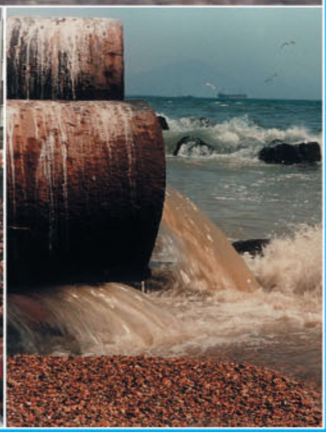

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WATER SUPPLY & SANITATION COLLABORATIVE COUNCIL

GUIDELINES ON MUNICIPAL WASTEWATER MANAGEMENT

A practical guide for decision-makers and professionals on how to plan, design, and finance appropriate and environmentally sound municipal wastewater discharge systems.

Disclaimer

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Earlier versions of this guide were based on a report usually referred to as "Recommendations for Decision-making on Municipal Wastewater" and on a background document "Strategy options for Sewage Management to Protect the Marine Environment" prepared by IHE, IRC and NEI.

In 2001 and 2002 version 2.1 of the guidelines formed the basis for extensive review and discussion at regional level with a wide variety of stakeholders, including national and local experts, representatives from non-governmental organisations, the private sector, professional organisations, international financial institutions, and potential donors.

The GPA Coordination Office wishes to thank all those who assisted in the development and production of this report, the participants of consultative meetings, the expert reviewers, the partner organizations, and the Regional Seas, Regional Offices and Coordinating Units.

Collaborative partner organizations are the World Health Organization of the United Nations (WHO), the United Nations Human Settlements Programme (UN-HABITAT) and the Water Supply and Sanitation Collaborative Council (WSSCC).

The contents of this document are shared with the Sanitation Connection Database http://www.sanicon.net .

Foreword

Since the adoption of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) in 1995, UNEP has pioneered the development of tools addressing marine pollution originating from land-based activities. GPA is the only global action programme addressing the interface between the fresh water and coastal environment. One of the problems the GPA address's is the uncontrolled discharge of wastewater into the fresh water and coastal environment.
A priority also identified by UNEP and reconfirmed at the 2002 Millennium Summit and the World Summit on Sustainable Development.
Indeed in many parts of the world sewage is still discharged directly into open water without treatment. Such uncontrolled discharge is one of the most serious threats to the productivity and biodiversity of the world's oceans. At the same time it causes serious environmental and human health problems and threatens sustainable coastal development.
In response to the daunting challenge faced by many governments in addressing municipal wastewater problems, the GPA has developed guidelines for municipal wastewater management, jointly with WHO, UN-Habitat, and WSSCC.
The guidelines provide practical guidance on how to plan appropriate and environmentally sound municipal wastewater management systems. The guidelines are meant for decision-makers, operational professionals in government institutions, and in the private sector, development banks and related organizations. The guidelines focus on four elements: approaches and policies, institutional arrangements, technological choices, and financing options. Each element is supported by a practical checklist.
The guidelines address and stress the need to link water supply and the provision of household sanitation, wastewater collection, treatment and re-use, cost-recovery, and re-allocation to the natural environment. Local participation is advocated and stepwise approach to technology and financing, starting at modest levels, expanding if and when more resources become available.
The guidelines are summarized in 10 keys for action covering: political commitment; action at national and local level; going beyond taps and toilets; integrated management; long-term perspectives with step-by-step approaches; time-bound targets and indicators; appropriate technology; demand-driven approaches; stakeholder involvement; transparency; and financial stability and sustainability.
UNEP and its partners are pleased to present this third version of the guidelines, which went through several rounds of review and consultation. UNEP very much welcomes comments to ensure that the guidelines address the needs of the users.

Veerle Vandeweerd
Coordinator
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Box

About the GPA and its Strategic Action Plan on Municipal Wastewater

The Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) was established in November 1995 when 108 governments and the European Union met in Washington, D.C. This action illustrated a clear commitment among national governments and the international community to protect and preserve the marine environment from adverse environmental impacts of land-based activities. UNEP was charged to provide the Secretariat and as such the UNEP/GPA Coordination Office in The Hague currently facilitates and catalyzes the implementation of the GPA.

The GPA framework provides a series of recommendations for action as well as criteria for their development at different levels. At the national level, it provides a comprehensive yet flexible framework, to assist countries in fulfilling their duty to preserve and protect the marine environment from sewage, physical alterations and destruction of habitat, nutrients, sediment mobilisation, persistent organic pollutants, oils, litter, heavy metals and radioactive substances.

Integral to the implementation of the GPA is the development of Key Principles and Checklists, within a framework of Practical Guidelines and Toolkits for the major GPA programme areas. These Principles and Checklists advocate innovative approaches on issues such as institutional set-up, financing mechanisms, alternative technologies and stakeholder involvement, including the private sector and local communities.

To further assist governments in implementing the GPA, a Strategic Action Plan on Municipal Wastewater (SAP) was prepared by the UNEP/GPA Coordination Office, in close cooperation with other international and regional organizations, donor agencies, financial institutions and development assistance agencies. SAP aims to promote concrete actions at both local and national levels. Actions focus on promoting the use of alternative solutions, including low cost and environmentally sound sanitation and wastewater treatment technologies, innovative financial mechanisms, appropriate partnerships, and the creation of an enabling environment for action. SAP provides for normative guidance, demonstration and capacity building initiatives. In November 2001, the First Intergovernmental Review of the GPA, held in Montreal, Canada, welcomed the Strategic Action Plan on Municipal Wastewater and urged UNEP to finalize SAP as a tool for implementing the objectives of the GPA.

The Plan of Implementation adopted at the World Summit on Sustainable Development (WSSD), held in Johannesburg, in September 2002, further endorses the GPA with particular emphasis on municipal wastewater. Furthermore, the Strategic Action Plan on Municipal Wastewater and the Guidelines on Municipal Wastewater Management presented in this document directly relate to the targets on water supply and sanitation agreed at the Millennium Summit and the WSSD.

The UNEP/GPA Coordination Office focuses on implementation of the Strategic Action Plan on Municipal Wastewater through the UNEP Regional Seas Programme, with emphasis on coastal cities domestic wastewater management. In association with partners, UNEP addresses the environmental dimension of water and sanitation in, among others, campaigns and programmes like the WSSCC campaign on Water Supply, Sanitation and Hygiene, the UN-HABITAT Water for African and Asian Cities programmes, the 'Cities Alliance' programme, and the UN Task Force on Water and Sanitation.

Relevant web-sites

http://www.gpa.unep.org
http://www.sanicon.net
http://www.wsp.org
http://www.unep.or.jp/ietc
http://www.unhabitat.org
http://www.unesco-ihe.org
http://www.who.in/water_sanitation_health
http://www.wsscc.org
http://www.uneptie.org
http://www.un.org/esa/sustdev/csd

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Acronyms

BAT	best available techniques
BATNEEC	best available techniques not entailing excessive cost
BOD	Biochemical oxygen demand
BOO	Build-own-operate contract
BOT	Build-own-transfer contract
BPT	best practicable techniques
CSD	United Nations Commission on Sustainable Development
DBO	Design-build-operate contract
EBRD	European Bank for Reconstruction and Regional Development
EU	European Union
FAO	Food and Agriculture Organization of the UN
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (IMO/FAO/UNESCO-IOC/WMO/WHO/IAEA/UN/UNEP)
GESI	Global Environmental Sanitation Initiative
GNP	Gross national product
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
ICZM	Integrated Coastal Zone Management
IDRC	International Development Research Centre
IETC	International Environmental Technology Centre (UNEP)
IFI	International financial institution
IPCC	International Panel on Climate Change
IRC	International Water and Sanitation Centre
ISO	International Organization for Standardization
MPF	Multiproject financing facility
NEI	Nederlands Economisch Instituut
NGO	Non-governmental organisation
OECD	Organisation for Economic Cooperation and Development
POP	Persistent organic pollutant
PPIAF	Public Private Infrastructure Advisory Facility
PPP	public-private partnership
PSP	private sector participation
ROT	Rehabilitate-operate-transfer contract
SPC	Secretariat of the Pacific Community
UN	United Nations
UN-HABITAT	United Nations Human Settlements Programme
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO-IHE	United Nations Educational, Scientific and Cultural Organization - Institute for Water Education
UNICEF	United Nations Children's Fund
US-EPA	United States Environmental Protection Agency
WCC	World Coast Conference
WHO	World Health Organization
WMO	World Meteorological Organization
WRI	World Resources Institute
WSSCC	Water Supply and Sanitation Collaborative Council

Glossary

ACTIVATED SLUDGE PROCESS A wastewater treatment process by which bacteria that feed on organic wastes are continuously circulated and put in contact with organic waste in the presence of oxygen to increase the rate of decomposition.

ADVOCACY Creating awareness and getting the commitment of decision-makers for a social cause

AEROBIC TREATMENT A wastewater treatment process in which bacteria and other organisms are used that feed on waste products and break them down, taking oxygen from their surroundings.

ANAEROBIC TREATMENT A wastewater treatment process that relies on anaerobic digestion processes in which bacteria are used that feed on the substrate on which they grow in the absence of oxygen.

BIOCHEMICAL OXYGEN DEMAND (BOD) A measure of the organic pollutant strength of wastewater measured in milligrams per litre. This is equal to the mass of oxygen consumed by organic matter during aerobic decomposition under standard conditions during a fixed period (usually five days).

CATCHMENT SOLIDARITY Solidarity among different user groups spread all over the river catchment (both up- and down stream).

COAGULATION Destabilization of colloidal particles used in water and wastewater clarification processes

COMBINED SEWER SYSTEM A sewer receiving intercepted surface (dry- and wet-weather) runoff, municipal (sanitary and industrial) wastewater, and subsurface waters from infiltration. Normally, its entire flow goes to a waste treatment plant or discharge point, but during a heavy storm, the volume of water may be so great as to cause overflows of untreated mixtures of storm water and wastewater into receiving waters. Storm water runoff may also carry toxic chemicals from industrial areas or streets into the sewer system

COMBINED SEWER OVERFLOW Discharge of a mixture of storm water and domestic waste when the flow capacity of a sewer system is exceeded during rainstorms.

DIGESTION (WASTEWATER) The reduction in volume and the decomposition of highly putrescible organic matter to relatively stable or inert organic and inorganic compounds. Sludge digestion is usually done by aerobic organisms in the absence of free oxygen.

DOMESTIC WASTEWATER Wastewater principally derived from households, business buildings, institutions, etc., which may or may not contain surface runoff, groundwater or storm water.

DRY LATRINE The term is used to describe both:

- Crude systems in which faeces are excreted onto a slab or into an improvised container from which they are manually removed; and
- Latrines from which water and urine are excluded in order to increase the rate at which excreta decomposes.

DRY WASTEWATER SLUDGE A sludge from a wastewater treatment plant which has been digested and dewatered and does not require liquid handling equipment.

EUTROPHICATION	The process of an aquatic body becoming enriched with nutrients that stimulate aquatic plant growth, such as algae, resulting in depletion of dissolved oxygen.
FLOCCULATION	The formation of macro flocs and agglomerations of micro flocs as a result of coagulation processes (see coagulation).
GROUNDWATER	Subsurface water in a saturation zone or aquifer that can be extracted through a well.
INDUSTRIAL WASTEWATER	Wastewater that results from industrial processes and manufacturing. It may either be disposed of separately or become part of the sanitary or combined wastewater.
LATRINE	An installation used for defecation and urination.
MUNICIPAL WASTEWATER	A mixture of domestic wastewater, effluents from commercial and industrial establishments, and urban runoff.
ON-SITE FACILITIES	Sanitation facilities that are located on a householder's plot. May be an on-plot system or the on-plot components of a more extensive system.
ON-SITE SANITATION	A sanitation system that is contained within a householder's plot occupied by the dwelling and its immediate surroundings.
ORGANIC MATERIAL	In wastewater treatment, material that can be biologically consumed in the secondary treatment process. A food source for various micro-organisms.
PACKAGE PLANT	Small scale, compact water / wastewater treatment unit; compound of one or more different units/ processes.
PATHOGEN	A disease-causing micro-organism such as bacteria, viruses, and protozoa
PIT LATRINE	Latrine with a pit for the accumulation and decomposition of excreta and from which liquid infiltrates into the surrounding soil.
POUR FLUSH LATRINE	A latrine that depends on small quantities of water, poured from a container by hand, to flush faeces away from the point of defecation. The term is normally used for a latrine incorporating a water seal.
PRIMARY TREATMENT	The first stage of contaminant removal in a wastewater treatment plant through screening and settling processes, which can remove 40-50% of contaminants.
PROGRAMME COMMUNICATION	The process of identifying, segmenting, and targeting specific groups or audiences with particular strategies, messages, or training programmes.
SANITATION	• Control of physical factors in the human environment that could harm development, health, or survival. • The study and use of practical measures for the preservation of public health

SECONDARY TREATMENT Second stage of wastewater treatment to reduce suspended solids through biological cleansing, to remove between 85-95% of contaminants.

SEPARATE SEWER SYSTEM Sewer system having distinct drain pipes for collecting superficial water and separate sewers for wastewater.

SEPTIC TANK A tank or container, normally with one inlet and one outlet, which retains wastewater and reduces its strength by settlement and anaerobic digestion of excreta.

SEWAGE See Wastewater

SEWER A channel or conduit that carries wastewater and storm-water runoff from the source to a treatment plant or receiving stream. "sanitary" sewers carry household, industrial and commercial waste. Storm sewers carry runoff from rain. Combined sewers handle both.

SEWERAGE (SYSTEM) System of pipes, usually underground, for carrying wastewater and human waste away from houses and other buildings, to treatment and/or discharge

SLUDGE
- A semi-fluid, slushy, murky mass of sediment resulting from treatment of water, wastewater, or industrial and mining wastes, and often appearing as local bottom deposits in polluted bodies of water.
- A soft, soupy, or muddy bottom deposit, such as found on tideland or in a streambed.

SLUDGE OR BIO-SOLIDS Residue after wastewater treatment. It can be, after proper treatment, used for soil amendment or as fertilizer, unless it contains toxic substances, such as heavy metals or persistent organic pollutants (pops).

SLUDGE STABILIZATION Usually anaerobic sludge digestion, a treatment that stabilizes raw sludge. Fully digested sludge has little readily biodegradable organic matter. It is not smelly and about 50% of the solids are inorganic. Sludge can also be digested aerobically.

SLUDGE TREATMENT The processing of wastewater sludge to render them innocuous. This may be done by aerobic or anaerobic digestion followed by drying in sand beds, filtering, and incineration, filtering, and drying, or wet air oxidation

SOAK AWAY A soak pit or drainage trench for the subsoil percolation of liquid waste.

SOAKPIT A hole dug in the ground serving as a soakaway.

SOCIAL MOBILIZATION The process of bringing together all feasible and practical intersectoral social allies to raise people's awareness of and demand for a particular development programme

SOLID WASTE Litter and other waste in the streets. It can be flushed away with stormwater into the sewer or drainage system and cause blockage in the system.

STORMWATER Stormwater runoff, snow melt runoff, and surface runoff and drainage; rainfall that does not infiltrate the ground or evaporate because of impervious land surfaces but instead flows onto adjacent land or watercourses or is routed into drain/sewer systems

STORM SEWER A conduit that collects and transports rain and snow runoff back to the ground water. In a separate sewerage system, storm sewers are entirely separate from those carrying domestic and commercial wastewater.

TERTIARY TREATMENT Third stage of wastewater treatment including filtration and disinfection, which effectively removes up to 99.999% of pathogens and suspended solids.

TRICKLING FILTER Trickling filters allowing water to trickle through a bed of stones (or some other suitable medium) so that it spreads as a fine film and is in contact with both air and the oxidizing organism.

URBAN SANITATION The renovation or redevelopment of the decaying areas of cities by the demolition or up-grading of existing dwellings and buildings and a general improvement in environmental conditions

VENTILATED IMPROVED PIT (VIP) LATRINE A pit latrine with a screened vent pipe and a dark interior to the superstructure.

WASTEWATER Water carrying wastes from homes, businesses and industries that is a mixture of water and dissolved or suspended solids.

WASTEWATER CHARGE Imposed fee, expense, or cost for the management of spent or used water that contains dissolved or suspended matter from a home, community farm, or industry.

WASTEWATER DISCHARGE The flow of treated effluent from any wastewater treatment process.

WASTEWATER DISPOSAL Collection and removal of wastewater deriving from industrial and urban settlements by means of a system of pipes and treatment plants.

WASTEWATER MANAGEMENT All of the institutional, financial, technical, legislative, participatory, and managerial aspects related to the problem of wastewater.

WASTEWATER POLLUTION The impairment of the quality of some medium due to the introduction of spent or used water from a community or industry.

WASTEWATER QUALITY The state or condition of spent or used water that contains dissolved or suspended matter from a home, community farm or industry.

WATER CLOSET A pan, incorporating a water seal, in which excreta are deposited before being flushed away with water.

WATER RECLAMATION Treatment and management of municipal, industrial, or agricultural wastewater to produce water of suitable quality for additional beneficial uses.

WASTEWATER SLUDGE The removed materials resulting from physical, biological and chemical treatment of wastewater.


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Summary

Wastewater causes serious environmental and human health problems, especially in coastal zones. There is no single solution to solve such problems, because of the large variation in economic, social, cultural, and physical characteristics in an area.

In the framework of the UNEP/WHO/UN-HABITAT/WSSCC Strategic Action Plan on Municipal Wastewater (SAP), adopted in 2001 at the UNEP/GPA Intergovernmental Review Meeting in Montreal, guidelines have been developed on municipal wastewater management. Version 3 is presented in this report. In parallel, ten key points have been formulated for local and national action on municipal wastewater. These 10 keys, listed and annotated below, are prerequisite for successful municipal wastewater management. The Guidelines and Keys for Action both cover policy issues, management approaches, technology selection and financing mechanisms.

10 Keys for local and national action on municipal wastewater

1 Secure political commitment and domestic financial resources

A political climate has to be created in which high priority is assigned to all the aspects of sustainable municipal wastewater management, including the allocation of sufficient domestic resources.

2 Create an enabling environment at national AND local levels

Public authorities remain responsible for water and wastewater services. The 'subsidiarity principle', i.e. the delegation of responsibilities to the appropriate level of governance, applies to the entire water sector. National authorities should create the policy, legal, regulatory, institutional and financial frameworks to support the delivery of services at the municipal level in a transparent, participatory and decentralized manner.

3 Do not restrict water supply and sanitation to taps and toilets

A holistic approach to water supply and sanitation should be adopted. This incorporates not only the provision of household services, but various other components of water resource management, including protection of the resource that provides the water, wastewater collection, treatment, reuse and reallocation to the natural environment. Addressing the environmental dimensions mitigates direct and indirect impacts on human and ecosystem health.

4 Develop integrated urban water supply and sanitation management systems also addressing environmental impacts

Municipal wastewater management is part of a wider set of urban water services. The wastewater component is usually positioned at the end of a water resource management chain. Integration of relevant institutional, technical, sectoral, and costing issues of all major components of the chain is required. Consideration should be given to the joint development, management, and/or delivery of drinking water supply and sanitation services.

5 Adopt a long-term perspective, taking action step-by-step, starting now

The high costs of wastewater systems necessitate a long-term, step-by-step approach, minimizing current and future environmental and human health damage as much as possible within existing budgetary limits. Non-action imposes great costs on current and future generations and misses out on the potential of re-using valuable resources. A step-by-step approach allows for the implementation of feasible, tailor-made and cost-effective measures that will help to reach long-term management objectives.

6 Use well-defined time-lines, and time-bound targets and indicators

Properly quantified thresholds, time-bound targets and indicators are indispensable instruments for priority setting, resource allocation, progress reporting and evaluation.

7 Select appropriate technology for efficient and cost-effective use of water resources and consider ecological sanitation alternatives

Sound water management relies on the preservation and efficient utilization of water resources. Pollution prevention at the source, efficient use and re-use of water, and application of appropriate low-cost treatment technologies will result in a reduction in wastewater quantity and in investment savings related to construction, operation and maintenance of sewerage systems and treatment facilities. Depending on the local physical and socio-economic situation, different technologies will be appropriate. Eco-technology is a valid alternative to traditional engineering and technical solutions.

8 Apply demand-driven approaches

In selecting appropriate technology and management options attention must be given to users' preferences and their ability and willingness to pay. Comprehensive analyses of present and future societal demands are required, and strong support and acceptance from local communities should be secured. With such analyses realistic choices can be made from a wide range of technological, financial and management options. Different systems can be selected for different zones in urban areas.

9 Involve all stakeholders from the beginning and ensure transparency in management and decision-making processes

Efforts and actions on domestic sewage issues must involve pro-active participation and contributions of both governmental and non-governmental stakeholders. Actors stem from household and neighborhood levels to regional, national and even international levels, and possibly the private sector. Early, continuous, targeted and transparent communication between all parties is required to establish firm partnerships. The private sector can act as a partner in building and improving infrastructure, in operating and maintaining of facilities, or in providing administrative services.

10 Ensure financial stability and sustainability

10.1 Link the municipal wastewater sector to other economic sectors

Sound and appropriate wastewater management may require substantial construction and operational investments in wastewater infrastructure and treatment facilities. Relative to the water supply sector, cost recovery in the wastewater sector is traditionally a long process. Developments in other (socio-) economic sectors, for instance water supply or tourism, may create opportunities to address sanitation at the same time. Linking wastewater management with other sectors can ensure faster cost-recovery, risk-reduction, financial stability and sustainable implementation.

10.2 Introduce innovative financial mechanisms, including private sector involvement and public-public partnerships

Traditionally, sanitation services have been provided by public authorities. Costs for investments, operation and maintenance, however, often outstrip their capacities, as do present and future requirements for serving the un-served. Therefore, innovative, more flexible and effective financial management mechanisms have to be considered, e.g. micro-financing, revolving funds, risk-sharing alternatives, municipal bonds. Public-private partnerships, and also public-public partnerships, are important tools to assist local governments in initial financing and operating the infrastructure for wastewater management.

10.3 Consider social equity and solidarity to reach cost-recovery

The employment of principles like ‘the water user pays’ and ‘the polluter pays’ is required to achieve stable and sustainable wastewater management with efficient cost-recovery systems. These principles should be applied in a socially acceptable way, considering solidarity and equitable sharing of costs by all citizens and facilities. Various user groups should be made aware of - and be able to identify with - concepts such as “water-” and “catchment solidarity”. All users will benefit from environmental improvement.

This report provides practical guidance on how these Keys for Action can be applied to develop locally appropriate and environmentally sound municipal wastewater discharge systems. Preventive action ‘now’ can substantially reduce future expenditures to mitigate the effects of wastewater pollution. The best locally applicable situation is achieved through integrated, realistic, and thus tailor-made, step-by-step approaches. Chapter 1 (Enabling Policy) sets the scene for the three more specific chapters that follow (Institutional Arrangements, Cost-effective Technologies, and Financial Mechanisms respectively).

Governments should create an enabling policy environment (Chapter 1) through which:

- wastewater management will ensure equity, promote health, protect from disease, and protect the environment;
- the role of governments transforms from service provider to initiator and facilitator of sustainable wastewater management;
- local authorities and communities, the private sector, regional and river basin agencies, and other partners can participate in planning and implementation of sustainable solutions; and
- technically and financially realistic, stepwise approaches can be applied, with appropriate time and geographic scales.

Institutional arrangements and social participation in wastewater management should result in commitment to a clean environment and “catchment solidarity” (Chapter 2). This requires:

- a long-term strategy for institutional reform;
- capacity building to strengthen weak or inadequate structures, legal and regulatory instruments, and organizations, both inside and outside government;
- involvement of all relevant actors and their real willingness to cooperate and contribute;
- creation of continued awareness among citizens regarding their dual role as polluters and beneficiaries of wastewater management.

While planning technologies focus should be on local applicability, cost-effectiveness and sustainability. The guidance provided in Chapter 3 highlights that:

- because of the wide variation in coastal zone characteristics and functions, no uniform technology can be prescribed for wastewater collection and treatment;
- the high cost of wastewater treatment warrants a careful search for low-cost technologies that tackle pollution prevention, water conservation, and efficient use of water.
- a stepwise approach to technology selection and planning is required, addressing pollution prevention, on-site treatment, and off-site transportation and treatment, including natural treatment, conventional treatment and re-use (the aspect of re-use receives specific attention).

Financial mechanisms selected to recover costs of wastewater management should balance three critical and interrelated aspects: (1) quality of the service, (2) investment costs, and (3) tariffs that users are willing and able to pay (Chapter 4). Some key messages are:

- users should receive an adequate service sensitive to their ability to pay and to their contributions to pollution: principles such as “water user pays”, “polluter pays” and ‘catchment solidarity’ are prerequisites for achieving sustainability;
- low and middle-income countries cannot afford capital-intensive conventional, engineered solutions; investments should go step-by-step (choose the best possible within the limited resources of the moment); and
- partnerships between public and private sectors are potentially useful tools to assist local governments in financing and operating infrastructure for wastewater management.

Practical checklists, suggestions for further reading and a glossary complement the guidance given in the four main chapters.

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Introduction

Main issues in wastewater management are insufficient stakeholder awareness and involvement and the high mitigation costs.
Urban wastewater management is a tool to improve and maintain environmental integrity and economic functions of coastal ecosystems.
The best locally applicable situation is achieved through integrated, realistic, and thus tailor-made, step-by-step approaches.

Wastewater discharge in coastal zones

Coastal zones are of tremendous importance for life on Earth. However, they have fragile ecosystems and are very vulnerable to pollution like uncontrolled wastewater discharges (see Box A below for some facts).

For centuries low population densities in prevailing rural economies meant that water consumption levels were modest and pollution from wastewater was localised. Besides, the natural environment could absorb these modest pollution loads, and thus coastal zones were not really polluted.

Wastewater causes serious problems in coastal zones

Nowadays, nature can often no longer cope with these pressures and the basis of various economic activities is threatened. Within the last three decades alone, the world population has doubled to six billion people, the world economy has more than doubled and the level of urbanisation has increased, especially in developing countries. Municipal wastewater discharged into the environment has increased concurrently. Continued growth of population and economy, occurring most prominently in coastal zones, will result in even more damage in the years ahead, unless appropriate action is taken to control pollution. Especially developing countries are vulnerable, since, despite global economic growth, the gap between rich and poor has widened in the last 30 years; per capita incomes have risen only marginally except in OECD countries.

Municipal wastewater is a mixture of domestic wastewater, commercial and industrial effluents, urban runoff, and infiltration. Wastewater quantity is mainly determined by water consumption, climate and state of the sewerage system. Variation in quality is mainly caused by the composition of industrial discharges (e.g. heavy metals and other toxic compounds).

The Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA - see the Box in preliminary pages for details on the GPA) confirms that significant wastewater-related problems are common in coastal areas throughout the world, and that urban wastewater discharges are considered as one of the most significant threats to sustainable coastal developments.

Box A

Facts and figures about coastal zones

Coastal zones with their complex fragile terrestrial and marine ecosystems:

- are hatcheries and breeding grounds for fish, marine mammals and amphibians;
- provide food and protection to hundreds of species (many of commercial value);
- support large populations of marine and land-based animals (mammals and birds);
- occupy 18% of the Earth's surface;
- support the life of more than 60% of the human population;
- provide protection against coastal erosion (wetlands, dunes, coral reefs, ….);
- provide more than 90% of world's fish catch;
- host two thirds of the worlds mega cities (more than 8 million inhabitants);
- receive almost all wastewater discharge from land (coastal and further inland).

Coastal zones are threatened by:

- destruction and alteration of habitats;
- changes in hydrology and the flow of sediments;
- overfishing and destructive fishing methods and management;
- the effects of sewage and chemicals; agricultural activity (eutrophication); shipping.

No single solution exists to solve municipal wastewater problems

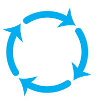
The wide variation in coastal zone characteristics and functions, makes it practically impossible to prescribe uniform wastewater discharge and treatment technologies and management options for all conditions. Each pollution issue often requires independent consideration and a **tailor-made approach.** For example, problems in coastal mega cities and on small islands, although similar by origin, may vary significantly in terms of magnitude, scope, state of urgency, and solutions.

Although there is no single recipe, approach, or strategy to address problems associated with municipal wastewater, ten basics, formulated under the GPA and summarised in Box B below, are widely acknowledged as useful instruments to try to make a difference. Many of these principles are closely related. As an overarching principle one should always keep in mind that, regardless of the approach chosen, different diciplines need to be integrated from the beginning. All actors need to be able to relate to each other's disciplines, so that they can grow together towards an **integrated system** for wastewater discharge.

Large, long-term investments are required

Economic impacts of wastewater on coastal ecosystems have not yet been quantified, but are likely to be extensive. Addressing wastewater pollution requires very substantial and long-term investments. Traditionally, the water supply sector enjoys a far higher priority than municipal wastewater management. Too little is being done to improve the latter.

Step-by-step approach



While developing more sustainable wastewater discharge systems a step-by-step approach is best applied, planning realistic investment steps over longer periods and taking logically organized steps, involving all stakeholders, while designing tailer-made systems. One can start anywhere in a sequence of steps, but certain steps should always be followed by specific others.

Box B

Ten keys for Local and National Action on Municipal Wastewater

These are prerequisite for successful municipal wastewater management; they cover policy issues, management approaches, technology selection and financing mechanisms.

1 Secure political commitment and domestic financial resources.
2 Create an enabling environment at national AND local levels.
3 Do not restrict water supply and sanitation to taps and toilets.
4 Develop integrated urban water supply and sanitation management systems also addressing environmental impacts.
5 Adopt a long-term perspective, taking action step-by-step, starting now.
6 Use well-defined time-lines, and time-bound targets and indicators.
7 Select appropriate technology for efficient and cost-effective use of water resources and consider ecological sanitation alternatives
8 Apply demand-driven approaches.
9 Involve all stakeholders from the beginning and ensure transparency in management and decision-making processes
10 Ensure financial stability and sustainability.
10.1 Link the municipal wastewater sector to other economic sectors.
10.2 Introduce innovative financial mechanisms, including private sector involvement and public-public partnerships.
10.3 Consider social equity and solidarity to reach cost-recovery.

Main issues while addressing wastewater discharge

Inadequate handling of wastewater has serious consequences for human health, the environment and economic development. It contaminates the water supply, increasing the risk of infectious diseases and deteriorating groundwater and other local ecosystems, for instance after flooding.

Wastewater pollution causes health problems

The increasing urban pressure on coastal zones further increases the risk of incidence of pathogen contamination, oxygen stress, and the emergence of red tides and toxic micro-organisms. These events may confront us with scientifically unknown problems. Especially in developing countries health problems due to wastewater pollution can become severe for the large population living in coastal areas.

Numerous reasons can be identified for inefficient or even failing wastewater management services, such as low prestige and recognition, weak policies and institutional frameworks, lack of adequate funding and political will, inappropriate technologies, low public awareness and neglect of consumer preferences. Two major constraints are highlighted below: lack of awareness and high mitigation costs.

Lack of awareness and solidarity

When the well-being of local communities is threatened, they are usually willing to collaborate in improving their living conditions, especially when they have certainty of tenure and when the government facilitates and sustains their efforts. However, as soon as residents install a drain or sewer, their own problems may be solved, but their wastewater is carried away, often causing problems for others downstream. Typically, polluters are unwilling to assume responsibility and reluctant to remedy such a situation because it requires substantial effort and money, and because they don't feel affected by problems they create elsewhere.

The complicated nature of water pollution hampers clear insight into the consequences of wastewater discharge and poses a constraint to "catchment solidarity" and

cooperation among water users. Reliable data, education and communication are needed to overcome this constraint. Similarly, appropriate institutional arrangements and knowledge about causes and effects are necessary to design procedures needed to raise the issues, stimulate dialogue among stakeholders, resolve conflicts, and achieve agreement on joint action.

High mitigation costs

A second key issue in wastewater discharge management is the cost involved (some facts and figures on costs are given in Box C below). Even in countries where labor and materials are inexpensive, the costs of wastewater treatment can be very high. Governments often have insufficient resources available for mitigating action, while residents do not have enough money or are unwilling to support such action financially. Only a few countries manage to recover their costs through user charges. Especially in lower income countries it is unrealistic to strive for high standards of advanced wastewater collection and treatment.

Box C

Facts and figures on costs of wastewater management

- To collect and treat a cubic meter of wastewater is usually more expensive than the intake, treatment, and distribution a cubic meter of drinking water;
- Operating and maintenance costs of sewerage networks and treatment facilities are higher than the annual depreciation of capital invested in the infrastructure.
- Biological wastewater treatment (the most widely applied technology) consumes substantial amounts of energy, generates large quantities of excess sludge, and, thus, requires relatively expensive equipment, operation and maintenance.
- In most EU countries, governments spend more money on wastewater treatment than on flood protection, pumping, and dredging combined.
- Many low and middle-income countries in Central and Eastern Europe cannot afford the technologies needed to comply with EU standards: the estimated time needed to finance such technology far exceeds the economic lifetime of the facility (20-30 years) and often even that of sewers (50-60 years) *(Gijzen 1997).*

Cost of inaction

Nevertheless, even though the cost of halting pollution from wastewater may seem prohibitive, and the constraints on initiating action may be numerous, allowing pollution to cause further damage will eventually cost more. Damage can generally be expressed in monetary terms, which allows a comparison with the cost of preventing or repairing damage. For other values, such as loss of biodiversity or the social functions of water, it is still difficult to put a price tag. However, while difficult to quantify, growing evidence exists that wastewater pollution is associated with large, direct costs to the economy; much higher than one would intuitively expect. Preventive action now can substantially reduce future expenditures to mitigate the effects of pollution (see some facts and figures in Box D below).

Box D

Facts and figures on damage and the cost of inaction

Facts on **damage** due to inadequate handling of wastewater:

- It results in increased illness or mortality due to ingestion or skin contact with contaminated water, raising direct health care costs (treatment expenses, lost income) and indirect opportunity costs.
- It makes additional treatment costs necessary in the drinking and industrial water production sector.
- Fishermen and aquaculture farmers loose income due to loss of productive days (interruption during industrial processing or cooling water discharge), and when water is so contaminated that their catch becomes unfit for consumption.
- Much of the tourism industry, often representing a large percentage of national income, depends on environmentally attractive coastal areas, but poor water quality deters tourists, immediately lowering income from tourism.
- International tourism and second homes have drastically raised the economic value of coastal assets, but real estate quickly looses its value when the quality of the surroundings deteriorates.

Figures on costs of **inaction**:

- GESAMP (2001) estimated the impact of bathing in and eating shellfish from polluted seas at approx. US$12-24 billion per year.
- In 1992 cholera spread in Peru due to poor sanitation and inadequate disinfection of drinking water. Peru's income from fish exports and tourism, which accounted for 34% of the gross national product before the epidemic, tumbled. Lost income and additional health costs were estimated at US$1 billion, which was ten times the annual national budget on water supply and sanitation.
- Spain's tourism industry, which employs 10% of the country's work force, depends on its coasts, where water quality is regularly threatened.
- The Caribbean Island Bonaire depends almost entirely on tourism related to its coral reef, which is threatened by the island's wastewater discharges.

Optimism nonetheless

Although the road to desired levels of prevention and control of wastewater pollution is long, the situation is more optimistic than the above facts suggest. Box E below gives an example of realistic, long-term planning. Indeed, affordable strategies and prioritization can be applied, such as:

- strategies that apply a combination of low-cost on-site sanitation, waste minimization, and conventional sewerage can be more appropriate than more advanced, expensive technologies;
- attaining efficiencies and reducing costs by integrating wastewater planning with other sectors, by taking a longer-term planning approach with step-by-step investing, and by ensuring stronger and continuous support from citizens;
- in urban areas, where wealth is higher than in rural areas, urban authorities should have more resources available to address wastewater problems.

Box E

Pollution prevention and control: Yangtze River in China

In a World Bank-financed programme on collection and treatment of wastewater in cities along the Yangtze River in China, the original proposal to collect and fully treat municipal wastewater had to be altered substantially because of concerns about the technical and financial feasibility.

The technical problem was that the wastewater contained far too many components originating from industries that would seriously hamper the operation of a biological wastewater treatment plant. Besides, full biological treatment required a too high budget. Since full treatment of domestic wastewater was considered a second priority because of the large dilution capacity of the Yangtze, a more realistic (less expensive) proposal could be formulated as follows:

- relocate the main factories to new industrial estates;
- provide clean technologies where possible, as well as the specialized treatment of industrial wastewater to remove all toxic components; and
- collect primarily household and non-toxic wastewater in sewers, apply simple mechanical treatment, and release it into the river.

Think long-term
Go step-by-step

Ample scope exists for (more) effective wastewater management. High costs necessitate a long-term, step-by-step approach, though, minimizing current and future environmental damage as much as possible within existing budgetary limits. Realistic choices will have to be made from a wide range of technological and management options. For instance, different technology will be appropriate in different zones of urban areas: cost-effective on-site sanitation and drainage in poorer neighborhoods; low-cost sewerage in middle-income neighborhoods; gravity sewers and treatment in more affluent quarters.

In chapter 1 some generally applied approaches are outlined, followed by a description of a realistic, step-by-step policy framework through which an enabling policy environment can be created. As an illustration, the policy framework is then applied to the special case of small islands.

Guidelines on municipal wastewater management

Guidelines

This report has been developed to provide practical guidance on how to develop locally appropriate and environmentally sound municipal wastewater discharge systems. The ten keys listed above form a red line through these guidelines in which a wide variety of issues are covered.

Four elements

The document focuses on four elements, with their respective sets of management tools:

- approaches and policies, including demand-driven, opportunity-driven, and integrated management approaches (Chapter 1);
- institutional arrangements, including public participation and new partnerships with the private sector and water users (Chapter 2);
- technological options, including steps for choosing the most appropriate technology, and considering wastewater as a resource (Chapter 3);
- financing options, including private capital and public-private partnerships (Chapter 4).

Management tools for these four elements are closely inter-related and should always be considered in combination.

Target groups

The main target groups of the guidelines are:

- decision-makers involved at a strategic level and responsible for ensuring an enabling environment, such as senior local staff in Ministries of Health and of Environment, Majors and Directors of Public Works in (coastal) municipalities;
- operational professionals like government employees involved in identifying problems together with the stakeholders and in planning and coordinating appropriate wastewater management; and
- regional organisations, the private sector, development banks, and related organisations that facilitate and participate financially in individual projects.

Checklists

For each of the elements listed above checklists have been developed, to be used as a guide rather than as a strict set of actions to be followed. These checklists can be used while considering options before making final decisions in accordance with national policies and plans. As some issues or keys may in future gain more importance than others, modifications or additions may become necessary to principles and checklists. Furthermore, for regionally specific additions regional annexes could be developed.

Report structure and how to use it

Chapter 1 describes the overall policy framework for integrated, tailor-made, step-by-step wastewater management. It highlights the need for governments to ensure an enabling environment for wastewater management. The chapter sets the scene for the more specific chapters 2, 3 and 4 which cover the other three elements decribed above: institutions and participation (Chapter 2); technological options (Chapter 3); and financial mechanisms (Chapter 4). An Executive Summary of the report is given upfront; a Glossary is included in the preliminary pages.
Each chapter starts with a number of bullets highlighting the main issues dealt with in the chapter. The keys most relevant to the chapter subject are then listed, followed by explanatory text describing major issues to consider. Boxes are included to give examples of good practices or additional facts and figures. Each chapter ends with a summary section comprising a step-by-step checklist, which should help to avoid pitfalls, and with a list of references and suggestions for further reading. The four interrelated checklists are presented as one full set in Annex 1. Individual chapter reference lists are compiled into one list in Annex 2.

Key principles

Good practices

Checklists

Pitfalls

References and suggestions for further reading

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UNEP / Topham

chapter 1

An enabling policy environment for sustainable wastewater management

Governments should create an enabling policy environment through which:

- **wastewater management will ensure equity, promote health, protect from disease, and protect the environment;**
- **the role of governments transforms from service provider to initiator and facilitator of sustainable wastewater management;**
- **local authorities and communities, the private sector, regional and river basin agencies, and other partners can participate in planning and implementation of sustainable solutions; and**
- **technically and financially realistic, stepwise approaches can be applied, with appropriate time and geographic scales.**

This chapter sets the scene for the three more specific chapters that follow.

Ample scope exists for (more) effective wastewater management in such a way that economic threats and problems related to human and environmental health, originating from wastewater discharge, would be avoided. Much experience has been gained over the years by many different institutions. It has become clear that the high costs involved necessitate a long-term, participatory, step-by-step approach, minimizing current and future environmental damage as much as possible within existing budgetary limits.
This first chapter focuses on governments' enabling role in policy formulation. It sets the scene for the following three more specific chapters, in which guidance is given on how to reach the best institutional arrangements and social participation (Chapter 2), on choosing appropriate and cost-effective technologies (Chapter 3), and on designing stable financial mechanisms (Chapter 4).

1.1 Creating an enabling environment for sustainable solutions: main issues and approaches

Main issues

Enabling policy

In many parts of the world Governments are these days ceasing to be providers of services. Instead, they focus on initiating, stimulating and facilitating, on enabling a policy environment in which the various institutional levels can function most effectively. To be successful, national authorities need to secure political commitment and domestic financial resources, always keeping three essential principles for sustainable sanitation systems in mind (WHO / UNICEF 2000):

Sustainability

- equity: all segments of society should have access to safe and appropriate sanitation, adapted to their needs and available means;
- health promotion and protection from diseases: sanitation systems should prevent users and other people from contracting excreta-related diseases and should interrupt the cycle of disease transmission;
- protection of the environment: sanitation systems should neither pollute ecosystems nor deplete scarce resources.

Holistic

Since wastewater management is part of a wider set of urban environmental services, it should be planned holistically. At the most elementary level, water should in fact not be delivered into an area unless appropriate means are in place, or at least planned, to handle wastewater generated in that same area. Holistic planning requires integration of relevant technical, costing, institutional, and sectoral issues.
Technical integration means that the full range of available, environmentally sound technologies is considered while selecting the most appropriate option for the existing economic situation. Institutional integration implies that all organizations that could contribute to the solution are involved and have appropriate roles in the planning process (including potential financing entities). Sectoral integration requires that interrelationships between sectors are taken into account and discrepancies resolved to achieve synergy and balance. For example, water supply, wastewater and solid waste should not be treated independently, but in an integrated manner, taking often complex inter-sectoral relations into account.

Delegated responsibilities

To ensure institutional sustainability in wastewater management the responsibility for services should be delegated to the local level, while central authorities remain responsible for strategic planning, policy, and regulatory aspects of sector development. Essential ingredients of such an enabling environment include (UNDP/World Bank, 2000):

- clearly defined and consistent responsibilities;
- a legal structure reflecting these responsibilities;
- an effective regulatory body;
- appropriate regulations, codes, and standards;
- reliable and updated information.

Autonomy

Public and private institutions that are / or will be responsible for the actual provision of services should have a high degree of autonomy. They should:

- participate in overall development planning;
- have management and operational autonomy, leaving them free to meet agreed targets by the most effective means;
- be permitted to raise funds from sources most suitable to their needs;
- develop their own cost-recovery policies and procedures;
- have autonomy in human resource development matters.

Main approaches

Supply-driven approach

Traditionally, a supply-driven approach was followed in wastewater management, but this approach has proven not to be very successful, especially in developing countries (see Box 1.1 below).

Box 1.1

Supply-driven wastewater management

A supply-driven approach is characterized by serious flaws:

- planners and engineers assess needs and decide what type of service to provide without true consultation with users;
- investments are costly, both absolute and relative to number of people served;
- investments are not recovered (Wright 1997);
- main beneficiaries are the wealthier neighborhoods that can afford subsidized, but still high connection charges;
- implications for environment and water resources are not assessed in comparison with environmental impacts of other options.

Acknowledging the problems with supply-driven approaches, many institutions all over the world have been trying to find better ways. Below some approaches are briefly described, both on a more strategic level, such as Integrated Coastal Zone Management, and on an actual design and planning level, such as demand- or opportunity-driven approaches. Often different approaches do not exclude each other and in fact each situation will require a tailor-made set-up, designed using several elements from various strategies or approaches.

Demand-driven approach

Learning from earlier supply-driven experiences, a demand-driven approach has been developed. It encourages the use of locally appropriate technologies and recognizes that technology alone can't do the job. It pays much attention to users' preferences, and their ability and willingness to pay (see Box 1.2 below).

Box 1.2

Demand-driven wastewater management

The demand-driven approach' main objective is to make service delivery sustainable, among others by ensuring community participation in selection, planning, implementation, and operation. It requires:

- transforming the role of central government from service provider to enabler;
- coordinating local agencies responsible for different sectors (water supply, sanitation, wastewater) and for planning (physical and land use planning, integrated water management, planning of industrial developments) (Watson and Jagannathan 1995; Peterson et. al. 1994);
- understanding requirements of users and stakeholders through consultation;
- learning what resources they have and are willing to use to finance facilities;
- learning what resources and capacities they have to participate in management operation and maintenance of facilities;
- selecting environmentally sound technology appropriate for local physical and socio-economic conditions;
- designing systems, financing mechanisms and institutional support structures that are best suited to the users' needs.

Opportunity-driven approach

Adequate handling of wastewater is a prerequisite for enabling healthy socio-economic development, but at the same time, developments in certain (socio-) economic sectors may create opportunities to address sanitation. An opportunity-driven approach can be followed by integrating different sectors, so triggering various side-effects (see Box 1.3 below).

Box 1.3

Opportunity-driven wastewater management

An opportunity-driven approach for wastewater management, which also may include voluntary initiatives, has a wider dimension than a demand-driven approach. It triggers:

- societal demands for sanitation;
- opportunities in other sectors, such as: development of coastal aquaculture; expansion of tourism development and infrastructure; urban expansion through project developers due to the potential for enhanced property values; and development of industries requiring clean, freshwater such as the food processing industry and breweries (WCC 1993);
- conflicts between users (e.g. conflicts between users of water resources for supply and users for discharge of wastewater comes to the surface);
- effects of non-product outputs on the state of the environment (e.g. discharge of untreated wastewater into sensitive aquatic systems becomes clear).

Stakeholder involvement

Clearly the above shows that there is an important role for many different stakeholders, ranging from household level to regional, national and even international levels, as well as the private sector (see also Box 1.4 below). All stakeholders should be involved in policy-making (demand-driven), and socio-economic developments should be linked with planning and investments for municipal wastewater management (opportunity-driven). The private sector is an important actor, both as a partner in building and improving infrastructure and providing services, and as a beneficiary of such measures. Indeed, stakeholders can be approached to pay their share of investment and operational costs.

Box 1.4

World Water Vision's views on stakeholder involvement

The World Water Vision presented at the Second World Water Forum in The Hague, emphasized the need for new mechanisms for managing water involving a wide range of stakeholders (Cosgrove and Rijsberman 2000). It lists requirements for successful municipal wastewater management, as follows:

- pricing water services at full cost providing the right incentive to users;
- ensuring service-oriented management to respond to users' needs; and
- empowering communities, both men and women, to stimulate people's initiative and capacity for self-reliance.

Integration of wastewater management into ICZM

The above described approaches all point towards the need for integration, the need to tackle issues in a more holistic way. Nowadays it is, indeed, widely recognized that integrated approaches and processes are more successful. Relevant examples are integrated water management, river basin (or watershed) management, and integrated coastal zone management (ICZM). The latter is briefly characterized in Box 1.5 below. Integration in ICZM asks for cooperation between all responsible players, so resulting in win-win situations. The players' incentive for cooperation is their common need to achieve coastal zone protection. The lessons learned from ICZM can benefit the development of appropriate wastewater management.

Box 1.5

Integrated coastal zone management (ICZM)

ICZM is performed in a dynamic context that often features changes in demographic, cultural and socio-economic conditions (including social preferences and demands), and in natural coastal systems. ICZM involves integration of (WCC, 1994):

- responsibilities at different levels of government (vertical integration);
- responsibilities of various government sectors (horizontal integration);
- responsibilities between governments and local groups;
- policies across economic sectors; and
- economic, technical, and legal approaches.

Considering the above flagged issues, many groups and organizations have formulated concepts, approaches, strategies and guidelines for realistic and sustainable wastewater and sanitation programmes. Examples are described in European Commission (1998), CSD (2000), GHK (2000), UNDP/World Bank (2000), and WHO/UNICEF (2000). Each example covers many of the issues described above. Together they provide a wealth of useful ideas for people dealing with wastewater management. Below details are summarized for two examples: Box 1.6 UNDP/World Bank (2000) and Box 1.7 CSD (2000)

Box 1.6

UNDP-World Bank Strategic Sanitation Approach

This approach sets out a number of key concepts as follows (Wright, 1997):

- a commitment to sound finances;
- a concern with cities as a whole rather than with discrete projects;
- a wide view of sanitation, encompassing storm water drainage, sludge disposal, the disposal of human waste and solid waste management;
- the use of different sanitation options in different areas within a city, depending on local conditions;
- the division and delegation of responsibilities for the management of sanitation services, recognizing that one organization does not have to be responsible for all aspects of sanitation provision;
- the use of a step-by-step approach, which portrays sanitation provision as a process rather than a series of large projects.

Box 1.7

Recommendations by the UN Secretary General

The UN Secretary General concluded that safe water and sanitation for all can only be achieved in the next 25 years when governments, the international community, NGOs, and civil society all drastically increase their commitments (CSD, 2000).
The UNGS' water supply and sanitation (WS&S) related recommendations for inclusion in national programmes on sustainable development are:

- integrate WS&S in holistic development, management, & use of water resources;
- make WS&S integral parts of poverty alleviation programmes;
- make WS&S integral parts of human settlement programmes;
- integrate WS&S with hygiene education;
- improve service delivery & reliability, operation, maintenance and water quality;
- couple massive financial infusions with effective cost recovery policies;
- delegate responsibilities to lowest appropriate management levels;
- promote effective participation of all stakeholders, emphasize the role of women;
- improve information management.

Ten key principles

Based on experience in wastewater management gained by institutions like UNDP, UNICEF, WHO, The World Bank, and numerous local authorities and NGOs, the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) has analyzed many of the existing concepts, approaches and strategies; an exercise that has recently resulted in a list in which recommendations are synthesized into ten keys for action on municipal wastewater management (see Box B in the Introduction, repeated here in Box 1.8).
In all principles governments have a major role to play to ensure a policy environment which enables sustainable planning and implementation of municipal wastewater management. This document provides guidance on how these ten keys can be applied in municipal wastewater management, using a realistic stepwise logical framework.

Box 1.8

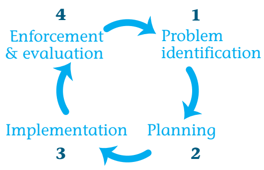
Ten Keys for Local and National Action on Municipal Wastewater

As prerequisite for successful municipal wastewater management, covering policy issues, management approaches, technology selection and financing mechanisms.

1 Secure political commitment and domestic financial resources.
2 Create an enabling environment at national AND local levels.
3 Do nor restrict water supply and sanitation to taps and toilets.
4 Develop integrated urban water supply and sanitation management systems also addressing environmental impacts.
5 Adopt a long-term perspective, taking action step-by-step, starting now.
6 Use well-defined time-lines, and time-bound targets and indicators.
7 Select appropriate technology for efficient and cost-effective use of water resources and consider ecological sanitation alternatives
8 Apply demand-driven approaches.
9 Involve all stakeholders from the beginning and ensure transparency in management and decision-making processes
10 Ensure financial stability and sustainability.
10.1 Link the municipal wastewater sector to other economic sectors.
10.2 Introduce innovative financial mechanisms, including private sector involvement and public-public partnerships.
10.3 Consider social equity and solidarity to reach cost-recovery.

1.2 Applying a logical policy framework

Logical framework for wastewater management



Regardless of the approach chosen, each wastewater management situation asks for a flexible, tailor-made set-up, in which necessary steps can be taken at different points in time, depending on available resources and capabilities. To do so, it is advisable to apply a well-defined logical framework that incorporates a comprehensive set of carefully prescribed, logically related tasks (European Commission 1998; GHK 2000). The framework should follow a dynamic and cyclic process, applicable also in situations where a wastewater management system is already in place. In principle each cycle consists of four major phases: (1) problem identification, (2) planning, (3) implementation, and (4) enforcement and evaluation. Box 1.9 below summarizes this wastewater management framework.

Box 1.9

Logical framework for wastewater management

1 Problem identification
- monitoring
- assessment and identification of the need for action.

2 Planning
- review of information
- identification of needs and opportunities
- formulation of management plan
- setting objectives and standards
- formal adoption.

3 Implementation
- design management tools
- operational management: on-site versus off-site
- institutional arrangements, incl. capacity building, awareness raising and public participation

4 Enforcement and evaluation
- operational management of water quality
- evaluation

Each phase can be subdivided into a number of tasks, where relevant stakeholders should always be involved as early as possible in the process. To achieve the objectives set, all the phases and tasks are best performed following a certain logical order. In practice, Phase 1, although often the logical place to start is not always the first phase taking place. For instance, an evaluation of the performance of an existing system (a Phase 4 task) may well show that there is a discrepancy between present and required performance. This then triggers a new management cycle, which may require re-defining originally set tasks, starting with new problem identification (Phase 1), planning (Phase 2) and implementation (Phase 3). Indeed, in real life, tasks like identifying opportunities or evaluating the current situation may well come first. This is no problem. One can start at any phase of the cycle, as long as it is clear that certain tasks should be followed by specific others, as laid down in the agreed logical framework. Below the four phases of the policy framework and their specific tasks are looked into, focusing on the enabling role of government authorities. The specific subjects of following chapters (institutional arrangements, technologies, and financing) have direct policy relevance and are, thus, flagged regularly in this section. For details on these subjects the reader is referred to the specific chapters.

Phase 1: Problem identification

To design the best possible solution for wastewater management one needs to be familiar with the current situation and preferably with the history. An assessment can be conducted on a city-wide basis by local government staff. It can also be done at a neighborhood level with involvement of local stakeholders. The assessment then becomes a powerful tool for raising public awareness and participation.

Task: Monitor the situation

The methodology for assessing and monitoring (both performance of the system and environmental monitoring) is nowadays well established. An adequate monitoring strategy is focused on:

- areas where impacts can be expected;
- quantity and quality of wastewater from industries and small enterprises that is mixed with domestic wastewater;
- quantity and quality of urban runoff and the frequency with which it drains into the wastewater collection system.

For the future, the GPA Clearing-house is considered as a platform for wastewater monitoring techniques (http://www.gpa.unep.org).

Task:
Assess and identify needs for action

The early successes in pollution control in industrialized countries in the 1950s and 1960s pertained primarily to oxygen-depleting substances, suspended solids, and some heavy metals. These types of pollution were easily recognized and technology to address them was available. However, other forms of pollution, particularly from pathogens and nutrients (nitrogen and phosphorus), can still not be sufficiently mitigated. Besides, a more supply-driven approach was often followed for wastewater management. Lessons from early pollution control efforts illustrate the need, at an early stage, to:

- identify the types of contaminants that cause serious harm to human health and the environment;
- identify financial resources realistically available for mitigation;
- identify stakeholders and key agencies and their needs.

Phase 2: Planning

Task:
Review existing information

Relevant development trends, policies and arrangements must be reviewed to identify linkages with the wastewater sector. For instance:

- demographic and socio-economic projections, such as the rate of urbanization, and projections on income (per capita and distribution), water supply and water demand;
- the existing legal framework including standards and regulations;
- the current institutional framework;
- the financial framework;
- related sector policies (such as for water supply, solid waste management, land use planning and zoning, and urban development);
- national economic and development planning.

Task:
Identify potential obstacles and opportunities

Obstacles may occur that will hamper implementation and performance of wastewater management. When designing a new system, obstacles can be identified while assessing the current situation or comparable situations elsewhere (Phase 1) and while reviewing existing information as listed above. In existing systems obstacles are at best recognized during a (later) evaluation phase.

It is important to identify potential obstacles early in the process, so that solutions can be sought up front and incorporated in the new plan. For example, it may turn out that insufficient institutional capacity exists; an obstacle that can be tackled by planning capacity building activities in the implementation phase. Or when funding problems are recognized early on, investment partners (such as regional development banks or international water companies) can be selected and involved from the beginning.

Adequate handling of wastewater is a prerequisite for enabling healthy socio-economic development. At the same time, developments in certain (socio-) economic sectors may create opportunities to address sanitation. For instance, breweries, food processing and tourism industries all require clean water. Thus, planning and investments for wastewater management should be linked with (planned) socio-economic developments and with overall river basins or coastal zone management. National economic and sector plans will provide relevant information on how and where to link plans and investments to wastewater management.

Task: Formulate management plan

Once an analysis has been made of the current situation, with its constraints and opportunities, an overall wastewater management plan can be formulated. Important strategic components to be considered in such a plan are:

- strive for prevention of pollution at the source (prevention of toxic substances and minimization of wastewater);
- consider re-use of municipal wastewater or sludge (in agriculture, horticulture, aquaculture, or for industrial cooling and processing);
- apply low-cost on-site sanitation wherever possible;
- take impacts on the environment into account, making use of the absorption and filtering capacity of natural systems;
- prioritize constituents and selection of cost-effective mitigation approaches, considering alternative technologies;
- integrate policy with other sectors (water supply, land use planning);
- apply zoning of polluting and beneficiary functions (like industry and coastal tourism);
- consider temporal (stepwise) and spatial differentiation (see below);
- strive for an integrated approach to river basin management, raising awareness and solidarity among communities upstream and downstream ('catchment solidarity').
- establish criteria to prioritize services to communities, based on the level of health risks or state of living conditions and budgetary limits.

While formulating the plan a step-wise investment approach is recommended, applying a long time horizon for future improvement and extension. After all, removing the first half of a pollution load is in general possible at moderate costs, removing the following 40% becomes expensive, and costs for removing the remaining 10% is often prohibitive.
Spatial differentiation in neighborhoods or suburbs should be allowed for, considering specific physical characteristics (slope, soil type, ground water level, existing infrastructure for water supply and sewerage) and the socio-economic situation (population density, income, willingness and ability to pay and participate, land prices, energy costs).

Task: Formulate environmental standards and objectives

Formulating environmental standards and objectives is a crucial part of wastewater management planning. They can be a subset of the overall objectives and quality standards for integrated water resources management. The formulation of objectives and related standards requires an analysis of the technical, economic, and social feasibility of different options. It asks for consultation and negotiation with all stakeholders. The objectives should be measurable and verifiable. Two groups of environmental standards are:

- ambient standards, which set maximum allowable levels of a pollutant in receiving water; these standards require explicit agreement on desired environmental quality objectives;
- emissions standards, which set maximum amounts of a pollutant allowed to be emitted by a plant or other source; they are typically expressed as concentrations, although there is increasing use of load-based standards, which more directly reflect the overall objective of reducing the total load on the environment.

Strict environmental standards alone, however, do not lead to a healthier environment. For example, initial compliance deteriorates when pollution control equipment is installed but poorly maintained or bypassed. Without enforcement, standards are simply ignored. Under serious financial constraints certain standards just can not be met everywhere. Besides, in certain areas favorable environmental conditions may exist due to which some standards could be less strict while still maintaining environmental integrity. In other words, standards set at a national level should not be uniform throughout large, diverse countries.

Environmental regulation should be realistic and allow local flexibility in implementation (World Bank 1998). The level of strictness of standards will depend on the level of development in a community (financial and technical). The more resources available, the stricter standards can be set. Technique based standards use knowledge of what can be achieved with current equipment and practices. A wide range of principles has been used, including "best available techniques" (BAT), "best practicable techniques" (BPT) and "best available techniques not entailing excessive cost" (BATNEEC).

Task:
Formal
adoption

A comprehensive approach for wastewater management requires mechanisms for coordinating responsibilities of agencies and other stakeholders at different levels of government -vertical integration- and those of different (government) sectors -horizontal integration- (see also the box on ICZM in Section 1.1). As the process moves from planning to implementation, the balance between horizontal and vertical integration may change. In identification and planning phases it is very important that all levels and sectors of government and stakeholders interact. During implementation and evaluation, some actors may have a more important role than others.

Formal adoption of a policy entails various steps (giving all stakeholders in the decision taking process a voice):

- an interagency coordination mechanism between relevant authorities;
- approve staffing and required organizational changes;
- adopt policies, goals, standards, and other management tools;
- assign, by legislation, responsibilities among the actors for monitoring, revenue collection, operation, and maintenance;
- approve the funding allocation (national grant budget & local funding mechanisms).

Phase 3: Implementation

Task:
Design
management tools

The implementing agencies need to be provided with management tools in the form of regulatory instruments (standards, permits, fines etc) and economic or market-based instruments (subsidies, taxes, covenants etc). See for details Chapter 2 on institutions.

Such instruments should be supported by legislation and other types of authorization. The framework must provide regulations that:

- create measures to prevent pollution at the source;
- enable use of economic instruments to promote waste minimization, pollution prevention, and recycling;
- ensure infrastructure is built applying adopted quality standards;
- ensure sludge is handled following adopted quality standards;
- enhance the capacity of authorities to enforce the instruments.

A distinction should be made between on-site sanitation and more complex off-site collection and treatment (see for details Chapter 3). Much less expensive on-site sanitation demands a distinct management approach, as it is also related to hygiene

Task: Organize operational management: on-site versus off-site

behavior, building regulations and local land use planning. Active involvement of households and neighborhood communities is essential. Small entrepreneurs can fulfill an important role in operational management.
Off-site systems are more demanding. Several technical agencies are involved in design, financing, operation, and maintenance of infrastructure for collection and centralized, off-site treatment of sewage. For example, public works departments of a municipality are often responsible for operating and maintaining sewers, while the more complex pumping stations and sewage works are often under the care of regional technical agencies; the latter to benefit from economies of scale and synergy.

Task: Set up institutional arrangements

Institutional arrangements provide a framework for the various management tasks and tools, as well as for capacity building, raising awareness, and public participation (see for details Chapter 2).

Phase 4: Enforcement and evaluation

Task: Operational management of water quality

Enforcing existing rules and regulations is one of the most difficult aspects of governance in developed and developing countries alike. The goal should be to have rules that are generally accepted by society and that can be enforced. Strong and objective enforcement is required when certain parties clearly benefit economically from breaking the rules (Post and Lundin, 1996). Enforcing wastewater policy also entails:

- monitoring water quality, comparing actual values with agreed effluent and receiving water quality standards;
- issuing discharge licenses;
- collecting discharge fees or penalties.

Evaluation

To ensure optimal performance, wastewater management plans should be subject to regular monitoring and evaluation, so that timely improvements can be introduced when necessary. Thus, as indicated under the third task of Phase 2 (planning) it is very important that goals and objectives are unambiguously formulated and measurable (quantifiable), so that they can be verified. Any discrepancies between actual and required performance must be communicated to the appropriate authorities, to initiate a new round of policy setting (policy adjustment).

1.3 Summary of the logical policy framework for municipal wastewater management.

Below a summary has been included of the logical framework for municipal wastewater management. This summary, presented as a checklist (Checklist 1) hints to potential pitfalls and can be used as a list to check if in principle all relevant aspects are being considered. This checklist is followed by a section in which the policy framework for planning water supply and sanitation management is discussed for small island states. Three principles up front:

- ensure equity, promote health, protect from disease, and protect the environment;
- secure political commitment for the required policy action;
- secure domestic financial resources, for implementation of the plan.

Checklist 1

Logical framework for municipal wastewater management

Phase 1: Problem identification

☐ **Tasks: Monitor and assess the current situation:**

- focus on areas where most positive impacts can be expected from new wastewater management;
- involve local communities and other local stakeholders in the assessment, so raising public awareness and stimulating participation;
- identify all stakeholders and key agencies;
- assess wastewater (both quantity and the quality) from industries and small enterprises that is mixed with domestic wastewater;
- assess of urban runoff (both quantity and quality) and the frequency with which urban runoff drains into the wastewater collection system;
- identify those contaminants that cause most serious harm to human health and the environment;
- assess the needs of all stakeholders.

☐ Are staff, funds, facilities, mechanisms in place to implement the tasks?

Phase 2: Planning

☐ **Task: Review existing information:**

- national economic and development plans;
- related sector policies (water supply, solid waste management, land use planning and zoning, urban development);
- demographic and socio-economic projections (rate of urbanization; projections on income -per capita and distribution-, water supply and water demand);
- the existing legal framework including standards and regulations;
- the current institutional framework;
- the current financial framework.

☐ Is access assured to required data and documentation?

☐ **Task: Identify potential obstacles and opportunities:**

- obstacles like insufficient institutional capacity or financial resources;
- opportunities such as collaborating with breweries, food processing and tourism industries which all require clean water;

☐ **Task: Formulate objectives, standards and management plan:**

- make an analysis of technical, economic, and social feasibility of different options;
- consult and negotiate with all stakeholders;
- include clear objectives that are measurable and verifiable;
- allow local flexibility in implementation of regulation;
- follow a realistic step-wise investment approach;
- apply spatial differentiation, considering specific physical and socio-economic characteristics in neighborhoods.

☐ **Task: Formal adoption:**

- establish an interagency coordination mechanism between relevant authorities (sectoral synergy) and all levels (from national to local);
- approve staffing and required organizational changes;
- adopt policies, goals, standards, and management tools;

Checklist 1
(continued)

- assign, by legislation, responsibilities among the actors (monitoring, revenue collection, operation, and maintenance);
- approve the funding allocation.

Are staff, funds, facilities, mechanisms in place to implement the tasks?

Phase 3: Implementation

Task: Design management tools

- provide management tools in the form of regulatory and economic or market-based instruments
- support instruments by legislation and other types of authorization.

Task: Organize operational management: on-site versus off-site

- make a distinction between cheaper on-site sanitation and more complex, expensive off-site collection and treatment.

Task: Set up institutional arrangements

- ensure institutional arrangements for management tasks and tools, as well as for capacity building, raising awareness, and public participation.

Are staff, funds, facilities, mechanisms in place to implement the tasks?

Phase 4: Enforcement and evaluation

Task: Operational management of water quality:

- ensure rules that are accepted by society and that can be enforced;
- ensure strong and objective enforcement when breaking the rules can give economic benefits

Task: Evaluation:

- provide for regular monitoring and evaluation, so that timely improvements can be introduced when necessary.

Are staff, funds, facilities, mechanisms in place to implement the tasks?

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1.4 Policy issues in small island states

Social and economic dependence on water

The lives of people on the thousands of small islands (about 2700 in the Pacific alone) are closely intertwined with the ocean. Most of the culture of islands is linked to the coastal areas and islanders depend heavily on marine life of coastal waters for food and income. Without subsistence fisheries, for instance, many small island states would have to import large amounts of food or equivalent proteins each year. Coastal areas also help support a huge tourism industry (estimated at over US$ 1 billion a year in World Bank, 2000), and are important sources of construction materials. Last but not least coral reefs and mangroves surrounding small islands play a critical role in protecting coastal infrastructure against storms and as habitat for many different species. In short, the economic and social well being of small island countries depends on the quality and quantity of their water (Falklans et al 2002).

Small islands extra vulnerable

Water quality and quantity problems are common all over the world, caused by issues such as inadequate rainfall or pollution due to high (urban) population densities and from production sectors like industry and agriculture. The damaging effects of such problems, however, are most persistent and dramatic in fragile (semi-) arid areas and in small isolated systems such as small islands. The size of small island states, their low population numbers and thus limited human resources and their higher than average vulnerability to environmental changes create extra constraints and higher pressures on resources of small island states. In such fragile and crowded environments even small changes can have a large impact.

Planning to be
- tailor-made
- stepwise
- integrated

This special situation asks even more specifically for careful long-term and integrated planning of tailor-made solutions (Kumarasuiyar 1999). Municipal wastewater management is indeed high on the political agenda of small island state governments. The principles of a comprehensive, stepwise approach are well recognized and wastewater and re-use issues are usually part of small islands' integrated coastal zone management. Below the four phases of the earlier described logical planning framework are illustrated for the special case of small islands.

Logical policy framework

When planning for water supply and wastewater management, an assessment needs to be made of the current situation and trends, so that specific needs and priorities for action can be identified (UNEP 2002). With such background information governments can formulate and adopt policies, incorporating the required institutional arrangements, the most appropriate and cost-effective technology and a realistic financing structure.

On small islands the main risks to fresh water resources, coastal and marine ecosystems and public health generally relate to climate change, human settlements and infrastructure (including mining), agriculture (including fisheries), and tourism.

Risks due to climate change

IPCC recently confirmed that "there is new and stronger evidence that most of the warming observed over the last 50 years is attributable to human activities", that much of the sea level rise over the past 100 years has probably been related to the concurrent rise in the global temperature, and that sea levels will probably continue to rise, so threatening, among others, low-lying islands and coastal areas (IPCC 2001a+b). Increases in intensity and frequency of storms will add to the risks for small islands.

Small islands do not contribute much to global warming since they burn little fossil fuel. Still small islands are likely to suffer disproportionately from enhanced effects of climate change. Cropland could disappear, water supplies could be contaminated and tens of millions of people could lose their homes and livelihoods (see also Box 1.10 below).

The vulnerability of small islands to extreme climate events is highest in coastal areas. Governments need to consider these risks in their resource management planning, when setting objectives and standards. Coastal degradation could also have an important external economic impact: in an increasingly globalized world the quality of the coastal environment and management strategies adopted by national governments are more and more becoming critical factors in investors' decision whether or not to invest in a particular island.

Box 1.10

Impacts of climate change on small islands

Potential effects of climate change on small islands in general:

- inundation of beaches and coastal lands;
- destruction to human settlements and infrastructure along coasts from intensified storm surge and flooding;
- salinization of aquifers and estuaries;
- submergence, silting and loss of sea beds;
- coral reef degradation and loss due to bleaching and physical damage caused by storms.

Some specific facts and figures for The Maldives:

- Most of The Maldives' 1196 islands do not rise above 3.5 meter and the majority of its people live less than 2 m above sea level;
- In 1987, Male, capital of The Maldives, was inundated by record-high waves;
- The next year, the waves swamped the island of Thulhaadhoo;
- High tides already submerge parts of Tuvalu twice a year;
- Even if the sea level rose by only 0.5 m. the international airport would be flooded regularly and the staple crop (taro root, grown in pits dug about 40 cm above sea level) would be at risk.

States like Tokelau, the Marshall Islands, and Kiribati are at similar risk. The Marshall Islands' government has already warned that many of its 50 000 inhabitants will be evacuated over the next few decades.

High population density and growth

Population density on small islands is unevenly distributed. Some remain sparsely populated (less than 50 people per km^2); other islands are overcrowded with more than 5000 people per square kilometer. Besides, most islands with good economic potential come more and more under stress due to changing consumption patterns (more resources used, more waste produced) and immigration from outer islands.

Fisheries

Coastal areas and lagoons have long been viewed as an infinite source of fish and an ever lasting purifying buffer for waste generated by towns and villages. With increasing pressures from a growing population and changing consumption patterns coastal waters are being threatened by over fishing and pollution. The perception that resources are infinite has to change, because coastal degradation has a direct impact on livelihoods and well-being of small islands people, for whom fish is vital.

Tourism

The coast has been a major tourist attraction since concepts like leisure and holiday exist. Waves, blue lagoons, beaches, dunes, sun, coastal forests, fresh seafood are all reasons why people are attracted to coastal areas. The challenge is to entertain and house tourists, and provide the infrastructure they need without destroying the very assets that bring in tourists in the first place. It is important to assess the tourist carrying capacity of an attraction or destination. On popular small islands, for instance, tourists can outnumber the resident population in peak seasons, stressing the infrastructure to a point where it is almost impossible for locals to get any services (too high freshwater demands, too much waste, etc.).

Several tools are available to minimize (potential) negative impacts of tourism, ranging from ecologically based site planning to demand management, zoning. Effective

strategies try to reduce tourist numbers to manageable levels through, for instance, crowd limits, pricing strategies, and time limits (to stay at a specific location).
Coastal zone policy and (waste) water management should ensure that the tourist industry develops in a sustainable way. This is only possible with strong government control, well planned management of the industry, and self-policing. Strictly controlled tourism, with clearly defined tasks and responsibilities for all partners, and with elaborate monitoring and transparent enforcement, can become a positive force for more sustainable development in stead of a source of pollution. Appropriate wastewater and re-use management are of vital importance for the tourist industry.

Cost effective technologies

The degradation of water quality through inadequate sanitation and waste disposal is arguably the largest hazard to small island water resources. The stepwise approach to wastewater treatment and re-use technology selection outlined earlier in this chapter is very relevant. It fits in broader integrated coastal zone management planning that takes into account specific measures ranging from water demand management and aquifer protection to alternative water supply such as rooftop water harvesting. Issues to consider while selecting technologies for wastewater treatment and re-use are:

- it should be an integral part of plans for coastal zone development;
- pollution prevention should be given high priority;
- on-site treatment should be promoted as much as possible;
- re-use should be advocated: it has become a pressing necessity that may be in line with local tradition in some places, while it may initially be resisted elsewhere;
- local communities should have a voice in technology selection (see also below);
- both the present situation and extreme events due to climate change should to be taken into account: high sea levels, droughts, and storms impact both wastewater collection and treatment and public health.

Institutional arrangements and social participation

Success of research applications and innovative management are determined as much by social, economic, and political factors as by choice of technology. Traditionally, powerful responses to constraints and risks have been mounted at household, village, and city neighbourhood level. Often traditional practices point the way to more effective local management of water supplies and sanitation, particularly when reinforced by science-based innovation. Armed with good information and sufficient autonomy, people usually prove to be reliable conservators of their own local resources.
This the case for small islands in particular. Close partnerships have to be developed between coastal communities, governments and the private sector. Neither governments nor communities can manage coastal areas on their own. Collaboration between the different relevant stakeholders will be necessary to effectively manage coastal areas and restore their productivities and functions.

Political commitment and finances

Especially increased risks due to climate change have put small islands high on the political agenda. As a result small island states are these days giving high priority to proper management and international financing institutions give specific support to small islands. Nevertheless the challenges faced by small islands are huge and cooperation at local and regional levels has to be promoted and improved.
As for the rest of the world, public-private partnerships are recommended in wastewater and re-use management (see mainly Chapter 4). However, apart from standard arguments for reform and partnerships between the public and private sectors there are some additional aspects specifically relating to the size of islands economies (PPIAF, 2002). Small islands countries face formidable obstacles in introducing competition in infrastructure as the markets are often too small to justify more than one operator in a specific sector (e.g. the water sector). For this reason there are compelling arguments for regional integration while pursuing public-private partnerships and designing relevant regulations.

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chapter 2

Institutional arrangements and social participation

Institutional arrangements and social participation in wastewater management should result in commitment to a clean environment and "catchment solidarity". This requires:

- **a long-term strategy for institutional reform;**
- **capacity building to strengthen weak or inadequate structures, legal and regulatory instruments, and organizations, both inside and outside government;**
- **involvement of and real willingness to cooperate and contribute by all relevant actors;**
- **creation of continued awareness among citizens regarding their dual role as polluters and beneficiaries of wastewater management.**

The previous chapter described tasks in policy setting for wastewater management; each complementary and each requiring distinct expertise and appropriate institutional arrangements. This chapter zooms in on how institutional arrangements can be organized to ensure sustainability in wastewater management. Relevant keys are listed in Box 2.1 below.

Box 2.1

Keys for Action on Municipal Wastewater: those most relevant to institutional arrangements

2	Create an enabling environment at national AND local levels.
3	Do not restrict water supply and sanitation to taps and toilets.
4	Develop integrated urban water supply and sanitation management systems also addressing environmental impacts.
5	Adopt a long-term perspective, taking action step-by-step, starting now.
8	Apply demand-driven approaches.
9	Involve all stakeholders from the beginning and ensure transparency in management and decision-making processes
10	Ensure financial stability and sustainability.
10.1	Link the municipal wastewater sector to other economic sectors.
10.2	Introduce innovative financial mechanisms
10.3	Consider social equity and solidarity to reach cost-recovery.

2.1 Partners and institutional arrangements: main issues

Many actors involved

As already emphasized in the introduction and the first chapter, there are many stakeholders to be considered when striving for sustainable wastewater management. Lessons from the past show that for wastewater discharge systems to be sustainable a demand-driven approach should be applied in which all potential stakeholders are involved as real partners. Actors that should participate in implementation of wastewater management are:

- governments (different sectors at national, regional and local levels);
- regional organizations (river basin authorities, water boards);
- households;
- non governmental organizations (civic action groups, environmental groups, consumer associations);
- professional (water) service providers (public and private); and
- private companies (as water polluters and as benefiting entities).

Type of implementing

Implementing agencies are typical "formal" agencies. Examples are: national ministerial departments, state or municipal technical departments (departments of environmental management, public works, public health), water utilities, and river basin agencies. At local levels, they can include community-based organizations such as NGOs and women's associations and private sector companies. The performance of implementing agencies depends on their mandate and means, the right balance between decision-making and financial autonomy and accountability, the quality of their leadership, and the mix of professional skills in their staff.

Flexibility

No blue print can be prescribed for the best institutional arrangements. Arrangements among actors, whether existing or to be newly developed, depend on a country's cultural, social, economic, and political conditions. Besides, when conditions change over time, arrangements may have to be adapted as well. For example, in the 1980s England and Wales went through a fundamental shift in the organization of their water management because the existing river basin-based Water Authorities could no longer cope with the high costs of addressing water pollution. This led to privatization of the water utilities in 1989.

Overall institutional structure

Links should be made with other relevant sectors, such as urban development, water supply, solid waste, and certain industries but also with sectors in which wastewater impacts are felt, such as health, environment, tourism and agriculture. All sectoral functions should be adequately addressed through technical organizations and other institutional arrangements. This requires clear formulation of and agreement on tasks, responsibilities, and authority to avoid overlap in competence, loopholes, or "blind spots."

To optimize communication and cooperation, both formal and informal platforms are required among all actors. The platforms should provide means for both vertical (national, regional, local) and horizontal (among sectors and stakeholders) communication, integration and awareness razing. Possible structures are: inter-ministerial and inter-departmental committees, commissions, working groups, task forces and specific programmes (see also section 2.3 which zooms in on public participation).

Legislation

A large web of legislation is required to determine the division of responsibilities and authority, performance standards, systems for regulation and incentives, financial flows, and so on. Legislative obligations can also come from international law. For example, conventions (binding arrangements between governments) are in place in a number of regions of UNEP's Regional Seas Programme. In the Wider Caribbean, for instance, a protocol was adopted in 1999 focusing specifically on municipal wastewater, obligating member countries to address the problem in a phased manner and on an agreed schedule.

Regulatory tools and incentives system

Restrictive and enabling regulations are agreed procedures through which stakeholders are stimulated to treat their wastewater properly. Typically, a mix of regulatory and incentive instruments ("sticks and carrots") is most effective. Incentives are especially relevant because they have the largest influence on behavior of people or an industry. Positive incentives include subsidies, co-financing arrangements, and tax reductions to promote the construction of wastewater facilities. Negative financial incentives include tariffs, charges, and penalties to discourage the production of

potentially polluting substances, to reduce water use, or generally to make polluting alternatives more expensive than clean alternatives. Some detail is included in Section 2.2.

Complex financial flows

Appropriate financial flows are particularly critical in attaining pollution control goals. The effectiveness of a wastewater management plan depends on successful completion of complementary activities by different agencies, such as wastewater collection, its treatment, and discharge regulation. For each activity, financing arrangements must be sustainable and the costs commensurate with willingness to pay. Each activity relies on various contributors, including households, industries, municipal governments, and national funds. Consequently, money flows originate in different sectors, are often managed by more than one agency, and must be directed to several cost sites that are frequently located in different sectors. In Chapter 4 the aspect of innovative financing mechanisms is dealt with in more detail.

2.2 Design of institutional arrangements

Identification

Assess the existing situation

Most countries have extensive central government agencies, while regional, and especially local levels have minimal experience and capabilities. Thus, institutional strengthening must begin with adjusting existing structures and capacities. The national institutional framework must be integrated to ensure that central, regional, and local agencies are aware of and committed to the fact that coordination and cooperation are essential when addressing wastewater issues.

Before modifying institutional arrangements, existing wastewater discharge system and institutional frameworks must be identified and their strengths and weaknesses assessed. The assessment should examine the system and agencies already in place, their organizational structure, roles, responsibilities, authorities, and the strengths, shortcomings, gaps and/or overlaps in all these aspects.

Based on such an assessment, initial needs for improvements can be flagged. With this vital background information an overall strategy for the reform of institutional arrangements can be formulated and the subsequent planning phase can start in an efficient and targeted way. An initial needs assessment will also clearly illustrate that any strategy towards reform of the institutional arrangements will have to be a long-term commitment.

Planning for sustainable wastewater management

Various design criteria can be devised for institutional arrangements in wastewater management. Applying such criteria will contribute to successful implementation of a wastewater management plan:

Promote catchment solidarity

Promote “catchment solidarity” and commitment by creating appropriate organizations and other institutions dedicated to:

- setting long-term goals and priorities;
- strengthening the sense of solidarity and cooperation among people within river basins;
- sharing information and exchanging technology through practical communication platforms (this can vary from local radio programmes to sophisticated web-based clearing houses);
- ensuring that all stakeholders in water use, including in-river ecological interests, are recognized and have a voice;

- collecting feasible financial contributions from all stakeholders (both water users and polluters) and allocate these funds through a step-wise investment programme.

Ensure proper management tools

Implementing agencies need to be provided with management tools in the form of regulatory and economic or market-based instruments. Some examples are given in Box 2.2 below. At the same time, such management tools should be supported by legislation and other types of authorization. Overall, the institutional framework must provide regulations that:

- create measures to prevent pollution at the source;
- enable use of economic instruments to promote wastewater minimization, pollution prevention, and re-use;
- ensure infrastructure is built applying adopted quality standards;
- ensure sludge is handled following adopted quality standards;
- enhance the capacity of authorities to enforce the instruments.

Box 2.2

Regulatory and market-based instruments

Some examples of regulatory (command and control) instruments are:
- standards on water quality of effluent and receiving waters;
- environmental impact assessments;
- licenses and permits;
- rules to discourage the abuse of monopoly privileges.

Economic or market-based instruments (penalties and incentives) are:
- fines on improper disposal of waste and effluents, including sludge;
- fees, taxes and tariffs for wastewater discharges;
- subsidies and co-financing;
- voluntary instruments such as:
  - public disclosure of pollution control records;
  - ISO 9000 and ISO14000 certificates;
  - eco-labeling;
  - covenants between government and industries and/or municipalities.

See also chapter 4 on public-private-partnerships (PPPs).

Allow flexible regulation at low level

Regulations, if enforced, can serve a number of purposes, but often come with hidden opportunity costs if they do not take local circumstances and opportunities for synergy into account. Many regulations for wastewater pollution control would be better formulated, allowing local regulators and polluters to devise the most cost-effective solutions. Market-based instruments are typical examples of flexible regulations. Especially voluntary initiatives should be stimulated. They are negotiated between the government and polluters, and set mid and long-term goals but leave detailed implementation to the polluters themselves.
Governments can also actively stimulate better public awareness of environmental and health aspects of the wastewater issue. Increased public interest in environmental and health quality will raise the pressure on polluters to comply with regulations. With such measures towards flexibility a government positions itself as facilitator, and as guarantor that goals will be achieved, rather than as implementer of a policy.

Separate operator, regulator and owner tasks

It is advisable to strictly separate functions of regulation and monitoring of wastewater discharges (typically a role for an environmental agency), and the function of attaining standards (typically the role of the municipality, a technical agency, or a utility). Similarly, a distinction must be made between "owner" and "operator."

Although municipalities may be vested with the responsibility and authority to collect and treat wastewater, and thus “own” the wastewater, they could choose to delegate parts of the operational tasks to private firms or other public agencies.

Consider enforcement, accountability and transparency

While designing tasks like monitoring water quality, issuing discharge licenses, collecting discharge fees or penalties, and operational management of water quality, one should always take the potential for enforcement into consideration. It is important to maintain public scrutiny on organizations that serve such public purposes as wastewater management to keep them efficient and effective.

Accountability to (the different interests in) the public and other stakeholders can be institutionalized by adjusting working procedures in organizations or by requiring them by law to submit to public audits or disclose critical information.

Transparency regarding organizational objectives, targets, performance as measured against benchmarks, and finance is essential to allow the public to assess the effectiveness of organizations and, if necessary, to call for remedial action. Transparency and access to information are essential to accountability; the effectiveness of transparency depends on agreement on detailed internal procedures.

Create synergies

To achieve an optimal arrangement of institutions entrusted with different pollution control functions synergies should be created among existing and/or new institutions. Different options exist depending on a country’s hydrological, organizational and other characteristics. Box 2.3 below gives a few examples.

Box 2.3

Synergies among institutions

United States:

The greatest synergy was created by combining all regulatory and several management functions into one environmental agency, the Environmental Protection Agency (EPA), while operations remain at the municipal level.

France:

Synergy between management of water quantity and water quality is found in river basin agencies, while wastewater operations remain in municipal hands.

Netherlands:

Synergy is achieved by assigning the task of wastewater treatment to the water boards.

Germany and Colombia:

The management of wastewater infrastructure is merged with other services, such as water supply, power, or public transport, into a city enterprise.

Stimulate competition

Networked systems for wastewater management present very strong natural monopoly characteristics, much stronger even than in water distribution. There is virtually no scope for introducing direct competition within such systems. Experience shows that direct government providers of wastewater services lack the competitive or regulatory pressure needed to stimulate efficient performance. Competition can be introduced using public-private-partnership contracts (PPPs - see also Chapter 4), a concept applied increasingly these days. This will not lead to “perfect” competition, but can nonetheless promote many of the beneficial effects of competition.

Ensure long-term financial equilibrium

Investment, maintenance, and operating costs of virtually all wastewater management systems are very high. Moreover, because much of the infrastructure is invisible, there is a strong tendency toward neglect, leading to rapid deterioration. It is therefore very important to ensure that a long-term financial equilibrium of the system is incorporated in the design of institutional arrangements. This applies to public operations and is even more important in public-private partnerships. In the latter the private sector has been asked to make very substantial capital injections and incur short-term

operating losses at the beginning of the contract to correct a backlog situation. These investments and operating losses must be compensated prior to the expiration of the contract.

Apply devolution and subsidiarity

Experience gained in water management calls for "decentralization to the lowest appropriate administrative level" (WMO 1992, CSD 2000). As a rule, national governments should not implement tasks that can be done more efficiently or effectively at lower government levels, although they should ensure that these tasks are executed (the subsidiary principle).

Similarly, governments should not implement tasks that can be done more efficiently by private firms or local communities. National governments are to keep control by facilitating agreement on broad national priorities and strategies, and by issuing and enforcing general regulations. Local government has clear responsibilities in meeting sanitary goals, but must seek cost-efficient ways for implementing these duties.

2.3 Building institutional capacity and public awareness

Institutional reform and capacity building

Long-term commitment

Often not all of the above described criteria for successful implementation of wastewater systems are met in existing institutional set-ups. On the contrary, weaknesses in institutions or institutional arrangements are a major cause of underperformance in the wastewater management sector. To improve the situation, it must be clear up front that, regardless of the type of reform or capacity building, a long-term commitment will be vital.

The 1996 United Nations Development Programme (UNDP) Symposium on Capacity Building in the Water Sector (Alaerts 1999) concluded that to remedy weaknesses it is insufficient to only train staff and students. Rather, it is necessary to work simultaneously on three basic elements:

- creation of an enabling environment with targeted policy and legal frameworks (see Chapter 1 and Section 2.2);
- institutional development, including community participation; and
- human resources development and strengthening of managerial systems.

Based on an assessment of the current situation and on the management plan formulated while considering design criteria as listed in the previous Section (2.2), an institutional capacity building strategy can be formulated.

In a number of cases, it may suffice to strengthen the existing situation, for example, by introducing new or additional procedures and skills, such as technological expertise, accounting, communication with local communities, or cost recovery mechanisms. Ample attention should also be paid to in-house research and exchange of experience and knowledge (both in-house and among different agencies).

In other cases, however, it will be necessary to reform existing arrangements. This can entail far-reaching interventions in administrative, organizational, legal, and regulatory frameworks. In all cases, capacity-building activities must be carefully tailored, long-term, and prioritized to suit local problems, and financial and personnel capabilities.

An important institutional issue for successful wastewater management, it can not be repeated often enough, is the need to involve all stakeholders, certainly not in the last place local communities. Fluency in communication with diverse user groups should receive ample attention in programmes to develop the capacity of human resources.

Advocacy and public awareness

Understanding public attitudes: a challenge

It is important to recognize that public understanding and attitudes regarding wastewater management differ significantly from every other form of infrastructure service. The very question is often subject to a taboo, since people do not want to recognize their individual contributions to waste generation. In addition, the system is one of collection; there is no tangible "product" with which "value" can be associated. And the infrastructure is almost entirely invisible and therefore suffers from a problem of "out of sight, out of mind." Furthermore people quickly forget problems and discomforts they suffered before an adequate system was established. Besides, it is very difficult to sanction non-payment or non-compliant use of the system. All these factors combined present a formidable challenge to policy and decision-makers, planners, and operators. This challenge has to be met both at the inception of the system and throughout the life of the service.

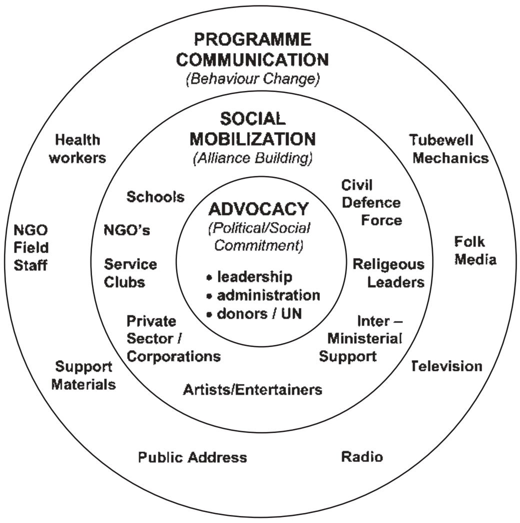
Communication to change behaviour: a complicated process

Success of wastewater management programmes depends on effective advocacy and public awareness through information, education, and communication. A communication process includes advocacy, social mobilization and programme communication, three components that do not necessarily happen consecutively (McKee 1992). Communication for behavioral change is a complicated process of human action, reaction, and interaction. It involves looking at situations from the viewpoint of other people, and understanding what they are seeking. It requires understanding potential obstacles to change (see also below), presenting relevant and practical options, and informing people about the impacts of choices they make.

Communication can help to make policy-makers, the private sector, and communities committed to programmes and to prevent expensive mistakes. People must be informed and convinced, or they do not feel part of a process and may not be motivated to change their behavior. Leaders who initiate, promote, and coordinate activities, contribute much to the success of a programme. Also "champions" like an active neighborhood or group of families can be a critical component for success.

Figure 2.1 below illustrates how the government of Bangladesh has used McKee's communication planning model for the Sanitation for All programme, implemented between 1993 and 1998.

Figure 2.1 Communication planning model (McKee 1992) applied in Bangladesh



Box 2.4 below describes a strategy for advocacy and raising awareness is. It lists the various steps required to mobilize different segments of society to support sustainable wastewater management.

Box 2.4

Stepwise approach to advocate and raise awareness

1 **Formulate the overall vision.**
What should be the result of implementing a wastewater management strategy. This could for example be a call for a clean river or lake, or for clean gutters.

2 **Assess the current situation.**
Focus on systems in place for wastewater collection, disposal and treatment. Conduct the assessment through local government staff (citywide or at neighborhood level) and involve major stakeholders, such as the private sector, community level authorities, and communities. The assessment itself is a powerful tool for raising public awareness.

3 **Conduct audience research and formulate target groups.**
Assess among the various segments in society what peoples' needs are, and what knowledge, attitudes and practices exist among them. Then divide all stakeholders into characteristic target groups, each with specific communication requirements. For instance policy-makers, sector professionals, local government staff, and communities. Develop clear target group-oriented messages. Messages must relate to present knowledge, attitudes, and practices in order to be effective.

4 **Set priorities.**
Set realistic priorities, especially for the short-term, which will actually influence decisions of the various segments. Usually local government has to take responsibility for action and play a leading advocating role to involve others.

5 **Find the right incentives.**
Find the specific incentives which will best mobilize people to become more involved in the management of wastewater. For each target group incentives may vary considerably. To stimulate active participation, ensure that incentives clearly relate to the target group.

6 **Set goals and agree on verifiable indicators.**
Reach agreement on specific operational goals that are realistic and achievable in the specified period. Involve main stakeholders in setting the goals and in developing and agreeing upon verifiable indicators. Chances of achieving set goals will increase when consensus was reached among the actors.

7 **Build alliances.**
Identify and mobilize potential partners for political and financial support and for actual implementation. Approach every stakeholder connected with wastewater management, including legislative bodies, industries, professional groups, NGOs, religious groups, the media, and communities.

2.4 Summary of issues and steps to consider for institutional arrangements

In the checklist below main issues and steps are summarized which should be considered while formulating or reforming institutional arrangements and social participation in municipal wastewater management. By checking if all aspects on the list have been considered, one can avoid falling into unforeseen pit falls. For details on an item the reader can go back to the full text in this chapter. In some cases the reader is referred to another chapter for details.

Checklist 2

Issues and steps to consider in planning institutional arrangements

☐ Has a thorough assessment been made of the current situation? Including:

- the current wastewater discharge situation, focusing on systems in place for wastewater collection, disposal and treatment (see Chapter 3) ;
- the current organizational structure of implementing institutions: responsibilities and authorities, level of collaboration with other institutions, strengths and weaknesses, gaps and overlaps;
- the potential stakeholders: characterize different segments of society each with their different knowledge, attitudes, practices and needs;
- the current financial situation with resources originating from complex financial flows (see also Chapter 4).

☐ Has an initial assessment been made of needs for improvements and have initial recommendations for action been formulated (e.g. to focus on simple strengthening of an existing situation or to strive for more rigorous reform)?

☐ Has an overall vision been formulated based on the information obtained from the identification assessments?

☐ Is catchment solidarity being promoted by advocating awareness among people in the entire river catchment and by emphasizing the need for all stakeholders to commit themselves to participate in wastewater management (also financially)? In doing so:

☐ Is it acknowledged that each segment of society has different knowledge, attitudes, needs, priorities, means, and incentives?

☐ Are citizens made aware of their dual role as polluters and beneficiaries of wastewater management?

☐ Is a communication strategy applied in which different stakeholders are approached with messages that are specifically targeted to their communication requirements?

☐ Have local experience and expertise been synthesized to help identify problems and formulate solutions?

☐ Are operational goals set and verifiable indicators agreed upon with direct involvement of all stakeholders in the basin (demand-driven)?

☐ Do local communities receive financial support to actively participate in formulation and management?

☐ Are all relevant stakeholders benefiting from and contributing their realistic share (financially) to improvements?

☐ Has an institutional structure been formulated which is flexible and which ensures integration with other relevant sectors (such as water supply or solid waste) and cooperation between national and local governments?

Checklist 2
(continued)

☐ Are proper management tools in place such as:

- relevant legislation (both national and international);
- verifiable standards and time-bound performance indicators which are realistic and can be measured against agreed benchmarks
- regulatory tools and market-based instruments to stimulate voluntary action;
- flexible application of such regulation at local level so that local regulators and polluters can devise the most cost-effective solutions?

☐ Are responsibilities and authority delegated to lowest appropriate management levels?

☐ Are functions of regulation and monitoring of wastewater discharges separated from the function of attaining standards?

☐ Has the potential for enforcement been taken into consideration while formulating regulations and standards?

☐ Does the overall institutional framework :

- enable use of economic instruments to promote wastewater minimization, pollution prevention, and re-use;
- ensure that adopted quality standards are maintained;
- enhance the capacity of authorities to enforce the instruments.

☐ Are mechanisms in place through which service providers can be held accountable by the public, and which allow knowledge sharing and proper feed back between providers and legislators?

☐ Is transparency regarding organizational objectives, targets, performance, and financial management assured?

☐ Have synergies been created among institutions of different sectors and government levels?

☐ Have alliances been built among potential service providing partners (in government, industry, private sector and communities)?

☐ Is competition being stimulated to reach more efficiency?

☐ While building alliances and competition: is a long-term financial equilibrium being ensured to stimulate innovative voluntary initiatives of collaboration?

☐ Has an institutional capacity building strategy been formulated with long-term political and financial commitment to ensure effective implementation of a new wastewater strategy?

☐ In doing so, have all relevant components been incorporated, such as institutional development, community participation, human resources development, strengthening of managerial systems?

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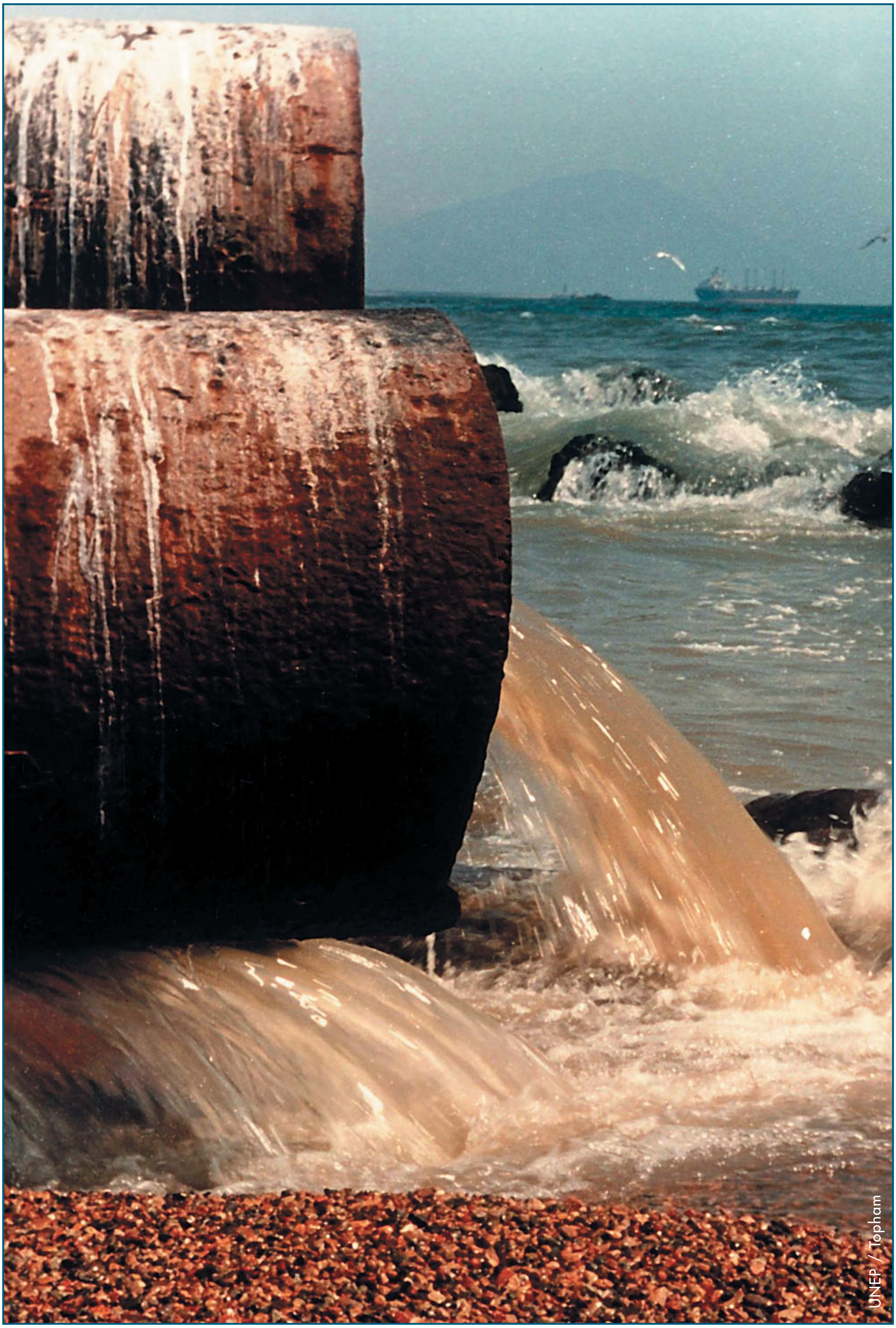

UNEP / Topham

chapter 3

Planning sustainable and cost-effective technologies

Because of the wide variation in coastal zone characteristics and functions, no uniform technology can be prescribed for wastewater collection and treatment.
The high cost of wastewater treatment warrants a careful search for low-cost technologies that tackle pollution prevention, water conservation, and the efficient use of water in a sustainable way.
A stepwise approach to technology selection and planning is outlined, addressing pollution prevention, on-site treatment, off-site transportation and treatment, including natural treatment, re-use and conventional treatment. The aspect of re-use receives specific attention.

While Chapter 1 described overall tasks in policy setting for wastewater management and Chapter 2 zoomed in on how to approach institutional arrangements, this third chapter focuses on what to consider while selecting and planning cost-effective wastewater technologies that best suit the local situation. Relevant keys are listed in Box 3.1 below.

Box 3.1

Keys for Action on Municipal Wastewater: focussing on technology selection

1	Secure political commitment and domestic financial resources.
3	Do not restrict water supply and sanitation to taps and toilets.
4	Develop integrated urban water supply and sanitation management systems also addressing environmental impacts.
5	Adopt a long-term perspective, taking action step-by-step, starting now.
7	Select appropriate technology for efficient and cost-effective use of water resources and consider ecological sanitation alternatives
8	Apply demand-driven approaches.
9	Involve all stakeholders from the beginning and ensure transparency in management and decision-making processes
10	Ensure financial stability and sustainability.
10.1	Link the municipal wastewater sector to other economic sectors.
10.2	Introduce innovative financial mechanisms
10.3	Consider social equity and solidarity to reach cost-recovery.

3.1 Main issues in selecting a technology

Existing systems are often inadequate

In many urban situations, both the municipal sewage system and industrial wastewater treatment are inadequate. A municipal sewage network may be in place, but coverage is usually incomplete and the level of treatment provided inadequate. Even where reasonable treatment facilities exist, poor maintenance and operation often result in failure to meet the initially set goals and standards.
From an environmental (as distinguished from the sanitation) point of view focus must be on receiving water bodies. For instance, by upgrading or extending a wastewater collection system one can reduce diffuse pollution. However, it may well create new

point discharges which must receive adequate treatment to avoid eventual discharges into the coastal and marine environment.

Many aspects to consider in technology selecting

Depending on the local environmental, economic, and cultural situation and on issue like population density, different wastewater discharge and treatment systems will have to be applied. The selection of a treatment technology is an essential step in any wastewater management strategy. In Box 3.2 below a number of criteria have been listed.

Box 3.2

Multi-criteria analysis for technological selection

A technology should be:
- environmentally sound;
- appropriate to local conditions;
- applicable and efficient in the context of the entire river basin;
- affordable to those who must pay for the services.

Other aspects to consider during the technology selection process are:
- awareness and the need for changes in behavior;
- workable policies and regulations;
- possibilities for enforcement;
- technical performance and reliability (under variable wastewater flows, compositions and operational problems);
- institutional manageability (planning, design, construction, operation and maintenance capacity, including local availability of skilled human resources);
- investment, operation, and maintenance costs.

Various overviews on selection, design, construction, operation, and maintenance of on-site and off-site wastewater collection and treatment systems exist, such as Metcalf and Eddy (1991), Viessman and Hammer (1993), and GHK (2000). UNEP's International Environmental Technology Centre (UNEP/IETC) offers an Internet-accessible database for environmentally sound technologies addressing urban environmental problems and management of river basins (http//:www.unep.or.jp).

Many options: from simple to complicated treatment

With development growth, water consumption per capita increases. Sanitation becomes increasingly water-based and old wastewater discharge systems no longer suffice. There are many ways to approach this problem. The most appropriate technology for a given situation is the technology that ensures an acceptable quality of the receiving water. Simple septic tanks can, for instance, be introduced as a decentralized, on-site treatment system at household or, at most, block level. However, septic tanks alone usually do not provide a sufficient degree of treatment of the water received. The liquid that leaves a septic tank usually needs to be purified first, through infiltration in soil or through storage in reservoirs, a process that requires relatively much space. In urban areas with higher water consumption rates and population densities, and thus a lack of space, wastewater usually needs to be collected and treated elsewhere in centralized, off-site systems.

Expensive not always better

Conventional treatment technologies do not necessarily provide better treatment efficiency than natural treatment systems. Low-cost, natural systems are easy to operate and virtually maintenance-free and therefore always recommended over mechanical systems when they will be effective enough and space is available. In the section below some detail is provided on approaches for wastewater treatment technology, which should help in selecting and planning the right system for a specific situation.

3.2 Choosing a sanitation technology

While selecting a sanitation technology one needs to consider pollution prevention at the source, on-site treatment, off-site transportation coupled with natural treatment and/or re-use, and, if all former options are exhausted, conventional treatment. Box 3.3 below lists relevant options, starting with the one that requires least intervention, gradually moving to the 'last-resort' option which requires the most expensive and complicated intervention (see also UNEP 2001).

Box 3.3

Sanitation technology approaches

Five different technology options can be distinguished ranging from prevention up-front and simple low-input systems to sophisticated high-input systems:

1 start with pollution prevention and wastewater reduction at the source;

2 apply on-site treatment and re-use to treat surplus wastewater;

3 install off-site transportation and collection systems for wastewater and stormwater (combined or via separate sewer and drain systems);

4 apply simple off-site treatment such as:

- **a)** natural treatment of collected wastewater using the natural self-purification capacity of receiving soil or water bodies;
- **b)** re-use and valorization using simple technology and ecological engineering so conversing wastewater into a valuable resource;

5 install conventional off-site wastewater collection and centralized, high technology, end-of-pipe treatment.

From Varis and Somlyody (1997)

Option 1:
Pollution prevention

Pollution prevention and waste minimization, also referred to as cleaner production or source reduction, aims at reducing and preventing pollution at its source. It minimizes the use of resources and thereby reduces the amount of waste discharged into the environment (for these guidelines focus is on wastewater). Industries have implemented a wide variety of pollution prevention measures, and many successes have been documented in recent years (see, for example, the website of UNEP's Cleaner Production Program at http://www.unepie.org).
Cleaner production technologies can reduce or even eliminate the need for investment in end-of-pipe treatment technology. As a rough guide, 20 to 30 percent reductions in pollution can often be achieved without any capital investment, and additional reductions of 20 percent or more can be achieved with investments that have a payback period of only a few months (World Bank 1998).
Water demand management by reducing domestic water consumption rates is also a very effective way of reducing wastewater treatment costs. Some benefits experienced in pollution prevention in municipal wastewater management are described in Box 3.4 below.

Option 2:
On-site treatment

After pollution is prevented to the largest possible extent, on-site treatment should be considered as the second step. On-site sanitation systems for wastewater collection and treatment are effective when little or no piped water is available. Such on-site systems are applicable at the level of a household, a community, or an apartment block. Package plants are used mostly for resorts, hotels, and other public buildings.
On-site systems use either a septic tank or a pit for collection (see Box 3.5 below). The congested nature of many peri-urban settlements restricts the space available for pit latrines and septic tanks. Furthermore, in densely populated areas, the volume of

Box 3.4

Benefits of pollution prevention in wastewater management

By reducing domestic water consumption, generating less polluted wastewater at the source, and using separate collection systems for different quality water:

- wastewater becomes better treatable;
- smaller, lower cost water supply and wastewater systems are required;
- development of dry sanitation systems is stimulated (see Box 3.8);
- waste components can be recovered and re-used; and
- wastewater of different quality can be re-used effectively for different purposes.

generated wastewater may exceed the capacity for ground infiltration. The additional risks of groundwater pollution and soil destabilization (affected by factors such as ground porosity, slope, and high water tables) often necessitate some form of more expensive wastewater collection and centralized treatment (see Options 3, 4 and 5 below). Depending on local physical and socio-economic conditions, on-site sanitation may only be feasible for lower density towns, city districts, and rural areas.

Box 3.5

On-site wastewater treatment systems

Collection characteristics:

- a septic tank is a watertight tank that collects wastewater from toilets, showers, sinks, and other household utilities through a pipe; solids settle on the bottom and liquid flows away;
- a pit latrine is even cheaper; it is a simple pit dug in the soil which also collects household wastewater; solids settle on the bottom, liquid seeps into the soil;
- septic tanks and pit latrines are low-cost technologies that allow construction, repair, and operation by local communities or homeowners and that effectively reduce public health problems related to wastewater.

Treatment Characteristics:

- liquid from a pit latrine seeps directly into the surrounding soil where the water is purified; liquid from a septic tank is guided away via an overflow into a drainage field or a drainage system for natural purification;
- in properly designed septic tank and pit systems the soil will remove remaining BOD, suspended solids, bacteria, and viruses from the effluent;
- the required effluent disposal area depends on flow rate and local soil infiltration capacity;
- the effects of the flows on groundwater quality must be carefully considered;
- accumulating solids have to be periodically removed from a tank or pit.

Selection criteria

Many factors influence the final selection of a system:

- population density (number of people per hectare);
- produced wastewater volume (in cubic meters per hectare per day);
- the presence of shallow water wells susceptible to wastewater pollution;
- soil permeability;
- unit cost of wastewater collection;
- socio-economic and cultural considerations.

Off-site options should be considered when on-site treatment could entail direct risks to public health or groundwater, or when the risk exists of faecal contamination or eutrophication of coastal waters, as in more densely populated areas. Centralized

Option 3: Off-site wastewater transportation and stormwater drainage

treatment systems (see Option 4 and 5 below) require wastewater collection and transportation through a sewer system. Combined sewer systems carry wastewater and stormwater in the same conduit. Separate systems transport stormwater and wastewater through separate stormwater drains and sanitary sewers respectively. For both collection systems, the construction costs are relatively high, depending on slopes, soil, and groundwater level.

Wastewater collection

The unit costs for wastewater collection decrease with higher population densities. Gravity sewers are preferred because of their lower operation and maintenance costs compared to pumped systems. Gravity wastewater collection becomes economically feasible at population densities of 200 to 300 persons per hectare in lower income countries, and at 50 people per hectare in higher income countries (Veenstra et al, 1997). Box 3.6 below presents experiences with small wastewater collection systems.

Box 3.6

Small wastewater collection systems

Successful examples exist of small wastewater collection projects in Brazil, Colombia, Egypt, Pakistan, and Australia (Veenstra et al, 1997). They show that:

- intermediate wastewater collection technologies can be applied where conventional collection systems are too difficult and expensive to construct in densely populated, low-income areas;
- small PVC pipes connected to septic tank overflows allow easy construction in rocky surfaces and prevent damage due to soil instability, while virtually eliminating infiltration;
- he operation and maintenance of these small systems is labor-intensive and requires community involvement;
- a potential problem arises if septic tanks are not de-sludged regularly, or if only the liquid is removed; this leaves solids in the tank until it overflows, causing blockage of small PVC sewers. Additional public health risks occur if such overflowing septic tanks are illegally connected to public, open drains or sewers.

Stormwater collection

Although the pollution load of stormwater is generally lower than that of municipal wastewater, it may contain as much solids as domestic wastewater, depending on the debris and pollutants in the path of stormwater run-off (see Table 3.1 below for some detailed figures). During heavy storms, combined sewer overflows containing a mixture of stormwater and municipal wastewater can seriously contaminate the surroundings and the receiving - coastal - environment.

Stormwater pollution sources are chemical spills, particulates from motor vehicle exhaust and deposition of atmospheric pollutants. In low-income areas stormwater drains often also function as solid waste disposal areas. When solid waste is not removed from the drains, they clog up, flow over and flood the surroundings so spreading the litter and polluted water.

Stormwater flows during rain storms can be attenuated by using basins and ponds. This allows control of flows downstream, while these basins or ponds also act as infiltration devices. Detention time is of the order of two to three weeks. Run-off water quality is improved during storage in such basins or ponds because of sedimentation of solids, bacterial action and nutrient uptake by vegetation. Water stored in ponds can also be used for irrigation of parks and gardens or for fire-fighting and other purposes. One has to realize, however, that stagnant water enhances the development of mosquitoes thus increasing health risks.

Table 3.1

Composition of domestic wastewater & stormwater			
Parameter		**Domestic wastewater** [1]	**Urban stormwater** [2]
TDS	mg/l	400 - 2,500	
TSS	mg/l	160 - 1,350	3 - 11,000
BOD	mg/l	120 - 1,000	10 - 250
COD	mg/l	280 - 2,500	
Kj-N	mg/l	30 - 200	3 - 10
Total-P	mg/l	4 - 50	0.2 - 1.
Coliforms	/100 ml	10^4 - 10^6 (faecal)	10^3 - 10^8 (total)

[1] Veenstra et al. 1997 [2] Novotny and Olem, in IETC (2000)

Option 4:
Centralized
treatment systems

a)
Natural treatment
systems

Use of the cleaning capacity of natural systems should be considered as the next step for treatment of collected wastewater. In areas with higher population densities, it is feasible to develop a local collection system and use a single facility to treat the community's wastewater. Lagoons and stabilization ponds are inexpensive, common biological treatment options with low operational costs. They are being used, for example, in mid-sized communities in the Wider Caribbean Region (UNEP 1998). The treatment is stimulated by self-purification of terrestrial ecosystems and water bodies or by stimulating these natural, biological processes in effective, low-cost, biologically engineered systems.
Criteria for natural treatment systems are:

- the potential to generate useable resources;
- the price and availability of land, as they require greater land area than conventional processes; and
- the possibility of reducing retention time by stimulating natural conversion processes and / or by anaerobic pre-treatment.

The capacity for nutrient removal may not be adequate for densely populated areas near estuaries sensitive to eutrophication or near coral reefs. More conventional natural treatment options may then be required. An example of natural self-purification technology is marine wastewater outfall: raw, pre-treated wastewater is discharged in coastal waters which are deep and dynamic enough to achieve a proper dilution.

b)
Re-use and
waste valorization

While opting for use of the cleaning capacity of natural systems, re-use of wastewater and wastewater products should also be considered. A main problem with wastewater treatment is that the result obtained after treatment is not widely recognized as a valuable product. This may explain in particular why many 'low-cost' wastewater treatment systems are poorly maintained and eventually become inactive. If the treatment process itself, in addition to the purified effluent, generates valuable spin-off products, it would create an important incentive to optimize the operation and maintenance of such a small treatment plant.

Systems exist, operated in both developing and industrialized countries, for the conversion of wastewater into useable resources. So-called integrated systems combine processes and practices to optimize resource use by recycling wastewater so that water, nutrients, and possibly other components (like clean sludge) can be re-used. Conversion processes for different sources of wastewater are set up in such a way that minimum inputs of external energy and raw materials are required and maximum self-sufficiency is achieved. To prevent toxic components from polluting bio-solids or sludge, these components should be retained at the source as much as possible. Clean bio-solids can be used in agriculture as fertilizer and to improve the soil structure. There are numerous examples of effective re-use or resource recovery from wastewater. In rural Asia, such integrated systems are an old concept that has been applied for hundreds, probably even thousands of years. In China, for example, there are huge farms that are almost completely self-sufficient in terms of energy and nutrients because of the effective recycling of their waste streams.
Box 3.7 below gives two examples of low-cost, land intensive systems in which wastewater is effectively re-used, so turning it from waste into a valuable resource. The application of such integrated concepts provides a good balance between resource use and re-use and environmental protection and could be attractive in low- and middle-income countries.

Box 3.7

Ecological engineering

Wastewater-fed aquaculture

The world's largest example of wastewater-fed aquaculture is the Calcutta wetland system, located immediately east of the city (Edwards and Pullin, 1990). The wetlands receive about 550 000 cubic meters of untreated wastewater per day, which flows through about 3 000 hectares of constructed fishponds within the wetlands area. The annual fish production amounts to 13 000 tons (mainly Indian Major Carp and Tilapia), which is supplied to fish markets in central Calcutta and consumed in the wider region.

Duckweed-based waste water treatment

A small-scale, duckweed-based pond to treat domestic wastewater has been operated for more than 10 years in Bangladesh (Gijzen and Ikramullah, 1999). The protein-rich duckweed biomass is harvested daily and fed to adjacent fishponds, which yield an annual fish production of 12 to 16 tons per hectare. A detailed financial evaluation of the wastewater treatment and aquaculture facility suggests that this is probably the first system that is able to generate a net profit from treatment of domestic wastewater. This is possible because the low-cost treatment is combined with revenue generating aquaculture.

Re-think the current concept

Clearly, the current 'Western' concept of high quality water supply and centralized high-tech wastewater treatment needs thorough re-thinking (WSSCC 2000). Measures could aim at effective recovery of nutrients and energy from wastewater by re-organizing the current set-up of water supply and sanitation. Innovative options in environmental sanitation such as the development of (high-tech) dry or semi-dry sanitation services (see Box 3.8 below) could provide completely new perspectives for energy and nutrient recovery. The next section in this chapter (Section 3.3) provides guidance on how to plan for more intensive re-use of wastewater.

Box 3.8

Ecological (dry) sanitation

The possibilities for re-use of specific components present in sewage can be positively influenced by re-organizing the collection of domestic sewage. Larsen and Guyer (1996) proposed the collection of urine, referred to as anthropogenic nutrient solution (ANS), at the source and to release it into the existing sewer sequentially. In doing so, a substantially enriched nutrient fraction is produced, which can be processed into high quality fertilizer in a central handling facility.
A general trend has been that technology developed in industrialized countries will be copied in developing nations when their economies start growing. Interest in ANS management in high-income countries could therefore possibly further stimulate the development of existing ANS strategies in China and other developing countries.
Web sites related to ecological sanitation:
http://www.undp.org/seed/water
http://www.wkab.se
http://www.laneta.apc.org/esac/drytoilet.htm

Option 5: Conventional treatment

Only after all options described above have been considered and rejected, the use of conventional systems should be considered. The 'Western' conventional wastewater management concept originates in the 19th century. It had the prime objective of preventing waterborne diseases. This has been achieved by tapping clean water resources and by developing effective systems for water treatment and distribution of potable water. Consequently, large volumes of clean drinking water are used to transport human waste out of the city. And indeed, since the large-scale introduction of such centralized water supply and wastewater collection infrastructure, cities in countries with a high gross national product have been essentially free of waterborne diseases. Conventional wastewater collection and disposal systems:

- aim to control transmission of waterborne diseases and to prevent degradation of the environment;
- require large volumes of diluted wastewater, which is collected through an extensive sewer system and is treated in modern, centralized treatment works;
- require large investments, highly skilled labor, and stable socio-economic conditions; and
- may increase the risk of waterborne diseases if collection of wastewater is not combined with effective end-of-pipe treatment.

All conventional wastewater treatment systems are based on processes that occur in the natural environment. Some of the systems are physical, some are biological in nature. The main aim of off-site treatment is to reduce biochemical oxygen demand (BOD) and suspended solids (SS) to acceptable levels. Heavy metals and other pollutants are not generally a problem in domestic wastewater, unless the sewerage system receives industrial discharges. Different treatment systems achieve removal of solids and provide oxygen in different ways. Conventional treatment systems can be classified as primary, secondary and tertiary processes.

Primary treatment

Primary or mechanical treatment involves the physical settlement of solids in sedimentation tanks. The treatment consists of screening and grit removal to eliminate sand, gravel and other coarse solids from the influent wastewater stream, followed by a gravity separation process to remove suspended solids (which settle at the bottom as

sludge). Sludge is usually removed from tanks by simply opening a valve at the bottom which has steep slopes towards the centre. The sludge then leaves the tank through a pipe (see also sludge maintenance below).
The most likely cause of failure in primary systems is lack of maintenance of the sludge scraping system (which ensures the sludge ends up near the valve in the bottom). Properly operated sedimentation tanks can remove 50-80 % of solids which can settle and 30-50 % of BOD. Septic tanks and anaerobic wastewater treatment (or stabilization) ponds can also be considered as forms of primary treatment although with a longer retention time (see also secondary treatment options below). In hot climates, they can even remove over 50 % of the total BOD.

Secondary treatment

Conventional secondary, biological treatment is directed at the removal of soluble biodegradable organic matter through biological degradation. Such treatment processes can be aerobic or anaerobic or a combination of the two. Aerobic processes use bacteria and other organisms that feed on waste products and break them down, using oxygen from their surroundings; anaerobic processes use bacteria that obtain the oxygen they require from the materials on which they are feeding. Box 3.9 below gives some technical details.

Box 3.9

Technical details on secondary treatment

By increasing the area of contact between wastewater and the air the opportunity for oxygen take-up from the air increases. The most common ways to achieve this are:
- produce activated sludge by using mechanical agitators such as a rotating biological contactor or by blowing air through wastewater; or
- create ‘bacteria beds’ or trickling filters, by allowing water to trickle through a bed of stones (or another suitable medium) so that it spreads as a fine film and is in contact with both air and the oxidizing organism.

The activated sludge system is a versatile system offering operational flexibility and high reliability. It allows integration of nutrient removal processes, such as nitrification, denitrification and biological phosphorous removal. Rotating biological contactors are frequently used for small wastewater flows, such as from hotels and small compounds.
Although trickling filters are more easily operated and consume less energy than activated sludge processes, they have a lower removal efficiency for solids and organic matter, they are more sensitive to low air temperatures, and can become infested with flies and mosquitoes. Trickling filters have no capacity for nutrient removal.
Compared to aerobic treatment, anaerobic treatment has high loading capacity, requires little energy input and produces low volumes of well-stabilized sludge. The bacteria they rely on perform well at high temperatures found in many developing countries. It is applicable at small and large scale and offers a possibility for on-site sanitation systems. A disadvantage, however, is that most systems require follow-up treatment to meet discharge standards.

Tertiary treatment

Tertiary treatment is directed at the removal of nutrients (nitrogen and phosphorous). Phosphorous removal processes involve either the addition of chemicals to precipitate phosphorous or controlled biological reactions to grow bacteria with high phosphorous levels and settle them out. Nitrogen removal is based on biological reactions to convert ammonium and organic nitrogen into nitrate (nitrification) and then into gaseous nitrogen (denitrification).

Sludge management

Removing pollutants from wastewater results in the production of sludge, which requires treatment (or stabilization) before its disposal. Sludge stabilization by digestion is the process of BOD reduction (decomposition) that can take place under aerobic or anaerobic conditions. Aerobic stabilization requires less energy when carried out as

part of a composting process. Anaerobic digestion produces biogas, a mixture of methane and carbon dioxide, and is the most commonly used process for sludge treatment. Digested sludge requires de-watering before its final disposal. If concentrations of heavy metals and toxic organics are below admissible standards, the de-watered sludge can be used for soil structure improvement and as fertilizer; if concentrations exceed these standards, sludge is placed in landfills or is incinerated (see also Box 3.10 below on separating wastewater). An adequate monitoring system is required to assess sludge quality.

Box 3.10

Separate industrial and domestic wastewater

Industrial wastewater frequently contains non-biodegradable pollutants and requires expensive physico-chemical treatment to de-contaminate it (chemical coagulation and flocculation). Due to the high treatment costs, industrial sludge is often remains heavily contaminated and not fit for re-use.
Because treatment of municipal wastewater sludge contaminated with heavy metals or toxic chemicals is difficult and expensive, the potential for re-use of such polluted sludge will be limited.
It is therefore essential to separate industrial from domestic wastewater or (pre-) treat industrial wastewater on-site, before discharging it into the sewer.

Economies of scale

Economies of scale can play an important role in designing conventional wastewater management and infrastructure. From a simple managerial, operational point of view, planning wastewater treatment based on administrative boundaries of small municipalities rarely makes sense. But the incentive to centralize the operation and capacity of treatment plants is balanced by the increasing cost of transporting wastewater over longer distances. Nonetheless, co-operation among municipalities or other local government creates major financial gains and offers stronger “win-win” options than it does in any other sector (see Box 3.11 below).

Box 3.11

Economies of scale: “win-win” options

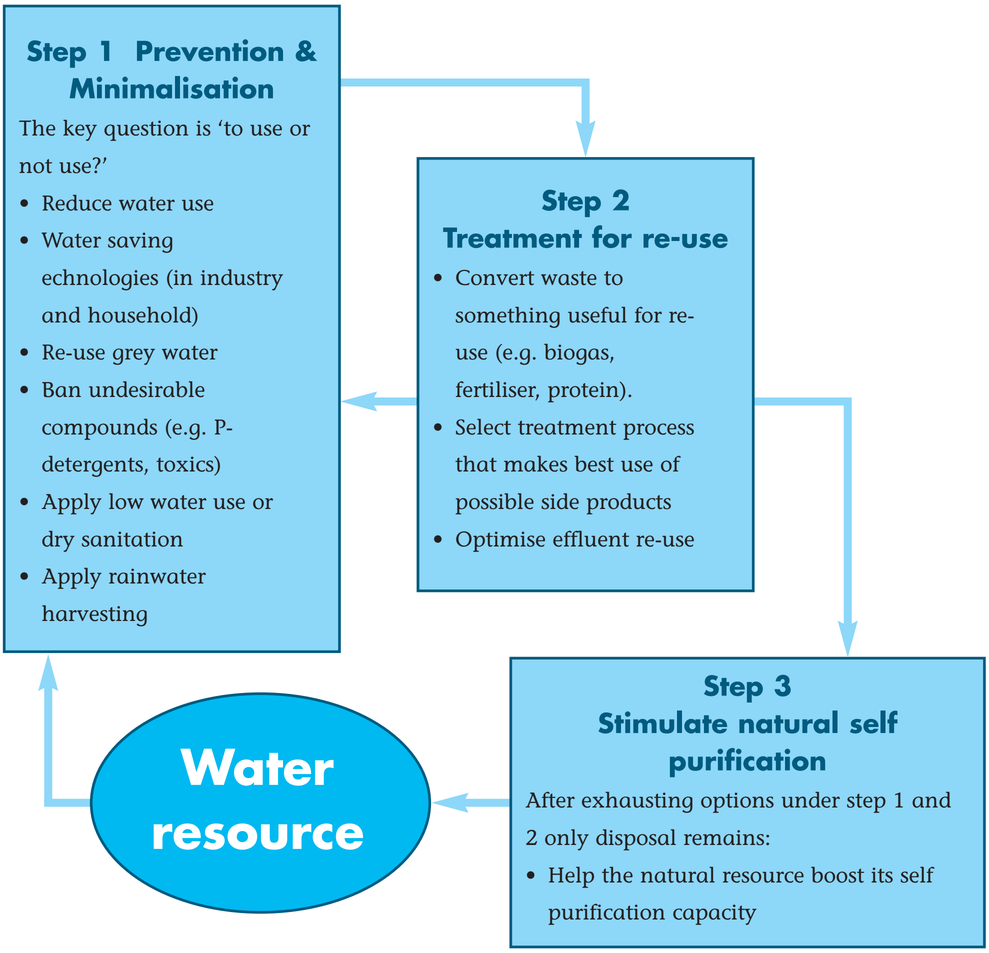
Large plants serving more than 300 000 people are able to invest in technologies that substantially lower operational costs for maintenance, energy, and sludge disposal. For example, only large plants can invest in sludge digestion reactors with methane gas recovery and gas-powered generators. Enough electrical power can then be generated to supply all the power required by the plant, which is often the largest recurrent operational expenditure. Similarly, it usually makes technical and, thus, financial sense to combine domestic and most industrial (pre-treated, not heavily polluted) wastewater streams.

The entire process of choosing a sanitation technology, involving all the options described above, can be summarized in a three step strategic approach (see Figure 3.1 below):

- Step 1 - maximize prevention and minimization;
- Step 2 - maximize treatment for re-use; and
- Step 3 - stimulate natural self purification.

The three steps should be implemented in chronological order, and possible interventions under each step should be fully exhausted before moving to the next step. Planning for re-use treatment is discussed in some detail in Section 3.3 below.

Figure 3.1
3-step approach to select sanitation technology



3.3 Planning for wastewater re-use

Main issues

Inter-related forces and constraints

The decision to re-use wastewater or not is deeply embedded in powerful social, ethical, cultural, economical and political forces. These forces are constantly confronting governments, particularly in developing countries with short-term needs for water, so limiting their ability to move to more effective long-term solutions. Implementation of wastewater re-use cannot be successful without dealing with all those forces and to do so governments will have to ensure strong political commitment. Box 3.12 below lists a number of constraints for re-use of wastewater.

Box 3.12

Constraints in re-use of wastewater

Reasons why wastewater re-use technology is not widely applied include:

- poor governance, both nationally and locally, such as:
  - failure to recognize inter-linkages between social, ethical, cultural, and economical aspects; and
  - lack of participation of different stakeholders in designing and implementing wastewater re-use systems;
- economic constraints, aggravated by:
  - failure to recognize the economic value of water treated for re-use; and
  - low priority given to re-use, also in times of water scarcity;
- institutional constraints, such as:
  - weak national structures which do not advocate re-use; and
  - deficiencies in national policies which hamper re-use of wastewater;
- scientific uncertainty and poor information management; issues like:
  - weak scientific infrastructure in developing countries;
  - little involvement of scientists in decision-making processes; and
  - ineffective communication between scientists, government and the public about risks, possible pre-cautions and reliability of re-use techniques;
- negative perceptions among the public, government staff and professionals alike:
  - sentiments and attitudes often culturally and socio-economic guided
  - insufficient public awareness of reliable re-uses options, and
  - consequently little public involvement and support for wastewater re-use.

Varied potential for re-use

Depending on the level of treatment of wastewater it can be re-used in a wide variety of ways, ranging from non potable uses like toilet flushing or industrial cooling water to re-uses with higher health related quality requirements such as composting to fertilize and improve soil structure, food crop irrigation, or recharge of potable groundwater aquifers. Figure 3.2 below shows treatment levels and respective re-use applications as recommended by the Environmental Protection Agency in the United States, focusing on fluid re-use components.

Perception in society

Before a sound decision can be taken on re-use of wastewater a number of issues need to be considered and assessed. There are common planning aspects such as technological and economic feasibility, legal issues and other institutional arrangements, such as staffing requirements (see also Chapters 1, 2 and 4). But more specifically, the perception of wastewater re-use needs to be assessed, both among the general public, potential professional users and in government institutions. In a survey issues like attitudes towards re-use, existing water rights and consequences of re-use, willingness and capability to pay, capacity to participate in planning, implementation, management, quality and quantity requirements of treated re-useable products should be considered.

In most cases such an assessment will need to be followed by elaborate communication campaigns, advocating wastewater re-use, urging society to change its (negative) perception. The latter may not be easy since often, deep-rooted socio-cultural barriers exists against re-use of wastewater. Figure 3.3 below summarizes different factors affecting the perception of wastewater re-use.

Figure 3.2
Wastewater treatment and re-use in the U.S.

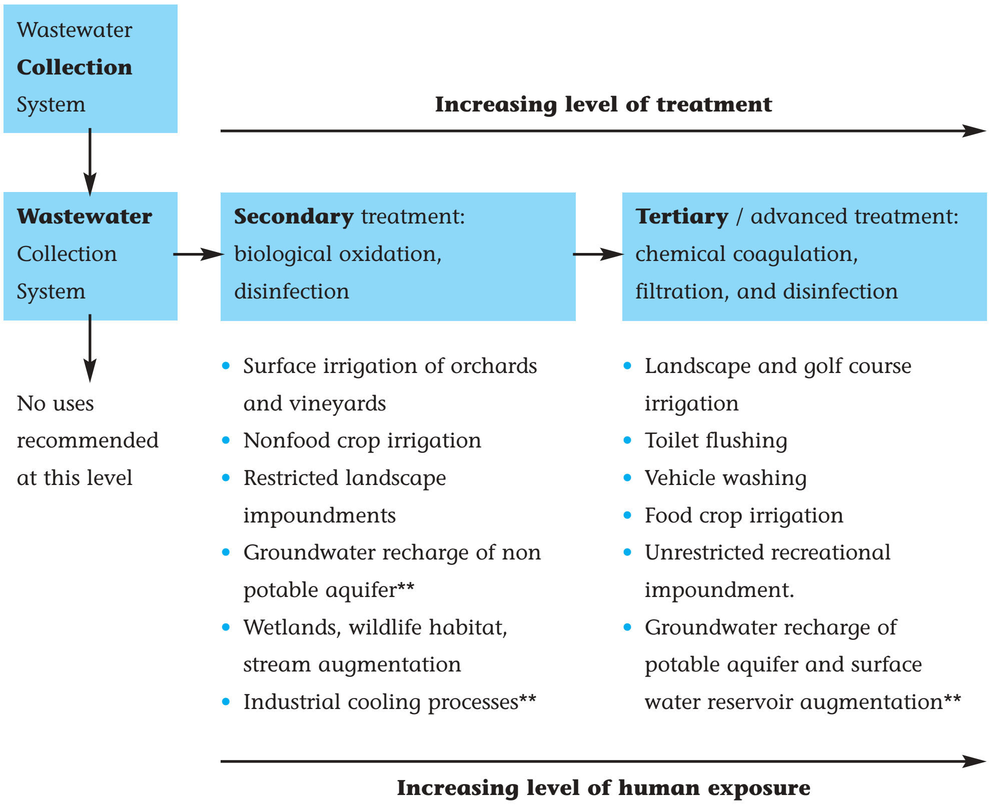
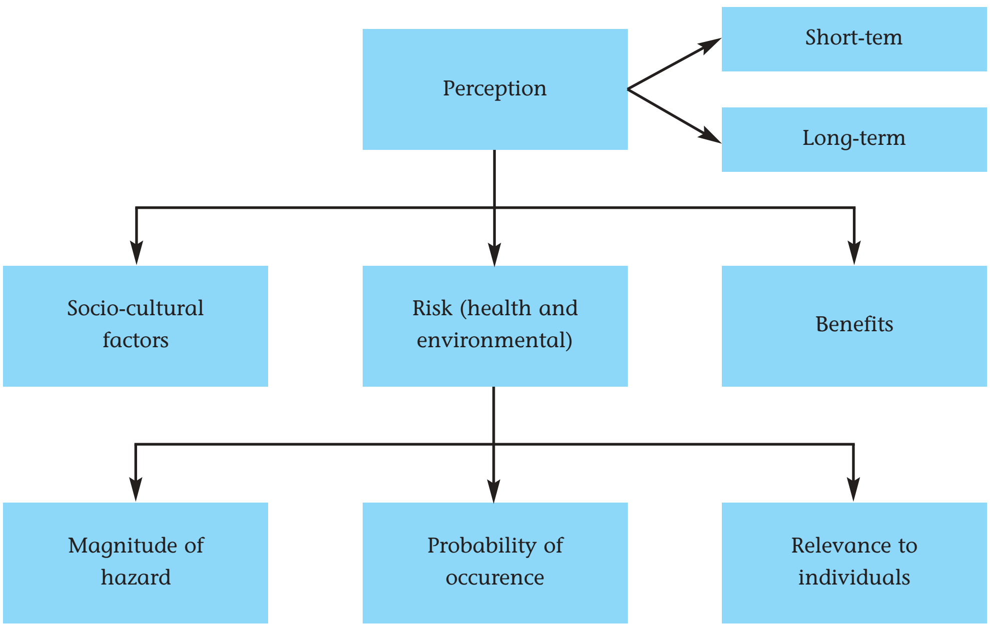


Figure 3.3
Factors affecting perceptions of wastewater re-use



Perceptions of health risks in wastewater re-use vary considerably among different social, cultural, and economic groups. This and the absence of comprehensive international guidelines has led countries, high- and low-income alike, to develop their own approaches for re-use of wastewater.

Despite the usual initial reluctance to accept the idea of re-using wastewater, experience around the world so far has proven that its valuable and reliable new products can be acceptable to societies. To achieve this acceptance, a number of important principles and tools should be applied, such as:

- health risk and environmental impact assessments;
- the pre-cautionary principle and the principle of preventive action;
- transparency and targeted advocacy campaigns; and
- market assessments and financial feasibility analyses.

Public health and environmental risk

If re-use technology is not handled properly its application would increase potential risk of infectious diseases. Detailed surveys of the local situation will be required to be able to assess health risks and environmental impacts and to select the most applicable technology.

A non-exhaustive list of characteristics to be surveyed could be as follows: physical characteristics (geology, morphology, physical and chemical soil characteristics, climate, surface water and groundwater situation, land cover) and socio-economic aspects (land use, population density and growth rates, income and development levels), water demand (current and future trends; seasonal differences), wastewater quality and quantity (including seasonal differences); required quality standards for re-use products (for different uses - potable and non-potable).

The combination of physical characteristics gives an area a certain purification or buffering capacity with specific resilience or thresholds levels. By integrating physical information with socio-economic and cultural aspects environmental and human health risks can be assessed.

Table 3.2 below shows levels of contamination and health risk when applying certain wastewater re-use control measures (from WHO 1989). Such information will be a vital tool while advocating re-use of wastewater to potential consumers (see also market assessment below).

Wastewater re-use control measures and related health risks

Control measures	Waste water	Field or pond	Crop	Desirable sanitary barrier	Worker	Con-sumer
	Level of contamination				Level of risk	
No protective measures	High	High	High		High	High
Crop restriction	High	High	High		High	Safe
Application measures	High	High	Safe		Safe	Safe
Human exposure control	High	High	High		Low	Low
Partial treatment in ponds	Low	Low	Low		Safe	Low
Partial treatment by conventional methods	Low	Low	Low		Low	Low
Partial treatments in ponds, plus crop restrictions	Low	Low	Low		Safe	Safe
Partial treatment by conventional methods, plus crop restrictions	Low	Low	Low		Low	Safe
Partial treatment, plus human exposure control	Low	Low	Low		Safe	Low
Crop restriction, plus human exposure control	High	High	High		Low	Safe
Full treatment	Safe	Safe	Safe		Safe	Safe

Precautions & transparency

Indeed, wastewater re-use demands an objective, scientific assessment of health risks and environmental impacts involved (see above). If uncertainty exists on potential risks to public health and/or to the environment or if the reliability of a technology is uncertain, precaution should always be the leading principle when planning for wastewater re-use. Transparency must be ensured in this assessment process, so that society can truly judge for itself and adjust its' believes and attitudes if needed.

Targeted advocacy

The clear message to society should be that reliable treatment technology exists, which can produce high quality products, posing no increased risk to consumers. Society should be ensured that adequate preventive action is taken where possible (such as separating municipal and industrial sludge) and that strong commitment exists to enforce agreed quality standards. Awareness raising campaigns will be required which target various potential consumer groups in specific ways (see also Section 2.3 in Chapter 2).

Market assessment

It is important that potential customers, who are willing and capable to re-use wastewater, are involved in planning from the beginning. They can be identified through a market assessment. Much background information will be required for such a market assessment, most of which will also form the basis for actual planning of alternative wastewater treatment and re-use management (see also the checklist at the end of this chapter). Box 3.13 below lists various steps to be taken in a market assessment.

Box 3.13

Surveys needed for a market assessment on re-use

- dentify the widest possible selection of potential users;
- identify user requirements through a user survey:
  - intended use(s);
  - required water quality (present and future);
  - required water quantity (present and future);
  - dependence on timely delivery;
  - willingness and capability to pay;
  - capacity to participate in planning, implementation and maintenance of re-use systems;
  - need for adjustment of current set-up to meet existing legal requirements;
  - required investment for adjustments, including desired pay-back period and desired water cost savings;
  - plans for future site changes;
- determine health-related requirements for each re-use application from documentation available in relevant health and technical institutions (water quality, treatment reliability, backflow prevention, irrigation methods);
- determine legal (or regulatory) requirements from existing documentation in relevant ministries (such as existing water quality standards and restrictions to protect groundwater);
- develop scenarios on future potable water quality under various levels of re-use treatment and compare those modeled qualities with current quality standards and user quality requirements;
- make estimates of future costs to supply society with sufficient freshwater (quantity and acceptable quality), comparing both “with” and “without” re-use technology options;
- present all the above to potential consumers in a clear, targeted and transparent way (see also Advocacy and public awareness in Section 2.3 of Chapter 2);
- based on all the above determine the preparedness of consumers to use reclaimed wastewater and other valuable side products now or in the future.

Financial benefits and feasibility

To present potential customers (including government institutions) with a convincing case, a financial feasibility study should be made, preferably for a set-up in which freshwater supply and wastewater management are integrated, and comparing both

"with" and "without" re-use technology options. All alternatives, from simple on-site natural treatment to complicated, expensive conventional off-site treatment, should be considered and budgeting should be realistic in the local situation. Ample attention should also be given to the "equity" and "polluter pays" principles, considering necessary regulatory and market based instruments (see also Chapter 2) and innovative financing mechanisms (see also Chapter 4) to make the re-use systems most cost-effective. Box 3.14 below lists aspects to consider in a financial feasibility study.

Such a financial analysis may well show that the use of reclaimed wastewater provides sufficient flexibility to allow a water agency or municipality to respond to short-term needs, while at the same time ensuring long-term water supply reliability. This would mean that substantial economic and environmental gains could be achieved because no additional storage and conveyance facilities need to be constructed. Also for potential consumers of re-use products the financial picture may well come as a pleasant surprise and provide an incentive to participate financially in re-use systems (irrigation water, compost, etc).

Box 3.14

Components of a financial feasibility study

Examples of components to include in a financial feasibility study are:

- capital costs;
- operation and maintenance costs;
- willingness and capability to pay;
- fair pricing (equity, polluter pays principles);
- realistic economic rate of return;
- benefits from the wide variety of re-uses of wastewater;
- cost benefit-ratio for wastewater treatment with and without re-use;
- benefits (or not) in other parts of the river basin (a least-cost strategy for achieving ambient water quality may involve different (or no) technologies at different locations);
- benefits (ambient quality and quantity) that could be achieved by phasing investments over 10 or more years.

Combine managerial tools

Most managerial tools for wastewater re-use, such as the planning framework or institutional arrangements, do not really differ from those in overall water supply and wastewater management. In practice the success of wastewater systems will depend on a combination of all management tools available (policy, institutional, technological and financial). In this chapter focus is on technological choices. Some examples of relevant institutional issues are: coordination mechanisms; delegation of authority to lowest possible level; availability of local manpower (to plan, design, construct, and run treatment and re-use facilities); quality control through objective monitoring and enforcement; and capacity building.

3.4 Summary of issues to consider while selecting wastewater treatment and re-use technology

This summary provides a checklist to ensure that selection and planning of cost-effective wastewater treatment and re-use technology is based on reliable and comprehensive procedures. The reader is mainly referred to Chapters 1, 2 and 4 on enabling policy, institutional arrangements and innovative financial mechanisms respectively. The checklists at the end of these chapters are useful additional tools to ensure that all aspects have been considered and received sufficient attention.

Checklist 3

Selecting wastewater treatment & re-use technology

- [ ] Is the political will and commitment towards cost-effective wastewater treatment and re-use strong?
  - How were political reactions to past health and environmental hazards associated with wastewater treatment and re-use?
  - Has an overall vision been formulated, considering issues like integrating (the planning for) wastewater treatment, wastewater re-use, and water supply?
  - What are attitudes of influential people towards wastewater re-use?
- [ ] Are all managerial tools (policy, institutional, technological and financial) applied in an integrated way?
- [ ] Have detailed inventories been made of the local situation to assess health risks and environmental impacts of the various technology options for wastewater treatment and re-use?
- [ ] In case of uncertainty in assessment results, has the precautionary principle been applied and is full transparency ensured?
- [ ] Have time-bound performance criteria been established to ensure quality control?
- [ ] Has a detailed survey been carried out among stakeholders (potential) and potential consumers with specific emphasis on perceptions on wastewater re-use?
- [ ] Has an inventory been made of existing health requirements and standards?
- [ ] Has an inventory been made of existing legal regulatory requirements and standards?
- [ ] Are all treatment and re-use alternatives feasible under national and/or state regulations?
- [ ] If not, can regulations be adjusted to fit the relevant alternative technologies?
- [ ] If no regulations exist, which treatments and re-uses seem feasible under WHO and FAO guidelines?
- [ ] Are major changes necessary in society in perceptions, attitudes and behavior?
- [ ] If yes, have awareness raising and education campaigns been planned targeting different potential stakeholders and re-use consumers in specific ways?
- [ ] Has a market assessment been carried out, which can be used to advocate wastewater re-use?

Checklist 3
(continued)

☐ Have all technological options for wastewater treatment and re-use been considered before final selection, and applying a multi-criteria analysis?
- environmental soundness;
- appropriateness to local conditions and regulations;
- applicability and efficiency in the context of the entire river basin;
- affordability to those who must pay for the services;
- technical performance and reliability;
- sludge management requirements;
- economies of scale;
- possibilities for maximum level of re-use?

☐ Has a step-wise selection approach been followed, starting with the most simple alternative, only opting for the most expensive and complicated solution if all other options fail? The logical order being:
- pollution prevention, waste minimization, water demand reduction;
- on-site treatment;
- off-site wastewater and stormwater transportation and collection;
- natural treatment systems combined with re-use;
- centralized high-tech wastewater treatment?

☐ Has a financial feasibility study been made for all treatment and re-use alternatives?

☐ Has the most cost-effective option been selected (the most expensive is not always the best)?

☐ Have other institutional requirements been secured (apart from above legal aspects)? (See text but mainly the Checklist 2).

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www.unep.or.jp Internet-accessible database for environmentally sound technologies
www.wkab.se

UNEP / Topham

chapter 4

Financial mechanisms for wastewater management

The financial system to recover costs of wastewater management should balance three critical and interrelated aspects: (1) quality of the service, (2) investment costs, and (3) tariffs that users are willing and able to pay. Users should receive an adequate service sensitive to their ability to pay and to their contributions to pollution: "water user pays" and "polluter pays" principles are prerequisites for achieving sustainability.
Low and middle-income countries cannot afford capital-intensive conventional, engineered solutions. Investments should go step-by-step.
Partnerships between public and private sectors are potentially useful tools to assist local governments in financing and operating infrastructure for wastewater management.

The fourth cluster of management tools, financial mechanisms, should be applied in close combination with the other three clusters, described in Chapters 1, 2 and 3 (enabling policy framework, appropriate institutional arrangements and cost-effective technologies). GPA keys most relevant to financial mechanisms are listed in Box 4.1 below.

Box 4.1

Keys for Action on Municipal Wastewater: focussing on financing

1 Secure political commitment and domestic financial resources.
5 Adopt a long-term perspective, taking action step-by-step, starting now.
6 Use well-defined time-lines, and time-bound targets and indicators.
8 Apply demand-driven approaches.
9 Involve all stakeholders from the beginning and ensure transparency in management and decision-making processes
10 Ensure financial stability and sustainability.
10.1 Link the municipal wastewater sector to other economic sectors.
10.2 Introduce innovative financial mechanisms
10.3 Consider social equity and solidarity to reach cost-recovery.

4.1 Cost recovery mechanisms

Three inter-related issues: investment, quality and tariffs

Target levels for water quality and wastewater management determine the required investment. The investment level, with its operational and maintenance costs, determines the costs that need to be recovered through a combination of tariffs or taxes. Cost recovery in turn determines the service level that can be provided and the associated water quality objectives that can be realized. Recognizing different needs of different users and selecting the technical and institutional solution for which those users are willing and able to pay are prerequisites for optimizing revenue.

Traditional investments

Traditionally, investments for wastewater management infrastructure have been met solely from public grants financing, foreign aid, or multilateral lending. The largest funding sources are local, originating from governments (who obtain funds through various local and national fiscal flows), users (paying for their own on-site systems or paying bills to official service providers), and local banks and donors (including private voluntary contributions).

Charges and fees

Various cost recovery instruments are being applied to cover at least operational costs of wastewater treatment, and possibly some of the capital investment. These include direct charges to users or pollution fees such as effluent charges and discharge permits (see Box 4.2 below).

Box 4.2

Cost recovery mechanisms

Consumption-based user charges:
User charges are levied upon discharge of wastewater into the sewerage based on volume and/or characteristics of the effluent. The volume of discharged wastewater is directly related to consumption of potable water. Consequently, the tariff is usually collected as a surcharge on the water consumption bill.

Effluent charges:
Effluent charges can be based on the actual quality and quantity of wastewater, on a fixed amount per household, or, with regard to an industry, on a proxy based on verifiable information about the industry (production, number of employees, etc.).
Effluent charges are mainly applied in Western Europe, in some developing countries (such as Indonesia and Mexico), and in a few Eastern European countries.

Discharge permits:
A responsible authority sets maximum limits on total allowable emissions of a pollutant to a sewer or to surface water. In discharge permits, charges or levies can be incorporated for cost recovery purposes. A permit system requires elaborate monitoring of effluent flows and quality.
Effluent charges and discharge permit systems are complex in design and implementation. They require: monitoring of effluents; the ability of authorities to assess appropriate tariffs and emission limits; the capacity to implement appropriate billing systems; and polluters' ability to change their behavior.
Tradable effluent permits can give polluters more flexibility in investment and operation of wastewater management.

Subsidies

Also subsidies have often been used to pursue social or political goals, so direct the cost recovery balance in a certain direction. For instance, subsidies for providing environmentally sound re-use services will stimulate innovative financing in re-use technology by private groups. Or subsidies can assist disadvantaged groups in society who could slip through inadequate social safety nets.
But subsidies must be implemented with great care, since they can introduce undesirable side effects. They can, for instance, create dependencies (people not willing to pay a "real" price for services when they are used to much cheaper subsidized services) or reduce incentives to economize wastewater production at the source. Such effects may be worse than the problem they were intended to solve.
Likewise, high costs for discharge permits may on the one hand encourage industries to pre-treat their wastewater flows to ensure that they are suitable for discharge to surface waters. However, high tariffs may also induce illegal discharges outside of the wastewater system.

Successful implementation is complex

Designing and enforcing cost recovery mechanisms is a complex process. It requires arrangements (technical, institutional, legal, and financial) for a good monitoring system, including regulations and legislation on receiving water quality levels and emission standards. An efficient revenue collection system should be in place, including capabilities and capacity to assess the right tariffs, to implement appropriate billing systems, and to enforce fines if needed. And lastly, polluters need to be willing and able to change their behavior. For efficient revenue collection it is better to advocate that users are required to pay for a service delivered to them rather than to impose a

penalty for disposing waste.

Encourage co-financing through funds

A special fund would best be established in which revenues from use charges or pollution fees are deposited. Such a fund can then be used for targeted co-financing of wastewater treatment facilities and for actual operation and maintenance, instead of considering revenues as taxes that enter the national budget. To ensure that revenues are indeed allocated to the appropriate service provider a fund should be accountable and provide transparency about its fund management.

4.2 Willingness to pay and cost sharing

Balance cost recovery and equity

Any sustainable wastewater management system must address the key issues of financing and cost recovery on the one hand while ensuring equity on the other. This concerns local community-based sanitation initiatives as well as large-scale programmes funded by international donor organizations. In most developing countries, a conflict will arise if sound financing is to mean full cost recovery and equity. In such cases, targeted subsidies are necessary creating a flow from the affluent part of society to those who cannot afford service costs.

Involve stakeholders

But even in low-income situations improvements can be affordable. For an intervention to be successful, participation of beneficiaries in the planning and decision-making process is always essential. This increases the sense of responsibility among beneficiaries to pay wastewater bills once the service is operating. In addition, solutions selected by local users tend to be lower cost technologies (see also Box 4.3 below).

Box 4.3

Cost sharing in the Orangi Pilot Project, Karachi, Pakistan

In the 1980s, the 600 000 residents of the Orangi slum area had no access to the city's sewer system. A renowned community organiser then started with a small amount of core external funding to explore alternatives. Residents were asked about their needs and wishes and some community members participated in the construction of facilities, which included in-house sanitary latrines and house sewers on each plot and underground sewers in lanes and streets. Simple techniques and free labour reduced infrastructural costs to less than US$100 per household. Elected lane and neighbourhood managers maintained the sewers, and households pay for the costs, partly in kind.

Serageldin (1994)

Ensure solidarity among different stakeholders and service levels

Many well-known case studies like the above have shown that people's willingness to pay for sanitation improvements is much higher than expected if they can select the type of system they prefer. Key features for success in achieving willingness to pay are listed in Box 4.4 below.

Households may be willing to pay for in-house sanitation facilities and for facilities that remove wastewater flows from their property. However, individual households often do not directly perceive more aggregate level benefits from wastewater services. Nevertheless, awareness can be created to achieve that, at a block, neighborhood or city level, households will collectively place high value on services that remove excreta from their area as a whole.

On the next level, waste discharged from one city may well pollute the water supply of a neighboring city. And indeed, groups of cities in a river basin, as well as farmers and industry, perceive a collective benefit from environmental improvement. They can easily identify with concepts such as "catchment solidarity". Costs assigned to each level in the household-neighborhood-city hierarchy should be in accordance with benefits accruing at each level, as described in Box 4.5 below.

Box 4.4

Key success factors in willingness to pay

1 Community members make informed choices, based on:
- their participation in the project;
- technology and service level options, recognizing that more expensive systems cost more per member;
- when and how services are delivered to them;
- how funds are managed and accounted for; and
- how services are operated and maintained.

2 An adequate flow of information is provided to the community and procedures are adopted to facilitate collective decisions within the community and between the community and other actors.

3 Governments play a facilitating role, set clear national policies and strategies, encourage broad stakeholder consultation, and facilitate capacity building and education.

4 An enabling environment is created for participation of a wide range of providers of goods, services, and technical assistance to communities, including the private sector and NGOs.

Box 4.5

Costs assigned in household-block-city hierarchy

- Households should pay for most costs for on-site facilities, such as bathrooms, on-site sewer connections, and septic tanks.
- Residents of a block or neighborhood should collectively pay costs of transferring collected waste to the boundaries of their block or neighborhood (and treating the groups' waste if a facility exists).
- Residents of a city should collectively pay additional costs of collecting waste from neighborhoods and transporting these to the boundary of the city (and treating the cities' wastewater).

Wright (1997)

User pays principle

In addition, negotiations could lead to opportunities whereby stakeholders in a river basin (cities, farmers, food processing industries, and so on) collectively assess the value of different levels of water quality for which they wish to pay and then agree on financial responsibility for treatment costs and water quality management: a good example of the "user pays" principle. In coastal areas, and around larger lakes and rivers, stakeholders may include hotels and fisheries for which water quality has a high (commercial) priority.

Polluter pays principle

Also the "polluter pays" principle is a fair and straightforward concept. In practice, it has been extremely difficult to implement though. There are categories of users unable or unwilling to pay for their contribution to pollution loads. For example, agriculture may well be the primary polluter in any large river basin, yet typically, the government will not attempt to charge or restrict agricultural operations. Furthermore, pollution from urban storm sewers (in either separate or combined systems) is usually ignored, and industries claim that they are unable to pay. An additional problem is formed by the lack of incentives that polluters face, mainly due to inconsistently applied policies and weak enforcement. All these practices distort the polluter pays concept. This problem of major polluters not paying their share is typical worldwide. To improve the situation, changes in "business as usual" practices should be promo-

ted. Regulatory instruments should be reformed to enforce the polluter pays principle and to foster a willingness to pay among polluters, including industry and government institutes. Concrete action with true partnership between the private and public sector should be encouraged.

4.3 Investment options for infrastructure

Innovation in investment

More traditional, mainly public, funding sources and trends in them are difficult to quantify. Nonetheless, it is clear that, to meet current challenges, existing funding sources and instruments are not sufficient. Unlocking additional funding and innovative mechanisms is important if progress is to be made in achieving sustainability in wastewater management. While public funding remains important, especially in developing countries, more governments are nowadays delegating financial responsibilities to local authorities and are interested in public-private offers. Since 1990, the participation of private sector companies in water and sewerage projects in developing countries has also accelerated.

Important role for local government

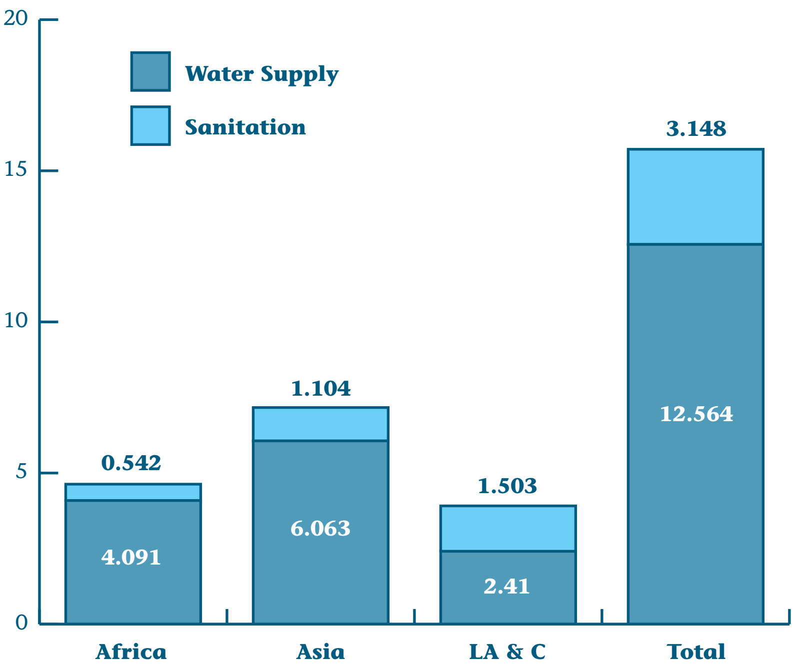
Local governments should play a key role in managing resources and societies. They are the primary party in the dialogue with the people and the local corporate community who are affected by government decisions. And local governments have the important task of monitoring compliance of national legislation. Unfortunately local authorities do not always have sufficient resources to implement these tasks.

More private funds in water supply than in sanitation

Public-private partnerships are still more common in the water supply sector than in wastewater management. Only about 14 percent of total private investment in water and sewerage is directed exclusively to the wastewater sector. About half of the total private funds have been allocated to investments in combined water and wastewater projects; but in these projects, water supply usually has priority (Silva et al. 1998; World Bank 1997).

The majority of urban water supply utilities are still publicly operated. Partnerships between the public and private sector are most commonly cited in concessions and management contracts. Figure 4.1 below shows the relatively small investment in sanitation compared to water supply.

Figure 4.1 Total annual investment in sanitation in Africa, Asia and Latin America and the Caribbean, 1990-2002 (WHO/UNICEF 2000)



In spite of the above findings, there are strong economic, environmental, and health reasons for combining municipal wastewater and water supply systems within single contracts.

Benefits of public-private partnership

International financial markets can be involved in financing various combinations of debt and equity. Transferring part of the responsibility for infrastructure management to private partners, so bringing in capital, spreading risk and gaining from typical private sector virtues in management and operation is a potentially promising solution. Water supply and sanitation projects can benefit from typical private company characteristics such as their professional managerial capacity, the fact that they are technically better qualified and equipped, and operate at high efficiency levels, all resulting in lower operating costs and more secure revenues. Besides, they offer potential for innovative solutions and risk sharing, and with their easy access to capital markets they open up routes to alternative and additional forms of cheaper and long-term financing (Figuères, 2003). Box 4.6 below summarizes how public-private partnerships can assist in moving a society towards more sustainable water supply and wastewater management systems.

Box 4.6

Towards sustainability with public-private partnerships

Public-private partnerships help in moving a society towards sustainability in many different ways:

Institutionally: They allow governments to attract private sector funding and involvement without incurring the adverse effects of full scale privatization. Governments can, for instance, retain a significant role so that they maintain the essential 'public' character of infrastructure.

Economically: They promote efficiency and indirectly economic growth through decentralization of services, corporatism of municipal utilities, cost recovery through user charges, economic efficiency in resource use and allocation.

Socially: They meet people's needs by offering better water supply and sanitation services. This helps in raising living standards and in alleviating poverty.

Environmentally: They can be used for the transfer of environmentally innovative technology and can help in raising environmental controls to national and/or international standards.

Table 4.1 below shows an overview of various financing options, from traditional grants to more innovative solutions such as revolving funds and bonds. Table 4.2 summarizes public-private partnership options. The described service and management contracts and simple lease structures have proven to be rather successful tools in improving operational efficiency. However, they do not provide a means for service expansion or upgrading, for which substantial amounts of capital are required. Other options like concessions, Build-Own-Transfer (BOT) contracts, and (partial) divestitures are means to raise funds for such investments.

Variations on the BOT model include: BOO (Build-Own-Operate: assets are not transferred); ROT (Rehabilitate-Operate-Transfer: investment in rehabilitation); Reversed BOOT: government responsible for asset construction, private company for operation; DBO (Design-Build-Operate: private company also conducts investment design). Table 4.3 below shows the allocation of key responsibilities for each main option.

Table 4.1

Investment options: from traditional to more complex innovative

Type of financing	Characteristics	Constraints
Grant Finance Most existing wastewater infrastructure has been financed through allocations from national or local government budgets.	Helps overcome lack of household or community willingness to pay for pollution abatement that only benefits those downstream. Systems fully cover costs at lower tariff rates than would otherwise be feasible.	Lower tariffs reduce incentive for households or industries to abate pollution. Reduces pressure to identify most efficient solution, since municipalities support only facility construction.
Government or multilateral institutions loans Focuses on capital costs of wastewater collection and treatment facilities. Typically contains a subsidy component (below-market interest rates; or credit risk guarantees)	Long grace & repayment periods (compared to commercial loans). Matches expected facility life to loan period. Fewer incentive risks than grants, as they must be repaid (incentive effects depend on tariff structure)	
Int. Financial Institutions loans IFI loans provide low-cost project financing. Includes loan conditions designed to maximize incentives for efficient service (tariff structures, financial performance measures).	Same characteristics as for Government or multilateral institution loans. In many cases, accepts country credit risks.	IFI Loans often require a sovereign guarantee. Denomination in a foreign currency exposes projects to a foreign exchange risk.
Market financing *a) Commercial bank loans* Bank loans are secured by contracts and documents to assure funds will be used to support projects in the way intended, using a mortgage (land, fixed assets etc).		Commercial banks typically require a public sector guarantee, which may not be available.
b) Bonds (municipal, international)	Traditionally, as in the US, such bonds have a tax-exempt status that makes them attractive to creditors (and are, in fact, a form of subsidized finance).	Requires good records on governance, sound local fiscal policy, adequate colla-teral or securitization of risk to cover foreign exchange risk and other risks involved.
Private capital Project pool structure spreads risks over number of projects: primary source of repayment is not cash flow from a single project, but rather the performance of a number of projects. *a) Revolving funds* Financed from various sources to finance project costs. Subsequent repayments from projects are then used to replenish the fund, permitting funding of other investments.	Debt payment risk spread by large, diversified pool of borrowers. Households, communities, & property investors can also apply revolving funds to finance on-site and local sewerage systems. In sanitation sector, revolving funds usually created with large gov'ment or donor involvement.	
b) Equity funds	Mitigate project and country risk by creating a portfolio of projects under a company.	

Table 4.2

Types of co-operation in public-private partnerships: from service contracts to divestiture

Type of partnership	Characteristics	Constraints
Service contracts Specific components are contracted out to private sector; government retains responsibility for operation and maintenance.	Examples are: operation of a treatment plant, billing, and collection operations.	
Management contracts Responsibility for entire operation and maintenance is transferred to contractor.	Payments can be a fixed fee, but are usually related to achievement of performance targets. This creates an incentive for increasing productivity.	Setting, monitoring, and evaluating targets difficult. Achievement of targets may be related to capital investments, which are not the responsibility of the private contractor.
Lease contracts Private operator is responsible for operating, maintaining, and managing a system, incl. revenue collection for rented assets.	Government remains sole owner of assets and is responsible for expansion and upgrading, investments, debt service, tariff setting and cost recovery policies.	Particularly beneficial if no substantial capital investments are required, and thus not popular in wastewater management sector.
Concessions Concessionaire has full responsibility for delivery of services: operation, maintenance, system expansion, collection of revenues and fundraising for investments. Government responsible for establishing and enforcing performance targets.	Concessionaire has strong incentives to make efficient investment decisions and to develop innovative technological solutions, since efficiency gains will directly increase its profits. Full utility concessions are attractive where large investments are needed to expand coverage of service or to improve quality.	A critical factor is quality of regulation, as it concerns a long-term monopolistic position of concessionaire.
Build-Own-Transfer contracts Private sector finances, builds, and operates new facility applying governmental performance standards. Government retains ownership of facility. In construction period, private sector provides investment capital. In return, government guarantees purchase of a specified output.	Operation period should be long enough for contractor to recover its construction costs and to realize a profit. Agreements mitigate commercial risks for private sector, because government is its only customer. Thus, BOT contracts are financed with a relatively high debt component.	Not for existing infrastructure: they do not tackle deficiencies nor do they turn financially weak utilities into strong ones. Length and complexity: most BOTs have to be renegotiated once underway. Size and time frames often require sophisticated and complicated financing packages
Divestiture Full divestiture pertains to a situation where utility has been fully privatized. Ownership of utility rests with private operator. Private operator is responsible for operation and maintenance, investments and tariff collection. Regulation (to safeguard public interest) in hands of Government, so completely separated from ownership and operation.	Improved incentives for efficient investment decisions and development of innovative technologies. Low transaction costs compared to costs of tendering and contract negotiations associated with models discussed above.	Possible conflict of interest: public sector responsible for regulation and company shareholder responsible for maximizing returns. Could lead to political interference and counteract private sector management advantages. No competition (as no tendering) can raise transparency and corruption concerns.

World Bank (1997)

Table 4.3

Private sector participation: allocation of key responsibilities

Option	Asset ownership	Operations & maintenance	Capital investment	Commercial risk	Typical duration
Service contract	Public	Public & private	Public	Public	1-2 years
Management contract	Public	Private	Public	Public	3-5 years
Lease	Public	Private	Public	Shared	8-15 years
Concession	Public	Private	Private	Private	20-30 years
BOT/BOO	Private & public	Private	Private	Private	20-30 years
Divestiture	Private or private & public	Private	Private	Private	Indefinite (may be limited by license)

World Bank (1997)

Strong commitments required

In summary: promising innovative tools are available to increase private investment for urban water and wastewater services, but they are not easy to implement. They involve extensive preparation, complex financial instruments and management of risk. Multiple tasks exist for municipalities, national governments, and international donors (Gentry and Abuyuan, 2000). Setting tariffs and performance standards, providing strong regulatory oversight, ensuring political and economic stability, using market access controls, increasing public awareness, ensuring stakeholder support and commitment, and addressing transitions are but a few of the important steps involved. Clearly, strong governments are needed to actively promote schemes among potential partners, to ensure that necessary tools are in place and that companies comply with their obligations.

4.4 Summary of issues to consider when selecting financing mechanisms

This summary provides a checklist to ensure that provides a checking opportunity to ensure that all necessary aspects are considered while designing the best financial mechanism for cost-effective municipal wastewater treatment and re-use. The list is based on the experiences described in this chapter and on a review of twelve projects in the water sector (Leclerc et al, 2001).

It is important to realize that this checklist is part of the set of four, compiled at the end of each of the four chapters of these guidelines. Together they cover the full set of aspects to be considered while designing and planning for sustainable municipal wastewater management. Chapters 1, 2 and 3 present provide for checklists related to enabling policy, institutional arrangements and technology selection.

Checklist 4

Designing sustainable financing for municipal wastewater infrastructure

- ☐ Have opportunities for integration of the wastewater and water supply sectors been thoroughly investigated?
- ☐ Has the important role of local government been acknowledged and are authorities delegated accordingly?
- ☐ Is co-financing encouradged and promoted by the government?
- ☐ Has a clear investment procedure been proposed, considering the range of options from traditional grants to more innovative solutions, such as revolving funds, and following a step-by-step approach?
- ☐ Have commitments from multilateral institutions been obtained to secure funding?
- ☐ Have local funding sources been used as much as possible to respond to the need for local flexibility?
- ☐ Has a market assessment been made among potential stakeholders?
- ☐ Have technological options been carefully studied (expensive is not always the best; prevention better than cure)?
- ☐ Are strong government agencies in place to formulate policy, legislation and regulation for quality control and enforcement?
- ☐ Are innovative economic instruments used in combination with admini-strative regulation as an incentive (e.g. tradeble effluen permits or loan-based licensing fees), giving polluters more investment and operational flexibility?
- ☐ Do government agencies have an adequate monitoring system in place, with capacity to set receiving water quality levels and emission standards and to measure performance and compliance with regulations?
- ☐ Is technical expertise available to design innovative partnership contracts?
- ☐ Has the involvement of the private sector been planned step-by-step in order to mitigate risk and adapt contracts to changes in the local situation?
- ☐ Are ownership rights to contributed assets and responsibilities in investment, construction, operation and maintenance clearly defined?
- ☐ Is appropriate legislation in place, strongly committing partnerships to maintain agreed performance levels?
- ☐ Are risks allocated realistically to reach a fair balance of risks and benefits among parties?
- ☐ Is a transparent and ongoing dialogue maintained or catered for among stakeholders (including civil society)?

Checklist 4
(continued)

☐ Has compliance with commitments in the long run been assured? (this is facilitated by local and national political stability)?

☐ Have different possibilities for cost recovery been evaluated in the context of the three inter-related issues of quality of service, investment cost and tariffs?

☐ In doing so, have the principles of "user pays", polluter pays", "equity" and "solidarity"been applied while formulating the cost recovery system?

☐ Has the need for tariff flexibility at local level been acknowledge, related to changing exchange, interest and inflation rates?

☐ Have investments been adapted to needs and resources of consumers, to obtain tariffs which are acceptable for consumers?

☐ Has the range of variation in tariffs been kept compatible with what society can afford?

☐ Are costs assigned to each level in the household-neighborhood-city hierarchy in accordance with benefits (to be) accrued at each level (solidarity among different stakeholders and service levels)?

☐ Are arrangements in place for adequate communication and information exchange among stakeholders?

☐ Are advocacy programmes formulated to achieve that users and polluters (often the same entity) will be willing and able to change their behavior?

☐ Are efficient revenue collection system in place, including capabilities and capacity to assess the right tariffs, to implement appropriate billing systems, and to enforce fines if needed?

☐ Are revenues allocated to the appropriate service provider, e.g. not just adding revenues to the national budget but setting up a special fund which is accountable and transparent in fund management?

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ANNEXES

annex **1**

The four checklists: policy, institutional, technology, financing

Checklist 1

Logical framework for municipal wastewater management

Phase 1: Problem identification

Tasks: Monitor and assess the current situation:
- focus on areas where most positive impacts can be expected from new wastewater management;
- involve local communities and other local stakeholders in the assessment, so raising public awareness and stimulating participation;
- identify all stakeholders and key agencies;
- assess wastewater (both quantity and the quality) from industries and small enterprises that is mixed with domestic wastewater;
- assess of urban runoff (both quantity and quality) and the frequency with which urban runoff drains into the wastewater collection system;
- identify those contaminants that cause most serious harm to human health and the environment;
- assess the needs of all stakeholders.

Are staff, funds, facilities, mechanisms in place to implement the tasks?

Phase 2: Planning

Task: Review existing information:
- national economic [and development] plans;
- related sector policies (water supply, solid waste management, land use planning and zoning, urban development);
- demographic and socio-economic projections (rate of urbanization; projections on income -per capita and distribution-, water supply and water demand);
- the existing legal framework including standards and regulations;
- the current institutional framework;
- the current financial framework.

Is access assured to required data and documentation?

Task: Identify potential obstacles and opportunities:
- obstacles like insufficient institutional capacity or financial resources;
- opportunities such as collaborating with breweries, food processing and tourism industries which all require clean water;

Checklist 1
(continued)

Task: Formulate objectives, standards and management plan:

- make an analysis of technical, economic, and social feasibility of different options;
- consult and negotiate with all stakeholders;
- include clear objectives that are measurable and verifiable;
- allow local flexibility in implementation of regulation;
- follow a realistic step-wise investment approach;
- apply spatial differentiation, considering specific physical and socio-economic characteristics in neighborhoods.

Task: Formal adoption:

- establish an interagency coordination mechanism between relevant authorities (sectoral synergy) and all levels (from national to local);
- approve staffing and required organizational changes;
- adopt policies, goals, standards, and management tools;
- assign, by legislation, responsibilities among the actors (monitoring, revenue collection, operation, and maintenance);
- approve the funding allocation.

Are staff, funds, facilities, mechanisms in place to implement the tasks?

Phase 3: Implementation

Task: Design management tools

- provide management tools in the form of regulatory and economic or market-based instruments
- support instruments by legislation and other types of authorization.

Task: Organize operational management: on-site versus off-site

- make a distinction between cheaper on-site sanitation and more complex, expensive off-site collection and treatment.

Task: Set up institutional arrangements

- ensure institutional arrangements for management tasks and tools, as well as for capacity building, raising awareness, and public participation.

Are staff, funds, facilities, mechanisms in place to implement the tasks?

Phase 4: Enforcement and evaluation

Task: Operational management of water quality:

- ensure rules that are accepted by society and that can be enforced;
- ensure strong and objective enforcement when breaking the rules can give economic benefits

Task: Evaluation:

- provide for regular monitoring and evaluation, so that timely improvements can be introduced when necessary.

Are staff, funds, facilities, mechanisms in place to implement the tasks?

Checklist 2

Issues and steps to consider in planning institutional arrangements

☐ Has a thorough assessment been made of the current situation? Including:

- the current wastewater discharge situation, focusing on systems in place for wastewater collection, disposal and treatment (see chapter 3);
- the current organizational structure of implementing institutions: responsibilities and authorities, level of collaboration with other institutions, strengths and weaknesses, gaps and overlaps;
- the potential stakeholders: characterize different segments of society each with their different knowledge, attitudes, practices and needs;
- the current financial situation with resources originating from complex financial flows (see also chapter 4).

☐ Has an initial assessment been made of needs for improvements and have initial recommendations for action been formulated (e.g. to focus on simple strengthening of an existing situation or to strive for more rigorous reform)?

☐ Has an overall vision been formulated based on the information obtained from the identification assessments?

☐ Is catchment solidarity being promoted by advocating awareness among people in the entire river catchment and by emphasizing the need for all stakeholders to commit themselves to participate in wastewater management (also financially)? In doing so:

☐ Is it acknowledged that each segment of society has different knowledge, attitudes, needs, priorities, means, and incentives?

☐ Are citizens made aware of their dual role as polluters and beneficiaries of wastewater management?

☐ Is a communication strategy applied in which different stakeholders are approached with messages that are specifically targeted to their communication requirements?

☐ Have local experience and expertise been synthesized to help identify problems and formulate solutions?

☐ Are operational goals set and verifiable indicators agreed upon with direct involvement of all stakeholders in the basin (demand-driven)?

☐ Do local communities receive financial support to actively participate in formulation and management?

☐ Are all relevant stakeholders benefiting from and contributing their realistic share (financially) to improvements?

☐ Has an institutional structure been formulated which is flexible and which ensures integration with other relevant sectors (such as water supply or solid waste) and cooperation between national and local governments?

Checklist 2
(continued)

☐ Are proper management tools in place such as:

- relevant legislation (both national and international);
- verifiable standards and time-bound performance indicators which are realistic and can be measured against agreed benchmarks
- regulatory tools and market-based instruments to stimulate voluntary action;
- flexible application of such regulation at local level so that local regulators and polluters can devise the most cost-effective solutions?

☐ Are responsibilities and authority delegated to lowest appropriate management levels?

☐ Are functions of regulation and monitoring of wastewater discharges separated from the function of attaining standards?

☐ Has the potential for enforcement been taken into consideration while formulating regulations and standards?

☐ Does the overall institutional framework :

- enable use of economic instruments to promote wastewater minimization, pollution prevention, and re-use;
- ensure that adopted quality standards are maintained;
- enhance the capacity of authorities to enforce the instruments.

☐ Are mechanisms in place through which service providers can be held accountable by the public, and which allow knowledge sharing and proper feed back between providers and legislators?

☐ Is transparency regarding organizational objectives, targets, performance, and financial management assured?

☐ Have synergies been created among institutions of different sectors and government levels?

☐ Have alliances been built among potential service providing partners (in government, industry, private sector and communities)?

☐ Is competition being stimulated to reach more efficiency?

☐ While building alliances and competition: is a long-term financial equilibrium being ensured to stimulate innovative voluntary initiatives of collaboration?

☐ Has an institutional capacity building strategy been formulated with long-term political and financial commitment to ensure effective implementation of a new wastewater strategy?

☐ In doing so, have all relevant components been incorporated, such as institutional development, community participation, human resources development, strengthening of managerial systems?

Checklist 3
(continued)

Selecting wastewater treatment & re-use technology

☐ Is the political will and commitment towards cost-effective wastewater treatment and re-use strong?
- How were political reactions to past health and environmental hazards associated with wastewater treatment and re-use?
- Has an overall vision been formulated, considering issues like integrating (the planning for) wastewater treatment, wastewater re-use, and water supply?
- What are attitudes of influential people towards wastewater re-use?

☐ Are all managerial tools (policy, institutional, technological and financial) applied in an integrated way?

☐ Have detailed inventories been made of the local situation to assess health risks and environmental impacts of the various technology options for wastewater treatment and re-use?

☐ In case of uncertainty in assessment results, has the precautionary principle been applied and is full transparency ensured?

☐ Have time-bound performance criteria been established to ensure quality control?

☐ Has a detailed survey been carried out among stakeholders (potential) and potential consumers with specific emphasis on perceptions on wastewater re-use?

☐ Has an inventory been made of existing health requirements and standards?

☐ Has an inventory been made of existing legal regulatory requirements and standards? Are all treatment and re-use alternatives feasible under national and/or state regulations?

☐ If not, can regulations be adjusted to fit the relevant alternative technologies?

☐ If no regulations exist, which treatments and re-uses seem feasible under WHO and FAO guidelines?

☐ Are major changes necessary in society in perceptions, attitudes and behavior?

☐ If yes, have awareness raising and education campaigns been planned targeting different potential stakeholders and re-use consumers in specific ways?

☐ Has a market assessment been carried out, which can be used to advocate wastewater re-use?

Checklist 3
(continued)

☐ Have all technological options for wastewater treatment and re-use been considered before final selection, and applying a multi-criteria analysis?

- environmental soundness;
- appropriateness to local conditions and regulations;
- applicability and efficiency in the context of the entire river basin;
- affordability to those who must pay for the services;
- technical performance and reliability;
- sludge management requirements;
- economies of scale;
- possibilities for maximum level of re-use?

☐ Has a step-wise selection approach been followed, starting with the most simple alternative, only opting for the most expensive and complicated solution if all other options fail? The logical order being:

- pollution prevention, waste minimization, water demand reduction;
- on-site treatment;
- off-site wastewater and stormwater transportation and collection;
- natural treatment systems combined with re-use;
- centralized high-tech wastewater treatment?

☐ Has an financial feasibility study been made for all treatment and re-use alternatives?

☐ Has the most cost-effective option been selected (the most expensive is not always the best)?

☐ Have other institutional requirements been secured (apart from above legal aspects)? (See text but mainly the chapter 2 check list).

Checklist 4

Designing sustainable financing for municipal wastewater infrastructure

☐ Have opportunities for integration of the wastewater and water supply sectors been thoroughly investigated?

☐ Has the important role of local government been acknowledged and are authorities delegated accordingly?

☐ Is co-financing encouradged and promoted by the government?

☐ Has a clear investment procedure been proposed, considering the range of options from traditional grants to more innovative solutions, such as revolving funds, and following a step-by-step approach?

☐ Have commitments from multilateral institutions been obtained to secure funding?

☐ Have local funding sources been used as much as possible to respond to the need for local flexibility?

☐ Has a market assessment been made among potential stakeholders?

☐ Have technological options been carefully studied (expensive is not always the best; prevention better than cure)?

☐ Are strong government agencies in place to formulate policy, legislation and regulation for quality control and enforcement?

☐ Are innovative economic instruments used in combination with admini-strative regulation as an incentive (e.g. tradeble effluen permits or loan-based licensing fees), giving polluters more investment and operational flexibility?

☐ Do government agencies have an adequate monitoring system in place, with capacity to set receiving water quality levels and emission standards and to measure performance and compliance with regulations?

☐ Is technical expertise available to design innovative partnership contracts?

☐ Has the involvement of the private sector been planned step-by-step in order to mitigate risk and adapt contracts to changes in the local situation?

☐ Are ownership rights to contributed assets and responsibilities in investment, construction, operation and maintenance clearly defined?

☐ Is appropriate legislation in place, strongly committing partnerships to maintain agreed performance levels?

☐ Are risks allocated realistically to reach a fair balance of risks and benefits among parties?

Checklist 4
(continued)

☐ Is a transparent and ongoing dialogue maintained or catered for among stakeholders (including civil society)?

☐ Has compliance with commitments in the long run been assured? (this is facilitated by local and national political stability)?

☐ Have different possibilities for cost recovery been evaluated in the context of the three inter-related issues of quality of service, investment cost and tariffs?

☐ In doing so, have the principles of “user pays”, polluter pays”, “equity” and “solidarity”been applied while formulating the cost recovery system?

☐ Has the need for tariff flexibility at local level been acknowledge, related to changing exchange, interest and inflation rates?

☐ Have investments been adapted to needs and resources of consumers, to obtain tariffs which are acceptable for consumers?

☐ Has the range of variation in tariffs been kept compatible with what society can afford?

☐ Are costs assigned to each level in the household-neighborhood-city hierarchy in accordance with benefits (to be) accrued at each level (solidarity among different stakeholders and service levels)?

☐ Are arrangements in place for adequate communication and information exchange among stakeholders?

☐ Are advocacy programmes formulated to achieve that users and polluters (often the same entity) will be willing and able to change their behavior?

☐ Are efficient revenue collection system in place, including capabilities and capacity to assess the right tariffs, to implement appropriate billing systems, and to enforce fines if needed?

☐ Are revenues allocated to the appropriate service provider, e.g. not just adding revenues to the national budget but setting up a special fund which is accountable and transparent in fund management?

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Wastewater causes serious environmental and human health problems, especially in coastal zones. There is no single solution to solve such problems, because of the large variation in economic, social, cultural, and physical characteristics in an area. This report gives practical guidance on how to plan locally appropriate and environmentally sound municipal wastewater management.

It is meant for:

- decision-makers involved at a strategic level;
- operational professionals in government institutions; and
- professionals in the private sector, development banks, and related organisations.

The report focuses on four elements, with their respective sets of management tools:

- approaches and policies, including demand-driven, opportunity-driven, and integrated management approaches (Chapter 1);
- institutional arrangements, including public participation and new partnerships with the private sector and water users (Chapter 2);
- technological options, including steps for choosing the most appropriate technology, and considering wastewater as a resource (Chapter 3);
- financing options, including private capital and public–private partnerships (Chapter 4).

Each of the four chapters is summarized at the end in the form of a practical checklist. The ten keys for action listed in this document form a red line through these guidelines.

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