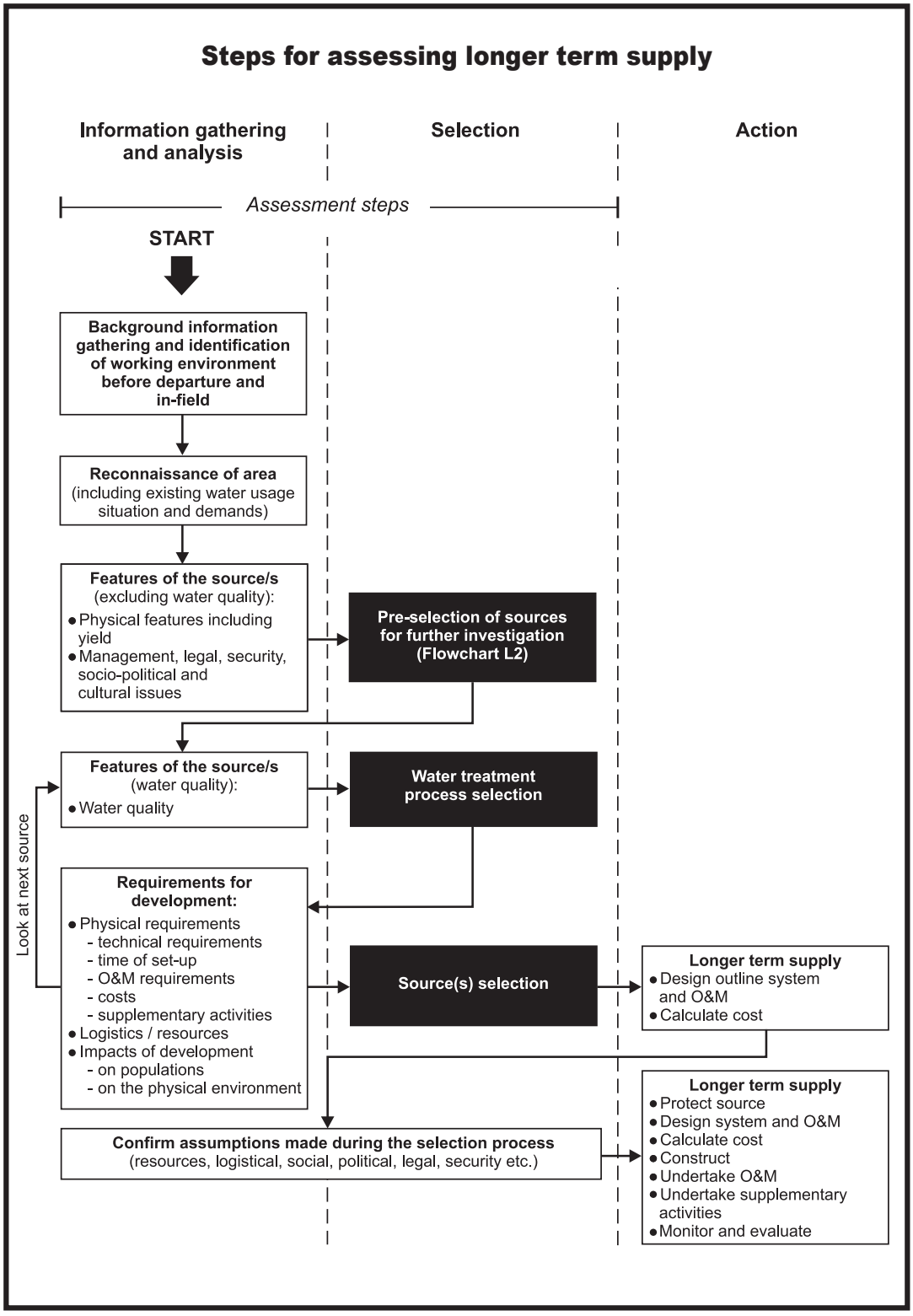
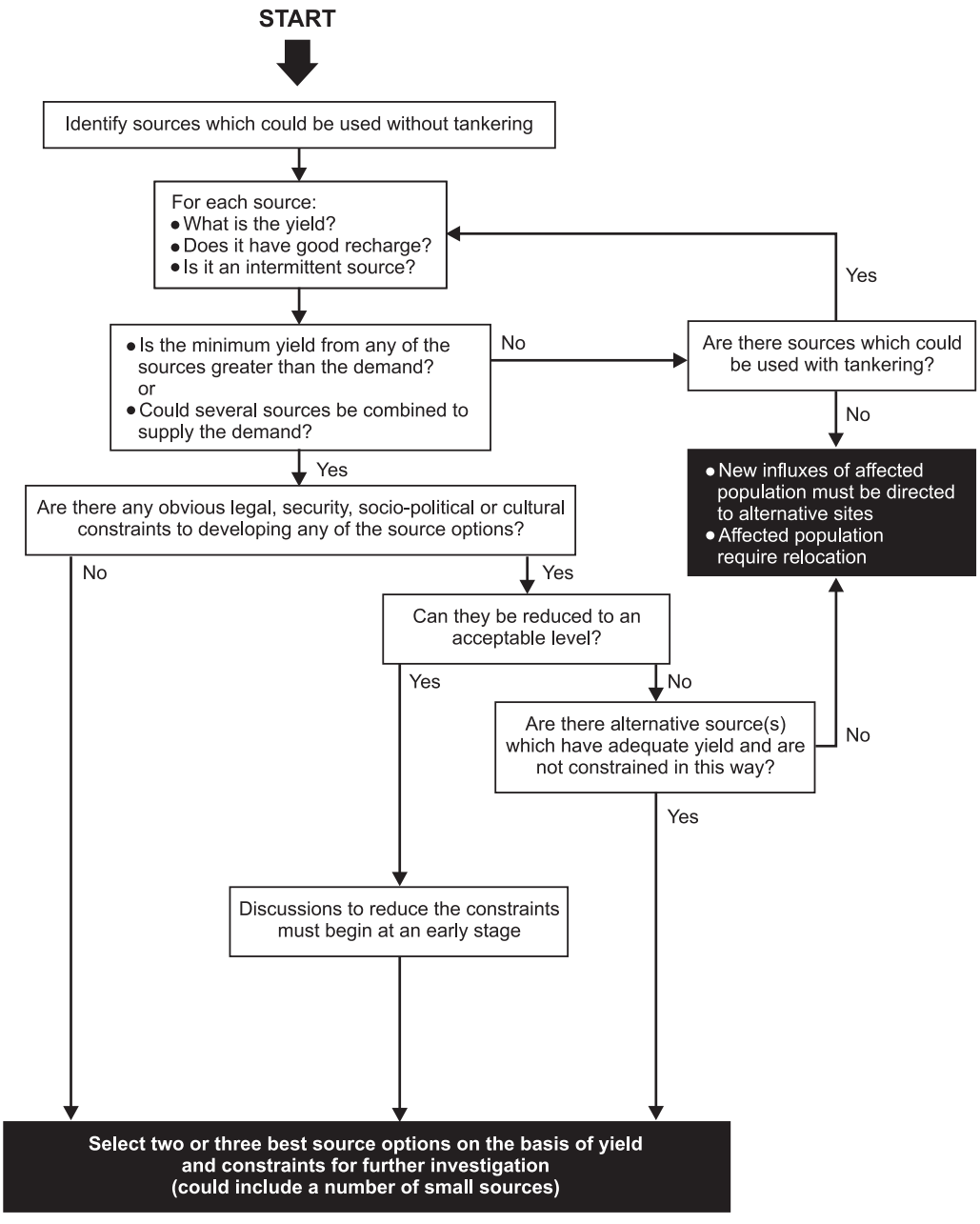
3

LONGER TERM SUPPLY


Steps for assessing longer term supply
Information gathering and analysis
Selection
Action
Assessment steps
START
Background information gathering and identification of working environment before departure and in-field
Reconnaissance of area (including existing water usage situation and demands)
Features of the source/s (excluding water quality):
• Physical features including yield
• Management, legal, security, socio-political and cultural issues
Pre-selection of sources for further investigation (Flowchart L2)
Features of the source/s (water quality):
• Water quality
Water treatment process selection
Look at next source
Requirements for development:
• Physical requirements
- technical requirements
- time of set-up
- O&M requirements
- costs
- supplementary activities
• Logistics / resources
• Impacts of development
- on populations
- on the physical environment
Source(s) selection
Longer term supply
• Design outline system and O&M
• Calculate cost
Confirm assumptions made during the selection process (resources, logistical, social, political, legal, security etc.)
Longer term supply
• Protect source
• Design system and O&M
• Calculate cost
• Construct
• Undertake O&M
• Undertake supplementary activities
• Monitor and evaluate

Pre-selection of sources for further investigation



Water treatment process selection for longer term supply

Introduction

There is more benefit gained in terms of health and convenience from supplying large quantities of reasonable quality water than small quantities of very good quality water. However, the aim should be to provide adequate quantities of good quality water.

The main objective of water treatment for drinking water is to remove anything which is harmful to health such as pathogenic organisms, toxins, and carcinogens. Assuming high levels of toxic chemicals are not present in the water, pathogenic organisms are the most serious threat to health in the short term.

Disinfection (usually chlorination) is used to destroy the pathogenic organisms. In non-emergency situations certain waters may not require disinfection (e.g. deep groundwater, mountain streams) as the faecal contamination may be low at the point of supply. However, because of the large numbers of possibly traumatized people in confined spaces, and the fact that contamination often occurs in individual containers after distribution, disinfection should be used wherever possible in emergencies as an added precaution.

The main constraint to eliminating pathogenic organisms is high turbidity, as turbidity prevents effective disinfection and hence can allow the passage of pathogenic organisms to the user. A range of solutions are available to remove turbidity, the most common ones being storage/sedimentation, and assisted sedimentation (coagulation, flocculation, and sedimentation). It is possible that in the next few years there may also be an increase in the use of roughing filtration, as a range of institutions and organizations are working to develop such systems for use in emergency situations.

Other processes can be added depending on the water quality problems. Examples include the use of aeration, pH adjustment, and activated carbon.

In the initial stages of an emergency water must be supplied quickly, so an upgrading approach to treatment is necessary.

The availability of material resources and organizational preferences often dictate the solutions chosen for water supply. Variations include the following:

- Organizations may send in equipment before a thorough assessment has been undertaken so as to ensure a speedy implementation phase. **Several organizations have their own modular kits which simplify the process of equipment selection, installation, operation, and maintenance.** The modular items of kit include pumps, water tanks, and distribution systems including pipelines and tapstands.

- **Some organizations also have modular 'mobile' treatment units which are very expensive but useful in the immediate stages of an emergency, especially for industrially polluted waters or to supply specific units such as health centres.** See pp283-4 for details of a selection of modular kits and mobile treatment units.

- Other organizations prefer to use **local materials, methods, and skills** wherever possible to benefit the local populations and to improve the effective operation and maintenance of systems over the longer term.

How to use this section

Study the following:

- Figure 3.1, below
- Tables pp41-2, which highlight water quality problems versus treatment options and give guideline quality levels; and
- Figure 3.2 which links the water treatment processes in a water supply scheme, p43.

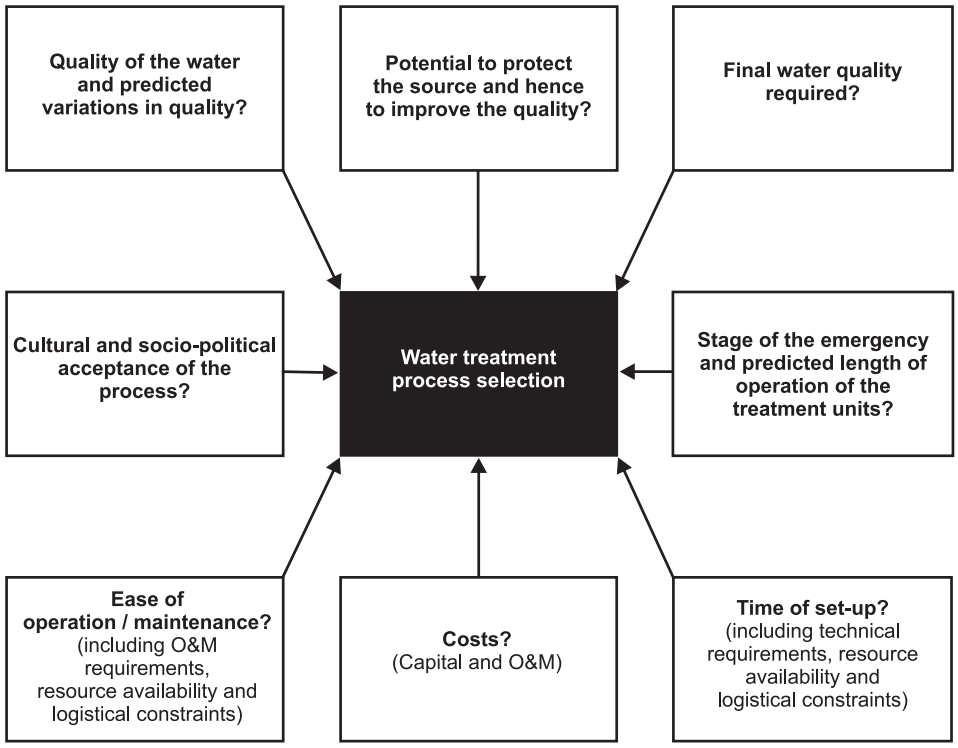


Figure 3.1 — Key factors for water treatment process selection

Complete the *Water treatment process selection tools* tables pp44-5, using the information noted on p40 and the following background information:

- *Water quality assessment routines,* section pp148-53;
- *Water quality parameter summary tables*, pp170-3;
- *Features of water treatment processes*, pp214-23; and
- *Mobile treatment units and modular kits*, section pp283-4.

Instructions on how to use Tables pp44-5 are included within the tables.

Common water quality problems versus treatment options

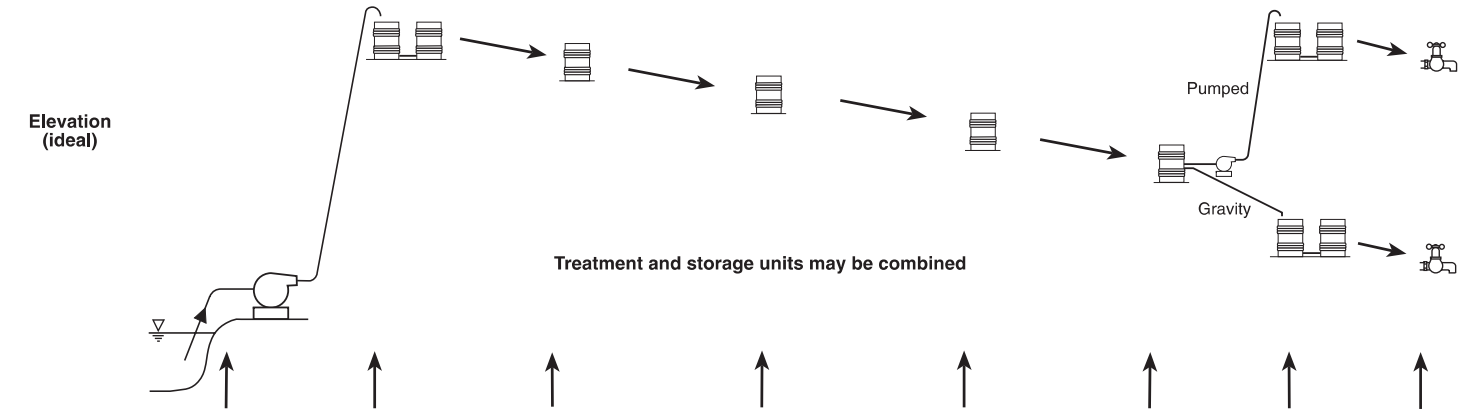
1A	1B	1C	1D	1E	1F
Parameter / feature	**Methods of assessment**	**Guide levels (max.)** (see tables pp170-3 for further information)			**Treatment process options or avoidance activities** (noted in general order of longer term preference for supply of populations in settlements rather than dispersed or for the short term)
		Survival	**Longer term** (min. recommended level)	**Longer term** (WHO)	
Floating solids	sanitary investigation / observation local knowledge	no large solids	none visible	none visible	screen water at or near to the inlet
Turbidity	sanitary investigation / observation local knowledge biological survey water quality analysis	20 NTU	10 NTU	5 NTU (1 NTU for disinfection)	infiltration storage and sedimentation roughing filtration assisted sedimentation use mobile treatment units including assisted sedimentation and / or rapid sand filtration (RSF)
Faecal pollution *(E.coli* level or sanitary risk)	catchment mapping sanitary investigation / observation local knowledge water quality analysis	<1000 *E.coli* / 100ml	<10 *E.coli* / 100ml	0 *E.coli* / 100ml	protect source, slow sand filtration (SSF) and disinfect with chlorine
		sanitary risk **medium - low**	sanitary risk **low**	sanitary risk **low**	protect the source and disinfect with chlorine for very high levels of contamination (>1000 *E.coli* / 100ml) pre-chlorinate prior to, and in addition to, pre-treatment (but **not** if SSF used)
pH (needs modifying for assisted sedimentation, disinfection or corrosion purposes)	local knowledge water quality analysis	See tables p171 and p216 for specific treatment process requirements			adopt different technologies which work well within the natural pH range add lime to raise the pH or an acid to lower it (lower the pH only if essential) modify quantities of treatment chemicals to compensate for an unsuitable pH

Notes:

1. Colour, taste, conductivity, chlorine demand and permanganate value are water quality tests which can indicate the presence of the parameters noted in tables pp41-2.
2. The treatability tests (p173 and pp176-83) can help to identify the treatment process is suitable for the particular water.
3. **In all cases, if a source needs to be treated, look for alternative sources that require less or simpler treatment which may potentially be more suitable.**
4. Treatment options noted in this table are those commonly used. Local alternatives may be more suitable and should be identified in the field.
5. National water quality standards and WHO guideline values should always be aimed at all stages of an emergency. However, should this not be possible the above figures may be used as a **last resort** guide.

Occasional water quality problems versus treatment options

2A	2B	2C	2D	2E	2F
Parameter / feature	**Methods of assessment**	**Guide levels (max.)** (see table pp170-3 for further information)			**Treatment process options or avoidance activities** (noted in general order of longer term preference for supply of populations in settlements rather than dispersed or for the short term)
		Survival	**Longer term** (min. recommended level)	**Longer term** (WHO)	
Chloride	sanitary investigation / observation local knowledge water quality analysis	600mg/l	250mg/l	250mg/l	blend sources move camp use mobile treatment units with reverse osmosis distillation
Fluoride	local knowledge water quality analysis	3mg/l	1.5mg/l	1.5mg/l	blend sources move camp high dose assisted sedimentation with aluminium sulphate and lime (Nalgonda process) contact with activated alumina contact with bone char use mobile unit with reverse osmosis
Iron or manganese	sanitary investigation / observation local knowledge water quality analysis	Fe - Mn -	Fe 1.0mg/l Mn 0.5mg/l	Fe 0.3mg/l Mn 0.1mg/l	aerate water prior to main treatment processes including sedimentation or filtration pre-chlorinate prior to sedimentation or filtration (but not SSF)
Nitrate (or nitrite)	catchment mapping sanitary investigation / observation local knowledge biological survey water quality analysis	50mg/l as NO_3^- 3mg/l as NO_2^-	50mg/l as NO_3^- 3mg/l as NO_2^-	50mg/l as NO_3^- 3mg/l as NO_2^-	blend water from two sources move the camp use mobile treatment units with reverse osmosis
Sulphate	catchment mapping local knowledge water quality analysis	400mg/l	400mg/l	400mg/l	blend water from two sources use mobile treatment units with reverse osmosis
Algae	sanitary investigation / observation	-	No visible algae		protect source from the addition of nutrients roughing filtration with graded media pre-chlorinate prior to main treatment (but not SSF) reduce algae with copper-based algaecide use mobile treatment units with microstraining capacity
Industrial or agrochemical pollutants	catchment mapping sanitary investigation / observation local knowledge biological survey water quality analysis	Refer to the section *Water quality analysis; Industrial pollution* and *Industries and activities and associates pollutants* pp181-92			protect source from inflow of pollutants move camp use mobile treatment units with activated carbon and / or reverse osmosis
Bilharzia	local knowledge	-	none present		stop people entering the water source, provide hygiene education storage > 24 hours
Guinea worm	local knowledge	-	none present		stop people entering the water source, provide hygiene education and filter the water before drinking



Common stages and treatment processes	Abstraction Source protection Screening	Raw water storage		Sedimentation Roughing filtration Assisted sedimentation		Disinfection (usually chlorination)	Treated water storage	Distribution
Occasional treatment processes	Infiltration		**Pre-chlorination** (for problems with algae or very high bacterial counts) **pH adjustment** (to improve treatment process) **Aeration** (to reduce bad tastes and precipitate iron and manganese)		**Filtration** • slow sand filtration • rapid sand filtration **Activated carbon** (mobile units) **Reverse osmosis** (mobile units) **pH adjustment** (to prevent corrosion) **Bone char or activated alumina contact**			
	Pre-treatment				Main treatment and advanced treatment		Storage and distribution	

Figure 3.2 — Linkage of water treatment processes in a water supply scheme

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Water treatment process selection tools for longer term supply

Complete the three tables below for each water source under investigation.

Common water quality problems treatment process selection

	(3A) Selection step	(3B) Parameter/feature	(3C) Details		
1	For each parameter or feature (column 3B) note the methods of assessment which have been used in column 3C (e.g. catchment mapping, local knowledge, etc.) Refer to table p41 for details.		**Methods of assessment used:**		
		Floating solids:			
		Turbidity:			
		E.coli or sanitary risk:			
		pH:			
2	Columns 1C to 1E (table p41) identify the maximum guide levels for each water quality parameter or feature versus the level of supply. Note the appropriate guide levels in column 3C.		**Appropriate guide levels:**		
3	In column 3C note the level or description of each parameter or feature and any variations expected in the parameter or feature (in the future or seasonally). Compare present and expected future levels with the guide levels. Note which will require treatment		**Level or description of each feature**	**Variations expected**	**Which will require treatment?**
		Floating solids:			
		Turbidity:			
		E.coli or sanitary risk:			
		pH:			
4	Can the parameter or feature requiring treatment be improved by protecting the source? If so will the water still require treatment?		**Can it be improved by protection?**		**Will it still require treatment?**
5	Column 1F (table p41) identifies alternative treatment / avoidance options for each parameter / feature. Consider each option in turn in relation to: · the stage of the emergency and predicted length of operation of the treatment units · its common usage in the area (and hence the likelihood of existing appropriate skills and resources to run the system effectively) · technical requirements · the availability of material, equipment and human resources · its time of set up · its cost · its ease of operation and maintenance · its acceptability to the group of concern (e.g. some groups will not drink water with 'medicines' in it and hence will not allow chlorine to be used) Select the most appropriate treatment processes.		**Treatment processes initially selected:**		
6	To ensure that the treatment process will be effective check each individual process against: · the information supplied in the features of treatment processes section, tables pp214-23; and · results of the treatability tests, pp176-83		**Problems envisaged:**		

Occasional water quality problems treatment process selection

	(4A) Selection step	(4B) Parameter / feature	(4C) Details
7	Refer to table p42 for steps 7 to 12. Repeat step 1 (Table p44) but for each of the occasional water quality problems.		**Methods of assessment used:**
8	Repeat step 2 (table p44) for the occasional features / parameters where a problem is expected.		**Appropriate guide levels:**
9	Repeat step 3 (table p44) for the occasional features / parameters where a problem is expected.		**Level or description of each feature** **Variations expected** **Which will require treatment?**
10	Repeat step 4 (table p44) for the occasional features / parameters where a problem is expected.		**Can it be improved by protection?** **Will it still require treatment?**
11	Repeat step 5 (table p44) for the occasional features / parameters where a problem is expected.		**Treatment processes initially selected:**
12	Repeat step 6 (table p44) for the occasional features / parameters where a problem is expected.		**Problems envisaged:**

Linkage of treatment processes or avoidance activities

	(5A) Selection step	(5B) Details
13	Link all of the treatment processes using Figure 3.2, p43 as a guide.	**Order of treatment:**
14	Check if any of the treatment processes can be removed from the chain. Some processes will be able to deal with several parameters/ features at the same time.	**Processes which can be removed:**
15	Identify the final selection of treatment processes.	**Order of treatment:**

Key references:

- Davis and Lambert, 1995, pp317-46
- Howard, 1979
- MSF, 1994, Section I, pp16-21, 38-45
- Shulz and Okun, 1984
- Tebbutt, 1992, pp107-91
- Twort et al, 1994
- UNHCR, 1992, pp80-93
- WHO, 1971, 1989, 1993

Source selection for longer term supply

How to use this section

Source selection for longer term supply should only be undertaken after a thorough assessment of available information. See the checklists for suggested information to be collected and note your findings on the survey sheets provided or in another easily accessible form.

Key factors for source selection are highlighted in the schematic chart opposite.

Complete a source summary table (p48) for each source(s) option. From here the source(s) may be selected:

- by scanning the alternative summary tables and undertaking a selection based on experience;

  or

- by using the source comparison tool and sample scoring chart to help analyse the variables.

Whichever method is used, experience, common sense and engineering judgement will be required to make an appropriate selection.

The source comparison tool does *not give an answer*; it is only to be used to guide the thought process, highlighting the features which are critical and those which are not so important.

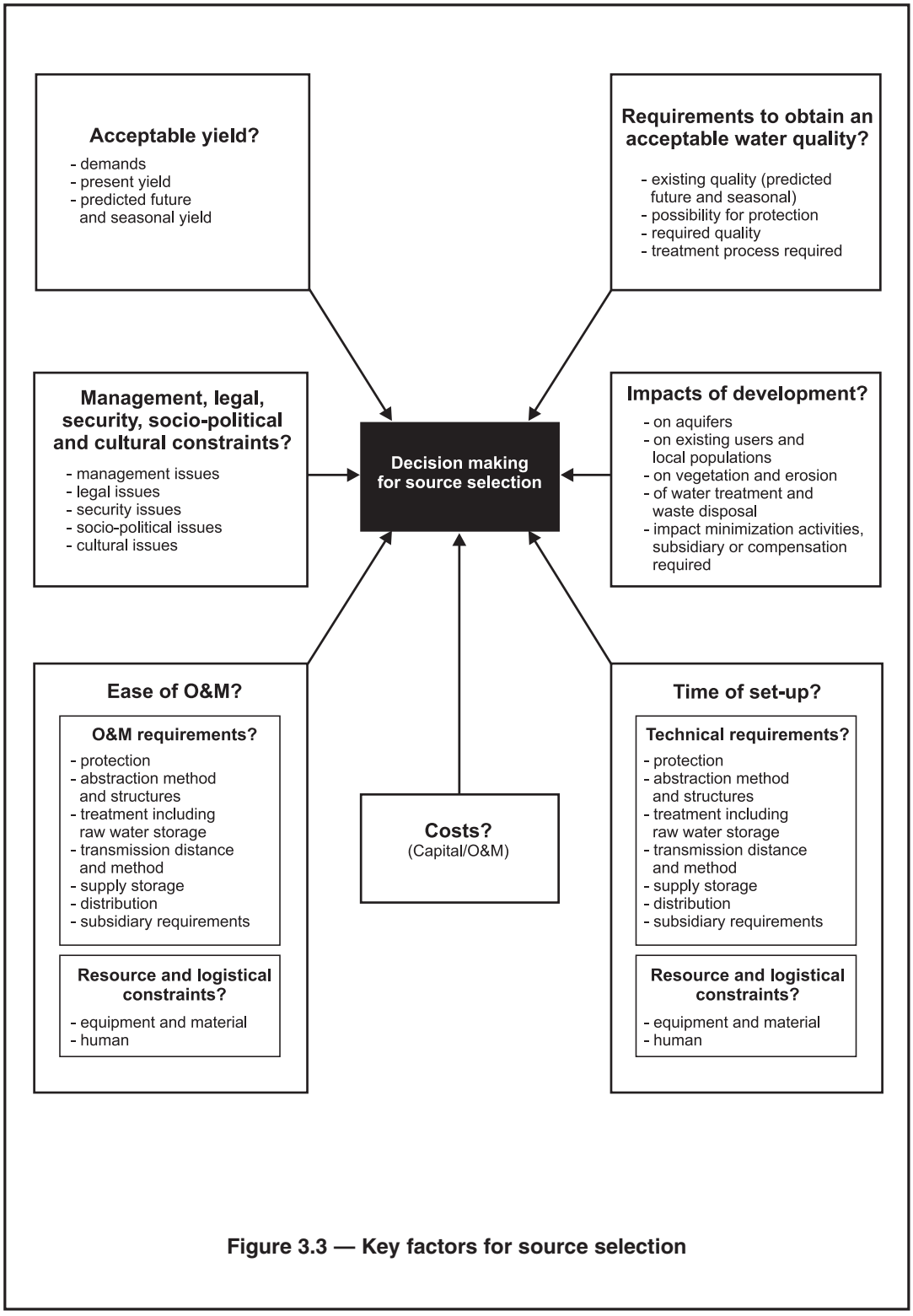

Figure 3.3 — Key factors for source selection

Source summary table

Affected population water demand = _____

Source details	**Source name / number and location**
	Type of source
Acceptable yield?	**Existing demand on the source** (excluding the affected population)
	Present yield
	Predicted future and seasonal yield
Requirements to obtain an acceptable water quality?	**Current water quality problems**
	Predicted future and seasonal water quality problems
	Treatment processes required
Management, legal, security, socio-political or cultural constraints?	**Management, legal, security, socio-political or cultural constraints**
Technical and O&M requirements?	**Protection**
	Abstraction method and structures
	Treatment (including raw water storage)
	Transmission distance and method
	Supply storage
	Distribution
	Subsidiary requirements
Resource and logistical constraints?	**Material and equipment resources**
	Human resources
	Logistical
Time of set-up?	**Time of set-up**
Ease of O&M?	**Ease of O&M**
Impacts of development?	**On aquifers, existing users and local populations, on vegetation and erosion and on water treatment and waste disposal**
	Impact minimization activities, subsidiary activities or compensation required
Costs?	**Capital**
	O&M

Note: This summary table may require adaption for sources for dispersed populations. A separate form could be completed for typical examples of each type of source used in the area.

Source comparison tool for longer term supply

Introduction

The ranking and weighting method was chosen for source comparison as it allows several factors to be included in the comparison at the same time. It also allows for weightings to be put on the factors changing their relative importance with the stage of the emergency. For example, in the immediate emergency stage the time of set-up is critical but the level of O&M required is not so important. Over the longer term period, the O&M requirements become more important and the time of set-up less so.

It should be understood, however, that it is difficult to apply objective weightings and their identification is purely arbitrary and based on best judgement. **They should be modified to suit the particular situation**. The original weightings have been set at 10 for a high level of importance and zero for unimportant. Sometimes a veto has to be applied (Davis et al.,1995). An example of this would be where the water source is located in an area controlled by a warring faction which is in conflict with the affected population. Under this situation access to the water cannot be guaranteed. Hopefully such problems will have been identified early in the information gathering process and the source option already discarded.

Source(s) with the highest total weighted scores are more favourable, but once the numerical determinations have been completed, a **visual analysis** should be undertaken on the results. **This is the most important step in the comparison** and should identify which were the critical factors for the source selection and whether additional activities could be implemented which would modify the results.

Survival supply weightings have not been provided in the scoring table. If required the following weightings could be used (from top to bottom: 9-2-9-5-2-2-1).

If two similar options are being considered, for example trucking from two different locations or abstraction from two different points on the same river, then comparison can be made using only the critical factors. For example the following may be considered:

- costs, security and impacts of development for the trucking programmes; or
- costs, security and requirements to obtain an acceptable quality water for the water source abstraction from two points on the same river.

This method may be more suitable for sources to supply camp populations rather than those in dispersed locations or mobile.

Instructions for use

1. Collect information on the alternative source(s) options and summarize this information in the **Source summary table p48**.
2. For the first source(s) option decide on **scores** for each of the key factors using the **sample scoring chart for source comparison p52** for guidance. A high score indicates that the factor is positive and a low one that it is negative.
3. Chose the **weightings indicated in the scoring chart p51 applicable to the level of supply** (in turn related to the stage of emergency to which the assessment applies).

4. Multiply the scores by the weightings in the table p51 to obtain the **'weighted score'.**
5. Repeat steps 2 to 4 for the other source options.
6. Add all of the weighted scores for each source and insert the **'total weighted scores'** into the final row on the table p51.
7. Identify the sources in order of total weighted score.

Analysis of results

1. Which source gives the highest score and which the lowest?
2. Compare the selected source(s) with the expected result by scanning the summary table. If they are different then investigate why.
3. Which key factors have been the deciding ones in making one option's total weighted score higher than the others?
4. Could the lower scores be raised by undertaking additional activities to modify the situation in the field?
5. Would this change the final order of preference of sources?
6. Look at the source(s) with the highest total weighted score. Are any of the key factor scores tenuous or dependant on unknowns? If these scores are replaced by ones representing the worst scenario, would the order of preference change between the sources?
7. Undertake a **'sensitivity analysis'**: weightings and scores are modified slightly and the final positions compared (Reed, 1995). If there is no change in the overall positions then the results can be accepted with more confidence, but if there are variations, the results should be treated with care and further thought should be given to acceptable weightings and scores.
8. Is the order of preference sensible?
9. If so, chose the source with the highest weighted score. If not re-assess the scores and weightings for the particular scenario and repeat the process for comparison.

Key references (decision-making):

- Davis and Lambert, 1995, pp563-7
- Gosling and Edwards, 1995
- Reed, 1995, pp13-8

Key references (water source selection):

- Cairncross and Feachem, 1978, pp3-7
- UNHCR, 1992, pp30-7

Source comparison tool for longer term supply

Key factors for source selection	Weighting (supply for several months)	Weighting (supply for several years)	Source(s) 1		Source(s) 2		Source(s) 3	
			Score for source	Weighted score	Score for source	Weighted score	Score for source	Weighted score
Acceptable yield?	7	6						
Requirements to obtain an acceptable water quality?	5	5						
Time of set-up?	5	1						
Management, legal, security or socio-political and cultural constraints?	4	4						
Impacts of development?	4	5						
Costs?	3	4						
Ease of O&M?	2	5						
Total weighted score for each source(s) option								

Refer to:

- *Key factors for source selection* Figure 3.2, p43
- *Sample scoring chart for source comparison*, p52

Sample scoring chart for source comparison

Key factors for source selection	Score			
	10	7	4	1
Acceptable yield?	· > 50% of yield remaining after all abstraction.	· > 10% of yield remaining after all abstraction. **or** · Unknown yield but indications are that yield exceeds supply.	· Yield only meets the demand of the affected population and local residents during period of maximum yield.	· Insufficient yield to meet affected population and local demands even at period of maximum yield. **or** · Unknown yield but indications are that it would be lower than required.
Requirements to obtain an acceptable water quality?	· Only simple source protection and disinfection required.	· Protection, storage, assisted sedimentation / filtration and disinfection required.	· Protection, storage, assisted sedimentation / filtration and disinfection required plus additional treatment such as aeration or other.	· Very bad quality. · Heavy industrial / agrochemical pollution expected. · Very difficult to produce acceptable water quality using standard treatment processes.
Time of set-up?	· Time of set-up < 1 week. · Equipment and expertise already available on site.	· Time of set-up 1-4 weeks. · Some equipment and expertise already available on site. · Most additional resources can be obtained locally.	· Time of set-up 1-2 months. · Significant construction required. · Materials need to be imported. **or** · Borehole drilling required into known aquifer.	· Time of set-up > 2 months. **or** · Groundwater exploration required.
Management, legal, security, socio/ political or cultural constraints?	· No such constraints. · Local government communities and landowners are very helpful and agreeable.	· Local government, communities and and owners are generally agreeable. · Some local level negotiations may be needed and local communities would need to be compensated.	· Some constraints to the development of the source. · Would require national level negotiations. **or** · Would require additional security at the source.	· Serious constraints to the development of the source. · Political interference. · Could lead to additional security problems. · Problems unlikely to be solved by negotiation.
Impacts of development?	· No obvious impacts on local users or the physical environment.	· Some negative impacts expected on the physical environment but not on local users.	· Groundwater to be used and pumping tests indicate a slow recovery of water levels and, potentially, effects on other sources. **or** · Some negative impacts expected on both local users and the physical environment.	· Groundwater source to be used from a known aquifer of limited capacity. **or** · Water sources already scarce for local communities. **or** · Negative impact expected on both the local users and the physical environment.
***Costs?**	· Low	· Lower than average	· Higher than average	· High
Ease of O&M?	· Would only require input from locally trained personnel. **and** · No fuel or power requirements.	· Would only require input from locally trained personnel **and** · Fuel or power required.	· Would require occasional input from specialist personnel. **or** · High cost of consumables.	· Would require regular input from specialist personnel and high cost of consumables. **or** · Tankering operation.

* Costs (both capital and O&M) are comparative between options. A project specific decision will be required as to the length of time considered for O&M costs. The same period must be used for all options.

Background information gathering and identification of working environment before departure and in-field

Note: The following two checklists and the *Availibility of resources / logistics checklist* pp56-7 may be sent ahead to the field so that information gathering may begin before the arrival of the assessors.

Background information gathering before departure and in-field

Information

- ❑ Maps (topographic, geological, road, hydrogeological, demographic, land-use, rainfall)
- ❑ Aerial photographs / landstat images
- ❑ Regional details
  - ❍ *Climate (including rainfall data)*
  - ❍ *Industrial and agricultural practices*
  - ❍ *Populations (culture, religion)*
  - ❍ *Economy*
  - ❍ *Political situation*
  - ❍ *Exchange rate*
- ❑ Previous surveys / studies (organizations' database or library)
- ❑ Other agencies working in the field
- ❑ Organizational structure of employing agency and policy and mandate
- ❑ Specific job information
  - ❍ *Job description*
  - ❍ *Responsibilities and chain of command*
  - ❍ *Other agency personnel in the field*
  - ❍ *Logistical and financial constraints*
  - ❍ *Communication procedures*
- ❑ Structure of government and local government (including which store information and which make decisions)
- ❑ Contacts in key departments (water and sewerage, water resources, planning, surveying, meteorological)
- ❑ National policies and development projects
- ❑ Existing national emergency plans
- ❑ Capacity of the government to cope with the water demands of the affected population
- ❑ Background to the crisis and projected developments

Sources of information

- ❑ Government departments of donor country (geological, land survey, environment, military)
- ❑ Government departments of host country (water resources, water and sewerage, surveying, meteorological, military, social, planning)
- ❑ Specialist shops (e.g. for maps: Stanfords, London, UK)
- ❑ Consulting engineers
- ❑ University departments (geography, geology, environmental science, civil engineering, mining, surveying)
- ❑ Employing organization head office (verbal from head office and returned personnel; reports from past projects)
- ❑ Organization field staff and experts in the area
- ❑ Government embassy
- ❑ Press reports
- ❑ Books, journals
- ❑ Travel guides
- ❑ The Internet
- ❑ 'District Surveys' in libraries for ex-colony countries
- ❑ Donor country briefings
- ❑ Checklist pp68-9

Identification of working environment

Information

- ❑ Field organizational structure of employing agency/organogram (chain of command, logistics, administration, technical, health education, medical personnel)
- ❑ Areas of responsibility for yourself and others
- ❑ Personnel from other organizations working in water or sanitation in the area (government, international and local)
- ❑ Operational structure for co-ordination between organizations, government — including role of UNHCR, organization and national and local government contacts, and employment agreements
- ❑ Decision-making structure re: water source selection. Are you working for the lead organization? Which camps or populations are you responsible for supplying?
- ❑ Communication channels with affected and local populations and community structures (contacts), and role of UNHCR and governments in communication channels
- ❑ Organization's policy for supporting local populations
- ❑ Team members / access to local personnel (translators, surveying assistants, driver)
- ❑ Working facilities (office space, telephone / radio, fax, photocopying, storage space for equipment and workshops, power sources, security, vehicle)
- ❑ Methods of payment

Sources of information

- ❑ Employing organization staff
- ❑ Other organization staff (including UNHCR)
- ❑ National and local government

Reconnaissance of the area

(including existing water usage situation, logistics and resources)

Regional orientation

Information

- ❑ Physical features (high and low areas, vegetation, water sources)
- ❑ Location and type of water source (developed? not developed?)
- ❑ Human features (settlements, industry, agriculture, roads)
- ❑ Distances between users and water sources
- ❑ Distances and approximate heights between features
- ❑ Areas vulnerable to natural threats (cyclones, mudslides, earthquakes, etc.)
- ❑ Areas with high security risk (e.g. mined areas)
- ❑ Areas subjected to extreme weather conditions

Sources of information

- ❑ Observation
- ❑ Published and unpublished maps, aerial photographs, etc. as collected in background information gathering
- ❑ Simple surveying (GPS, Abney level / clinometer, altimeter)
- ❑ National and local government
- ❑ Local and affected populations
- ❑ Other field staff
- ❑ Natural threat monitoring stations
- ❑ *Catchment mapping: maps and symbols* pp154-60
- ❑ *Catchment mapping: surveying* pp161-8

Methods

- ❑ Mapping
- ❑ Panoramic photographic records

Settlement orientation

Information

- ❑ Boundaries, present sub-divisions (including ethnic or clan divisions), possible areas for expansion (include distances)
- ❑ Population density where settlements are dispersed or mobile
- ❑ Slope of ground (and existing drainage channels if any)
- ❑ Water sources (and areas susceptible to flooding and other physical threats)
- ❑ Areas with buildings / shelters, open spaces and communal areas
- ❑ Access roads
- ❑ Sanitation facilities including excreta disposal, refuse dumps / collection areas and graveyards
- ❑ Administration centres and feeding centres
- ❑ Chemical stores
- ❑ Lighting
- ❑ Security arrangements

Sources of information

- ❑ Observation from high ground (using binoculars) and by walking around the camp
- ❑ Aerial photographs
- ❑ Simple surveying (pacing, Abney level / clinometer, GPS)
- ❑ Other field staff
- ❑ Local government
- ❑ Local and affected population
- ❑ *Catchment mapping: maps and symbols* pp154-60
- ❑ *Catchment mapping: surveying* pp161-8

Methods

- ❑ Mapping
- ❑ Photographic records

Demographics, present water usage and water demands

Information

- ❑ Water user numbers — affected population:
  - ❍ *Individuals*
  - ❍ *Livestock large and small (and average number per family)*
  - ❍ *Other users / uses **if specific supply is within remit**: e.g. health centres (in-patient, out-patient and cholera centres); feeding centres*
- ❑ Water user numbers — local population:
  - ❍ *As affected population (above) up and downstream*
  - ❍ *Industries and agriculture*
- ❑ Present water source (type, location, level of service, distance to collection point). Note: The populations' own coping mechanisms should be identified and potentially built upon.
- ❑ Current water consumption
- ❑ Does the affected population have adequate containers for water collection?
- ❑ Are the populations static or mobile?
- ❑ Diseases prevalent in the local and affected populations (e.g. cholera, dysentery, typhoid, malaria, fluorosis, diarrhoea to those new to the area, skin diseases)

Sources of information

- ❑ UNHCR
- ❑ Employing organization staff members
- ❑ Other field staff
- ❑ Local government (water and sewerage, social, statistical office)
- ❑ Local and affected population
- ❑ Observation
- ❑ Medical practitioners (traditional and non-traditional)
- ❑ Checklist pp70-1

Methods

- ❑ Calculation of water demand for affected and local populations using employing organization's water demand figures or those given on p141

Availability of resources / logistics

Information

Logistics

- ❑ Condition of roads in the dry and rainy seasons (major access roads; minor access roads; internal settlement roads; road crossings)
- ❑ Flooding and other physical threats (settlement areas; access roads)
- ❑ Security (on access roads and within settlements). Which groups are causing the security problem? How common are guns in the area?
- ❑ Access to international freight (airstrips; ports; railways; road links)
- ❑ Customs clearance (import taxes, procedures, problems, delays)
- ❑ Availability and reliability of freight transporters
- ❑ Journey time for freight

Note: This survey information can be collected as the assessment procedure progresses or after the resources required for the specific engineering solution are known. Depending on the agency procedure, the initial solution may be directed by the modular kit which has been brought to the field at the assessment stage.

Sources of information

- ❑ Observation
- ❑ National or local government (water and sewerage, building)
- ❑ Local contractors
- ❑ Local suppliers
- ❑ Head office modular kit lists
- ❑ Other field staff
- ❑ Local and affected populations
- ❑ Customs authorities
- ❑ National threat monitoring systems
- ❑ *Mobile water treatment units and modular kits* Table p283-4

Availability of resources / logistics (continued)

Information (continued)

Resources

- ❑ **Material and equipment** (type; make; size; condition; capacity; power consumption; fuel requirement; cost; volume / number available; availability of drivers / operators):
  - ❍ *Pumps (electrical; diesel; petrol; hand pumps)*
  - ❍ *Generators (diesel; petrol)*
  - ❍ *Tanks (galvanized steel / iron; Oxfam tanks; pillow tanks)*
  - ❍ *Pipes (cast iron; galvanized steel / iron; asbestos cement; UPVC; MDPE; flexible hose)*
  - ❍ *Pipe fittings (valves, bends, air valves, couplings, etc.)*
  - ❍ *Mobile water treatment units*
  - ❍ *Construction materials and tools (cement; reinforcement steel and tying wire; gabion mesh; aggregate; sand; construction handtools; masonry hand tools; nails / screws; timber; cement mixer)*
  - ❍ *Drilling rigs (rotary, percussion)*
  - ❍ *Water tankers or trucks (tankers; flat-bed truck with sides; flat-bed truck without sides; container truck)*
  - ❍ *Chemicals (chlorine; aluminium sulphate; ferric chloride; ferrous sulphate; lime)*
  - ❍ *Fuel / power (diesel; petrol; electricity)*
  - ❍ *General usage transport (pick-ups; small lorries or vans)*
- ❑ **Human resources** (names; point of contact; employer; numbers):
  - ❍ *Tradespeople: plumbers; mechanics; electricians; carpenters*
  - ❍ *General construction personnel and supervisors*
  - ❍ *Water technicians / engineers*
  - ❍ *Health educators / community development workers*
  - ❍ *Logisticians*
- ❑ **Local construction techniques** (details)**:**
  - ❍ *Well construction (hand dug well, tube well)*
  - ❍ *Spring tapping*
  - ❍ *Borehole drilling (are the drilling teams available with rigs?)*
  - ❍ *Pipe laying and joining*
- ❑ **Water treatment processes used locally:**
  - ❍ *Infiltration*
  - ❍ *Sedimentation*
  - ❍ *Roughing filtration*
  - ❍ *Assisted sedimentation*
  - ❍ *Slow sand filtration*
  - ❍ *Rapid filtration*
  - ❍ *Disinfection*
  - ❍ *Activated carbon*

Features of the source (excluding water quality)

Physical features including yield

COLLECT FOR EACH SOURCE

Information

- ❑ Source name / number, type and location
- ❑ Ground and water level (note instrument used for measurement)
- ❑ Layout / dimensions
- ❑ Yield estimation: (volumes / flows, variation with season, recharge capacity)
- ❑ Discharges (in and out; where are they from and where do they go)
- ❑ Environmental features of the area surrounding the source (river bed materials; plant and tree cover; activities such as farming or industries)
- ❑ Is the source affected by extreme weather conditions (e.g. below $0^{o}C$)?

Sources of information

- ❑ Observation
- ❑ Local and affected populations (including users and landowner)
- ❑ National or local government (may have pumping test records)
- ❑ Water diviners
- ❑ *Measurement of yield and water levels* pp143-7
- ❑ *Catchment mapping: maps and symbols* pp154-60
- ❑ *Catchment mapping: surveying* pp161-8
- ❑ Checklist pp64-5
- ❑ Checklist pp66-7

Methods

- ❑ Detailed sketch of source and abstraction point
- ❑ Flow measurement

Management, legal, security, socio-political and cultural issues

COLLECT FOR EACH SOURCE

Information

- ❑ Present demands (who, what for, how much, is there competition with animals)
- ❑ Are there intermittent users such as nomads
- ❑ Who owns the land and what is the procedure to obtain permission to abstract
- ❑ Responsible authority for control and maintenance
- ❑ Is a tariff being charged for using the source (paid to whom and how much)
- ❑ Accessibility at present for water collection (can elderly, children, or those with disabilities gain easy access to the source?)
- ❑ Security problems at the source (especially consider women and children and opposing groups in conflict situations)
- ❑ Are any areas mined?
- ❑ Socio-political constraints to using the source and cultural beliefs re: water provision
- ❑ Consider national development objectives
- ❑ What are the affected populations' and local populations' priorities for water provision
- ❑ Natural threats within the vicinity of the source (cyclones, earthquakes, mudslides, etc.)

Sources of information

- ❑ Observation
- ❑ Local and affected populations (including local users and landowner)
- ❑ National or local government (may have pumping test records)
- ❑ Natural threat monitoring stations
- ❑ *Management, legal, security, socio-political and cultural issues and case studies* pp108-24
- ❑ *Guidance on undertaking assessments and report writing* pp103-4
- ❑ Checklist pp68-9
- ❑ Checklist pp70-1

Features of the source (water quality)

Water quality assessment

COLLECT FOR EACH SOURCE

Information

- ❑ The quality of the water at present
- ❑ Existing protection and potential for improved protection of the source
- ❑ Predicted variations in the water quality in the future and pollution risks

Parameters commonly causing problems:

- ❑ Floating solids
- ❑ Turbidity
- ❑ Faecal contamination (thermotolerant coliforms / *E.coli* level)
- ❑ pH

Parameters occasionally causing problems:

- ❑ Algae
- ❑ Arsenic
- ❑ Chloride
- ❑ Fluoride
- ❑ Iron or manganese
- ❑ Nitrate (or nitrite)
- ❑ Sulphate
- ❑ Industrial or agrochemical pollutants

Sources of information

- ❑ Observation
- ❑ Field-testing equipment
- ❑ Local government
- ❑ Local and affected populations
- ❑ Health centres
- ❑ *Water quality assessment: Assessment routines* pp148-53
- ❑ *Water quality analysis* pp169-203
- ❑ *Biological survey* pp204-213
- ❑ *Water quality analysis and surveying equipment* pp261-82

Methods

- ❑ Catchment mapping
- ❑ Local knowledge including medical information
- ❑ Sanitary investigation / observation
- ❑ Water quality analysis
  - ❍ *Core parameters (common problems)*
  - ❍ *Secondary parameters (occasional problems)*
  - ❍ *Treatability tests*
  - ❍ *Industrial pollution assessment*
- ❑ Biological survey

Requirements for development and impacts summary

Physical requirements

COLLECT FOR EACH SOURCE

Information

- ❑ **Technical requirements:**
  - ❍ *Protection requirements*
  - ❍ *Abstraction method*
  - ❍ *Treatment requirements including storage*
  - ❍ *Transmission distance and means of transmission*
  - ❍ *Supply storage*
  - ❍ *Distribution requirements*
  - ❍ *Subsidiary requirements (e.g. road construction; threat mitigation activities)*
  - ❍ *Consider standardization with existing systems in-country as support to national development objectives*
- ❑ **O&M requirements (human and consumables):**
  - ❍ *O&M human resources*
  - ❍ *O&M consumables*
- ❑ **Resources / logistics:**
  - ❍ *Material and equipment requirements*
  - ❍ *Human resource requirements*
  - ❍ *Logistical requirements*
- ❑ **Costs:**
  - ❍ *Costs for capital and O&M (materials, equipment, human resources, logistics)*
- ❑ **Time of set-up:**
  - ❍ *Total time for system to be up and running (technical requirements versus resources / logistics and other constraints)*
- ❑ **Ease of O&M**
  - ❍ *O&M requirements versus resources / logistics and other constraints*

Sources of information

- ❑ Past technical solutions
- ❑ Head office WATSAN division
- ❑ Agency modular kit and equipment lists
- ❑ Standard text books
- ❑ Local government and other organizations in field
- ❑ *Requirements for development* pp131-5
- ❑ *Mobile water treatment units and modular kits* Table pp283-4

Impacts of development

COLLECT FOR EACH SOURCE

Information

- ❑ **Effects of source development on the aquifer and remote sources:**
  - ❍ *Location and capacity of aquifers*
  - ❍ *Which sources are fed from the same aquifers*
- ❑ **Effects of development on existing users of the source and local populations at the point of abstraction and downstream:**
  - ❍ *Determine: yield of source at present, existing demands, new abstraction demand, remaining yield (dry season) and the effects on existing users*
  - ❍ *Possible compensation for local communities up and downstream for the loss of yield or inconvenience. Also compare local and affected populations' supplies and consider upgrading local supplies to prevent friction*
  - ❍ *Consider migration of people and animals / livestock to improved water sources (may be pronounced with nomadic populations)*
  - ❍ *Effects on community structures / management capacity of organizations and populations*
  - ❍ *What subsidiary / ancillary activities are required (training, road construction, sanitation, agricultural extension, hygiene promotion, etc.)?*
- ❑ **Effects on vegetation and erosion:**
  - ❍ *Change in yield*
  - ❍ *Effects of abstraction on vegetation and erosion and potential actions to minimize effects*
  - ❍ *Effects of migration to improved water sources on vegetation and erosion*
- ❑ **Effects of water treatment and waste disposal:**
  - ❍ *Increase in waste water — how will it affect levels of standing water*
  - ❍ *How will chemicals and fuel for water treatment be stored (location, security)?*
  - ❍ *How will waste chemicals be disposed of?*
  - ❍ *How will the sludge produced during treatment be disposed of?*

Sources of information

- ❑ Observation
- ❑ National or local government
- ❑ Local and affected populations
- ❑ *Impacts of development section* pp136-8
- ❑ *Management, legal, security, socio-political and cultural issues with case studies* pp108-24
- ❑ *Groundwater investigation* pp249-52
- ❑ Checklist p64-5
- ❑ Checklist pp70-1

Confirmation of assumptions made during the selection process

Resources, logistics, legal, security, socio-political, and cultural issues ■

COLLECT FOR THE SELECTED SOURCE

Information

- ❑ **Resources**
  - ❍ *Can the required resources be made available within a suitable time-scale?*
  - ❍ *Are the costs within the available budget?*
- ❑ **Logistics**
  - ❍ *Will logistical constraints prevent the solution being implemented?*
- ❑ **Legal, security, socio-political, and cultural issues**
  - ❍ *Have there been any developments in these areas which could prevent implementation? (physical developments could be due to natural threats or human activities)*
  - ❍ *Have the selected options been discussed with the local and affected populations and accepted as culturally appropriate?*

Sources of information

- ❑ See previous checklists

Groundwater investigation

The use of groundwater is limited in the initial stages of an emergency because:

- ❑ It is difficult to locate;
- ❑ It is difficult to assess the capacity of the aquifer in a short time period; and
- ❑ Access to equipment and an experienced drilling team is often limited.

If groundwater is available, however, it is an excellent source of water, often with limited requirements for treatment, and if the conditions are right can supply large quantities of potable water. Development of new groundwater sources is limited in the initial stages of the emergency because of time restrictions. However a general overview of the groundwater situation in the area is an important addition to the initial assessment of emergency water sources. The information gathered can be used to identify whether further studies should be undertaken by a hydrogeologist and can be a useful start to his / her investigation.

Situations where groundwater could be used in the early stages:

- ❑ Spring sources;
- ❑ Existing developed groundwater sources such as shallow wells and boreholes which have reliable yields and additional capacity;
- ❑ Sub-surface flow abstracted from sandy / gravel river beds of rivers which flow intermittently and can be rapidly and easily abstracted; and
- ❑ New boreholes in areas where drilling equipment is readily available and the aquifer is already located and known to be reliable.

Information

Level 1 (possible to collect some of this information as part of the initial assessment of emergency water sources):

- ❑ Locations and details of all natural and man-made features including topography (can indicate potential recharge routes, pollution sources and location of populations who could supply information on water sources)
- ❑ Details of existing water sources including types, water levels, seasonal variations, present yields and reliability (can indicate locations, depths and reliability of aquifers)
- ❑ Existing borehole logs and testing results (indicates geology and hence possible aquifer characteristics, such as yield, water quality, drawdown during pumping, seasonal fluctuations)
- ❑ Climatic data (indicates potential for recharge)
- ❑ Soil and rock types (indicates potential aquifer characteristics)
- ❑ Vegetation (indicates potential locations of springs and shallow groundwater)
- ❑ Investigation of river beds, erosion channels and nearby hills for rock outcrops (identification of the rocks and angle of outcrops provide further information in the assessment of aquifer capacity)
- ❑ Use of aerial photographs (highlights topographical, vegetational and geomorphological features which can be interpreted by an experienced hydrogeologist. Aerial photographs can also highlight drainage patterns and land use)

Level 2 (unlikely to be collected as part of an initial assessment, but may be recommended in the RAEWS conclusions):

- ❑ Use of remote sensing images (1:12,500 to 1:25,000) (highlights topographical, vegetational and geomorphological features which can be interpreted by an experienced hydrogeologist)
- ❑ Geomorphological analysis and hydroclimatic monitoring
- ❑ Geophysical surveying assessment (electrical resistivity, seismic refraction, electromagnetic profiling, VLF profiling)
- ❑ Exploratory drilling (hand drilling, machine drilling, geological logging, test pumping)

* Note: Difficult to do in the field but useful if possible.

Sources of information

- ❑ Local well drilling team
- ❑ Observation
- ❑ Local populations
- ❑ National and local government (water resources, agriculture, geological survey and water supply departments)
- ❑ Other organizations working in the provision of water supply (consultants, NGOs, etc.)
- ❑ University departments of host country (geography, geology, environmental science, civil engineering, mining, surveying)
- ❑ Certain organizations such as the British Geological Survey can provide interpretations of information based on satellite imagery and their vast data information banks for a fee (See *Useful addresses* pp289-90)
- ❑ Other sources of information as indicated in the checklist p53
- ❑ Hand drilling — See reference Oxfam (1991)
- ❑ *Measurement of yield and water levels* pp143-7
- ❑ See *Background to groundwater and aquifers* pp230-5
- ❑ *Rock and soil identification* pp235-48
- ❑ *Groundwater investigation* pp249-52

Methods

- ❑ Catchment mapping
- ❑ Cross section drawing of topography and water levels using details from existing sources
- ❑ *Pumping tests on existing boreholes
- ❑ Interpretation of the information identified under Level 1 using table *Indicators of the presence of groundwaters* p252

Rainwater investigation

The use of rainwater in emergencies is limited because:

- ❑ It requires significant time and capital to set up large schemes;
- ❑ It may only be available for short periods of the year; and
- ❑ It is unpredictable.

However, rainfall can be a useful source of water as a supplement to individual household supplies if simple catchment structures can be constructed, or for small centres such as clinics or health centres where other sources are limited. Consideration should only be given for mid to long term projects where there is time to investigate yields and develop appropriate catchment structures and storage systems or for the short term if the emergency begins in the rainy season.

Rainwater can be collected on corrugated sheeting or plastic roofs, on other artificial material, or on the ground surface if it is relatively impermeable.

Techniques for storage include:

- ❑ Ponds (do not tend to have isolated abstraction point)
- ❑ *Birkas* (cement-lined ponds)
- ❑ *Hafir* dam (artificial pond with isolated inlet and outlet structures)
- ❑ Sand or sub-surface dams
- ❑ Household tanks (ferrocement, bamboo reinforced cement, concrete, steel, etc.)

Different geographical areas may have differing names for rainwater harvesting or storage techniques.

Information

- ❑ Is rainwater harvesting a common technique in the area?
- ❑ In which months of the year does it rain?
- ❑ Does the amount of rain vary each year?
- ❑ What technologies are used?
- ❑ Can the technologies be improved to prevent contamination (e.g. add isolated abstraction structures)?
- ❑ Are the storage units publicly or privately owned?
- ❑ Is there a tariff?
- ❑ What capacity of storage already exists in the area?
- ❑ How long does the stored water last taking into account existing demands prior to the emergency?
- ❑ Is there a possibility of increasing storage capacity?
- ❑ Who owns the land on which the catchment and storage units are located?

To estimate potential yields:

- ❑ Annual rainfall
- ❑ Temperature variations
- ❑ Permeability of the ground or catchment surface / run-off coefficient
- ❑ Size of catchment area
- ❑ Current position in rainfall cycle

Source of information

- ❑ Owners of storage units and catchment land
- ❑ Local populations
- ❑ Observation
- ❑ National and local government

Methods

- ❑ Calculate storage potential, run-off capacity, evaporation and seepage. See *Rainwater harvesting* pp253-4

National government / local government / NGO / international organization

This checklist may be used when collecting information from government departments or other organizations working in the field. It contains information included in the main checklists but which is brought together for ease of access during interview.

National or local government (includes organizations managing utilities) ■

Note that **caution is required in conflict situations when gathering information** especially from government departments. Requests for aerial photographs and similar items may be misinterpreted. Employer organization and co-ordinating organization (e.g. UNHCR) guidance should be followed in these circumstances. If you are a government employee of the host country or you are working alongside government counterparts this information may be easier to access.

Some of the information may have already been requested by the employing organization, country or regional co-ordinator. Organizational procedures for communicating with official personnel set down by the employing organization should be followed.

Reasons for contacting the host government:

- ❑ You are guests working in their area of responsibility
- ❑ It is necessary for gaining government approvals
- ❑ They will be responsible for looking after the facilities when the outside organizations leave
- ❑ They may be able to provide or loan resources (both human and material)
- ❑ They could be useful sources of information
- ❑ They know the area and probably the location, size and quality of water sources
- ❑ It can provide links with local populations
- ❑ A good relationship with the local authorities can reduce possible frictions
- ❑ It is courteous

Departments which may be useful to contact:

- ❑ National or regional government: administration of refugee or returnee affairs, water resources, environment, geological survey, health, military
- ❑ Local government: administration, water and sewerage, surveying, social, planning, engineering, public works

When meeting with government departments it may be useful to take with you:

- ❑ Information showing who you are and your areas of expertise
- ❑ Documents proving permission to act and letters of support
- ❑ Photographs of past emergency work for subsequent meetings (if requested)

Can the government department give you, or provide information on any of the following?:

- ❑ Logistical constraints
- ❑ Security situation and local clearance procedures
- ❑ Maps of the area (topographic, geological or road)
- ❑ Aerial photographs
- ❑ Aquifer details
- ❑ Numbers and water demands of local populations
- ❑ Water demands and effluent details of local industries and agriculture
- ❑ Government resources which could be made available (possibly for exchange or payment)
- ❑ Personnel assistance (engineers, technicians)
- ❑ Introductions to local leaders
- ❑ Contacts for local contractors and specialists
- ❑ Availability of local resources and supplier contacts
- ❑ Standard specifications for materials and equipment which they usually use (especially pumps)
- ❑ Where to find further information
- ❑ Local staff recruitment policy
- ❑ Method of payment for affected population if included in construction work
- ❑ Environmental problems in the area
- ❑ Main concerns of the government and local populations

On specific water sources:

- ❑ Details of land rights and who permission for abstraction should be sought from
- ❑ Construction drawings of sources already used
- ❑ Borehole logs
- ❑ Pumping or yield records
- ❑ Details of operating procedures or problems with existing systems
- ❑ Water quality records
- ❑ Socio-political or cultural issues to be considered when dealing with water
- ❑ River basin studies

Additional for national government:

- ❑ Permission to become active
- ❑ Procedures for importing goods
- ❑ Letters of introduction
- ❑ Line of government responsibility
- ❑ Policy and level of support to the affected populations
- ❑ Designated agency responsible for co-ordination of the interventions (often UNHCR)

Non-governmental organizations and international organizations

Much of the information noted above may also be requested from non-governmental organizations and international organizations working in the field. Requesting information from more than one source can verify or dispute information already collected. In conflict situations or where governments are inoperational, other field organizations may be the best source of information.

Affected population / local population issues

The person undertaking the rapid assessment of emergency water sources in the early stages of an emergency will often have to act within a short time frame. There are key factors which he / she must assess in order to select a water supply and treatment process to provide potable water.

In the initial stages of an emergency, the questioning of the affected population may be mostly superficial with questions used to confirm observations on existing water sources, pollution risks, availability of containers, etc. However, as soon as possible further questioning of greater depth should be undertaken to help the assessor gain an understanding of the populations he / she is supporting. This will help to ensure that the technological solutions are appropriate to the users. Care must be taken to question as many different groups as possible including those who are vulnerable (consider vulnerability on the basis of gender, age, ethnicity and culture). One method of involving the affected population at an early stage is to request that existing community groups come forward (e.g. women's groups or people who have previously been on water committees) when calls are made for workers. Representatives of these groups can then be consulted on subjects such as the suitability of chosen locations for standposts and the cultural acceptability of proposed sources.

Refer to *Guidance undertaking assessments and report writing* pp103-7 for guidance on avoiding assessment pitfalls. **Record answers to questions in the *Conversations / observations* log** pp79-80

Population / community structure and skills

- ❑ How is the population divided?
- ❑ Who are the population's representatives or acting representatives? (initial contacts for questions)
- ❑ What are the social hierarchies and which are the most vulnerable groups?
- ❑ Are there personnel with the following skills: tradespeople, construction personnel, supervisors, health educators, water technicians, engineers?
- ❑ How are food and other resources presently being distributed?
- ❑ What is the balance of males and females? (if high percentage of single men it may imply that both men and women may have lead responsibility for water usage in different family groups)

Cultural practices

- ❑ Which days are religious / cultural festivals or days of rest?
- ❑ General gender and age roles (before and after being affected by the emergency): who collects water, is responsible for family hygiene, cooks? (can indicate which groups have greatest responsibility for water use and hence who should be consulted)
- ❑ Are there any restrictions for a particular group (e.g. Muslim women in *purdah* may have to collect water in the dark)?
- ❑ Where do people bathe and wash clothes? (potential source of pollution)
- ❑ What forms of sanitation are used? (potential source of pollution)
- ❑ What are the requirements for sanitation: cleaning materials; segregation; level of privacy; water for hand washing? (can indicate level of hygiene practice and hence potential for post-supply contamination)
- ❑ Are there any particular attitudes to water treatment (e.g. are they worried about the use of chemicals)? (could lead to rejection of water supply)

- ❑ Do women have any particular needs or concerns (for example over water and privacy needs during periods of menstruation)?
- ❑ Are there any other cultural beliefs related to water not included above?

Past and present sources of water and, the populations needs and concerns

- ❑ What types of water source did they use before affected by the emergency (well, spring, stream)?
- ❑ Was it chlorinated?
- ❑ What was the level of service (piped supply, direct from source, etc.)?
- ❑ How much water did they use?
- ❑ Details of the water used at present (what does it taste like, does it look muddy or clear and does the taste or appearance change with the seasons)?
- ❑ Are the water collection containers adequate in number, quality and size?
- ❑ What are their priorities in the supply of water and sanitation?
- ❑ What are their needs and concerns?

Security of water collection points

- ❑ Are there any problems with the location of the water collection points in terms of security or accessibility (especially for women, children, the elderly, those physically impaired, those vulnerable due to their ethnicity, those vulnerable due to conflicts)?

Key references:

- Anderson et al, 1992
- Davis and Lambert ,1995, pp55-77
- Gosling and Edwards, 1995

Water treatment works and urban water supply systems

The following checklists are to be used for the assessment of existing water treatment works in urban environments in addition to the general checklists provided previously:

- ❑ Urban water supply system inventory
- ❑ Resources / spares checklist
- ❑ Water treatment works operational checklist

Sources of information: Local government water and sewerage departments; existing works staff; local and international consulting and contracting firms.

Urban water supply system inventory

General

- ❑ Are there maps / plans already available of the supply network?
- ❑ Does a contingency plan for emergencies already exist?
- ❑ Are recent test data results available and inventories of age and condition of pipes and other equipment?
- ❑ Identify damaged sections / items and potential causes of pollution: vandalism; war damage; cross-connections; back-syphonage; pipe near sewer; illegal tapping; fire (Hodgson and Tannock, undated)
- ❑ Who is responsible for operation and maintenance of each section of the supply system
- ❑ Identify and map location of:
  - ❍ *Sources*
  - ❍ *Treatment works*
  - ❍ *Pumping stations*
  - ❍ *Trunk mains*
  - ❍ *Distribution mains*
  - ❍ *Raw and clear water reservoirs*
  - ❍ *Location of consumers (domestic and industrial, including power plants)*
  - ❍ *Heights of all features*
  - ❍ *Power stations or fuel suppliers (e.g. electricity, diesel or petrol)*
  - ❍ *Workshop / storage facilities*
  - ❍ *Laboratories for water quality testing*
  - ❍ *Areas susceptible to physical threats (landslides, floods etc.)*

Sources (UNHCR, 1996)

- ❑ **Springs**

  Identify: expected yield at design and date of design; actual yield and date; description and condition of spring box; description and effectiveness of protection above and around spring; potential sources of contamination

- ❑ **Hand dug well**

  Identify: yield; draw down; lining type and condition; height and number of rings; parapet height and material; apron width and material; depth to bottom of well and to static water level; water drawing mechanism and condition; geology if known; potential sources of contamination

❑ **Borehole**

Identify: drilling company, technique used and date; diameter; pumping test results: date, duration, static water level, drawdown and safe yield; gravel packing type and volume; casing details: type, diameter, length, screen length, percentage of openings

❑ **Hand pump**

Identify: make; model; date of installation; number of strokes required to deliver output — note initial 5 litres and then subsequent 5 litres; borehole details (as above); sand presence in water

Pump units and power supply (UNHCR, 1996)

❑ **Pumps**

Identify: type; make; model; serial number; condition; rated yield and head; actual yield and head; power supply; stockage of fuel for how long; flood protection; motor house condition

❑ **Power unit (engine)**

Identify: type; make; model; serial number; condition; hp; r.p.m.; fuel use (l/hour); cooling system

❑ **Power (generator)**

Identify: type; make; model; serial number; power (KVA); power factor; phase; voltage; amperage; r.p.m.; frequency; condition

❑ **Electrical supply panel**

Identify: type; make; model; serial number; voltage; Hz; hp

Pipelines (UNHCR, 1996)

❑ Identify: materials; sizes; working pressures; isolation valves on pipelines; water hydrants; standpipes; air valves; corrosion protection; invert levels

Treatment works (see *Water treatment works operational checklist* for detailed assessment pp74-8)

❑ Process operation; process control; hydraulic operation; structural soundness

❑ Operation and maintenance: maintenance programme; chemicals and fuels; disposal of wastes; operational management and availability of skilled personnel; record keeping; budget; health and safety

Distribution

❑ Identify: details and condition of distribution units; wastewater drainage arrangements

Workshop / storage facilities

❑ Identify: capacity of staff; availability of spares; capacity for storage; management capability and systems

Sewage treatment works and sewerage system

❑ As water supply system and treatment work

❑ Identify possible areas of contamination to the water supply

Solid waste disposal

❑ What are the existing facilities and are they working?

❑ Does solid waste pose any potential hazards to the water supply?

Resources / spares checklist

See checklist pp56-7

Also:

- ❑ Locations of factories which make equipment
- ❑ What supplies does local government have?
- ❑ Who supplies the local government?
- ❑ What equipment do NGOs and international organizations have in stock; are the parts compatible, and if not what adapters are required?

Skilled personnel

- ❑ Who is still available from existing staff?
- ❑ Which skills are lacking?
- ❑ Is additional training required to run new or modified equipment?

Water treatment works operational checklist

Produce a process diagram and layout map of the operational treatment works including numbers and sizes of units and any spare land available for expansion.

Works details:

- ❑ Built in (and upgraded in) year _____
- ❑ Design capacity _____
- ❑ Operating capacity (usual) _____
- ❑ Operating capacity (at present) _____
- ❑ Area of supply _____
- ❑ Is the access to the works OK? _____
- ❑ Are there any natural threats to the system? _____
  (earthquakes, hurricanes, volcanoes, _____
  mudslides, etc) _____
- ❑ Which sections of the system are most _____
  vulnerable? _____
- ❑ Can mitigation measures be put in place to _____
  prevent further damage? (include details) _____

Process operation:

Screening / intake:

- ❑ Is screening in place and adequate?
- ❑ Are the screens being cleaned?
- ❑ Is the intake protected, such as by a fence?
- ❑ Is it located away from major pollution sources?
- ❑ Can the intake cope adequately with change in water levels?
- ❑ Is the point of abstraction susceptible to erosion?

Raw water storage:

- ❑ What is the turbidity at the inlet and outlet?
- ❑ What is the retention time?
- ❑ What is the size of the reservoir and its effective capacity?

Sedimentation:

- ❑ Are settled solids prevented from being disturbed to the outlet?
- ❑ Does the settlement tank have baffles?
- ❑ Is the retention time > 1 hour?
- ❑ How often are the tanks desludged?
- ❑ What is the turbidity at the inlet and outlet?

Assisted sedimentation (coagulation, flocculation, sedimentation):

- ❑ Is the coagulant mixed immediately?
- ❑ How is the coagulant being flocculated?
- ❑ Is the coagulant dose controlled?
- ❑ Is the turbidity at the outlet to the sedimentation tank < 10 TU?

Chlorination or other disinfection process:

- ❑ Is the contact time > 30 min?
- ❑ Are chlorine residuals checked regularly?
- ❑ Are chemicals weighed or measured accurately?
- ❑ Is the free residual entering the distribution system > 0.4mg/l?
- ❑ Are there no interruptions to disinfection?
- ❑ What is the method of dosage?
- ❑ In what form is the chlorine dosed?
- ❑ Is there safety equipment for handling the chlorine?

Slow sand filtration:

- ❑ Are the filters blocked or being bypassed?
- ❑ Is the top layer of the *schmutzdecke* being removed when required?
- ❑ What is the run time between subsequent removals of the top layer of *schmutzdecke*?
- ❑ Does the plant have facilities for washing filter sand?
- ❑ Is the turbidity on leaving the filter < 5TU?

- ❑ What is the media?
- ❑ Is the depth of sand > 600 mm?
- ❑ How long does the filter run before the removed sand needs replacing?

Rapid gravity filtration:

- ❑ Is the filter being regularly backwashed?
- ❑ What is the run time between backwashes?
- ❑ What is the backwash rate?
- ❑ Is air scour used?
- ❑ Where does the washwater go?
- ❑ Does the washwater contaminate the clean water?
- ❑ What is the media?

Clear water storage:

- ❑ Is the capacity > 1 day for demand?
- ❑ Is the tank clean, undamaged and covered?
- ❑ Are vents and overflow pipes protected by screens?

Other:

Consider the process operation of any additional processes:

- ❑ Grit chamber
- ❑ Oil / grease trap
- ❑ Aeration
- ❑ Pre-chlorination
- ❑ Activated carbon
- ❑ Fluoridation

Process control:

Are the following being checked on a regular basis:

- ❑ Turbidity?
- ❑ pH?
- ❑ Chlorine residuals?
- ❑ Jar test for assisted sedimentation?
- ❑ Microbiological (*E.coli* / total coliform)?

Hydraulic operation:

- ❑ Is the flow control equipment present and functional?
- ❑ Are the process units being operated at designed flow rates?
- ❑ Are overflows being used on a regular basis?

Structural soundness:

- ❑ Is there any point of leakage in the treatment system?
- ❑ Are any of the units cracked, broken or otherwise damaged?
- ❑ Are any of the units dirty?
- ❑ Is the drainage in the treatment works area adequate?

Operation and maintenance:

Maintenance programme:

- ❑ Is there an accepted and implemented programme of maintenance?
- ❑ What does it consist of?; check off each treatment process structure and equipment (pumps, dosing equipment, etc.); are the items of equipment and structures calibrated, oiled, greased, and any damage repaired?

Chemicals and fuels:

- ❑ Note usual dosages of all chemicals
- ❑ How are the treatment process chemicals and fuels stored?
- ❑ How are the chemicals handled?
- ❑ Are the chemicals delivered on a regular basis?
- ❑ Are there likely to be interruptions to deliveries?

Disposal of spoilt chemicals and sludges:

- ❑ How are spoilt chemicals disposed of?
- ❑ How are sludges produced during treatment disposed of?

Workshop / storage facilities

- ❑ What is the capacity of workshop staff?
- ❑ How available are spare items of equipment?
- ❑ How quick are systems for obtaining additional spares?
- ❑ What is the capacity of storage facilities?
- ❑ How effective are stock control systems?

Operational management and personnel:

- ❑ Names and duties of responsible personnel; also position, training, period in job, total experience in water treatment
- ❑ How much time is spent on tasks?
- ❑ Are there enough skilled personnel to keep the plant running?

Record keeping:

Are records kept of the following:

- ❑ Process control results (especially bacteriological and residual chlorine)?
- ❑ Chemical consumption?
- ❑ Problems with the treatment processes?
- ❑ Maintenance?

Health and safety:

- ❑ Are there obvious health and safety problems on the site?
- ❑ Are there facilities to cope with chemical spillage or injury to personnel? What are they?

Budget:

- ❑ Who pays?
- ❑ How much money is available? Is it adequate?
- ❑ How long does it take to get funds?

Assessment of potential for increase in capacity:

- ❑ Could the treatment works cope with further flow? How much?
- ❑ Could the works be expanded to cope with extra flow? How much? How could this be achieved?

Key references:

- Hodgson and Tannock (undated)
- Lloyd and Helmer, 1991
- Jagour, 1996
- Schulz and Okun, 1984
- Siru, 1992
- UNHCR, 1996
- Youde, 1996
- PAHO, 1997

Conversations / observations log

Name/organization ■	**Notes** (including location and date) ■

Conversations / observations log

Name/organization ■	**Notes** (including location and date) ■

Addresses

Name: ______________________________

Position: ______________________________

Organization: ______________________________

Address: ______________________________

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Phone: ______________________________

Fax: ______________________________

Telex: ______________________________

Email: ______________________________

Name: ______________________________

Position: ______________________________

Organization: ______________________________

Address: ______________________________

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Phone: ______________________________

Fax: ______________________________

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3

Published information log

Publication details

(including title, author/s, organization, date, contents, location)

Relevance

Published information log (continued)

Publication details ■	Relevance ■
(including title, author/s, organization, date, contents, location)	

Resources log

Resources:

❑ Materials and equipment ❑ Human ❑ Construction techniques and water treatment processes used

Resource ■	**Details** (numbers, cost, quality, logistical constraints where available) ■

Resources log (continued)

Resources:

❑ Materials and equipment ❑ Human ❑ Construction techniques and water treatment processes used

Resource ■	**Details** (numbers, cost, quality, logistical constraints where available) ■

Reconnaissance of area

(including existing water usage situation, resources and logistics)

Regional orientation

Draw a map of the area including details noted in the checklist p55.

Settlement orientation

Draw a map of the settlement including details noted in the checklist p55.

Demographics, present water usage and water demands

Water user numbers from affected population:

People: _____ Livestock: (large) _____ Livestock: (small) _____ Other users: _____

Water user numbers from local population:

People: _____ Livestock: (large) _____ Livestock: (small) _____

Other users: (e.g. industry agriculture) _____

Comment on reliability of figures: _____

Calculation of total water demand:

Present water sources in use: (type, location, level of service, distance to collection point). Note: The populations' own coping mechanisms should be identified and potentially built upon.

Current water consumption:

Do affected population have adequate containers for water collection?

Are the populations static or mobile?

Diseases prevalent in the local and affected populations:

Logistics (see also 'Resources log')

Condition of roads and areas susceptible to flooding and other physical threats (at present and throughout the seasons)

Security conditions (on access roads and in settlements)

Access to international freight (airstrips, ports, railways, link roads)

Airport / port handling facilities

Customs clearance procedures

Availability and reliability of freight transporters

Journey time for freight

Other logistical issues

Features of the source (excluding water quality)

Physical features including yield

Source name/ number and location and type (including grid reference)

Ground and water levels (note instrument for measurement)

Layout / dimensions (attach sketch, see p93)

Yield estimation

- **volumes / flows**
- **variation with season**
- **recharge capacity**

Discharges in and out (where from, where to)

Environmental features of catchment area (farming, industry, settlements, tree cover, etc.)

Is the source affected by extreme weather conditions (e.g. below 0°C)

For groundwater sources

	Date	Date
Test reference number		
Constant yield or step drawdown test		
Pump details		
Method of flow measurement used		
Reference point / level		
Static water level		
Drawdown		
Specific capacity		
Safe yield		
Observations		

Note: If a supply system already exists then refer to the *Urban water treatment works and supply system* checklist pp72-8

Draw a sketch of the source and the surrounding area

Include:

- ❑ Layout / dimensions
- ❑ Ground level and water level
- ❑ Discharges (in and out; where do they come from and where do they go)
- ❑ Environmental features (river bed materials; plant and tree cover, activities in catchment area)
- ❑ Water collection points
- ❑ Current structures and source protection activities

Management, legal, security, socio-political and cultural issues

Present demands (who, what for and how much, is there competition with animals?)

Are there intermittent users such as nomads?

Who owns the land and what is the procedure to obtain permission to abstract?

Who is responsible authority for control and maintenance?

Is a tariff being charged for the water? (how much and paid to whom?)

Is the source accessible for all? (elderly, children, disabled)

Are there security problems at the source? (especially for women and children and other vulnerable groups such as opposing groups in conflicts)

Are any areas mined?

Socio - political constraints to using the source and cultural beliefs re- water provision

What are the local and affected populations' priorities for water provision?

Are there natural threats in the vicinity of the source? (cyclones, earthquakes, mudslides, etc.) **What are they and what is the risk?**

Features of the source (water quality)

For further information refer to:

- ❑ *Water quality assessment routines* pp148-53;
- ❑ *Catchment mapping: surveying* pp161-7;
- ❑ *Biological survey* pp204-13
- ❑ *Water quality analysis and surveying equipment* pp261-92;
- ❑ *Catchment mapping: maps and symbols* pp154-60;
- ❑ *Water quality analysis* pp169-203;

Water quality assessment summary

Water quality assessment method	**Water quality inferences for** source name/ number and location _____
Catchment mapping	Observations: Inference:
Local knowledge including medical information	Observations: Inference:
Sanitary investigation & observation	**Sanitary risk:** high - medium - low - very low **Improved sanitary risk:** high - medium - low - very low **Specific risks which can potentially be improved:** 1. 2. 3. 4. 5. **Observations of the water source:** **Inference:**
Water quality analysis (see following page for details)	**Key findings:** ❑ Core parameters: ❑ Secondary parameters: ❑ Treatability tests: **Inference:**
Biological survey	**Species found:** **Yes** **No** ❑ intolerant ❑ slightly intolerant ❑ moderately tolerant ❑ tolerant **Inference:** Clean water / some minor pollution / moderate pollution / some major pollution / severe pollution **Type of pollution expected:**
Overall conclusions	**Present quality:** **Predicted variations in quality:**

Water quality analysis

	Measured value / description	Prediction of variation	Date of assessment	Test kit / method used
Core tests				
Turbidity (TU)				
Odour				
Colour				
Conductivity (µS/cm)				
pH				
E.coli / 100 ml				
Secondary tests (only test if there is an indication that there may be a problem)				
Chloride mg/l				
Fluoride mg/l				
Iron mg/l				
Manganese mg/l				
Nitrate mg/l				
Nitrite mg/l				
Sulphate mg/l				
Taste				
Arsenic mg/l *				
Permanganate Value				
Chlorine demand (of raw water) mg/l				

* Suitable field equipment may not be available for this parameter

Treatability tests

	Dosage required / time	Date of assessment	Test kit / method used
Treatability tests			
Sedimentation			
Assisted sedimentation			
pH adjustment			
Chlorination (chlorine demand of treated water)			
Other			

Industrial pollution laboratory analysis

Date sample sent to the laboratory

Address of laboratory

Details:

- ❑ chemicals added for stabilization
- ❑ storage conditions in transit
- ❑ time from sampling to laboratory analyses

Key results (attach data sheet)

Requirements for development and impacts summary

Source name, location and reference:

Technical and O&M requirements and time of set up

Technical and O&M requirements	Details	Predicted time for set-up	Potential time delays for set up / problems for set up and O&M
Protection			
Abstraction method and equipment structures			
Treatment (including raw water storage)			
Transmission distance and means of transmission			
Supply storage (if additional to raw water storage for treatment)			
Distribution			
Other (subsiduary)			
Estimated total time of set-up (items can be implemented in parallel)			

Resources and costs

	Key resources (capital and O&M)		Capital cost	O&M costs
	Material	Human		
Protection				
Abstraction				
Treatment system (including raw water storage)				
Transmission				
Supply storage (if additional to raw water storage for treatment)				
Distribution				
Other (subsiduary)				
Total costs				

Impacts of development

Potential effects of source development on the aquifer and remote sources

- ❑ Potential effects on aquifer

Effects of development on existing users of the source and local populations at the point of abstraction and downstream

- ❑ Determine: yield of source at present, new abstraction demand, existing demands, remaining yield (dry season) and the effects on existing users
- ❑ Possible compensation for local communities for the loss of yield or inconvenience
- ❑ Consider migration of people and animals / livestock to improved water sources (may be pronounced with nomadic populations) and the effects
- ❑ What are the effects on community structures / management capacity of organisations and populations?
- ❑ What subsidiary / ancillary activities are required? (training, road construction, sanitation, agricultural extension, hygiene promotion etc.)

Effects on vegetation and erosion

- ❑ What are the effects of abstraction on vegetation and erosion?
- ❑ What are the effects of migration to improved water sources on vegetationand erosion?

Effects of water treatment and waste disposal

- ❑ Increase in waste water - how will it affect levels of standing water?
- ❑ How will chemicals and fuel for water treatment be stored ?(location, security)
- ❑ How will waste chemicals be disposed of?
- ❑ How will the sludge produced during treatment be disposed of?