	20.30 for 200	1 con	10.55
	Aluminium sulphate (18 hydrate)		-	-	-	-	1 cap 1 con	- 20.30
	HTH 65%	buy in-country						
	35 % chlorine	buy in-country						
	ferric chloride	buy in-country						
Kit box								

Water treatment: Mobile treatment units and modular kits

Details

Mobile treatment units are self-contained and portable. Modular kits come in pieces and are fitted together on location. The following table identifies a selection of mobile units and two modular treatment kits. Most of the larger relief organizations have their own selection of modular kits which are ordered through their logistics departments. Items such as water storage tanks have not been included in this table. For information on Oxfam tanks, bladder tanks, fast tanks, modular distribution kits, pumping units, etc. contact the relief organizations directly.

Nothomb (1995, p8), referring to mobile treatment units states that 'The uses are still not clearly defined, nor are the specifications. No unit seems to live up to the high expectations. The performances have not been properly and independently evaluated, as neither the indicators of performance nor test protocols are defined.'

Water treatment: Mobile treatment and modular kits

Description	Performance (details taken from manufacturers' literature or from Nothomb, 1995)	Supplier	Approximate cost (1995)
Modular kits			
Treatment unit for water for emergency situations {includes: Four containers mounted on 'euro-palettes' weighing a total of 500kg. Contains all material for approx. 1.5 months of treatment (except fuel). Includes pumps, feed controls, piping, etc.} .	30 m^3/h max. Used at 5 to 8m^3/h at a pressure of approx. 1 bar produces an effluent of 5 NTU from water of 50 - 200 NTU. Uses coagulation with ferric chloride (or alternatively aluminium sulphate with pH adjustment), and rapid sand filtration with chlorination to complete. Storage tanks are not part of the kit.	MSF Belgium	250,000 fb (8000 ecus)
Oxfam slow sand filter kit {includes 2 x 95,000 litre and 2 x 75,000 litre tanks and fittings including underdrainage, but does not include treated water tanks}	Will supply 3.2m^3/hour	Oxfam (UK & Ireland)	£16,310 (US$26,000)
Mobile units			
Self-contained water purification kit {includes: 1 trailer-mounted water purification unit, 1 steel tank 40m^3, six water distribution kits with six taps each, piping, tools, necessary accessories such as monitoring tools and consumables for min six months (excluding gasoil)}	Can fulfil daily water requirement of 10,000 people. Slotted well PVC pipe is provided with 6m-long perforated water collection pipe to construct an infiltration gallery to reduce turbidity. Sand and gravel required locally. Main treatment process of unit is rapid sand filtration.	UNICEF	$US29,000
Portable water purifier {includes: purification unit only with cartridge for 25 to 5000 litres depending on size of unit}	Small-scale use only. Up to a maximum of 1500 litres / day. Uses coarse filtration, absorption filtration with activated charcoal cloth, primary disinfection and secondary disinfection with an iodine-resin complex. Can also have post filtration to remove iodine residual. Tests have indicated > 99.9% of virus removal.	Pre-Mac, Kent, UK	
Aquarius 150 * water purification unit	Uses pre-chlorination, coagulation and flocculation, horizontal sand filters and an activated carbon filter. Flow rate of 0.6m^3/hr at 75 NTU. (Sizes vary from 0.18 - 6m^3/hr). 90kg. US$200 consumables for 90 days. Disinfection capacity not consistent.	Water International Ltd. UK	US$3000

Description	Performance (details taken from manufacturers' literature or from Nothomb, 1995)	Supplier	Approximate cost (1995)
GB13000D* water purification unit	Uses diatomaceous earth coated filter. Chlorination. Flow rate of 4.3m³/hr at 75 NTU. (5-7m³/hr) 350kg. US$20,900 consumables for 90 days. Can reduce max. turbidity of 200 NTUto 5 NTU. Disinfection capacity not consistent.	Goodmann Ball Inc. USA	US$37,000
LMS* water purification unit	Uses course straining. Sand and activated carbon filtration and optional microstrainer. Venturi chlorine doser. Flow rate of 8.0m³/hr at 75 NTU.1600kg. US$270 consumables for 90 days. Can reduce max. turbidity of 50 NTU to 5 NTU. Disinfection capacity not consistent.	LMS Industries, France	US$18,000
Berkefeld* water purification unit	Uses pre-chlorination, coagulation with ferric chloride, adsorption with powdered activated carbon, flocculation with lime, filtration (using candle filters pre-treated with diatomite and activated carbon). Flow rate of 5.4m³/hr at 75 NTU. 3000kg (includes weight of vehicle). US$33,500-93,000 consumables for 90 days. Can reduce max. turbidity of 500 NTU to 5 NTU. Good disinfection to WHO recommended levels.	Berkefeld Anlagebau GmbH, Germany	US$87,000
CLM5000* water purification unit	Pre-chlorination, pH correction, coagulation and flocculation with polychlorate aluminium sulphate and then filtration on a foam medium. Activated carbon filtration. UV disinfection and / or chlorination. Flow rate of 4.0m³/hr at 75 NTU. 1600kg. US$2680 consumables for 90 days. Can reduce max. turbidity of 200 NTU to 5 NTU. Good disinfection but to < 30 min contact time.	Sulzer Chemtech Ltd., Switzerland	US$56,000
Conniston* water purification unit	Filtration in filter coated with diatomaceous earth and chlorination via a venturi chlorine doser. Flow rate of 4.0m³/hr at 75 NTU. 250kg. US$200 consumables for 90 days. US$24,300 consumables for 90 days. Can reduce max. turbidity of 200 NTU to 5 NTU. Disinfection capacity not consistent.	Stella-Meta, UK	US$21,000
Lightweight water purification unit (WPU(L)) portable**{strainer, pump unit, filter, chlorinator and fittings, two tanks capacity 1,550 l }	Average 1.36 m³/h. Unit will filter 95% of all particles greater than 0.005 mm. Raw water is passed through a floating suction strainer and pumped into a Vokes filter unit (diamotaceous earth) and then it is chlorinated using a venturi feed system. Uses liquid chlorine. Flexible water tanks.	Refer to British army	
Standard Water purification unit (WPU(S)) portable**{strainer, pump unit, filter, chlorinator and fittings, two tanks capacity 8,000 l }	Average 6.8m³/h. Unit will filter 95% of all particles greater than 0.005mm. Raw water is passed through a floating suction strainer and pumped into a Vokes filter unit (diamotaceous earth) and then it is chlorinated using a venturi feed system. Uses liquid chlorine. Flexible water tanks. Total weight 540kg.	Refer to British army	
Reverse Osmosis Plant (Weir Westgarth) containerised**	Average 4.15m³/h.	Refer to British army	
Water purification unit (NBC)** {All equipment mounted in a trailer. pumpset, filtration unit, high pressure pumps set, reverse osmosis units, carbon absorption columns, chlorine dosing, two 13,640 l fabric water storage tanks and relative fittings}.	Average 6.8m³/h in non-NBC mode or 2.28m³/hr in NBC mode. Can supply water from brackish sources, or water contaminated by sewage, nuclear, biological or chemical substances but not sea water. Process involves filtration, reverse osmosis, activated carbon absorption and chlorination. There are four eight inch diameter reverse osmosis modules and four stellacarb carbon absorption columns. Total weight for towing is 3300kg.	Refer to British army	
Water purification unit (NBC) Desalination version: Trailer mounted **	Average 1.9m³/h	Refer to British army	

* Information on these units was taken directly from Nothomb (1995) and the results of an interagency collaborative testing meeting in Geneva, Switzerland on June 12-20, 1995. For further direct comparisons refer to Nothomb (1995).

** Units used by the British Army

Useful addresses

Organizations which may be able to interpret industrial pollution data ■

Should you not be able to interpret industrial pollution laboratory data yourself, or you are not able to find an organization in the vicinity to do it then the following organizations may be able to assist. They should either have the capacity to interpret the data or will be able to provide alternative contacts. There is likely to be a charge for any interpretation work and this should be discussed with the organiation when you first contact them.

This study does not have the capacity to confirm the skill of the organizations or the personnel responding to requests and so further investigations should be undertaken where necessary.

Details of organizations and contacts

The National Centre for Environmental Toxicology
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Henley Road
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Office of Science and Technology
United States Environmental Protection Agency
Washington DC 20460
USA

Contact for accidental spills of contaminants: Mr Jim Taft of the Office of the Ground Water and Drinking Water (OGWDW)
Tel: +202 260 5519

Contact for treatment and removal of contaminants: Dr Krishan Khanna of the Health and Ecological Criteria Division (HECD)
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Umweltbundesamt Institute for Water, Soil and Air Hygiene
PO Box 33 00 22
14191 Berlin
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Equipment manufacturers and suppliers

International suppliers

Company	International head office	Africa, Asia, Middle East	European Office	The Americas & Australasia
Berkefeld Anagebau GmbH	Luckenweg, 5 Postfach 3202 29227 CELLE Germany		as international	
Business on the Move Ltd.	2, Woodhill, Kentish Lane, Hatfield, Herts. AL9 6JY, UK Tel: +44 1707 663533 Fax: +44 1707 645976 internet location: www.21store.com/botm/botm.htm		as international	
Camlab Limited (Hach products)	HACH Company International Marketing Department, PO Box 389 Loveland, Colorado 80539 USA Tel: +1 303 669 3050 Fax: +1 303 669 2932 Telex: 160840	HACH distributes through a network of dealers and distributors. Details can be obtained from the head office.	Camlab Limited, Nuffield Road, Cambridge CB4 1TH, UK Tel: +44 1223 424222 Fax: +44 1223 420856	as international
Cotswold	Contract Department tel: +44 1277 224647 fax: +44 1277 260 789		as international	
ELE International Limited	Eastman Way Hemel Hempstead Hertfordshire HP2 7HB, UK Tel: +44 1442 218355 Fax: +44 1442 252474 / 219045 Telex: 825239 ELELTD G		as international	
Field & Trek Plc.	Contracts Department Unit 3 Wates Way Brentwood, Essex CM159TB, UK Tel: +44 1277 263 554		as international	
GB Nets	Linden Mill Hebden Bridge West Yorkshire, HX7 7DP, UK Tel: +44 422 845365		as international	
Geosupplies Ltd.	16, Station Road Chapeltown Sheffield, S30 4XH, UK Tel: +44 114 245 5746 Fax: +44 114 240 3405		as international	
Goodman Ball Inc.	3639, Haven Avenue Menlo Park CA 94025, USA		as international	
LMS Industries	73100 Aix-les-Bains, France		as international	
Merck Ltd. (BDH Products)	PROMOCHEM GMBH POB 101340 Mercatorstrasse 51 D46469 Wesel Germany Tel: +49 281 98 87 0 Fax:+49 281 9887199 Telex: 812741 Promo D	Howse & McGeorge Ltd. Laboratory Division PO Box 72030 Nairobi, Kenya Tel: +254 2553064 / 2553154 Fax: +254 2601345 Telex: 21554 Arabco JO	Merck House Poole, Dorset BH15 1TD, UK Tel: +44 1202 664 778 Sales tel (freephone): +0800 223 344 Fax: +44 1202 666536 Telex: 411 186 TETRA G	MERCK PTY LTD 207 Colchester Road, Kilsyth, Victoria 3137, Australia Tel: +61 03 97285855 Fax: +61 03 97287611

There are many other distributors in Africa, Asia, the Middle East, Europe, USA and Australasia other than those noted here.

Company	International head office	Africa, Asia, Middle East	European Office	The Americas & Australasia
Merck Ltd. (BDH Products) (cont.)		E MERCK (INDIA) Limited Shiv Sagar Estate 'A' Dr Annie Besant Road PO Box No. 16554 Worli, Bombay 400 018 Tel: +91 22 4922855 Fax: +91 22 4950307 Telex: 1173756		Gallard Schlesinger Industries Inc. 584, Mineola Avenue Carle Place New York, 11514-1731 USA Tel: +1 516 333 5600 Fax: +1 516 333 5628 Quimibras Industrias Quimicas SA Praca de Bandeira 141, GR 201, Rio de Janeiro RJ 20220, Brazil Tel: +55 21 273 2022 Fax: +55 21 293 3291 Telex: 30083 REDY
Millipore Corporation	80, Ashby Road, Bedford, MA 01730, Massachusetts, USA Tel: +1 800 645 5476 Fax: +1 617 275 5550	For Austria, Central Europe, Africa, Middle East and the Gulf: Millipore Ges.m.b.H. A-1130 Wein, Austria, Tel: +43) 1 877 8926 Fax: +43 1 877 1654 Telex: + 43 1 877 1654 Millipore also has subsiduaries in many other countries including: China, India, Japan, Malaysia, Taiwan etc.	Millipore (U.K.) Ltd. 'Tehe Boulevard' Blackmore Lane, Watford Hertfordshire, WD1 8YW,UK Tel: +44 923 816 375 Fax: +44 923 818 297 Telex: 24191 milipor g Millipore S.A. BP 307, F-78054 Saint- Quentin Yvelines Cedex, France Tel: +33 1 30 12 7000 Fax: +33 1 30 12 7180 Telex: 698371 F Millipore has many other subsiduaries across Europe.	As international office
MSF Belgium	Logistics Department Duprestr 94 B-1090 Jette Brussels Belgium Tel: +32 2 474 7474 Fax: +32 2 474 7575		as international	
OXFAM (UK and Ireland)	Public Health Team OXFAM (UK and Ireland) 274, Banbury Road Oxford OX2 7DZ, UK Tel: +44 1865 312 135 Fax: +44 1865 312 600 Telex: 83610 OXFAM G		as international	
Palintest Ltd.	Palintest House Kingsway Team Valley Gateshead Tyne & Wear NE11 ONS, UK Tel: +44 191 491 0808 Fax: +44 191 482 5372		as international	21, Kenton Lands Road PO Box 18733 Erlanger, Kentuky 41018 USA Tel: +1 606 341 7423 Fax: +1 606 341 2302 4/84-88 Riverside Road, Chipping Norton, PO Box 318, Padstow, NSW 2211, Australia Tel: +61 2 755 3486 Fax: +61 2 755 3491
Pre-Mac (Kent) Ltd.	40, Holden Park Road Southborough, Tunbridge Wells, Kent TN4 OER, UK Tel: +44 1892 534 361 Fax: +44 1892 515 770		as international	
Robens Institute (Delagua)	Robens Institute University of Surrey Guildford, Surrey GU2 5XH, UK Tel: +44 1483 509 203 Fax: +44 1483 503517 Telex: 859331		as international	

Company	International head office	Africa, Asia, Middle East	European Office	The Americas & Australasia
Silva (UK) Ltd.	Unit 10 Sky Business Park Eversley Way Egham, Surrey TW20 8RF, UK Tel: +44 1784 471 721 Fax: +44 1784 471 097		as international	
Stella-Meta	Laverstoke Mill Whitchurch Hampshire RG28 7NR, UK		as international	
Sulzer Chemtech Ltd.	PO Box 65 8404 Winterthur Switzerland		as international	
The Tintometer Ltd. (Lovibond products)	Waterloo Road Salisbury SP1 2JY UK Tel: +44 1722 327242 Fax: +441722 412322 Telex: 47372		Tintometer GmbH Schleefstraße 8a D-44287 Dortmund Germany Tel: +49 231 94510 0 Fax: +49 231 94510 20 Tintometer AG Hauserstauáe 53 CH-5200 Windisch Switzerland Tel: +41 56 422829 Fax: +41 56 424121	
UNICEF	UNICEF Supply Division UNICEF Plads Freeport DK-2100 Copenhagen Denmark Tel: + 45 27 35 27 Fax: + 45 26 94 21			
Wagtech International Limited	10, Thatcham House Turners Drive Thatcham, Berkshire RG13 4QD UK Tel: +44 1635 872929 Fax: + 44 1635 872808 Telex: +846256 wagtec g	Kitgum House 103, Jinja Road P.O.Box 3218 Kampala Uganda Tel: +256 41 232100 / 259646 Fax: +256 41 244606 Telex: 61208 magric uga	as international	
Water International Limited	The Atrium, Mercury Court Tithebarn Street Liverpool L2 2QP, UK		as international	

Equipment manufacturers and suppliers — Local

Company	Address
Fundacion Zumaque	Oficina: Edificio Maraven, Piso 6o, Chuao-Apartado 829 - Caracas 1010A, Venezuela Telefono: +58 2 908.22.06
Premier Health Care Products	41 & 42, S.V. Co-op, Ind. Estate, Balanagar, Hyderabad 500 037, A.P. India Tel: +91 40 273515 / 273525, Fax: +91 40 271879
All India Institute of Hygiene & Public Health and UNICEF, Calcutta	Contact either of the organizations noted on the left

General

The addresses which follow are only a few of the many which could be useful for obtaining information on water sources around the world. The **embassy of the country of concern** or your **home country government survey department** may be able to provide relevant addresses for the country under consideration.

General addresses

Address	Information
Ordnance Survey RomseyRoad Maybush Southampton SO9 4DH UK	Topographic maps, geological maps
British Geological Survey Keyworth Nottingham NG12 5GG, UK or Hydrogeology unit Macclean Building Crowmarsh Gifford Wallingford Oxfordshire OX10 0RA UK	Geological maps, hydrogeological maps, reports, satellite imagery and general data for Great Britain and Overseas. BGS also have a system under trial where they answer any request made for hydrological information for any area to be used in an emergency response, and they are attempting to respond using interpretations of satellite imagery and other data within two to five weeks.
Spot image 16, Bis Avenue Edourd Belin BP 4359 31030 Toulouse, Cedex France	Satellite imagery
National Cartographic Information Center (NCIC) US Geological Survey, 507 National Center, Reston Virginia 22092, USA	Free information on national state topographic maps and information and remote sensing.
Operations section WRD US Geological Survey 405, National Center, Reston Virginia, 22092, USA	Data on surface water, groundwater and water quality collected by the US Geological Survey
United States Geological Survey Box 25425 Federal Center Denver, Colorado 80225, USA	USGS maps, books, professional papers and other publications on the geology of the USA and overseas

United Nations addresses

Address	Information
United Nations Environment Programme (UNEP) PO Box 30552, Nairobi, Kenya Tel: +254 2 230 800 Fax: + 254 2 226 886 IPAUNEP@Igc.apc.org	Responsible for the Global Environmental Monitoring System (GEMS)
World Meterological Organisation World Weather Watch Department WMO/OMM, Case Postale No.2300 CH-1211 Geneva 2 Switzerland Tel: +41 22 730 8333 email: nkootval@www.wmo.ch	In case of emergency, natural disaster or other crises for which UN assistance has been requested and in which meterology or hydrology may affect the process of providing humanitarian relief, 24-hour operational contacts through DHA's emergency number +41 22 917 2010
Department of Humanitarian Affairs (DHA) Vienna International Centre PO Box 500 1400 Vienna Austria Tel: +43 1 21131 Fax: +43 1 232156 Telex 135 612 and Palais des Nations CH–1211 Geneva 10 Switzerland Tel: +4122 9171234 Fax: +4122 9170023 e.mail: DHAGVA@DHA.UNICC.ORG	Assists the UN system in co-ordinating humanitarian assistance
United Nations High Commissioner for Refugees (UNHCR) Centre William Rappard 154, rue de Lausanne 1202 Geneva 21 Switzerland Tel: +41 22 739 8111 Fax: +41 22 731 9546 Telex: 415 740	Concerned with the international protection of refugees and the promotion of durable solutions for their problems. Often acts as the co-ordinating organization in the field.
Food and Agriculture Organisation (FAO) via delle Terme di Caracalla 00100 Rome, Italy Tel: +39 6 579 73152 Fax: +39 6 579 75155	Soils, vegetation cover and other aspects of land use around the world.

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