REFERENCE PACK

Best Practice Resources for Mitigation of Environmental Impacts

SMALL-SCALE WATER PROJECTS

USAID/West Bank and Gaza Course in Environmental Assessment and Environmentally Sound Design for Small-Scale Activities

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Water supply and sanitation

Brief Description of the Sector

To remain healthy, human beings need an adequate supply of high-quality water throughout the year. Many debilitating or even fatal diseases are transmitted by the contamination of the water supply with human fecal matter containing disease-causing viruses, bacteria, and parasites. Unfortunately, over one-third of the world's population, nearly 2.5 billion people, have inadequate access to sanitation and over 1 billion people do not have access to enough safe water. These conditions, combined with poor hygiene, are largely responsible for the fact that 50 percent of the world's population suffers from debilitating diarrheal diseases (e.g., typhoid, cholera, dysentery)at any given time. Of those affected by such diarrhoeal diseases, three million die every year.

Overall, polluted water affects the health of 1.2 billion people every year, and contributes to the death of 15 million children under five every year. Vector-borne diseases, such as malaria, kill another 1.5 to 2.7 million people per year, with inadequate water management a key cause of such diseases. (*UNEP Global Environmental Outlook Report 2000*).

Disease and mortality are not the only consequences of polluted and scarce water. Less attention is paid to the fact that women and children bear much of the cost of dirty water and water shortages. Children are more likely to become ill, and women have to look after them. Women and girls carry out most water collection, and many spend hours doing so. Hours spent collecting water could be spent in more productive activity, such as food production or, especially in the case of children, education. As a result, there is a high opportunity cost to the lack of clean water. (When people are sick, they and their caregivers cannot carry out other tasks, so there are opportunity costs there as well.)

Significant international focus and investment during the "Water and Sanitation Decade" (1981-1990) brought water to 80% of the world's population and sanitation to 50%. During the 1990's no additional gains were made, and population growth led to an increase in the absolute numbers of people without safe water or sanitation. Water resources in general are poorly managed, especially in the developing world. For example, many urban areas lose more than 50% of distributed water through leaking pipes. Water and sanitation technology used in the developed world, such as extensive sewer systems and large wastewater treatment plants, are frequently too costly or impractical for developing countries, although this has not necessarily discouraged attempts to implement them. Rural populations and the rapidly growing peri-urban and urban poor are disproportionately underserved.

Since good sanitation and hygiene are key to preventing contamination and good sanitation facilities have little benefit if the water remains contaminated, water supply and sanitation projects have come to be viewed as interdependent. Implementing them at the same time leads to the greatest benefit and is now considered ideal. However, this approach is not yet widely practiced.

Over the past three decades, experience has shown that water and sanitation activities are most effective and sustainable when they adopt a participatory approach that acts in response to genuine demand, builds capacity for operation and maintenance and sharing of costs, involves community members directly in all key decisions, cultivates a sense of communal ownership of the project, and uses appropriate technology that can be maintained at the village level. Also important are educational and participatory efforts to change behavioral practices.

These guidelines are designed for application to a variety of rural and urban water supply and sanitation systems that PVOs and NGOs may help design or manage. Water supply technologies covered by these guidelines include:

- progress made in providing safe water supply and sanitation for all during the 1990s;
- pond and spring improvements, hand-dug wells, small diameter boreholes wells with hand pumps, roof rainwater catchments, small dams and seasonal impoundments;
- showers, clothes-washing basins, cattle troughs, spring-fed gravity feed water distribution systems;

- more complex water systems including well or surface water source pump, storage tank and distribution to standposts, individual yard taps or connections, extensions of existing urban water lines into unserved or under-served peri-urban zones.

Sanitation systems covered by this guideline include:

- individual latrines (VIP, composting, dehydrating, pour-flush);
- community latrines;
- small-scale septic and leach field systems;
- settled and simplified sewers;
- water stabilization ponds;
- constructed wetlands;
- water-borne sewage with disposal to surface waters.

Large-scale water projects are not considered here.

Potential Environmental Impacts of Development Programs in the Sector and Their Causes

Debilitating disease and death, loss of drinking water sources, increased costs.
Water supply and sanitation projects may cause increased incidents of infectious water borne diseases such as cholera, non-infectious disease such as arsenic poisoning, and water-enabled diseases such as malaria.

- Especially serious is the contamination of surface and groundwater supplies with infectious organisms from human excreta. Contamination may be caused by poorly designed, operated or maintained sanitation facilities, such as sanitation systems that transfer sewage to receiving waters without treatment, or pit latrines located in areas with high water tables.
- Infectious diseases may also be spread by improper use of wastewater to grow food crops.
- Failure to test new sources of water, especially groundwater, for possible natural or industrial chemical contaminants, such as arsenic or mercury, can have devastating consequences.

Overdrawing wells can alter groundwater flows or cause aquifers in coastal or island areas to experience salt-water intrusion, potentially leading to loss of drinking water sources locally or in down-stream or down-gradient locations. Finally, if water is treated for domestic or industrial use, chemical and biological contamination may lead to increased treatment costs.

All of these impacts may be present in both urban and rural areas. Increased population densities and the lack of facilities can increase the impact in peri-urban areas.

Native plants and animals harmed and associated land, water, and coastal ecosystems degraded. These adverse impacts from water supply and sanitation facilities most often arise from water diversion, construction or decommissioning activities in or near a watercourse, or fecal contamination of water. Numerous impacts on ecosystems are possible:

- Construction of facilities in sensitive areas (wetlands, estuaries, etc.) can destroy flora or fauna or their habitats, leading to loss of biodiversity, reduction of economic productivity and loss of aesthetics and recreational value.
- Water supply projects can also lead to depletion of fresh water and soil erosion from pipe leakage or poor drainage at taps. Associated soil erosion may cause sedimentation in receiving waters which may reduce the capacity of ponds and reservoirs, increase flooding, or substantially alter aquatic ecosystems by changing streambed, lakebed and estuary conditions. Increased consumption of water can reduce flows and cause loss of habitat, wetlands and wildlife downstream.

- Contamination of receiving waters with human excreta or animal manure can cause nutrient enrichment, depletion of dissolved oxygen and other changes that disturb natural ecosystems and reduce the vigor, abundance, and/or diversity of plants and animals that live either in the water or on land. Pathogenic microorganisms from excreta and manure may also contaminate fish or shellfish, creating health hazards.

Fresh-water resources depleted.
Depletion of water resources may occur by not adequately assessing the quantity of available surface and groundwater historically and seasonally. Other causes include poor mechanisms for regulating withdrawals and use, and insufficient monitoring and maintenance of leaks.

- Depletion of surface water sources destroys the resource itself, damages aquatic life, reduces economic productivity, diminishes downstream use, and reduces recreational possibilities.

- Exhaustion of groundwater can lead to land subsidence, altered groundwater flow in other locations, and loss of economic productivity. Both these situations increase the cost of future water supply systems. In addition, depletion of water resources may lead to poorer water quality, health impacts, and elevated costs of potable water supplies in downstream or down-gradient locations.

Increased disease transmission from standing, stagnant water.
Poor design, operation and/or maintenance of water supply improvements can lead to pools of stagnant water near water taps, water pipes and storage tanks. Improper or ineffective excreta and solid waste disposal practices exacerbate this problem. These pools form an excellent breeding place for disease vectors (mosquitoes that carry malaria, etc.). They can also increase transmission of water-related diseases, especially when the wet spots are clogged or contaminated with solid waste or excreta.

Adverse environmental impacts of water supply projects and their causes are summarized in Table 1.

Adverse environmental impacts of sanitation projects and their causes are summarized in Table 2.

Table 1: Potential Environmental Impacts of Water Supply Projects and Their Causes

Problems	Possible Impacts	Possible Causes
1. Depletion of fresh water resources (surface and groundwater)	Destruction of the natural resource Destruction of aquatic life Loss of economic productivity Loss of recreation areas Land subsidence Increased cost of water supplies in the future or in down-gradient locations	Overestimation of water supplies Underestimation of water demand Over-pumping of water resources Lack of information on resource yields Waste and leakage of potable water Poor water pricing policies and practices, leading to excessive use, wastage and leakage
2. Chemical degradation of the quality of potable water sources (surface and groundwater)	Concentration of pollution in surface water sources Salt water intrusion Poorer quality water, with associated health impacts Increased water treatment costs in the future or in down gradient locations	Depletion of surface and groundwater resources (see above) Reduced stream flows Runoff/drainage from improper solid and liquid waste or excreta disposal
3. Creation of stagnant (standing) water	Increased in vector-borne diseases Contamination of standing water with fecal matter, solid waste, etc, leading to health impacts Soil erosion/sedimentation	Lack of, or inadequately designed drainage systems Leakage from pipes/wastage from taps Lack of user/operator concern for stagnant water

4. Degradation of terrestrial, aquatic, and costal habitats	Alteration of ecosystem structure & function and loss of biodiversity Loss of economic productivity Loss of aesthetics Loss of recreational values Soil erosion/sedimentation	Improper siting of facilities (within wetlands or other sensitive habitats, etc) Poor construction practice Leakage/wastage from pipes and taps Increased population density/agricultural activity because of new water systems
5. Increased human health risks	Arsenic poisoning Mercury poisoning Other water-related infectious diseases	Failure to test water quality before developing the water resource Lack of on-going water quality monitoring Inadequate protection of wells and water supply points. Biological contamination from inadequate protection of wells and water supply points.

Source: Alan Wyatt, Hogrewe, William and Brantly, Eugene (1992). *Environmental Guidelines for PVOs and NGOs: Potable Water and Sanitation Projects,* Water and Sanitation for Health Project, USAID.

Table 2: Potential Environmental Impacts of Sanitation Projects and Their Causes

Problems	Possible Impacts	Possible Causes
1. Increased human health risks from contamination of surface water, groundwater, soil, and food by excreta, chemicals and pathogens	Increased disease transmission associated with excreta (diarrheal, parasitic, etc.) Malnutrition caused by above diseases High infant mortality Reduced economic productivity Poor quality surface and groundwater Health impacts associated with use of chemically contaminated water Increased cost of down-gradient water treatment for domestic and industrial uses	Failure to use sanitation facilities Disposal of excreta or wastewater directly on land or into surface water without adequate treatment Improper siting of sanitation facilities near water supplies Inadequate protection of groundwater Improper operation of sanitation facilities Failure of sanitation facilities due to lack of maintenance Improper use of wastewater in food production
2. Ecological harm from degradation of stream, lake, estuarine and marine water quality and degradation of terrestrial habitats	Health impacts associated with contact with contaminated water Fish or shellfish contamination Nutrient contamination (eutrophication) Alteration of ecosystem structure & function and loss of biodiversity Reduced economic productivity Soil erosion and sedimentation	Failure to use sanitation facilities Disposal of excreta or wastewater directly into sensitive areas without adequate treatment Improper operation of sanitation facilities Failure of sanitation facilities due to lack of maintenance Improper siting of facilities (within wetlands or other sensitive habitats, etc) Poor construction practice

Source: Alan Wyatt, Hogrewe, William and Brantly, Eugene (1992). *Environmental Guidelines for PVOs and NGOs: Potable Water and Sanitation Projects,* Water and Sanitation for Health Project, USAID.

Sector Program Design—Some Specific Guidance

As with other program and project development activities, potentially adverse environmental impacts need to be addressed early in the design process in order to avoid possible costly mistakes or project failure. Many adverse environmental, social and cultural impacts of water supply and sanitation projects occur when the improvement is not used, used improperly, not maintained, or if people do not adopt necessary complementary behaviors, such as hand washing after defecating. There are many lessons from water supply and sanitation projects over the past 30 years, a few of which are summarized below under best practices.

Best practices applicable to both water supply and sanitation projects

- **Take advantage of the experience of others**. Excellent and detailed guidelines, manuals, source books, and check lists exist which provide clear and concise guidance on developing water supply and sanitation projects. In most cases these are available electronically. A number of these resources, most with URLs, can be found in the Resources and References section at the end of these guidelines.
- **Concentrate first on preparing and developing the human component of the project** and use a demand-focused approach. Projects will be welcomed and supported by the local community only when they perceive a need. At a minimum, there must be commitment to cost-share in the operation and maintenance of systems prior to project development. Such commitment grows out of such genuine household level demand as does an interest in adopting hygienic behaviors.
- **A promotional program must accompany infrastructure development**. Community participation (discussed below) and joint understanding are essential. The focus on improved hygiene practices requires sensitivity to the community's cultural and social preferences. Realism must be applied in this process—it may take years for the community to adjust to new practices.

  Water supply and sanitation projects that fail to improve hygiene behavior generally show little or no improvement in public health. Reaching school children is often an effective strategy, but efforts to bring about behavior change must focus on all other family members as well. Sanitation practices for infants, and those of pre-school age children, the elderly, the sick, and the disabled, generally contribute more to the contamination of water supplies and transmission of disease than healthy adults.

  Understanding local hygiene behaviors and social-cultural beliefs that constrain options is an essential first step in design. For example, in some cultures sanitation facilities for men and women must be strictly segregated even at the family level, so that a single latrine per family is inadequate. In other cases there may be the belief forbidding defecation in roofed structures. Materials have been developed to help promote the adoption of better hygiene behaviors. See *Sanitation Promotion* (SimpsonHébert and Wood, 1998), *PHAST step-by-step guide: a participatory approach for the control of diarrhoeal disease* (Sawyer et al., 1998), and *Towards Better Programming: A Sanitation Handbook* (UNICEF, 1997), listed in the Resources and References section at the end of this guideline for descriptions and access information.

- **Use a participatory approach, including choice of technology,** that actively engages the community in all stages of the project, including planning and development of management systems, establishment of user fees, construction, operation and maintenance, and possible future decommissioning. This will lead to appropriate design, enhance adoption of new behaviors and help generate the levels of community commitment and support for proper maintenance of the project.

  An essential element of the participatory process is to give families and communities a selection of generally appropriate technology and design options to choose from, instead of beginning the project with a predetermined technology. Offer technology alternatives that can be operated and maintained locally/at the village level (VLOM). Confirm that spare parts and necessary expertise are readily available. The VLOM approach has not worked well in practice for communal hand pumps. If other options are preferred by the community these should be pursued.

- **Utilize some form of cost sharing**. When households share the cost of building latrines, overall costs drop, the sense of ownership and responsibility increases, usage is greater, and maintenance improves.
- **Integrate water supply, sanitation, and hygiene promotion**. If these elements are treated individually, the fecal-oral route of disease transmission will not be broken and public health benefits will be limited.

If it is not possible to implement an integrated program, the first priority should be to improve hygiene behavior and provide sanitation improvements; next on increasing water quantity, and last on infrastructure improvements for water quality. When programs are implemented independently, those that focus on improved sanitation, including the adoption of good hygiene behaviors, show the greatest reduction in disease transmission. Those focused exclusively on improving water quantity show the next best performance and those focused only on improved water quality have the least benefit.

- **Draw upon existing community organizations** instead of starting new ones.
- **Design the program so that it will be economically self-sustaining**. Generally, necessary features for economic sustainability include cost recovery mechanisms such as user fees, taxes or levies to finance operations, monitoring, maintenance and repairs, and a sustainable management structure for collecting these monies and overseeing their use.
- **Include a system for sustaining operation and maintenance** as part of overall program design. The failure to ensure on-going operation and maintenance is one of the most common causes of project failure. The system should include a mechanism for training local residents to operate, monitor, maintain, and repair the improvement and to maintain institutional memory, for example, maintaining a pool of community members trained in operation and maintenance.

Best practices for water supply projects

- **Calculate yield and extraction rates** in relation to other area water uses in order to avoid depletion of the resource or damage to aquatic ecosystems or communities down stream/down gradient. These calculations should take into account historic and projected upstream/up-gradient and downstream/down-gradient supply and demand for water, and for projects tapping groundwater, depth to water table and groundwater hydrology.

- **Design improvements with an appropriate scale and capacity**. Estimate current and projected water quantity and availability based on current water sources and preferences, baseline measurements on quantity of water available including seasonal fluctuations, current and historic use data (household, agricultural, and institutional), population data and forecasts, current and projected demand up and down stream/up and down gradient, and actual water use in similar projects conducted in the past. Data on typical water leakage rates in other existing water schemes should be examined. Demand projections should take into account the likelihood that the project will generate additionally users.

- **Assess water quality** to determine if water is safe to drink and to establish a baseline so that any future degradation can be detected. Ideally, for these purposes, tests should be performed on the chemical, biological, physical quality of the proposed water source. At a minimum arsenic and fecal coliform tests should be conducted. USAID requires testing for arsenic for all USAID-funded water supply projects as there is currently no way to determine which locations may contain natural arsenic deposits. (For international water quality standards on virtually any parameter see Guidelines for Drinking-Water Quality. Vols. 1 and 2 (1997). Geneva, WHO. http://www.who.int/water_sanitation_health/GDWQ/GWDWQindex.html).

- **Maintain periodic testing**. *On-going testing is the only way to determine if a water supply is or has become contaminated* (other than by observing dramatic and sustained increases in water-borne disease).

- **Minimize downstream/down-gradient effects of intervention**, perhaps by establishing some form of communication with downstream parties.

Best practices for sanitation projects

- **Develop a hygiene promotion strategy** that takes into account the current hygiene behavior of all users, including women, infants, children, the elderly and the infirm and any social/cultural religious factors that may hinder changing behavior.

- **Design improvements to match demand, user customs and preferences, climate, and abundance of water**.

- **Test water quality downstream/down gradient** of the proposed site (fecal coliform, total suspended solids (TSS), biological oxygen demand (BOD), and nutrients) before construction of infrastructure to set a baseline. Maintain on-going testing to monitor for contamination.
- **Minimize downstream/down-gradient effects of intervention**.
- **Consider appropriate natural treatment systems instead of mechanical systems**. These tend to be preferable for small-scale activities as they generally cost less, do not require highly skilled labor, and can frequently be manufactured locally. Also, supplies for maintenance and repair are likely to be more readily available. There are many proven natural treatment options. These include:

  Double vault batch composing toilets, double vault batch dry toilets, upflow anaerobic filters, biogas reactors, confined space constructed wetlands, subsurface wetlands, floating aquatic macrophytes and stabilization ponds.

Process for evaluating potential environmental impacts

Potential environmental impacts of a project should be evaluated after the PVO/NGO and community have defined the project's objective, the types and extent of services, and the types of facilities that will provide the desired services in a manner appropriate to the physical, social, and economic conditions of the community.

Appropriate options should have been identified for each "component" of the system. For a water supply system these would include the water source, storage facilities, the distribution system, and possibly treatment facilities. For a sanitation system they would include facilities for excreta, collecting, transporting, treating, and disposal or reuse of excreta or wastewater.

Once a set of appropriate options for the various components of the system has been defined, a PVO/NGO can evaluate the potential environmental impacts of each option and identify appropriate mitigation measures. See major section II for a more comprehensive summary of Concepts for Environmental Assessment.

Environmental Mitigation and Monitoring Issues

Table 3: Environmental Mitigation and Monitoring Issues for Water Supply and Sanitation Projects

Activity/ Technology	**Impact** *The activity or technology may. . .*	**Mitigation** *Note: Mitigations apply to specified project phase: Planning and design (P&D), Construction (C), or Operation and Maintenance (O&M)*
General		
Site selection (P&D)	Damage sensitive ecosystems or endangered species (P&D)	Survey for, and avoid, wetlands, estuaries or other ecologically sensitive sites in the project area. Identify nearby areas that contain endangered species and get professional assessment of sensitivity of species to construction at site (P&D)
Construction of buildings and structures (C)	Damage sensitive ecosystems or endangered species (C) Cause erosion and sedimentation (C) Cause excessive dust Cause excessive noise for workers and surrounding community	Follow guideline on Construction in this manual (P&D) (C) Train and monitor workers (P&D) (C) Gather data on soil type, slope and topography to determine the potential for significant erosion (P&D) Use silt screens, straw bales or similar erosion control measures (C) Avoid damaging vegetation (C) Revegetate areas damaged during construction. Do not remove erosion control measures until revegetation is complete (C) Use proper bedding materials for pipes (P&D) (C) Periodically water down dusty areas (C) Install and maintain mufflers on construction equipment Ensure workers follow proper health and safety guidelines for wearing hearing protection devices
Soakways and drainage structures	Cause erosion (O&M) Alter the natural flow of rainwater runoff (O&M) Create pools of stagnant water (O&M)	Use riprap (cobbled stone), gravel, or concrete as needed to prevent erosion of drainage structures (P&D) (C) Monitor and keep drains and soakways clear (O&M)

Water Supply Improvements		
Hand-dug wells, seasonal ponds, improved springs, ground level catchment and similar structures	Contaminate water with human pathogens (O&M) Contaminate water with animal manure (O&M) Create pools of stagnant water (O&M) Exhaust water supply (not applicable to improved springs or hand dug wells) (O&M)	Include focus on proper use and maintenance of improvement as part of behavior change and education program (P&D) Construct spigot or similar system that prevents people from touching impounded water with their hands or mouths (P&D) (C) Use fencing or equivalent that will keep live stock from grazing up-hill or up gradient of the water supply improvement (P&D) (C) Do not allow animals to drink directly from water source (O&M) Monitor drains and soakways and keep clear of debris (see entry on drains and soakways above for more detail) (O&M) Monitor and repair leaks from cracked containment structures, broken pipes, faulty valves and similar structures (O&M) Put in place a system for regulating use, such as a local warden or appropriate pricing (P&D) Provide training in operation to community (P&D) (O&M) Monitor water levels in wells or impoundment structures to detect overdrawing (O&M)
Wells	Contaminate water with nutrients and bacteria from animal waste (O&M) Create pools of stagnant water (O&M) Change groundwater flow (O&M) Create saltwater intrusions (O&M) Deplete aquifer (O&M) Cause land subsidence (impact from many wells) (O&M)	Do not allow animals to graze or be watered up-gradient of the well-head (P&D) (O&M) Monitor and repair leaks from cracked containment structures, broken pipes, faulty valves and similar structures (O&M) On islands and coastal areas, maintain withdrawals within safe yield limits to avoid overdrawing, possible salt water intrusion and contamination of the well (P&D) Put in place a system for regulating use, such as a local warden or appropriate pricing (P&D) Include focus on proper use and maintenance of improvement as part of behavior change and education program (O&M) Monitor water levels (O&M)
Standpipes	Create pools of stagnant water (O&M) (This problem can be more severe when water table is high, clay soils are present, or population/tap density is high)	Ensure spilled water and rainwater drain to a soakway or equivalent structure and do not accumulate and create stagnant standing water (C) Monitor and repair leaks from cracked containment structures, broken pipes,

		faulty valves and similar structures
Treatment systems		
Pit latrine	Increase transmission of vector borne diseases (O)	Devote adequate attention to identifying and addressing social barriers to use of latrine (P&D) Use the ventilated improved pit latrine design that traps insect vectors (P&D)
	Contaminate groundwater supply with pathogens (O)	Evaluate depth to water table, including seasonal fluctuations and groundwater hydrology. The size and composition of the unsaturated zone determine the residence time of effluent from the latrine, which is the key factor in removal, and elimination of pathogens. Pit latrines should not be installed where the water table is shallow or the composition of the overlying deposits make groundwater or an aquifer vulnerable to contamination (P&D)
	Contaminate water supplies, damage water quality and/or transmit disease at other locations if waste is not properly handled and treated during or after servicing (O)	Ensure that a reliable system for safely emptying latrines and transporting the collected material off-site for treatment is used. This should include use of a small pit-emptying machine such as the vacutug that relies on an engine driven vacuum pump. The vacutug was tested for UNCHS in low income areas of Nairobi, Kenya that afford workers much greater protection from disease than conventional methods. See Wegelin-Schuringa *Small Pit Emptying Machine an Appropriate Solution in Nairobi Slum* for more details) (O&M) Ensure that collected material is adequately treated and not directly applied to fields or otherwise disposed of improperly (O&M)
	Cause injury to people or animals	Properly decommission pit latrines. Do not leave pits open. Fill in unused capacity with rocks or soil.
Composting toilets	Increase transmission of vector borne diseases (O)	Maintain humidity of composting material above 60% and supplement excreta with generous quantities of carboniferous material (dry leaves, straw, etc.). The pile should then remain aerobic, odor free and insect free (O&M)
	Contaminate groundwater supply with pathogens (O)	Construct sealed vaults to hold composting material if using fixed batch systems. If using movable batch systems check removable containers for leaks before installing (O&M)
	Cause disease transmission to field workers and consumers of agricultural products (O)	Test samples from active chamber and mature chamber after fallow period for Ascaris eggs and fecal coliforms (O&M) Allow sufficient residence time in mature chamber. This may vary from 6 months warm climates to 18 months in cooler climates (O&M) Ensure that the systems will be properly operated and maintained so that the soil amendment taken out after the treatment period is truly sanitized (O&M)
Dry toilets	Increase transmission of vector-borne diseases (O) Cause disease transmission to field workers and consumers of	Maintain humidity of composting material below 20% and supplement excreta with alkaline material (ashes or lime). The pile should then remain both odor free and insect free. (O&M). Generous applications of ashes will help ensure

	agricultural products (O)	free and insect free (O&M). Generous applications of ashes will help ensure that pathogens are destroyed. pH is the most important factor for sterilization (O&M) Construct sealed vaults to hold dehydrating and curing material (C) Ensure that the systems will be properly operated and maintained so that the soil amendment taken out after the treatment period is truly sanitized (O&M) Test samples from active chamber and mature chamber after fallow period for Ascaris eggs and fecal coliforms to assess level of sterilization (O&M) Allow sufficient residence time in mature chamber. This may vary from 6 months warm climates to 18 months in cooler climates (O&M)
Septic tanks	Contaminate groundwater supply with pathogens (O&M) Contaminate surface water supplies with nutrients, biological oxygen demand (BOD), suspended solids (SS) and pathogens. (Septic tank effluent generally contains relatively high concentrations of pathogens, BOD, and SS) (O&M) Contaminate water supplies, damage water quality and/or transmit disease at other locations if waste is not properly handled and treated during or after servicing (O&M)	Evaluate depth to water table, including seasonal fluctuations and groundwater hydrology. If water table is too high line tank with clay, plastic sheeting or some other impermeable material to prevent leakage (P&D) (C) Avoid direct discharge of effluent to waterways if possible. Direct discharge to waterways with sufficient volume and flow to assimilate the waste may be acceptable. Addition of secondary treatment should be preferred such as passing effluent through an anaerobic filter followed by discharge to an absorption field or better yet a constructed wetland (P&D) Ensure that a reliable system for safely removing sludge and transporting the collected material off-site for treatment is available. This should include use of a mechanized, probably vacuum based, removal system (P&D) (O&M) Ensure that collected sludge is adequately treated and not directly applied to fields or otherwise improperly disposed of (See Sludge management below) (O&M)
Upflow anaerobic filters	Damage ecosystems and degrade surface water quality. Sludge contains high concentrations of nutrients, BOD, and solids (O&M) Cause disease transmission to field workers and consumers of agricultural products. (Sludge may still contain pathogens) (O&M)	Treat sludge before secondary use (see Sludge management below). Do not allow disposal in or near water bodies (O&M) Provide workers servicing, transporting, and otherwise exposed to sludge with appropriate protective clothing including at a minimum rubber gloves. Train workers to wash hands and faces frequently with soap and warm water and make both available. (See Wastewater and sludge use in agriculture and aquaculture below) (O&M)
Settled and simplified sewers	Damage ecosystems and degrade surface water quality (O&M) Cause disease transmission to field workers and consumers of agricultural products (O&M)	Ensure that collected sewage will be treated, e.g., in a wastewater stabilization pond, and not simply discharged to a river or stream or used directly in agriculture or aquaculture. This is especially important for simplified sewerage since there is no interceptor tank (P&D) (O&M)
Biogas reactors	Damage ecosystems and degrade surface water quality (O&M) Cause disease transmission to field workers and consumers of	Do not allow disposal of digested slurry in or near water bodies (O&M) Follow WHO, or other national or international guidelines for use of sludge in

	agricultural products (O&M)	wastewater in agriculture and aquaculture (see Sludge and wastewater reuse below) (P&D) (O&M)
Wastewater stabilization ponds (Anaerobic, Facultative, Aerobic)	Damage ecosystems and degrade surface water quality (O&M) Cause disease transmission to field workers and consumers of agricultural products (O&M)	Avoid discharging single (facultative) pond systems directly into receiving waters. If unavoidable construct hydrography controlled release lagoons that discharge effluent only when stream conditions are adequate. Install secondary treatment such as a constructed wetland, if possible (P&D) (C) (O&M) Use two or three or five pond systems if possible (anaerobic, facultative, (maturation)) (P&D) Allow only restricted uses for agriculture and aquaculture of effluent from all but five pond systems (O&M)
Reed Bed Filter	Contaminate ground or surface water (O&M)	Evaluate depth to water table, including seasonal fluctuations and groundwater hydrology. If water table is too high line tank with clay, plastic sheeting or some other impermeable material to prevent leakage (P&D) (C)
Subsurface Wetland	(See reed bed filter above)	
Free Water Surface Wetland Floating Aquatic Macropytes	Provide breeding ground for disease vectors (O&M) Introduce invasive non-native species (O&M)	Use plant and animal species that are native to the region. Avoid introducing water hyacinth, water milfoil, or salvinia, which have proven extremely invasive outside of their natural range (P&D) If using water hyacinth, maintain dissolved oxygen at 1.0 mg/L, frequently harvest and thin plants and or add mosquitofish (*Gambusia affinis*) to the wetland or use other plant species such as duckweed, water lettuce (*Pistia stratiotes*), water milfoil, or salvinia (*Salvinia spp.*) (O&M)
Slow-rate overland flow	Contaminate ground or surface water (O&M)	Use where growing season is year round. Requires vegetation (P&D) (O&M) Use only where soil textures are sandy loam to clay loam (P&D) (O&M) Use where groundwater is >3 ft. below surface (P&D) (O&M)
Slow-rate subsurface flow	Contaminate ground or surface water (O&M)	Use only where soil textures are sand to clayey loam (P&D) Use only where groundwater is >3 ft. below surface (P&D)
Rapid infiltration	Contaminate ground or surface water (O&M)	Use only where soil textures are sandy to loam (P&D) Use only where groundwater is >3 ft. below surface (P&D)
Sludge management	Damage ecosystems and degrade surface water quality (O&M) Cause disease in handlers and processors (O&M)	If possible, choose treatment technologies that do not generate sludge, such as wastewater stabilization ponds (P&D) Compost sludge then use as soil amendment for agriculture (O&M) Provide workers with appropriate protective clothing including rubber gloves, boots, long sleeved shirts and pants. Train workers to wash hands and faces frequently with soap and warm water and make both available (O&M)
Wastewater use in	Cause disease in field workers and consumers of agricultural	WHO guidelines recommend 1) treatment to reduce pathogen concentrations,

agriculture and aquaculture	products (O&M)	2) restriction of use to crops that will be cooked, 3) application methods that reduce contact with edible crops 4) minimization of workers, crop handlers, and field workers and consumers exposure to waste (P&D) (O&M) Wastewater used in aquaculture should have $<10^3$ fecal coliforms per 100 ml to minimize public health risk. (*See Guidelines for the safe use of wastewater and excreta in agriculture and aquaculture: Measures for Public Health Protection*, 1989, WHO, Geneva (P&D) (O&M) http://www.who.int/environmental_information/Information_resources/documents/wastreus.pdf

REFERENCES AND RESOURCES

General Resources

- *Sanitation Promotion* (1998). Mayling SimpsonHébert and Sara Wood, Eds. Water Supply and Sanitation Collaborative Council (WSSCC) Working Group on Promotion of Sanitation, Geneva, World Health Organization (WHO). http://whqlibdoc.who.int/hq/1998/WHO_EOS_98.5_pp1-140.pdf and http://whqlibdoc.who.int/hq/1998/WHO_EOS_98.5_pp141-277.pdf

  A valuable resource consisting of a number of short sections that can be used independently. A Checklists section (pp. 141-153) includes checklists for planning better sanitation projects, sanitation in emergency situations, hygiene behavior-change, and suggestions for addressing gender issues. Other sections focus on building political will and partnerships, and promotional programs including subsections on principles and guidelines, empowerment, checklists, and promotion through innovation.
- *DFID Guidance Manual on Water Supply and Sanitation Programmes* (1998). Department for International Development (DFID) of the United Kingdom. http://www.lboro.ac.uk/well/gm/contents.htm.

  An excellent general resource designed to assist DFID staff and partners in developing effective and sustainable water supply and sanitation programs. Comprising three chapters and appendices, it takes the reader from an overview of the sector, through specific development perspectives, to detailed recommendations for each stage of the project cycle.
- *PHAST step-by-step guide: a participatory approach for the control of diarrhoeal disease* (1998). R. Sawyer, M. Simpson-Hébert, S. Wood. Geneva, WHO.
  English: http://whqlibdoc.who.int/hq/1998/WHO_EOS_98.3.pdf; French: http://www.who.int/water_sanitation_health/Environmental_sanit/PHAST/phastf.htm
- *Operation and maintenance of rural water supply and sanitation systems: a training package for managers and planners* (2000). Prepared by François Brikké. WSSCC Operation and Maintenance Network and IRC International Water and Sanitation Centre, Geneva. http://www.who.int/water_sanitation_health/wss/O_M/Rural.htm
- *Towards Better Programming: A Sanitation Handbook* (1997). UNICEF Programme Division and USAID. Water, Environment and Sanitation Technical Guidelines Series No. 3, Environmental Health Project, New York. http://www.dec.org/pdf_docs/PNACB124.pdf
- *Sanitation for all* (2000). UNICEF. http://www.unicef.org/sanitation/sanitation.pdf.
  Good overview of key issues. Offers a short set of recommendations for better programming.
- *Community-Based Technologies for Domestic Wastewater Treatment and Reuse: options for urban agriculture.* (1999). G. D. Rose. International Development Research Centre (IDRC). http://www.idrc.ca/cfp/rep27_e.html.

  This document provides information on urban wastewater management. It specifically discusses issues involved in wastewater resource recovery, wastewater management, project planning and implementation. It also includes a good discussion of wastewater treatment technologies such as on-site treatment, anaerobic treatment systems, water-based treatments and sludge management.
- *PROSANEAR: People, Poverty And Pipes A Program Of Community Participation and Low-Cost Technology Bringing Water and Sanitation to Brazil's Urban Poor.* (1998). Y. Katakura and A. Bakalian. UNDP-World Bank Water and Sanitation Program. www.wsp.org/pdfs/working_prosanear.pdf.

  This report is a description of a water supply and sanitation project in the urban slums of Brazil. Includes participation strategies, design costs and listings of different technologies. A good discussion of solutions to specific urban problems, such as the condominial sewage system that created shared access to sewers for clusters of closely located houses.
- *Best Practice Sourcebook on Water, Sanitation, and Environmental Health* (2000). CARE (in press).

- *AQUA PLUS Guidelist: appropriate technology for water supply and sanitation in the developing countries.* UNICEF Supply Division. Can be ordered at http://www.irc.nllproducts/publications/descr/aqe.html. 997 pp. 91 euro.

  A catalogue of appropriate equipment, tools, and materials for water supply and sanitation projects in developing countries. Prepared in consultation with WHO, the World Bank and IRC. Targeted at UNICEF field staff and government technical staff at the central and local level.
- *Learning What Works A 20 year Retrospective View on International Water and Sanitation Cooperation* (1998). Maggie Black. World Bank. English:. http://www.wsp.org/English/lww.pdf: French: http://www.wsp.org/French/lww_fr.pdf: Spanish: http://www.wsp.org/Spanish/lww_sp.pdf; or contact the World Bank Water Help Desk (see Websites section below for contact information).

  A more detailed history of water supply and sanitation programs and lessons learned.
- *WHO guidelines for drinking water quality: training pack.* (2000). World Health Organization Protection of the Human Environment Geneva, WHO. http://saturn.who.ch/uhtbin/cgisirsi/K7nEEzh07Y/23602116/9
- *WELL Studies* (see Website section below for description of WELL).

  Practically oriented review of studies relating to water supply, sanitation, solid waste disposal studies and related issues in the developing world.

  See http://www.lboro.ac.uk/well/studies/contents.htm for links to full text of the following studies:

  - *Assessing demand for water supply and sanitation projects.* (2000). Sarah Parry-Jones. An exploration of the issues surrounding a demand responsive approach to water and sanitation service provision, with a discussion of the relative merits of the most commonly used demand assessment tools.
  - *Sanitation programmes revisited* (1999). Darren Saywell and Caroline Hunt. A comparative analysis of two notable African sanitation programs, focusing on an historical analysis (investigating how, when and why the programs developed in the way they did). and an understanding of critical issues common to each program, including demand assessment, sanitation promotion, community participation, responsibility for service provision, finance and cost recovery, and health aspects of promotion.
  - *Groundwater, latrines & health* (1999). Ben Cave and Peter Kolsky. A review of the risks to health posed by groundwater contamination from on-site sanitation. The study focuses on microbiological contamination because this is the most widespread and direct threat to health from on-site sanitation. The risks from nitrate contamination (the most frequent chemical contaminant of concern from pit latrines) are summarized in the report.
  - *Review of safety in construction & operation* (1999). Paul Larcher and M. Sohail. Review of safety in construction and operation for the water supply and sanitation sectors: *Part 2: literature review* (1999). M Sohail. A critical literature review of construction safety in developing countries, highlighting the most relevant and useful publications, and identifying possible areas for future work or research. The report is accompanied by a brief summary note for policy-makers and practitioners.
  - *Lessons learned from Village Level Operation and Maintenance (VLOM)* (1999). Jeremy Colin. A literature review of sector experience of the Village Level Operation and Maintenance Management (VLOM) approach to rural water supply.
  - *Private sector participation in the water and sanitation sector: Public-Private Partnership and the poor* (1999). Mike Webster and Kevin Sansom. A review of existing work examining the impact of Public-Private Partnerships (PPP) in the water and sanitation sectors on service delivery to the poor. Important gaps in current knowledge are also identified.
  - *Promoting change in environmental health behaviour* (1999). Ben Cave and Dr. Valerie Curtis. A literature review focusing on the potential effectiveness of approaches to environmental health promotion in developing countries, and appropriate expectations and targets for change in health behavior.

- *A review of policy and standards for wastewater reuse in agriculture: A Latin American perspective, (1999)* Ursula Blumenthal, Anne Peasey, Guillermo Ruiz-Palacios and Duncan Mara. This document aims to assist in the development of appropriate wastewater reuse policies, including the formation of guideline standards for effluent destined for agricultural irrigation and the implementation of health protection measures, including wastewater treatment, crop restriction, selection of irrigation technique and community intervention programmes.
- *Guidelines for wastewater reuse in agriculture and aquaculture: recommended revisions based on new research evidence* (1999). Ursula Blumenthal, Anne Peasey, Guillermo Ruiz-Palacios and Duncan Mara. The implications of the studies for the setting of international guidelines for the use of wastewater in agriculture and aquaculture are considered, along with the wastewater treatment and other health protection measures needed to achieve these guidelines.
- *Learning Lessons from Sector Studies* (2000). Paul Deverill. A synthesis of lessons learned from donor-funded programmes, in water supply, sanitation and environmental health. Reviews sector study reports in Uganda, Nigeria, Tanzania and Kenya.
- *Health aspects of dry sanitation with waste reuse* (2000). Anne Peasey. A review that collates current knowledge of health risks associated with dry sanitation technologies and the problems associated with their use and maintenance.
- *Provision of water & sanitation services to small towns* (2000). Jeremy Colin and Joy Morgan. This report describes and analyses the findings of rapid investigations in two small towns in Uganda and two in the Southern Indian state of Kerala.

Operation and maintenance, practical tools

- *Operation and maintenance of rural water supply and sanitation systems: a training package for managers and planners* (2000). Prepared by François Brikké. WSSCC Operation and Maintenance Network and IRC International Water and Sanitation Centre. Geneva. http://www.who.int/water_sanitation_health/wss/O_M/Rural.htm

  See http://www.who.int/water_sanitation_health/wss/o_m.html for links to the following guides:

  - *Selected Case Studies on Operation and Maintenance of Water Supply and Sanitation Systems.* These case studies describe different O&M experiences in a variety of countries in both rural and urban settings. They are a useful source of information for improving O&M practice.
  - *Tools for the Assessment of Operation and Maintenance Status of Urban and Rural Water Supply.* These comprehensive guidelines show how to assess O&M performance in both rural and urban areas.
  - *Operation and Maintenance of Urban Water Supply and Sanitation Systems: A Guide for Managers.* This publication examines factors, which may prevent existing urban water supply systems from working efficiently, and provides guidelines and solutions for optimization.
  - *Leakage Control: Source Material for a Training Package.* Materials trainers can adapt for use in local training courses, covering all aspects of leakage control, divided into individual modules for ease of use.
  - *Upgrading Water Treatment Plants (in preparation).* Summarizes many different field experiences with efforts to improve the quality of water and to upgrade the capacity of water treatment plants. It provides a practical approach to improving the performance of water treatment plants.
  - *Management of Operation and Maintenance in Rural Drinking-Water Supply and Sanitation: A Resource Training Package.* This package contains resource material for training courses aimed at improving the management of O&M in rural areas.
  - *Models of Management Systems for the Operation and Maintenance of Rural Water Supply and Sanitation Systems.* This document evaluates the factors, which influence the development of

O&M management systems for rural facilities. It describes models in eight representative countries and offers guidance to planners and designers in selecting the best approach.

- *Linking Technology Choice with Operation and Maintenance.* This document helps users make more appropriate technology choices by providing information on the O&M implications—particularly the costs—of selecting a specific technology.

Detailed Technical Resources

- *WELL Technical Briefs.* A selection of recommendations made by WELL, primarily in response to immediate technical assistance. Commonly asked questions and information of particular interest to water and environmental health practitioners, updated regularly. http://www.lboro.ac.uk/orgs/well/services/tecbriefs/contents.htm.

- *Engineering Theme W4 -Executive Summaries.* DFID. Covering topics including water supply, water treatment, sanitation, wastewater, drainage, project cycle, and others. http://www.lboro.ac.uk/well/themew4/contents.htm

- *Water For The World* (1982). USAID Development Information Center. A series of 160 Technical Notes covering all aspects of rural water supply and sanitation. Out of print but available on-line through Lifewater International. http://www.lifewater.org/wfw/wfwindex.htm

- *A Guide to the Development of On-Site Sanitation* (1992). R. Franceys et al. Geneva, WHO.

- *Standard Methods for the Examination of Water and Wastewater*, 20th ed. (1995). APHA. Washington, D.C.

- *Guidelines for Drinking-Water Quality.* Vols. 1 and 2 (1997). Geneva, WHO. http://www.who.int/water_sanitation_health/GDWQ/GWDWQindex.html

  Volume 1 sets out guideline values for a large number of water contaminants relevant to the quality of drinking water. The book also provides an explanation of how the guideline values should be applied, the criteria used in selecting the various chemical, physical, microbiological, and radiological contaminants considered, a description of the approaches used to derive the guideline values, and brief summary statements supporting the values recommended or explaining why no health-based guideline value is necessary at present.

  Volume 2 reviews and interprets the extensive toxicological, epidemiological, and clinical evidence that shaped the determination of guideline values for drinking-water quality. Organized to parallel and extend the coverage of Volume 1, which presented the recommended guideline values and brief summary statements supporting these values. This volume communicates the scientific rationale for individual recommendations based on a critical review of data linking health hazards to specific exposure levels. In so doing, it aims to establish an authoritative basis for national water-quality standards that are consistent with the goal of providing sufficient quantities of wholesome, safe drinking water. Well over 3000 references to the literature are included.

- *WHO Guidelines for Drinking-Water Quality. Volume 3, 2nd Ed.: Surveillance and Control of Community Water Supplies* (1997). Geneva, WHO. http://www.who.int/water_sanitation_health/GDWQ/pdF_docs/gdw3.pdf

  A comprehensive guide to all practical procedures and technical measures required to ensure the safety of drinking-water supplies in small communities and peri-urban areas of developing countries. Now in its second edition, the book has been vastly expanded in line with broadened appreciation for the many factors that influence water quality and determine its impact on health. Revisions and additions also reflect considerable new knowledge about the specific technical and social interventions that have the greatest chance of success in situations where resources are scarce and logistic problems are formidable.

- *Guidelines for the safe use of wastewater and excreta in agriculture and aquaculture: Measures for Public Health Protection* (Executive Summary) (1989). D. Maraand and S. Cairncross WHO, Geneva. http://www.who.int/environmental_information/Information_resources/documents/wastreus.pdf

- *Water quality assessments: a guide to the use of biota, sediments and water in environmental monitoring*, 2nd edition (1996). Deborah Chapman, Ed. Published on behalf of UNESCO, WHO and UNEP. E & FN Spon, London.

- *Multi-Stage Filtration: an innovative water treatment technology* (2000). Gerardo Galvis, Jorge Latorre, and Jan Teun Visscher. Technical Paper no. 34. IRC International Water and Sanitation Centre.

- *Cholera and Other Epidemic Diarrhoeal Diseases Control* (1996). Prepared by the Robens Institute, University of Surrey, UK. WHO, Geneva. http://whqlibdoc.who.int/hq/1996/WHO_EOS_96.4_1.p1-52.pdf

- *On-line bore-well and hand-pump installation tutorial.* Lifewater Canada. http://www.lifewater.ca/ndexdril.htm.

- *Tecnología Manual de Vaciado de Pozos Negros (Manual Pit Latrine Emptying Technology(MAPET)), Dar es Salaam (Tanzania)*, Habitiat, United Nations Best Practices Database. In Spanish: http://habitat.aq.upm.es/bpn/bp271.html

  The Manual Pit Latrine Emptying Technology (MAPET) is a neighbourhood based service for the emptying of pit latrines in Dar es Salaam, Tanzania. The service is carried out by independent, informal sector micro-enterprises (MAPET teams). The teams use MAPET equipment that is specifically developed to suit the technical, planning and economic conditions in the low income neighbourhoods.

- *Appropriate Solution Small Pit Emptying Machine an in Nairobi Slum*, Madeleen Wegelin-Schuringa. IRC International Water and Sanitation Centre, and Manus Coffey, Manus Coffey Associates (MCA) for UNCHS (Habitat). http://www.irc.nl/themes/sanitation/smallpit.html

  This article describes the results of the trial period of a pedestrian controlled pit emptying machine. The 'vacutug' has been tested for UNCHS (Habitat) in a low income settlement in Nairobi, Kenya through a local NGO. The trial confirmed the viability of the principle of the vacutug as the machine has been in operation for two and a half years. Repairs have been made locally out of income of the service, spare parts can be obtained and demand for the service is high.

Websites

- *Water Supply and Sanitation Collaborative Council.* http://www.wsscc.org/

- Water and Environmental Health at London and Loughborough (WELL). *http://www.lboro.ac.uk/well/index.htm*

  WELL offers technical expertise in response to specific requests from the British Government Department for International Development (DFID) staff and works closely with the Department's overseas partners. Well also supports development of technical manuals and guidance notes designed to reduce short and long-term problems through better documentation and dissemination of existing knowledge and understanding. WELL offers technical assistance and support to representatives of developing countries, UN agencies and UK non-governmental organizations.

- *The interWATER Guide to Organizations.* http://www.wsscc.org/interwater/organizations.html

  A resource provided by the International Water and Sanitation Centre. Provides the addresses of selected organizations concerned with water supply and sanitation in developing countries, organized

by country. The list includes organizations able to provide additional information in various forms, including newsletters, reports and publications, technical expertise, products, training courses, Internet sources, etc.

- *Water Supply and Sanitation Collaborative Council* (WSSCC) http://www.wsscc.org/index.html Established in 1990 at the end of the International Drinking Water Supply and Sanitation Decade. Its purpose is to maintain the momentum of the Decade, by providing a regular way for water and sanitation sector professionals to exchange views and experiences and develop approaches to foster more rapid achievement of the goal of universal coverage.

- *Vision 21: Water for People.* http://www.wsscc.org/vision21/wwf/index.html WSSCC's vision for solving the water supply and sanitation crisis. Brings together all of the approaches and insights to date. A roadmap for countries. Home page contains links to main document and supporting articles. A pilot program testing the vision recommendation is under implementation in the Indian state of Gujarat.

- *The International Training Network for Water and Waste Management* (ITN). http://www.wsp.org/English/itn.html A network of regional and international training institutions, launched in 1984 by the Water and Sanitation Program to support training in low-cost water supply and sanitation. ITN Centers provide training, disseminate information and promote local applied sector research on low-cost water supply and sanitation options. The Network links affiliated institutions serving Asia and Africa in Ouagadougou, Burkina Faso (serving countries in francophone West Africa); Kumasi, Ghana (Ghana); Harare, Zimbabwe (Zimbabwe); Nairobi, Kenya (Ethiopia, Kenya, Tanzania, and Uganda); Dhaka, Bangladesh; Calcutta, India (India); and Manila, Philippines (Philippines). New centers are under development.

- *The World Bank and the Water and Sanitation Program Help Desk.* Global contact information: http://www.worldbank.org/watsan or http://www.wsp.org/ Email: whelpdesk@worldbank.org; Washington, D.C. Telephone: 202-473-4761; Fax: 202-522-3228.

  Regional contact information. New Delhi, India Tel: (91-11) 4690488; Nairobi, Kenya Fax: (254-2) 260386.

  A 24-hour advisory service for global and regional requests in the water supply and sanitation sector.

Other References

- *Drinking Water and Disease: What Healthcare Providers Should Know* (2000). Physicians for Social Responsibility. Washington, DC. http://www.psr.org/dwprimer.pdf

- *Environmental Sanitation from Eco-Systems Approach* (1999). Steven Esrey and Ingvar Andersson. Vision 21. http://www.wsscc.org/vision21/docs/doc39.html

- *Household-centered Environmental Sanitation* (1999). Roland Schertenleib. Vision 21. http://www.wsscc.org/vision21/docs/doc09.html

  All Vision 21 Thematic Papers: http://www.wsscc.org/vision21/docs/index.html

- *Participation in the Water and Sanitation Sector.* World Bank Dissemination Note based on Environment Department Paper No.002. Written by Gabrielle Watson and N. Vijay Jagannathan as a contribution to the Participation Sourcebook. Copies of the full paper are available from the Environment Department, Social Policy and Resettlement Division, of the World Bank, Washington, D.C. 20433, Fax (202) 522-3247 http://www-esd.worldbank.org/html/esd/env/publicat/dnotes/dn150695.htm

- *WHO Catalogue 1991-2000.* http://www.who.int/dsa/cat98/zcon.htm See: http://www.who.int/dsa/cat95/zhow.htm for details regarding ordering WHO publications

- *Environmental Guidelines for PVOs and NGOs: Potable Water and Sanitation Projects* (1992). Alan Wyatt, Hogrewe, William and Brantly, Eugene. Water and Sanitation for Health Project, USAID.

  A guideline designed to assist PVOs and NGOs in identifying and mitigating environmental impacts of water supply and sanitation projects. The guideline outlines a process for conducting an environmental evaluation of proposed projects.

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Table 8.7. Irrigation and Drainage

Potential Negative Impacts	Mitigating Measures
Direct	
1. Soil erosion (furrow, surface).	1. • Proper design and layout of furrows or field avoiding too steep a gradient. • Land leveling. • Design of terraces on hillside minimizing surface erosion hazard.
2. Soil erosion (with sprinkler irrigation on hilly area).	2. Design of sprinkler system minimizing erosion hazard assuring infiltration rate exceeds application rate of the sprinklers.
3. Waterlogging of soils.	3. • Regulation of water application to avoid overwatering (including controlled turn-out to allow cutting off water supply to irrigation ditches). • Installation and maintenance of adequate drainage system. • Use of lined canals or pipes to prevent seepage. • Use of sprinkler or drip irrigation.
4. Salinization of soils.	4. • Measures to avoid waterlogging: • leaching of salts by flushing soils periodically • cultivation of crops with salinity tolerance

Table 8.7. Irrigation and Drainage (continued)

Potential Negative Impacts	Mitigating Measures
Direct (continued)	
5. Scouring of canals.	5. Design of canal system to minimize risk and use of lined canals.
6. Clogging of canals by sediments.	6. • Measures to minimize erosion on fields. • Design and management of canals to minimize sedimentation. • Provision of access to canals for removal of weeds and sediments.
7. Leaching of nutrients from soils.	7. • Avoidance of overwatering. • Replacement of nutrients by fertilizers or crop rotations.
8. Algal blooms and weed proliferation.	8. Reduction of input to and release of nutrients (nitrogen and phosphorous) from fields.
9. Clogging of canals by weeds.	9. • Design and management of canals to minimize weed growth. • Provision of access to canals for treatment or removal of weeds.
10. Deterioration of river water quality below irrigation project and contamination of local ground water (higher salinity, nutrients, agrochemicals) affecting fisheries and downstream users.	10. • Improved water management; improved agricultural practices and control of inputs (particularly biocides and chemical fertilizers). • Imposition of water quality criteria.

Table 8.7. Irrigation and Drainage (continued)

Potential Negative Impacts	Mitigating Measures
Direct (continued)	
11. Sea water intrusion into downstream freshwater systems.	11. • Reduction of takeoff to maintain adequate downstream flow. • Recharge of coastal aquifers through injection wells.
12. Reduction of downstream flows affecting flood plain use, flood plain ecology, riverine and estuarine fisheries, users of water, dilution of pollutants.	12. • Relocation or redesign of project. • Regulation of takeoff to mitigate effects. • Compensatory measures where possible.
13. Encroachment on swamps and other ecologically sensitive areas.	13. Siting of projects to avoid or minimize encroachment on critical areas.
14. Alteration or destruction of wildlife habitat or impediment to movement of wildlife.	14. • Siting of project to minimize loss or avoid encroachment on most sensitive or critical areas. • Establishment of compensatory parks or reserved areas. • Animal rescue and relocation. • Provision of corridors for movement.
15. Impediment to movement of livestock and humans.	15. Provision of passageways.

Table 8.7. Irrigation and Drainage (continued)

Potential Negative Impacts	Mitigating Measures
Direct (continued)	
16. Threat to historic, cultural or aesthetic features.	16. • Siting of project to prevent loss. • Salvage or protection of cultural sites.
17. Alteration or loss of flood plain vegetation and disturbance of coastal ecosystems (e.g., mangroves).	17. • Siting of project to less vulnerable area. • Limitation and regulation of water take-off to minimize problems to extent possible.
18. Dislocation of populations and communities.	18. • Siting of project to minimize effect. • Resettlement scheme ensuring at least equal standard of living.
19. Introduction or increase in incidence of water-borne or water-related disease (schistosomiasis, malaria, onchocerciasis, etc.).	19. • Prevention measures: • use of lined canals or pipes to discourage vectors • avoidance of stagnant or slowly moving water • use of straight or slightly curving canals • installation of gates at canal ends to allow complete flushing • filling or draining of borrow pits along canals and roads • disease prophylaxis • disease treatment

Table 8.7. Irrigation and Drainage (continued)

Potential Negative Impacts	Mitigating Measures
Direct (continued)	
20. Disease and health problems from use of wastewater in irrigation.	20. • Wastewater treatment (e.g., settling ponds) prior to use. • Establishment and enforcement standards for wastewater use.
21. Conflicts over water supply and inequalities in water distribution throughout service area.	21. Means to ensure equitable distribution among users and monitor to assure adherence.
22. Overpumping of groundwater.	22. Limitation of withdrawal so that it does not exceed "safe yield" (recharge rate).
Indirect	
23. Increased pollution and health hazards from downstream industrial and municipal pollutants caused by decreased flow (decreased dilution) of river water.	23. • Control of waste sources downstream. • Reduction of water take-off.
External	
24. Water quality deteriorated or made unusable by upstream land use and pollutants discharge.	24. • Control of land use in watershed areas. • Control of pollution sources. • Water treatment prior to use.

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Table 9.8. Wastewater Collection, Treatment, Reuse, and Disposal Systems

Potential Negative Impacts	Mitigating Measures
Direct	
1. Disturbance of stream channels, aquatic plant and animal habitat, and spawning and nursery areas during construction.	1. • Do not route sewer lines in stream channels. • Require erosion/sedimentation controls during construction.
2. Alterations in watershed hydrologic balance when wastewater is exported by collection in large upstream areas and discharge downstream.	2. • Consider sub-regional and small community systems in water-short areas. • Take full advantage of opportunities for wastewater reclamation/reuse, especially in water-short areas.
3. Degradation of neighborhoods or receiving water quality from sewer overflows, treatment works bypasses, or treatment process failure.	3. • Phase construction of collector systems and treatment works to avoid raw wastewater discharges. • Select appropriate technology. • Design for reliability, ease of maintenance. • Implement management and training recommendations, monitoring program, and industrial waste pretreatment program (see text for guidelines).
4. Degradation of receiving water quality despite normal system operation.	4. • Site and design treatment works and disposal or reuse systems on the basis of adequate data on the characteristics of the wastewater and the assimilative capacity of the receiving water body.

Table 9.8. Wastewater Collection, Treatment, Reuse, and Disposal Systems (continued)

Potential Negative Impacts	Mitigating Measures
Direct (continued)	
	• Use mathematical models for siting surface water discharges and determining required level of treatment, and for siting and designing ocean outfalls.
	• Take full advantage of appropriate land application alternatives, especially in water-short areas.
	• Implement monitoring program and industrial waste pre-treatment program (see text for guidelines).
5. Public health hazards in vicinity of discharges or reuse sites during normal operation of system.	5. • Select appropriate technology.
	• Ensure preapplication treatment and operating guidelines for land application and other water reuse systems are adequate to safeguard health of humans and livestock.
	• Restrict access to wastewater or sludge disposal sites where health hazards are unavoidable.
6. • Contamination at land application sites:	6. • Site and design treatment works and disposal or reuse systems on the basis of adequate data on the characteristics of the wastewater and land application site.
• soil and crops by toxic substances and pathogens • groundwater by toxic substances and nitrogen	• Implement monitoring program and effective industrial waste pretreatment program (see text for guidelines).
	• Ensure preapplication treatment and operating guidelines for land application and other wastewater reuse systems are adequate.

Table 9.8. Wastewater Collection, Treatment, Reuse, and Disposal Systems (continued)

Potential Negative Impacts	Mitigating Measures
Direct (continued)	
7. Failure to achieve desired beneficial uses of receiving waters despite normal system operation.	7. • Establish realistic use objective and select water quality criteria consistent with desired uses. • Establish system performance standards by modeling or other means which will result in meeting criteria.
8. Odors and noise from treatment process or sludge disposal operations.	8. • Site treatment works only near compatible land uses. • Select appropriate technology. • Include odor control and low-noise equipment in design. • Implement management and training recommendations (see text).
9. Emissions of volatile organic compounds from treatment process.	9. Establish effective industrial waste pretreatment program (see text for guidelines).
10. Soil, crop or groundwater contamination and disease vector breeding or feeding at sludge storage, reuse or disposal sites.	10. • Incorporate sludge management in system feasibility studies, technology selection, design, staffing, training, budgeting and start-up plan. • Implement effective industrial waste pretreatment program (see text for guidelines). • Ensure preapplication treatment and operating guidelines for land application and other reuse or disposal systems are adequate to safeguard health of humans and livestock. • Inspect for compliance with operating guidelines.

Table 9.8. Wastewater Collection, Treatment, Reuse, and Disposal Systems (continued)

Potential Negative Impacts	Mitigating Measures
Direct (continued)	
11. Worker accidents during construction and operation, especially in deep trenching operations.	11. Enforce adherence to safety procedures.
12. Worker accidents caused by gas accumulation in sewers and other confined spaces or by hazardous materials discharged into sewers.	12. • Emphasize safety education and training for system staff. • Implement effective industrial waste pretreatment program (see text for guidelines). • Provide appropriate safety equipment and monitoring instruments. • Enforce adherence to safety procedures.
13. Serious public and worker health hazard from chlorine accidents.	13. • Incorporate safety provisions in design, operating procedures, and training. • Prepare contingency plan for accident response.
14. Nuisances and public health hazard from sewer overflows and backups.	14. • Routinely inspect sewers for illegal connections and obstructions. • Clean sewers as necessary. • Provide monitoring system with alarms for pump station failure. • Provide alternate power supply at critical pump stations. • Educate public to prevent disposal of solid waste in sewers.

Table 9.8. Wastewater Collection, Treatment, Reuse, and Disposal Systems (continued)

Potential Negative Impacts	Mitigating Measures
Direct (continued)	
15. Failure to achieve public health improvement in serviced area.	15. Conduct sanitation and hygiene education program.
16. Dislocation of residents by plant siting.	16. Assist with resettlement (see "Involuntary Resettlement" section).
17. Perceived or actual nuisances and adverse aesthetic impacts in neighborhood of treatment works.	17. Incorporate neighborhood improvements and useful public facilities in project.
18. Accidental destruction of archaeological sites during excavation.	18. Include notification and protection procedures for cultural properties in construction contract documents (see "Cultural Property" section).
Indirect	
19. Unplanned development induced or facilitated by infrastructure.	19. • Coordinate installation of sewerage with land use planning. • Strengthen land use control regulations and institutions. • Integrate planning for infrastructure in urban development projects.
20. Regional solid waste management problems exacerbated by sludge.	20. • Incorporate sludge, excreta and septage in regional solid waste management planning and in wastewater system feasibility studies and technology selection. • Implement industrial waste pretreatment program.

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Table 9.8. Wastewater Collection, Treatment, Reuse, and Disposal Systems (continued)

Potential Negative Impacts	Mitigating Measures
Indirect (continued)	
21. Loss of fisheries productivity.	21. • Evaluate importance of receiving water in local and regional fisheries. • Implement mitigating measures for direct impacts 3, 4 and 7.
22. Reduction of tourist or recreational activity.	22. • Give special attention to real or perceived nuisances and aesthetic impacts in selecting site and technology. • Implement mitigating measures for direct impacts 3, 4, 5, 7, 8 and 14.

PART 1 OF THE SCOPING CHECKLIST: QUESTIONS ON PROJECT CHARACTERISTICS

No.	Questions to be considered in Scoping	Yes/No/?	Which Characteristics of the Project Environment could be affected and how?	Is the effect likely to be significant? Why?
1. Will construction, operation or decommissioning of the Project involve actions which will cause physical changes in the locality (topography, land use, changes in waterbodies, etc)?				
1.1	Permanent or temporary change in land use, landcover or topography including increases in intensity of land use?			
1.2	Clearance of existing land, vegetation and buildings?			
1.3	Creation of new land uses?			
1.4	Pre-construction investigations eg boreholes, soil testing?			
1.5	Construction works?			
1.6	Demolition works?			
1.7	Temporary sites used for construction works or housing of construction workers?			
1.8	Above ground buildings, structures or earthworks including linear structures, cut and fill or excavations?			
1.9	Underground works including mining or tunnelling?			
1.10	Reclamation works?			
1.11	Dredging?			
1.12	Coastal structures *eg* seawalls, piers?			
1.13	Offshore structures?			
1.14	Production and manufacturing processes?			
1.15	Facilities for storage of goods or materials?			
1.16	Facilities for treatment or disposal of solid wastes or liquid effluents?			
1.17	Facilities for long term housing of operational workers?			

No.	Questions to be considered in Scoping	Yes/No/?	Which Characteristics of the Project Environment could be affected and how?	Is the effect likely to be significant? Why?
1.18	New road, rail or sea traffic during construction or operation?			
1.19	New road, rail, air, waterborne or other transport infrastructure including new or altered routes and stations, ports, airports etc?			
1.20	Closure or diversion of existing transport routes or infrastructure leading to changes in traffic movements?			
1.21	New or diverted transmission lines or pipelines?			
1.22	Impoundment, damming, culverting, realignment or other changes to the hydrology of watercourses or aquifers?			
1.23	Stream crossings?			
1.24	Abstraction or transfers of water from ground or surface waters?			
1.25	Changes in waterbodies or the land surface affecting drainage or run-off?			
1.26	Transport of personnel or materials for construction, operation or decommissioning?			
1.27	Long term dismantling or decommissioning or restoration works?			
1.28	Ongoing activity during decommissioning which could have an impact on the environment?			
1.29	Influx of people to an area in either temporarily or permanently?			
1.30	Introduction of alien species?			
1.31	Loss of native species or genetic diversity?			
1.32	Any other actions?			
2. Will construction or operation of the Project use natural resources such as land, water, materials or energy, especially any resources which are non-renewable or in short supply?				
2.1	Land especially undeveloped or agricultural land?			
2.2	Water?			
2.3	Minerals?			

No.	Questions to be considered in Scoping	Yes/No/?	Which Characteristics of the Project Environment could be affected and how?	Is the effect likely to be significant? Why?
2.4	Aggregates?			
2.5	Forests and timber?			
2.6	Energy including electricity and fuels?			
2.7	Any other resources?			
3. Will the Project involve use, storage, transport, handling or production of substances or materials which could be harmful to human health or the environment or raise concerns about actual or perceived risks to human health?				
3.1	Will the project involve use of substances or materials which are hazardous or toxic to human health or the environment (flora, fauna, water supplies)?			
3.2	Will the project result in changes in occurrence of disease or affect disease vectors (eg insect or water borne diseases)?			
3.3	Will the project affect the welfare of people eg by changing living conditions?			
3.4	Are there especially vulnerable groups of people who could be affected by the project eg hospital patients, the elderly?			
3.5	Any other causes?			
4. Will the Project produce solid wastes during construction or operation or decommissioning?				
4.1	Spoil, overburden or mine wastes?			
4.2	Municipal waste (household and or commercial wastes)?			
4.3	Hazardous or toxic wastes (including radioactive wastes)?			
4.4	Other industrial process wastes?			
4.5	Surplus product?			
4.6	Sewage sludge or other sludges from effluent treatment?			
4.7	Construction or demolition wastes?			
4.8	Redundant machinery or equipment?			

No.	Questions to be considered in Scoping	Yes/No/?	Which Characteristics of the Project Environment could be affected and how?	Is the effect likely to be significant? Why?
4.9	Contaminated soils or other material?			
4.10	Agricultural wastes?			
4.11	Any other solid wastes?			
5. Will the Project release pollutants or any hazardous, toxic or noxious substances to air?				
5.1	Emissions from combustion of fossil fuels from stationary or mobile sources?			
5.2	Emissions from production processes?			
5.3	Emissions from materials handling including storage or transport?			
5.4	Emissions from construction activities including plant and equipment?			
5.5	Dust or odours from handling of materials including construction materials, sewage and waste?			
5.6	Emissions from incineration of waste?			
5.7	Emissions from burning of waste in open air (*eg* slash material, construction debris)?			
5.8	Emissions from any other sources?			
6. Will the Project cause noise and vibration or release of light, heat energy or electromagnetic radiation?				
6.1	From operation of equipment eg engines, ventilation plant, crushers?			
6.2	From industrial or similar processes?			
6.3	From construction or demolition?			
6.4	From blasting or piling?			
6.5	From construction or operational traffic?			
6.6	From lighting or cooling systems?			

No.	Questions to be considered in Scoping	Yes/No/?	Which Characteristics of the Project Environment could be affected and how?	Is the effect likely to be significant? Why?
6.7	From sources of electromagnetic radiation (consider effects on nearby sensitive equipment as well as people)?			
6.8	From any other sources?			
7. Will the Project lead to risks of contamination of land or water from releases of pollutants onto the ground or into sewers, surface waters, groundwater, coastal waters or the sea?				
7.1	From handling, storage, use or spillage of hazardous or toxic materials?			
7.2	From discharge of sewage or other effluents (whether treated or untreated) to water or the land?			
7.3	By deposition of pollutants emitted to air, onto the land or into water?			
7.4	From any other sources?			
7.5	Is there a risk of long term build up of pollutants in the environment from these sources?			
8. Will there be any risk of accidents during construction or operation of the Project which could affect human health or the environment?				
8.1	From explosions, spillages, fires etc from storage, handling, use or production of hazardous or toxic substances?			
8.2	From events beyond the limits of normal environmental protection eg failure of pollution control systems?			
8.3	From any other causes?			
8.4	Could the project be affected by natural disasters causing environmental damage (*eg* floods, earthquakes, landslip, *etc*)?			
9. Will the Project result in social changes, for example, in demography, traditional lifestyles, employment?				
9.1	Changes in population size, age, structure, social groups *etc*?			
9.2	By resettlement of people or demolition of homes or communities or community facilities eg schools, hospitals, social facilities?			
9.3	Through in-migration of new residents or creation of new communities?			
9.4	By placing increased demands on local facilities or services eg housing, education, health?			
9.5	By creating jobs during construction or operation or causing the loss of jobs with effects on unemployment and the economy?			
9.6	Any other causes?			

No.	Questions to be considered in Scoping	Yes/No/?	Which Characteristics of the Project Environment could be affected and how?	Is the effect likely to be significant? Why?
Question - Are there any other factors which should be considered such as consequential development which could lead to environmental effects or the potential for cumulative impacts with other existing or planned activities in the locality?				
9.1	Will the project lead to pressure for consequential development which could have significant impact on the environment eg more housing, new roads, new supporting industries or utilities, etc?			
9.2	Will the project lead to development of supporting facilities, ancillary development or development stimulated by the project which could have impact on the environment eg: • supporting infrastructure (roads, power supply, waste or waste water treatment, etc) • housing development • extractive industries • supply industries • other?			
9.3	Will the project lead to after-use of the site which could have an impact on the environment?			
9.4	Will the project set a precedent for later developments?			
9.5	Will the project have cumulative effects due to proximity to other existing or planned projects with similar effects?			

PART 2 OF THE SCOPING CHECKLIST: CHARACTERISTICS OF THE PROJECT ENVIRONMENT

For each project characteristic identified in Part consider whether any of the following environmental components could be affected.

Question - Are there features of the local environment on or around the Project location which could be affected by the Project?
• Areas which are protected under international or national or local legislation for their ecological, landscape, cultural or other value, which could be affected by the project?
• Other areas which are important or sensitive for reasons of their ecology e.g.
  • Wetlands,
  • Watercourses or other waterbodies,
  • the coastal zone,
  • mountains,
  • forests or woodlands
• Areas used by protected, important or sensitive species of fauna or flora e.g. for breeding, nesting, foraging, resting, overwintering, migration, which could be affected by the project?
• Inland, coastal, marine or underground waters?
• Areas or features of high landscape or scenic value?
• Routes or facilities used by the public for access to recreation or other facilities?
• Transport routes which are susceptible to congestion or which cause environmental problems?
• Areas or features of historic or cultural importance?

Question - Is the Project in a location where it is likely to be highly visible to many people?
Question - Is the Project located in a previously undeveloped area where there will be loss of greenfield land?
Question - Are there existing land uses on or around the Project location which could be affected by the Project? For example: • Homes, gardens, other private property, • Industry, • Commerce, • Recreation, • public open space, • community facilities, • agriculture, • forestry, • tourism, • mining or quarrying
Question - Are there any plans for future land uses on or around the location which could be affected by the Project?
Question - Are there any areas on or around the location which are densely populated or built-up, which could be affected by the Project?
Question - Are there any areas on or around the location which are occupied by sensitive land uses which could be affected by the Project? • hospitals, • schools, • places of worship, • community facilities
Question - Are there any areas on or around the location which contain important, high quality or scarce resources which could be affected by the Project? For example: • groundwater resources, • surface waters, • forestry, • agriculture, • fisheries, • tourism, • minerals.
Question - Are there any areas on or around the location of the Project which are already subject to pollution or environmental damage e.g. where existing legal environmental standards are exceeded, which could be affected by the project?

Question - Is the Project location susceptible to earthquakes, subsidence, landslides, erosion, flooding or extreme or adverse climatic conditions e.g. temperature inversions, fogs, severe winds, which could cause the project to present environmental problems?
Question - Is the Project likely to affect the physical condition of any environmental media? • The atmospheric environment including microclimate and local and larger scale climatic conditions? • Water - eg quantities, flows or levels of rivers, lakes, groundwater. Estuaries, coastal waters or the sea? • Soils - eg quantities, depths, humidity, stability or erdodibility of soils? • Geological and ground conditions?
Question - Are releases from the Project likely to have effects on the quality of any environmental media? • Local air quality? • Global air quality including climate change and ozone depletion • Water quality – rivers, lakes, groundwater. Estuaries, coastal waters or the sea? • Nutrient status and eutrophication of waters? • Acidification of soils or waters? • Soils • Noise? • Temperature, light or electromagnetic radiation including electrical interference? • Productivity of natural or agricultural systems?
Question - Is the Project likely to affect the availability or scarcity of any resources either locally or globally? • Fossil fuels? • Water? • Minerals and aggregates? • Timber? • Other non-renewable resources? • Infrastructure capacity in the locality - water, sewerage, power generation and transmission, telecommunications, waste disposal roads, rail?
Question - Is the Project likely to affect human or community health or welfare? • The quality or toxicity of air, water, foodstuffs and other products consumed by humans? • Morbidity or mortality of individuals, communities or populations by exposure to pollution? • Occurrence or distribution of disease vectors including insects? • Vulnerability of individuals, communities or populations to disease? • Individuals' sense of personal security? • Community cohesion and identity? • Cultural identity and associations? • Minority rights? • Housing conditions? • Employment and quality of employment? • Economic conditions? • Social institutions?

CHECKLIST OF CRITERIA FOR EVALUATING THE SIGNIFICANCE OF IMPACTS

Instructions for Scoping

This checklist is designed to help users decide whether or not an impact is likely to be significant and is to be used in conjunction with the Scoping Checklist.

The Scoping Checklist provides a list of questions to help identify where there is the potential for interactions between a project and its environment. This checklist is designed to help decide whether those interactions - effects - are likely to be significant.

Those responsible for scoping often find difficulties in defining what is "significant". A useful simple check is to ask whether the effect is one that ought to be considered and to have an influence on the development consent decision. At the early stages of a project there is likely to be little information on which to base this decision but the following list of questions may be helpful.

The questions to be asked are the same as in Screening but at the Scoping stage it is important to provide as much information as possible on why the effect is considered likely to be significant, rather than a simple "yes/no" answer.

Questions to be Considered

1. Will there be a large change in environmental conditions?
2. Will new features be out-of-scale with the existing environment?
3. Will the effect be unusual in the area or particularly complex?
4. Will the effect extend over a large area?
5. Will there be any potential for transfrontier impact?
6. Will many people be affected?
7. Will many receptors of other types (fauna and flora, businesses, facilities) be affected?
8. Will valuable or scarce features or resources be affected?
9. Is there a risk that environmental standards will be breached?
10. Is there a risk that protected sites, areas, features will be affected?
11. Is there a high probability of the effect occurring?
12. Will the effect continue for a long time?
13. Will the effect be permanent rather than temporary?
14. Will the impact be continuous rather than intermittent?
15. If it is intermittent will it be frequent rather than rare?
16. Will the impact be irreversible?
17. Will it be difficult to avoid, or reduce or repair or compensate for the effect?

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Checklist for Rural and Urban Water Supply and Sanitation Projects

Aspects of EIA	Checklist Questions Will the project:		Yes	No	Additional Data needs
Sources of Impacts	1.	Require the acquisition or conversion of significant areas of land for reservoir/treatment works etc. (e.g. > 50 ha rural, > 5 ha urban)?	☐	☐	☐
	2.	Result in significant quantities of eroded material, effluent or solid wastes?	☐	☐	☐
	3.	Require significant accommodation or service amenities to support the workforce during construction (eg > 100 manual workers)?	☐	☐	☐
Receptors of Impacts	4.	Flood or otherwise affect areas which support conservation worthy terrestrial or aquatic ecosystems, flora or fauna (eg protected areas, wilderness areas, forest reserves, critical habitats, endangered species); or that contain sites of historical or cultural importance?	☐	☐	☐
	5.	Flood or otherwise affect areas which will affect the livelihoods of local people (eg require population resettlement; affect local industry, agriculture, livestock or fish stocks; reduce the availability of natural resource goods and services)?	☐	☐	☐
	6.	Involve siting sanitation treatment facilities close to human settlements (particularly where locations are susceptible to flooding)?	☐	☐	☐
	7.	Affect sources of water extraction?	☐	☐	☐
Environmental Impacts	8.	Cause a noticeable permanent or seasonal reduction in the volume of ground or surface water supply?	☐	☐	☐
	9.	Present a significant pollution risk through liquid or solid wastes to humans, sources of water extraction, conservation worthy aquatic ecosystems and species, or commercial fish stocks?	☐	☐	☐
	10.	Change the local hydrology of surface water-bodies (eg streams, rivers, lakes) such that conservation-worthy or commercially significant fish stocks are affected?	☐	☐	☐
	11.	Increase the risk of diseases in areas of high population density (eg onchocerciasis, filariasis, malaria, hepatitis, gastrointestinal diseases)?	☐	☐	☐
	12.	Induce secondary development, eg along access roads, or in the form of entrepreneurial services for construction and operational activities?	☐	☐	☐
Mitigation Measures	13.	Be likely to require mitigation measures that may result in the project being financially or socially unacceptable?	☐	☐	☐
Comments					
		I recommend that the programme be assigned to Category	☐		
		Signature: Delegation.....Desk.....			

Source: Directorate-General for Development Commission of the European Communities, 1993

Checklist for Irrigation Projects

Aspects of EIA	Checklist Questions Will the project:	Yes	No	Additional Data needs
Sources of Impacts	1. Require the conversion of significantly large areas of land (eg > 250 hectares)?	☐	☐	☐
	2. Require the construction of a supply reservoir, or require the significant extraction of surface or ground water supplies (eg > 100 ha of irrigated land from surface waters, > 200 ha from groundwater)?	☐	☐	☐
	3. Require the mechanised clearing or levelling of a significant area of land (eg > 50 ha)?	☐	☐	☐
	4. Require a significant increase in the use of fertilisers or pesticides (significance dependent upon the nature of crop, chemical type, application volumes/rates, users' experience)?	☐	☐	☐
Receptors of Impacts	5. Conflict with downstream extraction of water for agriculture/irrigation or human settlement; or with the utilisation of surface water-bodies (eg rivers, lakes, freshwater lagoons) by conservation-worthy aquatic ecosystems and species or commercially significant fish?	☐	☐	☐
	6. Conflict with the downstream wastewater absorption capacities of surface water-bodies?	☐	☐	☐
Environmental Impacts	7. Lead to an increase in the incidence of water-borne or water- related diseases (dependent upon incidence of disease vectors, irrigation management practices, proximity to settlement etc.) ?	☐	☐	☐
	8. Lead to significant waterlogging or salinisation of soils (significance dependent upon soil type, crop tolerance, management practices, drainage capacity)?	☐	☐	☐
	9. Cause people to alter greatly the method by which they sustain their livelihood?	☐	☐	☐
Mitigation Measures	10. Require significant extension services and training to establish or sustain the project (eg long-term > 2 years, intensive training and regulation of water extraction and use, agro-chemical inputs, wastewaters, pests and diseases)?	☐	☐	☐
	11. Be likely to require mitigation measures that are on a financial scale such that the programme or project may be impeded?	☐	☐	☐
Comments				
	I recommend that the programme be assigned to Category	☐		
	Signature: Delegation.....Desk.....			

Source: Directorate-General for Development Commission of the European Communities, 1993

Assessment Matrix: Wasterwater Disposal

	Environmental Effects / Development	Treatment	Disposal - Land	Disposal - Marine Water
BIOLOGICAL ENVIRONMENT	Forest			
	Shrubland			
	Grassland			
	Herbfield (alpine)			
	Sand/shingle/rock			
	Cropland			
	Urban land			
	Lakes			
	Rivers			
	Estuaries			
	Inter-tidal			
	Marine			
	Wetlands			
PHYSICAL ENVIRONMENT	River regime			
	Erosion/land stability			
	Sedimentation			
	Surface water			
	Ground water			
	Agricultural soil			
	Foundation materials			
	Climate/atmosphere			
	Nuisance (noise, dust, smell)			
	Landform			
SOCIAL ENVIRONMENT	Public participation			
	Employment			
	Settlement			
	Land value			
	Existing land uses			
	Risks and anxieties			
	Personal and social values			
	Historical/cultural			
	Landscape/visual			
	Recreation			

Treatment	Disposal - Land	Disposal - Marine Water
Comminution	Rapid infiltration	Estuary
Sedimentation	Surface flooding	Inshore marine
Milliscreening	Spray irrigation	Offshore marine
Oxidation ponds	Disposal - Inland Water	Deep well injection
Activated sludge	River	
Trickling filter	Lake	
Nutrient removal		
Chlorination		
Further treatment offsite		

Source: Institution of Engineers Australia 1989

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6. Domestic Water Supply and Sanitation Checklist

1. Does a new source of water need to be developed or can the communities' water requirements be met by upgrading and renovating existing systems (e.g., by deepening and cleaning existing wells; reducing water losses due to evaporation and seepage)?

2. a) Is the yield of the proposed water source adequate for the anticipated demand[9]?
   b) Has this been assessed for the dry period?

3. Have water conservation measures been incorporated into the project design, such as:

   a) the use of appropriate valves and reduction pipes to constrain flow and minimize loss at the various works?
   b) a reforestation/revegetation program to increase the water-retaining ability of the soil and minimize surface water runoff?
   c) an education program to ensure the proper care of newly planted young trees (i.e., watering, protection from grazing, etc.)?
   d) construction of sand reservoirs, as opposed to open reservoirs, in arid regions?
   e) water recycling education?
   f) agricultural practices that maximize soil moisture conservation (e.g., mulching, terracing and contour-strip cropping, maintaining soil cover, etc.)?

4. Will the improved access to water resources result in any changes in the population size or the group using the water source (such as immigration from another community or use by nomadic pastoralists)?

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[9] Also considering the long-term capacity given population growth and pressure on water resources for multiple use (such as livestock and crop watering).

5. If an increase in user number is anticipated:

   a) can the water supply support the increased demand[10]?
   b) will there be increased pressure on local infrastructure (such as housing, schooling, health care, etc.)?
   c) will there be increased pressure on local natural resources (such as fuelwood, soils, vegetation including pastures and forests)?
   d) have the politics of water user rights and priorities been addressed?

6. How will the community (especially women as the primary users) be involved in:

   a) the planning and identification of potential water sources?
   b) the site selection for wells, handpumps, water piping routes, and other water supply works?
   c) the construction and installation of wells, drains, handpumps, and other water supply works?

7. How will a local community maintenance and repair committee be established for the various water supply facilities?

8. How will the community make decisions regarding water consumption patterns, costs, policing, and maintenance of the utilities?

9. Can wells, handpumps, and water works be repaired and/or made locally?

10. Will there be any loud, continuous noises (such as the loud "clunk" of a hydraulic ram) near residential areas as a result of the water supply development?

11. Will the water quality be tested to ensure that it is both safe and desirable for the community for its various uses[11]?

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[10] Also considering the long-term capacity given population growth and pressure on water resources for multiple use (such as livestock and crop watering).

[11] For example, measurements of fecal coliform concentrations, turbidity, smell, and taste for drinking water.

12. If necessary, will measures be taken to improve the quality of the supplied drinking water to decrease the incidence of certain water-related diseases and/or to make it acceptable to the community[12]?

13. Will steps be taken to minimize the seepage of contaminated water back into the well by:

    a) lining the well and extending the casing above ground level?
    b) packing layers of clay around the casing?
    c) surrounding the well with sloping aprons with drainage furrows?
    d) covering the well?
    e) installing a handpump or a permanently attached bucket to withdraw water?

14. Will steps be taken to avoid contamination of the water sources or transported water by:

    a) fencing off water sources (springs, streams, wells, reservoirs) to keep livestock and people away?
    b) providing a separate drinking area for animals and piping water from the source to the trough area?
    c) providing a separate area for bathing and laundering away from the source?
    d) covering conduits and reservoirs?
    e) burying pipes when possible to protect them from breakage?
    f) locating latrines away from the water source?
    g) checking pipes and tanks regularly for cracks and leaks?

15. Will the following factors be considered during the design, site selection, and development of a water source:

    a) avoiding close proximity to latrines or traditional defecating areas?
    b) avoiding close proximity to animal pens?
    c) local cultures, customs, and beliefs?
    d) depth of water table[13]?

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[12] For example, by using sedimentation tanks, slow sand filtration systems at the tap, chlorination.

[13] Avoid digging wells in areas where the water table rises to 1 m below ground surface to avoid surface water pollution of source.

16. How will puddles around wells, cisterns, standing pipes, and other potential breeding sites for disease vectors, such as mosquitos and snails, be adequately minimized (e.g., provide adequate drainage around wells and spring outlets; cover water storage devices; etc.)?

17. If a rain water catchment system for drinking water is planned:

    a) what steps will be taken to minimize the contamination of collected rain water by algae, disease-carrying pests, and dirt[14]?
    b) is the community already suffering from mineral-deficiency illnesses and should a health program addressing supplemental sources of minerals be included?

18. Will the project be coupled with a sanitation program?

19. Does the community want the sanitation facilities?

20. How will the community be involved in planning, designing, and siting the sanitation facilities to ensure they are compatible with local needs, customs, and beliefs?

21. Can the latrines and other sanitation facilities be made and repaired locally?

22. How will a local community maintenance and repair committee be established for the various sanitation facilities?

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[14] For example, by covering tanks with something opaque to prevent sunshine, dirt, and pests from entering; screening overflow and entry pipes; allowing the first 10-20 litres to bypass the holding tank; and frequently cleaning gutters and tanks.

23. Has the most appropriate excreta disposal technology for the community been selected so that it will:

    a) minimize odours and not attract flies or animals (e.g., using ventilation pipes, tank covers, screens, water seals)?
    b) minimize contamination of the surrounding water and soil (e.g., proper siting of facilities with adequate spacing between, proper septic tank design and maintenance, use of composting techniques)?
    c) be safe for children and adults to use (squatting or sitting holes and pit designs not dangerous or frightening to children)?
    d) not introduce harmful chemicals to the environment (e.g., toxic formaldehyde which is used in many chemical toilets)?
    e) minimize human contact with raw wastes?
    f) render wastes harmless of pathogenic organisms and be useful as agricultural fertilizer (through composting techniques)?
    g) minimize the use of water in arid regions?

24. Has a hygiene education program for the whole community, especially women and children, been incorporated into the project? Does this program include the following objectives:

    a) training in maintenance and repair of wells, handpumps, standpipes, drains, latrines, and other facilities?
    b) education in personal hygiene, water contamination prevention both in the home and at the source?
    c) training children in personal hygiene and where to defecate?
    d) relationships between human and animal excreta disposal, water, and disease?

25. If the water supply will be frequented by nomads and other non-residents, will:

    a) they be included in the health and hygiene education program?
    b) strategies for the prevention of overgrazing around the water source be addressed[15]?

[15] Such as herding strategies (age, sex, and species composition of herds); timing of grazing based on life cycle of vegetation; penning animals; etc.

26. If routing a water distribution system, drilling wells, or other activity will involve the removal of vegetation on slopes or other erosion susceptible areas, what measures will be taken to minimize:

    a) disturbance to vegetation?
    b) surface runoff and soil erosion during and after construction[16]?

27. How will a monitoring program be incorporated into the project that would:

    a) involve the local community from inception to implementation?
    b) successfully identify environmental impacts as they occur both during the project set-up and after the development team has left the site?

28. After comparing the project activities with the questions above, have areas been identified in which negative environmental impacts are likely to occur? If this is the case, which mitigating measures have been proposed to minimize or eliminate these negative impacts?

NOTE: If the project involves a *dam/reservoir* and/or *irrigation* component, please consult one or both of the following:

"Environmental Screening of NGO Development Projects: ***Small Dams/Reservoirs***"

"Environmental Screening of NGO Development Projects: ***Irrigation***"

[16] For example, by selecting routes and equipment that minimize disturbance; using check dams, culverts, water interception ditches, and levees; revegetating slopes after installation.

6. Irrigation Checklist

1. Will the following information be used to determine the irrigation water requirements[7]:

   a) rainfall data (when and how much) of the area[8]?
   b) the size of the area to be irrigated?
   c) soil type?
   d) soil infiltration and percolation rates?
   e) water retention capacity of the soil?
   f) crop water requirements?
   g) evapotranspiration rates[9]?

2. Does a new source of water need to be developed or can the irrigation water requirements be met by upgrading or renovating existing systems[10]?

3. Have water and soil conservation measures been incorporated into the project design, such as:

   a) minimizing water losses due to evaporation and seepage[11]?
   b) re/afforestation and revegetation of the watershed to improve the water-retaining ability of the soil and to minimize surface water runoff?
   c) an education program to ensure proper care of newly planted young trees (watering, protection from grazing, etc.)?
   d) use of agricultural practices that would maximize soil moisture conservation (such as contour plowing, terracing, mulching, maintaining soil cover, etc.)?

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7 See attached "Suggested Readings" list for references that describe how to measure or obtain this information.

8 Preferably from the last 5 years or more, including information on drought patterns.

9 Water lost via evaporation from the soil and by plants.

10 Such as by cleaning and deepening canals; installing proper drainage; rerouting channels; reducing water losses due to evaporation and seepage; and rejuvenating wells.

11 Such as making deeper and narrower ditches and canals; lining canals and ditches; enclosing transported water in pipes or covered canals.

e) appropriate crop selection and planting for the local soil, water, and climate conditions?
f) construction of sand reservoirs in arid regions (as opposed to open reservoirs)?
g) appropriate water application rates and water user system to avoid overuse of water?
h) installation of adequate surface and subsurface drainage systems?
i) water-recycling education?

4. Will the following characteristics be determined to assess whether and what type of artificial drainage may be necessary to prevent waterlogging and salinization of the soil[12]:

   a) effective crop root zone depth?
   b) topography of the area?
   c) infiltration and percolation rates of the soil?
   d) presence of hardpans and lateritic soils?
   e) existing natural surface and subsurface drainage sources?
   f) water table depth (during the wet season)?

5. Will the calculation of appropriate water usage rates be based on:

   a) seasonal and cyclic water availability?
   b) irrigation water requirements?
   c) natural and artificial drainage of the area?

6. Have flood and drought cycles been accounted for in the project design? How could they affect the project when they occur?

7. Will the water quality be tested to ensure that it is suitable for irrigating the crops to be grown[13]?

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[12] This information can be obtained from local farmers, agricultural extension workers, field tests, existing tables and charts, and from technical experts.

[13] The tolerance of various crops to salt and boron, for example, is available from tables.

8. Could upstream activities (such as industrial, forestry, irrigation, or hydro-power activities[14]) affect the project[15]?

9. Will there be any loud, continuous noises (such as the loud "clunk" of a hydraulic ram) near residential areas as a result of the project?

10. If the project will result in the use of fertilizers and pesticides:

    a) how will farmers be trained in proper and safe application and storage methods?
    b) is there a risk of polluting the water locally or downstream which would limit its use?
    c) is there a risk that the pesticides may poison or kill fish or other aquatic organisms eliminating a food source locally or downstream?

11. If the project involves stream diversion, will reducing water flow:
    a) negatively affect aquatic organisms, their food source or habitat?
    b) reduce a food source for people downstream?
    c) prevent the use of the water for irrigation, drinking, aquaculture, livestock watering, or other purposes downstream?
    d) result in sea water encroachment at the mouth of the river?

12. If ground water is the source of irrigation water, will pumping it result in a significant lowering of the water table?

13. If lowering the water table is expected due to pumping ground water, how will this affect:

    a) dug and drilled wells in the area?
    b) the survival of crops and natural vegetation in the area whose roots may be unable to reach the water table?
    c) stream and river volumes?
    d) the chances of salt-water intrusion of the ground water at coastal sites thereby contaminating fresh-water wells?
    e) marshes and other wetlands?

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[14] These may be outlined in a watershed plan or national five-year development plan.

[15] For example, by creating floods, droughts, fluctuations in seasonal flow, or by contaminating the water source.

14. Have various water management techniques been included in the project to control salinization in areas where this may be a problem?

15. How will the community be involved in:

    a) planning and designing the irrigation works?
    b) identifying water needs and crop selection?
    c) constructing canals, channels, ditches, and other works?
    d) operating water application?

16. How will a local community maintenance and repair committee be established for the various waterways and works?

17. How will the community make decisions regarding the allocation of water, costs, policing and maintenance of the various waterworks?

18. Has a training and education program been incorporated into the project that includes the following objectives:

    a) maintenance and repair of canals, drainage systems, and waterworks?
    b) appropriate water management techniques[16]?
    c) education in personal hygiene, water contamination, and health with regard to the use and maintenance of irrigation waterways?

19. Will steps be taken to minimize habitats for disease vectors, such as mosquitos and snails, by:

    a) lining canals and ditches?
    b) covering canals or piping the water where feasible?
    c) improving drainage?
    d) properly applying water to avoid puddles of standing water for extended periods of time?
    e) keeping canals and ditches free of weeds, sediment, and snails?

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[16] How and when to apply water, salinization control; problems with overwatering; etc.

20. Will steps be taken to minimize health hazards associated with the use of contaminated water from irrigation canals and ditches[17] for domestic purposes by providing:

    a) wells for drinking water?
    b) alternate areas for bathing and laundering?
    c) latrines or other sanitation facilities?
    d) alternative animal watering areas?

21. Has the possibility of using locally available, natural molluscicides, or raising ducks, geese, and native fish that eat snails and mosquitos been explored[18]?

22. Will steps be taken to minimize soil erosion and surface water runoff of susceptible areas (e.g., slopes) during the construction and operation of the project, such as:

    a) choosing the optimum irrigation method for the soil type, topography, and crop?
    b) using apppropriate techniques to intercept and slow down runoff water (such as terracing, contour furrows, check dams, levees, mulching, etc.)?
    c) applying proper water volumes and rates for the soil type, slope, and crop?
    d) establishing reforestation/revegetation of disturbed slopes?

23. Will the improved access to water resources result in any changes in the local population size or the group using the irrigation water (such as immigration from other communities or use by nomadic pastoralists)?

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[17] Usually highly contaminated with pesticides, fertilizers, animal faeces, and disease-vectors.

[18] Biological control methods that involve the introduction of species not native to the area require expert knowledge and assistance due to the potential of serious impacts, such as introducing new pests and diseases or eliminating beneficial organisms.

24. If an increase in user number is anticipated:

    a) can the water supply support the increased demand, also considering long-term capability given population growth and pressure on water resources for multiple use?
    b) will there be increased pressure on local resources (such as housing, schooling, health care, etc)?
    c) will there be increased pressure on local natural resources (such as fuelwood, grazing of natural vegetation, the soil resource, clearing of forest to create arable land)?
    d) have the politics of water user-rights and priorities been addressed?

25. How will a monitoring program be incorporated into the project that would:

    a) involve the local community from inception to implementation?
    b) successfully identify environmental impacts as they occur both during the project set-up and after the development team has left the site?

26. After comparing the project activities with the questions above, have areas been identified in which negative environmental impacts are likely to occur? If this is the case, which mitigating measures have been proposed to minimize or eliminate these negative impacts?

NOTE: If the project involves a *dam/reservoir,* a *drinking water* component, or *pesticide* use, please consult one or all of the following:

"Environmental Screening of NGO Development Projects: ***Small Dams/Reservoirs***"

"Environmental Screening of NGO Development Projects: ***Domestic Water Supply and Sanitation***"

"Environmental Screening of NGO Development Projects: ***Pesticides and Integrated Pest Management***"

HSE
Health & Safety Executive

Construction health and safety checklist

Construction Sheet No 17 (revised)

This checklist identifies some of the hazards most commonly found on construction sites. The questions it asks are intended to help you decide whether your site is a safe and healthy place to work. **It is not an exhaustive list**. More detailed information can be found in HSG150 *Health and safety in construction* and other HSE publications.

Safe places of work

- Can everyone reach their place of work safely, eg are roads, gangways, passageways, passenger hoists, staircases, ladders and scaffolds in good condition?
- Are there guard rails or equivalent protection to stop falls from open edges on scaffolds, mobile elevating work platforms, buildings, gangways, excavations, etc?
- Are holes and openings securely guard railed, provided with an equivalent standard of edge protection or provided with fixed, clearly marked covers to prevent falls?
- Are structures stable, adequately braced and not overloaded?
- Are all working areas and walkways level and free from obstructions such as stored material and waste?
- Is the site tidy, and are materials stored safely?
- Are there proper arrangements for collecting and disposing of waste materials?
- Is the work adequately lit? Is sufficient additional lighting provided when work is carried on after dark or inside buildings?

Scaffolds

- Are scaffolds erected, altered and dismantled by competent persons?
- Is there safe access to the scaffold platform?
- Are all uprights provided with base plates (and, where necessary, timber sole plates) or prevented in some other way from slipping or sinking?
- Are all the uprights, ledgers, braces and struts in position?
- Is the scaffold secured to the building or structure in enough places to prevent collapse?
- Are there adequate guard rails and toe boards or an equivalent standard of protection at every edge from which a person could fall 2 m or more?
- Where guard rails and toe boards or similar are used:
  - are the toe boards at least 150 mm in height?
  - is the upper guard rail positioned at a height of at least 910 mm above the work area?
  - are additional precautions, eg intermediate guard rails or brick guards in place to ensure that there is no unprotected gap of more than 470 mm between the toe board and upper guard rail?
- Are the working platforms fully boarded and are the boards arranged to avoid tipping or tripping?
- Are there effective barriers or warning notices in place to stop people using an incomplete scaffold, eg where working platforms are not fully boarded?
- Has the scaffold been designed and constructed to cope with the materials stored on it and are these distributed evenly?
- Does a competent person inspect the scaffold regularly, eg at least once a week; always after it has been substantially altered, damaged and following extreme weather?
- Are the results of inspections recorded?

Powered access equipment

- Has the equipment been erected by a competent person?
- Is fixed equipment, eg mast climbers, rigidly connected to the structure against which it is operating?
- Does the working platform have adequate guard rails and toe boards or other barriers to prevent people and materials falling off?
- Have precautions been taken to prevent people being struck by the moving platform, projections from the building or falling materials, eg barrier or fence around the base?
- Are the operators trained and competent?
- Is the power supply isolated and the equipment secured at the end of the working day?

Ladders

- Are ladders the right means of access for the job?
- Are all ladders in good condition?
- Are they secured to prevent them slipping sideways or outwards?
- Do ladders rise a sufficient height above their landing place? If not, are there other hand-holds available?
- Are the ladders positioned so that users don't have to over-stretch or climb over obstacles to work?
- Does the ladder rest against a solid surface and not on fragile or insecure materials?

Roof work

- Are there enough barriers and is there other edge protection to stop people or materials falling from roofs?
- Do the roof battens provide safe hand and foot holds? If not, are crawling ladders or boards provided and used?
- During industrial roofing, are precautions taken to stop people falling from the leading edge of the roof or from fragile or partially fixed sheets which could give way?
- Are suitable barriers, guard rails or covers, etc provided where people pass or work near fragile material such as asbestos cement sheets and roof lights?
- Are crawling boards provided where work on fragile materials cannot be avoided?
- Are people excluded from the area below the roof work? If this is not possible, have additional precautions been taken to stop debris falling onto them?

Excavations

- Is an adequate supply of timber, trench sheets, props or other supporting material made available before excavation work begins?
- Is this material strong enough to support the sides?
- Is a safe method used for putting in the support, ie one that does not rely on people working within an unsupported trench?
- If the sides of the excavation are sloped back or battered, is the angle of batter sufficient to prevent collapse?
- Is there safe access to the excavation, eg by a sufficiently long, secured ladder?
- Are there guard rails or other equivalent protection to stop people falling in?
- Are properly secured stop blocks provided to prevent tipping vehicles falling in?
- Does the excavation affect the stability of neighbouring structures?
- Are materials, spoil or plant stored away from the edge of the excavation in order to reduce the likelihood of a collapse of the side?
- Is the excavation inspected by a competent person at the start of every shift; and after any accidental collapse or event likely to have affected its stability?

Manual handling

- Has the risk of manual handling injuries been assessed?
- Are hoists, telehandlers, wheel-barrows and other plant or equipment used so that manual lifting and handling of heavy objects is kept to a minimum?
- Are materials such as cement ordered in 25 kg bags?
- Can the handling of heavy blocks be avoided?

Hoists

- Is the hoist protected by a substantial enclosure to prevent someone from being struck by any moving part of the hoist or falling down the hoistway?
- Are gates provided at all landings, including ground level?
- Are the gates kept shut except when the platform is at the landing?
- Are the controls arranged so that the hoist can be operated from one position only?
- Is the hoist operator trained and competent?
- Is the hoist's safe working load clearly marked?
- If the hoist is for materials only, is there a warning notice on the platform or cage to stop people riding on it?
- Is the hoist inspected weekly, and thoroughly examined every six months by a competent person?
- Are the results of inspection recorded?

Cranes and lifting appliances

- Is the crane on a firm level base?
- Are the safe working loads and corresponding radii known and considered before any lifting begins?

- If the crane has a capacity of more than 1 tonne, does it have an automatic safe load indicator that is maintained and inspected weekly?
- Are all operators trained and competent?
- Has the banksman/slinger been trained to give signals and to attach loads correctly?
- Do the operator and banksman find out the weight and centre of gravity of the load before trying to lift it?
- Are cranes inspected weekly, and thoroughly examined every 14 months by a competent person?
- Are the results of inspections and examinations recorded?
- Does the crane have a current test certificate?

Plant and machinery

- Is the right plant and machinery being used for the job?
- Are all dangerous parts guarded, eg exposed gears, chain drives, projecting engine shafts?
- Are guards secured and in good repair?
- Is the machinery maintained in good repair and are all safety devices operating correctly?
- Are all operators trained and competent?

Traffic and vehicles

- Have separate pedestrian, vehicle access points and routes around the site been provided? If not, are vehicles and pedestrians kept separate wherever possible?
- Have one-way systems or turning points been provided to minimise the need for reversing?
- Where vehicles have to reverse, are they controlled by properly trained banksmen?
- Are vehicles maintained; do the steering, handbrake and footbrake work properly?
- Have drivers received proper training?
- Are vehicles securely loaded?
- Are passengers prevented from riding in dangerous positions?

Fire and emergencies

General

- Have emergency procedures been developed, eg evacuating the site in case of fire or rescue from a confined space?
- Are people on site aware of the procedures?
- Is there a means of raising the alarm and does it work?
- Are there adequate escape routes and are these kept clear?

Fire

- Is the quantity of flammable material on site kept to a minimum?
- Are there proper storage areas for flammable liquids and gases, eg LPG and acetylene?
- Are containers and cylinders returned to these stores at the end of the shift?
- If liquids are transferred from their original containers are the new containers suitable for flammable materials?
- Is smoking banned in areas where gases or flammable liquids are stored and used? Are other ignition sources also prohibited?
- Are gas cylinders and associated equipment in good condition?
- When gas cylinders are not in use, are the valves fully closed?
- Are cylinders stored outside?
- Are adequate bins or skips provided for storing waste?
- Is flammable and combustible waste removed regularly?
- Are the right number and type of fire extinguishers available and accessible?

Hazardous substances

- Have all harmful materials, eg asbestos, lead, solvents, paints etc been identified?
- Have the risks to everyone who might be exposed to these substances been assessed?
- Have precautions been identified and put in place, eg is protective equipment provided and used; are workers and others who are not protected kept away from exposure?

Noise

- Are breakers and other plant or machinery fitted with silencers?
- Are barriers erected to reduce the spread of noise?
- Is work sequenced to minimise the number of people exposed to noise?
- Are others not involved in the work kept away?

- Is suitable hearing protection provided and worn in noisy areas?

Welfare

- Have suitable and sufficient numbers of toilets been provided and are they kept clean?
- Are there clean wash basins, warm water, soap and towels?
- Is suitable clothing provided for those who have to work in wet, dirty or otherwise adverse conditions?
- Are there facilities for changing, drying and storing clothes?
- Is drinking water provided?
- Is there a site hut or other accommodation where workers can sit, make tea and prepare food?
- Is there adequate first aid provision?
- Are welfare facilities easily and safely accessible to all who need to use them?

Protective clothing

- Has adequate personal protective equipment, eg hard hats, safety boots, gloves, goggles, and dust masks been provided?
- Is the equipment in good condition and worn by all who need it?

Electricity

- Is the supply voltage for tools and equipment the lowest necessary for the job (could battery operated tools and reduced voltage systems, eg 110 V, or even lower in wet conditions, be used)?
- Where mains voltage has to be used, are trip devices, eg residual current devices (RCDs) provided for all equipment?
- Are RCDs protected from damage, dust and dampness and checked daily by users?
- Are cables and leads protected from damage by sheathing, protective enclosures or by positioning away from causes of damage?
- Are all connections to the system properly made and are suitable plugs used?
- Is there an appropriate system of user checks, formal visual examinations by site managers and combined inspection and test by competent persons for all tools and equipment?
- Are scaffolders, roofers, etc, or cranes or other plant, working near or under overhead lines? Has the electricity supply been turned off, or have other precautions, such as 'goal posts' or taped markers been provided to prevent them contacting the lines?
- Have underground electricity cables been located (with a cable locator and cable plans), marked, and precautions for safe digging been taken?

Protecting the public

- Are the public fenced off or otherwise protected from the work?
- When work has stopped for the day:
  - are the gates secured?
  - is the perimeter fencing secure and undamaged?
  - are all ladders removed or their rungs boarded so that they cannot be used?
  - are excavations and openings securely covered or fenced off?
  - is all plant immobilised to prevent unauthorised use?
  - are bricks and materials safely stacked?
  - are flammable or dangerous substances locked away in secure storage places?

Reference

HSG150: *Health and safety in construction* HSE Books 1996 ISBN 0 7176 1143 4

HSE priced and free publications are available by mail order from:

HSE Books, PO Box 1999, Sudbury, Suffolk CO10 2WA Tel: 01787 881165; Fax: 01787 313995. HSE priced publications are available from good booksellers.

For other enquiries ring HSE's InfoLine, tel: 0541 545500, or write to HSE's Information Centre, Broad Lane, Sheffield S3 7HQ.

HSE home page on the World Wide Web: http://www.open.gov.uk/hse/hsehome.htm

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Trade Contractor Quality Control

by Ed Caldeira, NAHB Research Center

When you have quality problems, do you shop for a new trade contractor that will make your problems go away? Do all the replacement candidates tell you the familiar "we're reliable and do quality work"? Is it the same pitch you heard last year from the trade contractor that you're firing?

Certainly some trade contractors do better than others. But it seems that no matter how many of the poor performers are weeded out, the average quality performance doesn't seem to rise very much.

As surely as you'll have a few new trade contractors next year, you can also be sure that you will have more quality problems and you'll start looking around again.

As the saying goes "if you always do what you do, you'll always get what you got." Changing trade contractors is doing what you always do. Why should you expect overall quality to get better? Improving quality is more than finding new ways to hire and fire trade contractors.

We need to change the approach to quality control. First, we need to know how a trade contractor quality control system should work. To find out, the NAHB Research Center analyzed quality control issues in residential construction, identified areas where the current system needed improvement, and determined how they can be improved. The study concluded that effective quality controls must operate within the trade contractor's work crews to prevent problems before they occur. To accomplish this, the quality control system should set requirements for approved materials, use of qualified persons to perform specific tasks, work standards, explicit sales contracts, and jobsite inspection by the crews performing the work.

ISO 9000, the internationally recognized quality control standard integrates these elements into a comprehensive system. On the basis of ISO 9000, the Research Center developed a Trade Contractor Quality Control Manual (see sidebar).

Builders can use the Trade Contractor Quality Control Manual as a model to help their trade contractors bring good quality control practices to their crews. This

involves training contractors on the approach, helping them to adapt the Manual to their trades, and making sure that it applies to existing quality problem areas.

To test this approach, the Research Center adapted the quality manual to the insulation trade. This involved obtaining all of the manufacturer's installation standards, developing an insulation inspection checklist and training contractors in the quality control system. Three insulation contractors participated in an pilot program sponsored by CertainTeed. This program produced positive results, and a second program for External Insulation and Finish System (EIFS) Installers has been designed and is in the pilot testing phase.

Assessing compliance to the quality control requirements is straightforward. The first step is to verify the paper trail of contracts, jobsite inspections, use of approved materials, and records of qualified installers. The next step involves detailed jobsite audits to observe workmanship, use of materials, and quality control procedures. The Research Center uses these procedures in a new program to independently certify the quality controls of insulation contractors. Currently over 65 contractors are certified.

Next time you have a quality problem with a trade contractor don't just change your contractor, change your contractor's quality controls!

Trade Contractor Quality Control Guidelines

The NAHB Research Center's Trade Contractor Quality Control Manual sets requirements that enable trade contractors to address key elements of a quality control system. The manual provides a general approach that is to be tailored to each trade.

Qualified Materials and Installation Procedures

Materials and the designed use of materials are critical elements of quality installations. To prevent confusion regarding what materials are to be used and how, a list is made of acceptable materials, acceptable installation methods, and any requirements for special equipment.

Qualified Installers

Installer capabilities are critical to every quality installation. Trade contractors may set their own standards and methods for evaluating the installers' skill, knowledge, and workmanship or recognize a trade skills certification program. When all requirements are met, trade contractors keep lists of installers qualified to perform various installation tasks. Helpers may assist on the jobsite, although quality responsibility remains with the qualified installer.

Sales Contracts

Sales contracts must clearly describe the work to be performed. The contracts are used as the basis for an agreement with the builder, and by installation crews for work instructions. The contracts consist of two parts. The first part, Installation Requirements, defines the responsibilities of the builder and of other trade contractors necessary for a high performance, durable installation.

The second part of the sales contracts is called the Scope of Work. It contains the specifications for installation work to be performed by the trade contractor.

Jobsite Inspections

The preceding sections describe the foundation for quality controls on the jobsite. Jobsite inspections involve checklists specific to each trade to verify that approved materials are used according to the installation instructions, that qualified installers perform the work, and that the Scope of Work requirements are met.

Each inspection checklist should address key quality control checkpoints and quality problem areas specific to the trade. Quality inspections should use checklists at each work phase to verify that:

- architectural design requirements and building conditions are suitable for installation;
- previous work phases are complete;
- work was performed by qualified personnel;
- only approved materials were used;
- The amount of materials used was sufficient to complete the work phase;
- Scope of Work requirements have been met;
- installation specifications and procedures have been met;
- the work phase is complete; and
- any quality problems have been corrected.

Quality System Audits

Periodic audits assess whether the system is effective at controlling quality, and whether the contractor is conforming to the requirements of the Trade Contractor Quality Manual. The audits involve periodic reviews of installation crew performance, and of the overall quality system. They can be performed by the trade contractor, builder, or a third party auditor.

Quality questions? Looking for specifications? Call the ToolBase Hotline (800)898-2842.

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The NAHB Research Center is the not-for-profit research arm of the National Association of Home Builders, and is located in Upper Marlboro, MD. In its nearly 40 years of service to the home building industry, the Research Center has provided product research and building process improvements that have been widely adopted by home builders in the United States. Through testing and certification services, the NAHB Research Center seal is recognized throughout the world as a mark of product quality and an assurance of product performance.

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Inspection Checklists for Trade Contractors

by Ed Caldeira, NAHB Research Center

A properly designed inspection checklist form can demonstrate due diligence in complying with regulations, manufacturer's instructions, and workmanship standards. You can use it to set expectations for what needs to go right, and once completed it can serve as a record of what actually happened.

The trade contractor's crew supervisor should use an inspection checklist to perform inspections on every job. If the trade has several phases of work on a home, prepare a separate inspection form for each one. In addition, the builder can use a copy of the same forms while performing quality reviews.

ISO 9000, the internationally recognized quality control standard, sets requirements necessary to assure conformance to specifications. The ISO 9000 approach not only assures that specifications are met but also confirms that all the elements of a reliable construction process are in place.

Jobsite Installation Record provides basic information about job location, start date, and the type of product or system that is to be installed.

Job Readiness questions verify there are no adverse conditions that impact quality and the job is suitable for work to begin. This should include availability of installation instructions and adequacy of work performed by previous trades, as well as building or environmental conditions that can affect quality.

Use of Materials should be documented. When materials affect quality, the inspection form should capture specific information on primary as well as secondary materials when they make a difference to the completed job.

Installation Inspection questions verify that product manufacturer's specifications are followed and that workmanship meets expectations. Examine manufacturer's installation instructions, NER product evaluation reports, codes, and regulations to identify key requirements that need to be followed for performance and durability. Supplement this with provisions for the needs of the following trades and your own expectations. Whenever inspection questions verify conformance to dimensional specifications, actual

measurements should be recorded. Also verify the use of specific equipment or tools if they affect quality results.

Problems Found should be recorded, even if they are corrected. When the problem results in a deviation from specifications, note the deviation.

Job Complete sign-off should be done by the responsible craftsman after verifying satisfaction with workmanship and that the work is complete to specification. List any remaining repair items to be completed.

I encourage you to collaborate with your trade contractors and product manufacturers to prepare inspection checklists for each of your trades. The jobsite inspection checklist is an important element of a builder's quality control system to help you build problem-free, durable homes.

A sample "Trade Contractor Inspection Checklist" and answers to your quality questions are free by calling the NAHB Research Center's ToolBase Hotline ***(800) 898-2842****. Visit the quality pages at http://www.nahbrc.org.*

The NAHB Research Center is the not-for-profit research arm of the National Association of Home Builders, and is located in Upper Marlboro, MD. In its nearly 40 years of service to the home building industry, the Research Center has provided product research and building process improvements that have been widely adopted by home builders in the United States. Through testing and certification services, the NAHB Research Center seal is recognized throughout the world as a mark of product quality and an assurance of product performance.

NOTE TO EDITORS ON STYLE USAGE: In order to correctly identify this company and its work, first reference should be "NAHB Research Center." If clarification of the acronym is necessary, the phrase, "a subsidiary of the National Association of Home Builders (NAHB)," can follow. In subsequent mentions, "Research Center" is the only acceptable and accurate alternative reference.

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NAHB RESEARCH CENTER