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Environmental Guidelines for Small-Scale Activities in Africa (EGSSAA)

Environmentally Sound Design and Management of Primary & Secondary Day Schools

Contents

Background 1
Potential Environmental and Health Impacts of Schools and Their Causes 2
Potential adverse impacts on learning, safety, and facilities durability from failure to design and site in response to local environmental conditions 3
Potential adverse impacts on student health from inadequate water supply 4
Overview of Environmental Best Practice in School Design 4
Environmental Best Practice during Construction 12
Overview of Environmental Best Practice in Operation and Maintenance 12
Annotated Resources 15

Background

Formal education is essential to social and economic development, and school *facilities* are essential to formal education. USAID's support to the education sector often includes funding for the construction, expansion and/or rehabilitation of schools.

Environmentally sound design and management (ESDM) of schools is essential to creating a school environment that facilitates learning, safeguards the health and safety of students, reinforces the basic hygiene behaviors that are important to public health; and to assuring that school facilities will be durable, returning social benefits over many years on the substantial investment they represent.

ESDM requires:

- ✓ Siting, design and materials choices that are responsive to local environmental conditions;
- ✓ Appropriate environmental management of the construction process;
- ✓ Minimizing environmental contamination (and thus consequent health impacts) with well-designed and maintained waste management and sanitation facilities;
- ✓ Provision of safe, adequate water supplies

Failure to address these issues in school design and management results in environmental and health risks that may diminish or negate many of the benefits schools are intended to deliver: School facilities can:

- become breeding grounds and transmission points for disease, increasing the health risks for students and the general community.
- provide physical environments unfavorable for learning—or worse, that are physically unsafe.

***Environmentally sound* design and management of schools is essential to creating a school environment that facilitates learning, safeguards the health and safety of students, reinforces the basic hygiene behaviors that are important to public health. .**

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- have, in their construction and operation, adverse impacts on the local environment, compromising the resources that the community needs for current subsistence and future development.
- deteriorate rapidly, becoming unusable or requiring rehabilitation and placing additional demands on already scarce education resources.

This chapter describes how these potential effects and outcomes arise and recommends mitigation and monitoring measures to prevent or reduce them, both in design and operation. As in other sectors, effective mitigation is much easier when potential adverse outcomes are identified and addressed *early* in the design and construction process.

This guidance is intended as an environmental supplement to traditional engineering, construction or technical standards. *This is not a stand-alone construction manual*.

This guidance is targeted at *day (non-boarding) schools, and does not address environmental management of science laboratories, vocational workshops or school farms*. Dormitories, laboratories, workshops and farms impose additional environmental design and management needs beyond the scope of this guidance.

Potential Environmental and Health Impacts of Schools and Their Causes

Potential environmental and health impacts of schools can be divided into three categories:

1. Effects of construction on environment

Environmental impacts of school construction are identical to those of small-scale construction more generally. These impacts are mainly related to sourcing, extraction and disposal of construction material. Potential impacts may include erosion and sedimentation, habitat degradation, and local deforestation. These are discussed in more detail in the *Small-Scale Construction* chapter of these *Guidelines.*

(Construction can also present significant safety and health hazards to workers and others on the site, though these hazards are usually physical/occupational rather than environmental in nature—e.g., injuries from falls, dropped objects, and tools and equipment; inhalation of cement dust, paint fumes, etc.)

2. Effects of operations on environment and student/community health.

School operations can result in:

- ***Biological contamination of ground and surface water*** from latrines, septic and wastewater systems and waste pits that are poorly sited and designed or improperly maintained and managed. (See photo at left.) Contamination can occur through overland flow into surface waters, seepage into ground water, or by direct disposal into waterways. Two issues should be particularly noted:

  Human excreta generated at schools present particularly high risks for the transmission of "oral-fecal route" diseases between students or to the community at large. Poorly sited/designed, operated, or maintained sanitary facilities significantly increase the chances of ground and surface water contamination—and thus of such disease transmission. (See Chapter 16: Water Supply and Sanitation for detailed guidance on design and maintenance of latrines.)

Photo: B Popkin

Septic seepage is clearly visible around the septic tank behind this school latrine. This latrine is a source of environmental contamination and a threat to student health.

Grey water is the waste water from kitchens, cleaning, and ablutions. Unmanaged discharge of grey water can contaminate drinking water sources with pathogens and pollutants.

- ***Spread of pathogens from*** unscreened pit latrines (see photo at right) and unsecured waste by insect vectors, birds, mice, livestock etc.
- ***Concentration/Breeding of disease vectors*** resulting from ***poor facilities design and management:***

  Solid waste. Primary *s*chools generate a variety of solid wastes, particularly food wastes, papers and packaging. Generally, these wastes are not themselves toxic or otherwise hazardous, but must be collected, and properly disposed of, to avoid attracting disease vectors. Doing so also reduces fire hazards, and promotes a clean environment for students. Some waste, however, particularly sanitary napkins/pads from latrine waste bins, may be hazardous/infectious. (See Chapter 15: Solid Waste for more information.)

  If water pools or stands (e.g., from a water supply point or from a grey water discharge) it may provide a breeding medium for vectors transmitting malaria and other diseases. This may also occur from rainwater runoff in a waste pit.

  Kitchen hygiene. Many schools include a kitchen or canteen. Poor kitchen hygiene can attract pests which become vectors for disease transmission.

- ***Toxic or nuisance air pollution*** produced by burning waste, and/or by poorly ventilated and designed cooking facilities. Exposure to smoke increases the incidence of asthma in the young and may render them more prone to lung diseases later in life.
- ***Local Deforestation*** from fuelwood harvesting in the immediate vicinity of the school to support the school canteen.

Photo: M Stoughton

These side-by-side simple open pit latrines are situated ~8m from the school building. The open-pit design and proximity substantially increase the risk that insect vectors will carry pathogens from the latrine back to the classroom.

Children are particularly vulnerable to "oral-fecal route" diseases and malaria, among others. In areas of endemic malnutrition or high HIV infection rates, compromised immune systems further increase this vulnerability. Thus, student populations—particularly of primary school age—are at particular risk from poor waste management and deficient hygiene practices.

3. Induced effects: Impacts of in-migration & induced settlement.

Schools are usually constructed in response to an existing need and to serve an existing population. But as a vital social service, they (along with roads and health facilities) may encourage additional settlement and in-migration, which places additional demands on the local environment. These "induced" or "indirect" effects are in addition to the direct or "first-order" effects described above.

In-migration and induced settlement are in almost all cases beyond the control of school project proponents. However, proponents may want to discuss likely settlement trends with district or town planners and education authorities. This may help determine whether the school site design should accommodate future, on-site expansion, and help planners anticipate environmental management and social services needs associated with additional settlement.

Potential adverse impacts on learning, safety, and facilities durability from failure to design and site in response to local environmental conditions

The previous section summarized impacts *of* school construction and operation *on* the environment—with consequent impacts on health and well-being. But

Photo: M Stoughton

Strong winds ripped the corrugated roof off a new community school and toppled the landcrete and mud-block walls. This inadequate replacement structure (with plank walls and a split-bamboo roof) is intended to be temporary, but may be in service for many years.

Previously in this area, storms of this strength were very rare. With widespread deforestation, however, one storm of this strength occurs at least every other year. Design choices failed to respond to this new reality.

failure to design and site *with* sensitivity to local environmental conditions can result in significant adverse impacts on learning, safety and facilities durability.

As with all construction, siting that fails to protect the structure to the extent possible from flooding; roofing and other design choices not robust to "50-year" storms; foundations and footings that are inappropriate for soil types and water tables; and inadequate/poorly designed drainage could adversely affect the durability of the structures, sometimes with critical results (e.g. complete loss of the structure in a storm of easily foreseeable strength).

For schools particularly, the following are potential significant adverse consequences of designs that are insufficiently responsive to local environmental conditions:

- **Design and materials choices that are inappropriate to the local climate result in inadequate ventilation and poor thermal performance.** The physically uncomfortable classroom environment that results has *significant adverse effects on learning*.
- **Siting too close to noise sources** such as markets, transport yards, or busy roads results in high background noise in classrooms, with significant adverse effects on learning.
- **Siting too close to high concentrations of pathogens and disease vectors,** including open dumps, rubbish pits, markets, abattoirs, transport yards can create a significant health hazard for students.
- **Structural failures** in storms (see photo at left) or earthquakes can have tragic consequences in the case of schools, and appropriate design choices (and construction quality control) are thus all the more important. Design and management should include measures to minimize potential structural damage from locally prevalent pests (i.e. termites and other borers). Such damage, often hidden, substantially increases the risks of structural failure.

Potential adverse impacts on student health from inadequate water supply

Schools require a clean, year-round water supply in sufficient quantity for drinking, hand-washing, cleaning/washing up and, in many cases, cooking. Water supplies that are inadequate with respect to either quantity or water quality present a significant risk to student health.

Avoiding the pitfalls of "standard designs"

Design and planning of schools is often centrally controlled and coordinated and based on "standard designs."

For any particular site, these designs may not be sufficiently responsive to the local environment or may otherwise be environmentally unsound.

Systematic review of such "standard designs" against the guidance in this section—and making appropriate adjustments based on that review—should resolve these problems.

Overview of Environmental Best Practice in School Design…

The tables in this section are organized by major design element (e.g. siting, structure design, etc.) and provide key design considerations under each element. These considerations address both prevention of environmental impacts and design response to local environmental conditions.

The tables do *not* replace general architectural/engineering/construction standards and guidance that apply to all structures. They rather address environmental issues of particular relevance to (and which are often neglected in) school design.

The tables are additional to—not in lieu of—national design or construction standards. Designs must meet any such mandatory standards.

The guidance reflects the three non-negotiable core requirements for a school's physical facilities: simple classroom shelters, adequate sanitation and safe and adequate water supply.

Siting & site dimensions:
The site should be chosen—and structures situated on the site— with respect to the considerations detailed in the table below:

Design consideration	Comments and Guidance
Avoid proximity to health hazards	If possible, the school site should be a minimum of 100m away from rubbish dumps, abattoirs, markets, transport yards, and other facilities/land uses with a high concentration of pathogens and disease vectors. *A separation of less than 100m may be acceptable, depending on the situation—and is almost always better than no separation at all.*
Avoid road noise and dust	If possible, the school site should *not* be located along a primary road, due to both noise and dust nuisance.* If the school grounds are adjacent to a well-travelled road: • If at all possible locate the school structures behind the observed "settling zone" for road dust. • Minimize road noise in classrooms by maximizing set-back from the road and/or minimizing road-way facing windows (though without compromising ventilation needs). • If the design features a perimeter wall, build this higher along the roadway. Alternatively, plant a buffer strip of trees suitable to help block dust and sound (though it will be several years before such a barrier is effective.)
Assure adequate site dimensions	The site should be large enough to accommodate planned structures, water supply, and sanitation facilities *at appropriate separations*: • As a rule of thumb, latrines should be sited 30-50m from school buildings and 30m from any well. Also remember to note the locations of wells and latrines in properties adjacent to the school site. • For latrine types in which pits fill up and must be decommissioned, the site must provide space for replacement latrines.
Flood risk below the local baseline	Ideally, schools should be located out of flood zones, but the reality is that this is often not possible—whole communities and districts often lie in flood zones, and must be serviced by educational facilities. It is important, however, to assure that the school site is not *more* flood prone than the community it serves—and ideally is somewhat less vulnerable. In times of flood, schools often serve as shelters and relief staging areas, and siting should facilitate this function.

Siting Schools in "Black Cotton Soil" Areas

While there are several criteria that should be taken into consideration when determining where to site a school, "black cotton soils" presents a special challenge.

"Black cotton soils" (vertisols) have a high percentage of clay minerals (primarily montmorillonite) that expand greatly when wet. They are found primarily in parts of Ethiopia, Sudan (Gezira and the southern plains); South Africa and Tanzania.

During dry periods, wide and deep cracks form that can be large enough to pose hazards to animals such as sheep and goats.

Following rain, the soil swells, the cracks close, and the soil surface can undergo significant upheaval.

These soils are also called "self mulching" soils as surface material accumulates in the cracks during the dry season and is "swallowed" by the soil in the wet season, creating the 'self mixing' or 'self mulching' effect.

Building permanent structures on black cotton soil presents special challenges.

In an area of mixed soil types, avoid siting on black cotton soil. Where there is no option, consult a qualified architect/ structural engineer regarding appropriate design and construction techniques.

Structure Design/Materials Choices

School structural design and materials should address the considerations detailed in the table below:

Design consideration	Comments and Guidance
Appropriate Earthquake resistance	Verify local risk of earthquake. If more detailed information is not available, see the UN OCHA Africa risk map at: *ochaonline.un.org/OchaLinkClick.aspx?link=ocha&docId=1087248* If risk is more than slight (e.g., 50-year risk of a strength VI ("strong") quake on the Modified Mercalli Scale is 20% or higher), consult a qualified architect/structural engineer to assure that the design is appropriately earthquake-resistant *given the specifics of the site.* *In general, earthquake resistance means adding reinforcement to walls and foundations so that the structure can withstand side-to-side forces, not just vertical weight. Normally, reinforced plinth-beams surrounding the floor area along with reinforced pillars and tie beams at roof level will considerably reduce damage to the structure and habitants. (See Small-Scale Construction chapter.)*
Appropriate wind resistance	Ascertain the strongest winds remembered in the local community (will correspond to a "50 year storm") and the damage done to typical structures at that time. Examine local roofing techniques and inquire about storm frequency and typical damages. Note that if deforestation is occurring in the area, future wind strength on the ground will tend to increase in future. Assure that the design—roof, walls, and drainage—is resistant to the "50-year storm;" consult a qualified architect/structural engineer if in doubt. *At a minimum, roofing always should be thoroughly tied down to the roof frame, and the roof frame to the structure.*
Appropriate thermal performance	In hot climates, consider the "design options for enhanced ventilation and thermal performance" outlined on page 7.
Pest resistance	**Ascertain if termites are locally prevalent**. (They are throughout most of Africa.) If yes, at a minimum: • Extend slab at least 20cm beyond external walls. Set wooden structural poles on an elevated concrete or stone footing. Design walls with a concrete course near the base to prevent termites from tunneling through wall interiors (especially if walls are built of mudblock, landcrete, or hollow blocks.) • Use termite-resistant woods for key structural members. (Will vary by location; local contractors and communities will know locally available termite-resistant species.) Where available, "16 grit sand" (grains of .06 to 0.1 inches or 1.6 to 2.5 mm diameter) can be used as a termite barrier beneath concrete slabs and footings. (Termites are unable to dig through or move sand grains of this size.) **If chemical treatments are used**, apply using the dosage and procedures specified by the manufacturer. Note that the use of any pesticides in USAID projects must be specifically approved. Historically, organic hydrocarbon pesticides such as chlordane, DDT, aldrin, dieldrin and BHC were widely used for termite control. These chemicals have been banned in the US, and pose particular hazards when used in schools. *Treating wood with waste oil will* ***not*** *protect against termites.*

Is building with local materials best?

Sometimes.

Depending on the site, locally available building materials may include timber, stone, rubble, soil blocks, fired brick, sand and gravel, bamboo, and thatch.

These local materials are often cheaper to acquire and easier to maintain. In some cases they can offer superior performance. (For example, walls of adobe or "landcrete" (mud blocks mixed with a portion of cement) are economical and keep interior spaces cooler than cement blocks.

However, these materials may or may not be environmentally preferable to commercial materials and non-local procurement.

Brick-making, for example, can have significant adverse local impacts such as deforestation; destruction of arable land, or increased malaria prevalence from standing water in clay pits.

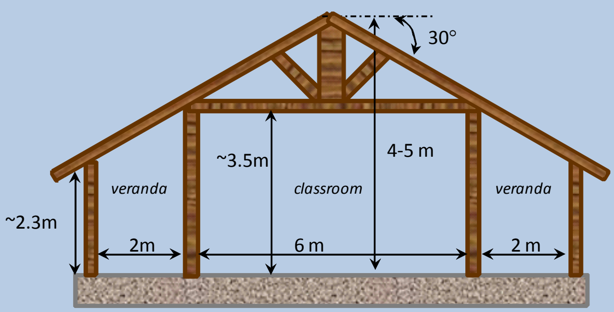
Responsible construction requires minimizing the adverse environmental impacts of local materials procurement *to the extent feasible*—for example, avoiding materials that are locally scarce, backfilling borrow pits, or (in countries that have established chain-of-custody systems for timber sales), assuring that locally purchased timber is certified as legally harvested.

For more detail, see the *Construction* chapter of these Guidelines.

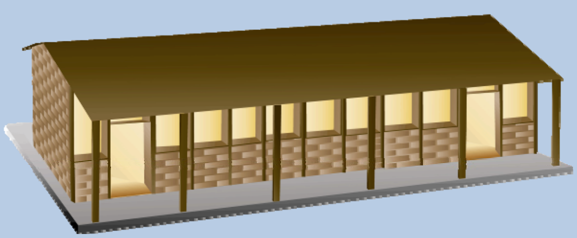
Simple design options for enhanced ventilation and thermal performance in hot climates

Designing for comfort in the local climate is essential; an uncomfortable school provides a poor learning environment. Modern structures can provide increased durability and safety, and are often perceived as embodying progress and development. But the reality is that many are far less *comfortable* than structures built in more traditional styles and using local materials. This page presents an inventory of simple design options to enhance building comfort in hot climates. No design option is appropriate for all projects; this inventory is intended for *consideration* both by architects and by project proponents consulting with architects and the community to develop a suitable design.

"Build up and out." High ceilings (3.25 m or higher) and long eaves covering a front-and-back veranda significantly increase comfort in hot climates. Larger roof areas do increase costs, but long eaves/verandas can also save money by sheltering walls from rain and thus (1) permitting the use of mud bricks, landcrete rammed earth, and similar materials; and (2) eliminating the need for glass louvers in windows/permitting half-wall construction (see below).

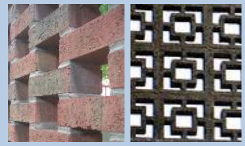


Half wall construction (diagram below) is a frequently used, effective design for rural schools in tropical climates. Pillars bear the weight of the roof, with side walls rising only to a height of ~1.1m between the pillars. The design requires extended eaves (e.g., the 2m veranda of the diagram above) for storm protection. Classroom end walls are full height.



Build thick. Concrete is expensive and has poor thermal performance. Structures of rammed earth, mud brick, adobe, landcrete, stone, and rubble all keep interior spaces cooler than cement-block construction. Extended eaves add to comfort and are the best way to protect walls made of these materials.

Well-protected mud brick and adobe are highly durable; some of the oldest standing buildings in Africa (and the world) are made of these materials.



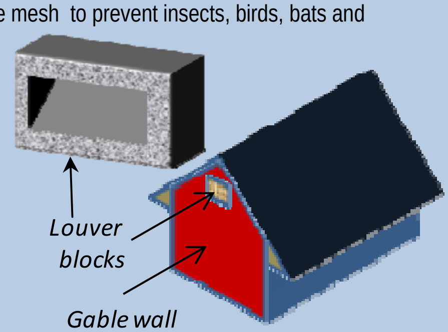
Latticework Brick latticework/ openwork concrete blocks are widely used in many parts of Africa. They can easily be incorporated into walls for light and ventilation.

If the design includes a ceiling, a strip of latticework or openwork blocks just below ceiling level will vent hot air that will otherwise be trapped in the room.

Cross-ventilate. If using windows instead of a half-wall design, these should be on at least two sides of each classroom, both for cross-ventilation and light.

Ventilate the under-roof space. Cross-ventilating the under-roof space is critical to maintain comfort.

If using *gable walls* (end walls that rise up to the point of the roof; see illustration) consider installing openwork concrete louver blocks (see illustration) near the point of the roof *on both ends of the building* to permit airflow without water entry. In designs with ceilings, screen louver blocks on the inside and back the screen with sturdy 1cm wire mesh to prevent insects, birds, bats and other animals from nesting in the above-ceiling space.



Combine local knowledge and professional design. The combination of a knowledgeable architect and consultative design approaches can result in affordable solutions that simultaneously deliver comfort, durability, local maintainability and community acceptance. The school design illustrated below features a metal roof over round, open-top classrooms of mud-brick walls on concrete slabs. The roof both provides extended shade and harvests rainwater; the materials and circular forms are typical of the region. The design was developed in close consultation with a local community in Mali.

Image courtesy Ronald Rael, Rael San Fratello Architects

School sanitation and gender

Beyond its important public health dimensions, sanitation is also a gender equity issue:

Girls are particularly disadvantaged if no latrines or toilets are available, as they prefer more privacy than boys when relieving themselves. They are therefore inclined to seek locations beyond the school, putting themselves at greater risk. Alternatively, they may put up with greater discomfort than boys, with adverse impacts on concentration and learning.

The lack of private sanitary facilities for girls can discourage parents from sending girls to school and contributes to the drop out of girls, particularly at puberty.

(WELL FACTSHEET: School Sanitation and Hygiene Education. M Snell, 200 3.)

Fears of Kenyan School Children about Sanitation and Hygiene Facilities

Percentage of children interviewed who expressed fear of:

Snakes and other animals	86%
Falling into the pit	56%
Smells, filth, and insects	48%
"Black magic"	35%
Being left alone	14%

Source: *Low cost sanitation*, F. Pickford, 1995, as quoted in J. Zomerplaag and A. Mooijman, 2005.

Sanitation and Waste Management

To safeguard student and community health, provision for environmentally sound sanitation and waste management must be an integral part of school design.

Design of school sanitation and waste management infrastructure should address the considerations detailed in the table below:

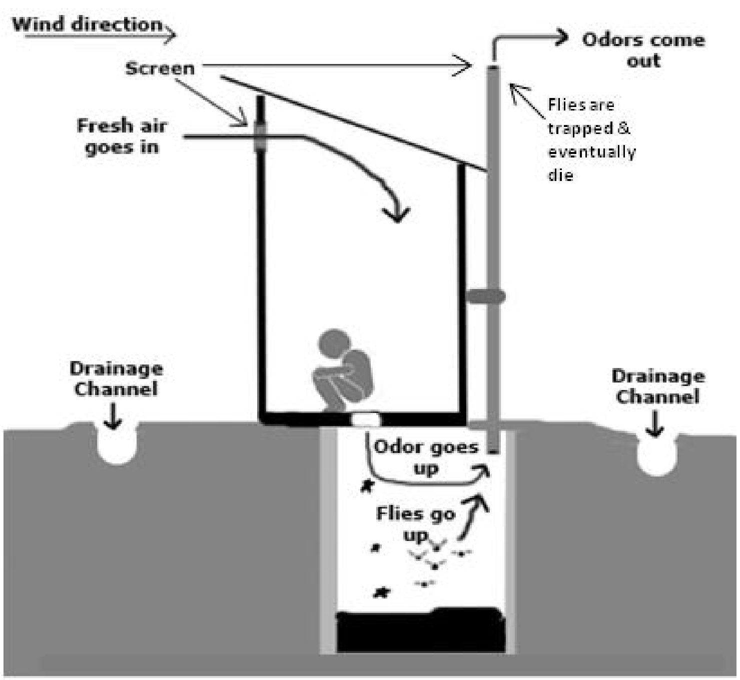
Design consideration	Comments and Guidance
Sufficient latrine capacity	A rule of thumb is one toilet per 20-30 students. Where male and female toilets must be kept strictly separated, the minimum number of toilets is one for each gender. Ideally, four latrines for students (two for boys and two for girls) and one for teachers should be provided for each two- classroom block. (Students and teachers should have separate facilities.)
Appropriate latrine technology	Basic pit latrines are open to disease vectors. Never ideal, they are particularly inappropriate for schools. Improved latrine designs that minimize odor (thus encouraging use), improve decomposition of wastes, and reduce the potential for insect vectors, runoff, or seepage to transmit disease are more suitable for schools. An example is the ventilated improved pit (VIP) latrine design (see diagram below). See (Greaves, 2008) for a discussion of latrine technologies and selection criteria. (Selection factors include depth of water table, soil type, and local preferences.)
Latrine siting/ configuration	The following are general guidelines for siting of latrines to prevent contamination of the school water supply and promote usage. Latrines should be sited at least 30 meters away from the school, kitchen, and wells. If possible, they should also be DOWNSLOPE of these facilities. (This is only a general rule of thumb; see the *Water and Sanitation* chapter of these *Guidelines* for more information.) If possible, site latrines downwind from classrooms using wind direction prevailing during the hot season. In some areas, cultural norms require that male and female latrines be widely separated. This and any other cultural requirements must be accommodated in latrine design and the site plan. For latrine designs that "fill up," the site plan must reserve locations for future latrine pits in close proximity to the first—when the first pit fills up, it is sealed, and the latrine top structure is moved on top of a new pit. If need be, sealed pits can usually be opened after a year and excavated; the contents should be reduced to a safe manure. (Though local attitudes in most of Africa prohibit its use on crops.)
Child-friendly design	Latrines only serve their function if they are used. Children will avoid latrines that are dark, have handles or locks placed for adult use, or have adult-sized squat holes. (See box at right: "Fears of Kenyan Schoolchildren. . .") *Children (and adults) also avoid poorly maintained latrines; see maintenance section.* If the school will service older students (common in many rural areas), both child- and adult-size latrines should be provided.

Design consideration	Comments and Guidance
Hand-washing stations	Handwashing is an essential complement to latrines in preventing oral-fecal disease transmission. (In addition, good hygiene practices learned at school are likely to be carried to the home.) Handwashing stations (see photos at right) should be located next to latrines or in locations where teachers can supervise use (such as by classroom entrances). Stations must be kept clean and well-drained. Signs or murals should be painted on latrines to encourage hand washing.
Solid waste management (burn pit, storage)	Day primary schools produce almost entirely general (i.e., non-hazardous) waste: food wastes, papers, plastic wrapping. The exception may be the contents of latrine waste bins, especially sanitary napkins/pads.) Appropriate food wastes (excluding oils, meats) should be composted. Except where reliable municipal collection exists (rare in rural areas), papers and non-compostable foods wastes should be burned; the school facilities should include a *fenced burn pit* (may be adjacent to latrines but well away from the water point) and a sealed barrel or bin for storing waste to be burned.

Examples of simple handwash stations: above: earthenware pots with spigots; below: suspended PET bottles. These designs do not require plumbing, but do require effective management to make sure water and soap are available.

Photos: USAID/Madagascar

The Ventilated Improved Pit (VIP) Latrine



Based on a drawing, courtesy of WELL, at http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/lcsahgt.htm

The "VIP" latrine is one of the most widely deployed and successful improved latrine designs, and is effective at reducing odors and insect vectors. This is a generic representation; several variants exist. When the pit fills up, the top structure can be moved to another.

Extensive references are available in the *Water and Sanitation* chapter of these *Guidelines*.

Consider rainwater harvesting

Roof rainwater harvesting (photo below) is a often an economical and effective way to help meet school water demands.

The water is suitable for washing and cleaning; slow sand filtering is often sufficient to render the water suitable for drinking,

Guttering and a rainwater collection tank generally do not add greatly to the cost of a school.

See resources section for more information.

Photo: USAID/Madagascar

Rainwater harvesting in Madagascar. Gutters lead to a circular storage tank made of plastered concrete blocks. A gravity-fed tap is located below the floor level of the tank.

Water supply

A safe, sufficient, and reliable water supply is likewise an integral part of sound school design. *If feasible*, this should also be a *dedicated* supply. Sharing existing public water supplies located near a school—or sharing the school water supply with the community—is a second-best solution, increasing health risks to students and teachers.

In addition, water supply design should address the considerations detailed in the table below:

Design consideration	Comments and Guidance
Sufficient quantity	10 liters per student per day is a good average estimate of day school supply requirements. Note that requirements can increase with climate, the latrine/toilet technology chosen (e.g. VIP vs pour-flush systems), religious/cultural practices, and water-intensive food preparation.
Potability	Both cooking and drinking water should be potable: • If other than a municipal supply, the proposed water source should be tested for potability. 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.) USAID has developed Guidelines For Determining the Arsenic Content of Ground Water in USAID-Sponsored Well Programs in Sub-Saharan Africa (http://www.usaid.gov/our_work/environment/compliance/ane/tool_shed/arsenic_guidelines.doc). This includes reference to the Hach arsenic test kit (http://www.hach.com) Simple and cost-effective test kits for E. coli and fecal coliforms are available through a variety of manufacturers (e.g., Idexx Colilert (http://www.idexx.com/water/colilert/) or Coliscan Easygel (http://www.micrologylabs.com/). • The following design *measures* should be followed to better assure that water remains potable: Site wells to reduce chance of contamination from latrines (see sanitation section) Assure that the ground around latrines drains away from water supply points. Always cover wells. A better option is to seal the well and install a manual pump. If feasible, regular water quality testing is desirable. Maintenance and proper operation is also important to assuring water purity; see operation and maintenance guidance, below.
Sufficient and separate supply points	Hand wash stations should be separate from water provision for cooking and drinking.

Landscaping, Grounds and Drainage

The school *grounds* are an integral part of school facilities. Grounds, including landscaping and drainage, should address the considerations detailed in the table below:

Design consideration	Comments and Guidance
Livestock Barrier	Livestock, unless part of school operations, should be prevented from entering school grounds to (1) prevent contamination of school grounds with excreta—especially kitchen areas, water supply points and classrooms; and (2) to protect school buildings and garden. *Live fencing* is the environmentally preferred livestock barrier and, depending on its full-growth height, may help block dust from road traffic and reduce temperatures in buildings and on school grounds. Local communities and contractors will know appropriate local "live fencing" species.
Runoff Management & Rainwater Harvesting	Gutters, drainage channels and site grading that prevent standing water and protect foundations, plantings and neighboring properties are important in all construction. In the context of schools, it is particularly important to assure that water supply points, handwashing stations, and kitchens are well drained, and that potential for standing water on school grounds is minimized. Erosion and gullying are significant problems in many African settlements and farming areas, as is groundwater depletion. So that schools do not contribute to these problems, drainage should be channeled to soakpits. (Even more ideally, rainwater should be harvested from roofs (see illustration, previous page) and excess channeled to soakpits.)
Plantings	As noted above, plantings can provide important shade, dust and erosion control, and livestock-barrier functions. Plantings for this purpose should be a part of school design; *landscape plants* should be indigenous or at least common to the area and well-suited to climatic conditions---i.e., after establishment, they should not require watering. These functional and any purely ornamental plantings are also aesthetic, generally enhancing the learning environment.

A typical school. How many of the features for "enhanced ventilation and thermal performance" (see page 7) do these structures feature?

Environmental Best Practice during Construction

In a well-sited, well-managed small-scale construction project, adverse environmental impacts should be minor if materials sourcing, site management, and the disposal of construction debris are handled in an environmentally sensitive manner.

For example, excavation of sand or gravel from stream/river beds can foul surface waters. Stagnant water that accumulates in borrow pits can breed mosquitoes. The former can be avoided by sourcing elsewhere; the second can be addressed by filling in the pit, managing drainage into the pit, etc.

These issues are not specific to the construction of schools and therefore no detailed guidance is provided here; please see the Small-Scale Construction chapter of these *Guidelines.*

Overview of Environmental Best Practice in Operation and Maintenance

Environmentally sound *design* of latrines, water supplies, drainage and building structures does not achieve its objectives unless complemented by appropriate cleaning and maintenance. While project proponents often have little or no control over school operations and maintenance after construction is complete, they can—and should—discuss with the community/school administration how maintenance will be undertaken during the operations phase. They can also help develop a maintenance plan/strategy.

It is best to identify maintenance needs and responsible parties during the design phase.

Often, at least some elements of cleaning and maintenance are a community responsibility—either directly, or in the form of local assessments and school fees. If the community's ownership of the school has been cultivated from the design stage, these community contributions are more likely to be forthcoming and sustained.

Environmental best practice in operation and maintenance is presented in the tables below. This framework can be used as part of a maintenance plan/strategy.

Photo: USAID/Madagascar

Latrine squat areas should be cleaned daily.

Sanitation

At all times
Provide waste bins in latrines for sanitary towels/pads. Girls should be advised not to dispose of these in the pit. A sturdy sign on the inside of the door should be adequate. Hand washing after toilet use must be strictly mandated.
Daily
Pick up any garbage in handwash areas, drain/sweep away any puddles; ensure soap and water are present. Empty latrine waste bins, disposing to secure storage for burn or burial pit. Wash "squat areas" inside the latrines. Should be part of daily student duties. Add ash from kitchen fires to latrines to control odors. Sweep classrooms, latrines, offices, and verandas. (Should be part of daily student duties). Clear any termite tunnels, wasp/bird nests from structure. Empty refuse (sweepings, litter, non-compostable food waste) to storage bin. Add appropriate food waste (not meat or oils) and landscape trimmings to compost.

Weekly
Wash latrine interior walls Wash school floors Burn refuse (paper, light plastic wrappings) and non-compostable food wastes in burn pit and cover with a light layer of soil. (**Conduct burn after school hours**.) Burn or bury the contents of latrine waste bins, as is most suitable to local customs. *Low-temperature (open-pit) burning of any plastic is not desirable, but burning plastic wrappings, packaging and lightweight containers (e.g. PET bottles, if not usable) is often the best of a set of poor options, especially as such wastes will be produced in very low volumes in most schools. Do NOT burn broken plastic pipes or guttering; these are likely made of PVC plastic and produce highly toxic smoke when burned.*

Water supply

Conduct any regular/periodic pump maintenance specified by manufacturer.

If an unshared bucket-well is in use, the number of individuals who draw water should be limited, and they should always wash hands before drawing water. The well cover should be kept locked to prevent unauthorized use.

Immediately upon need
Repair broken pumps. If repair is not prompt, students and staff may get water at unsafe locations. Have a plan for how this will be accomplished. This may require having extra parts on hand. A member of school staff or a community member should be trained in pump repair. They must know the warning signs for pump failure such as poor vacuum, leaking, difficult operation, etc. In some cases, a water user association may have or share responsibility for training, maintenance, fees and spare parts.
Daily
Clean drains and remove visible garbage around water point. Clean drinking water dippers (if containers are used instead of taps) and cups
Weekly
Check for any needed repair work/maintenance. Cleaning inside of water storage containers (if containers are used rather than taps.)
Monthly
Test water for bacteriological contamination. (See “assure potability” guidance under *Water Supply* design guidance, above.) (Monthly testing is ideal, but at least one test each in the wet season and dry seasons should be a minimum.) For rooftop rainwater harvesting systems: *Clean gutters, funnels, screens, and drains (also after any particularly strong storm)*
Seasonally
For rooftop rainwater harvesting systems: Check and repair gutters, funnels, and screens before start of rainy season. If accessible, clean inside of storage tank.

Landscaping, Grounds and Drainage

Daily (or as needed)

Pick up litter and store for burning.
Weekly (or as needed)
Water trees, shrubs, and live fencing at the roots in the evening for maximum water retention. (Landscape plants should be indigenous or at least common to the area and well-suited to climatic conditions---after establishment, they should not require watering.)
Clear drains
Monthly
Maintain berms around foundations; provide any needed maintenance to drainage structures.

Annotated Resources

Other *Small Scale Guidelines* Chapters

A number of the issues summarized in this guidance are treated in more detail in other chapters of *The Environmental Guidelines for Small-Scale Activities in Africa (2nd Edition).* Refer to these chapters for more detailed information on specific issues:

- Chapter 3 Construction
- Chapter 13 Safer Pesticide Use
- Chapter 15 Solid Waste
- Chapter 16 Water Supply and Sanitation

All chapters include extensive annotated bibliographies and are available for download at www.encapafrica.org.

Latrine Siting & Technology Selection

S. Sugden. The Microbiological Contamination of Water Supplies. (WELL Factsheet). April 2006. http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/Contamination.htm.

> Provides a risk assessment method for assessing risk of biological contamination of groundwater from pit latrines.

Greaves, Frank. *Selecting Appropriate Latrines. TILZ (Tearfund International Learning Zone) Footsteps Series no. 73. http://tilz.tearfund.org/Publications/Footsteps+71-80/Footsteps+73/Selecting+appropriate+latrines.htm*

> A short brief on latrine technology selection, including a decision flow chart and criteria ranking approach.

Boot, Niall. *Types of toilet and their suitability.* (Practical Action Technical Brief). August 2008. http://practicalaction.org/practicalanswers/product_info.php?cPath=22_82&products_id=356&attrib=1.

Rainwater Harvesting

Global Rainwater Harvesting Collective – http://www.globalrainwaterharvesting.org

> The Global Rainwater Harvesting Collective (GRHC) aims to empower schools in developing countries to improve their access to water by raising and channelling donor funding to local partners to assist grass root organizations and schools in building their own rooftop water systems. Website offers news, articles, photos, and for purchase films about rainwater collection systems.

Smet, Jo. *WELL Fact Sheet: Domestic Rainwater Harvesting,* 2003 - http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/drh.htm

> This fact sheet gives an overview of rainwater harvesting systems, component technology, planning and management and the potential effects and impacts. While the factsheet specifically addresses rainwater collection for domestic use, the information can be easily adapted to school contexts.

School Construction and Maintenance

Architecture & Behaviour Colloquium, Architectural Quality in School Buildings: School Building Design and its Relevance to Students’ Learning Performance - with a Specific Focus on the Planning and Design of Schools in Developing Countries, 12th Architecture & Behaviour Colloquium, March 30-April 1, 2006, Monte Verità, Ascona, Switzerland - http://www.colloquia.ch/en/colloquiums/aetc06.htm

The 12th Architecture & Behaviour Colloquium brought together researchers and representatives of instances implicated in decision making about and building of new schools to discuss the interrelationship between school buildings and the level of students' scholarly performances in developing country settings. Proceedings of the Colloquium will be published in the Architecture & Behaviour series.

Bonner, Roger R.M. & Das P.K., Vidyalayam, Cost Effective Technologies for Primary School Construction, Overseas Development Administration, New Delhi, 1996 (Department for International Development, British Development Cooperation Office, 50M Shantipath, Chanakyapuri, New Delhi - 110 021, India)

A very useful and practical guide on school building with some emphasis on innovative technology and practice to reduce costs, especially of roofs. This includes use of arches, corbelling and precast elements. Although some of the technologies presented have been little used outside India, others have more widespread application.

Building Advisory Service and Information Network (basin) case studies, produced by Swiss Resource Centre and Consultancies for Development (SKAT):

a. Education Development Project, School Infrastructure, Laos (1999) - http://www.basin.info/publications/skat/ef1-99.pdf

b. Rural School Construction in Nicaragua (2000) - http://www.basin.info/publications/skat/ef2-00.pdf

These briefs provide short case studies of design and construction of school infrastructure for education projects in Laos and Nicaragua. They address technical design and construction issues, as well as related institutional, community and project management issues.

Designshare, The International Forum for Innovative Schools - http://www.designshare.com/

The focus of this website is largely on schools in Western countries, North America in particular. It includes details on articles and a newsletter. The design awards are the most important component, where featured school buildings are described and plans, drawings and photographs presented.

Dierkx, René, *Toward Community-Based Architectural Programming and Development of Inclusive Learning Environments in Nairobi's Slums*, Children, Youth and Environments Vol. 13, No.1 (Spring 2003) - http://www.colorado.edu/journals/cye/13_1/Vol13_1Articles/CYE_CurrentIssue_Article_CommunityBasedArch_Dierkx.htm

An interesting article describing a project to redesign schools in Nairobi slums which involved incorporation of children's ideas in the design.

ITGD (now renamed Practical Action) Technical Brief, *School Buildings in Developing Countries*, 2005 - http://www.itdg.org/docs/technical_information_service/school_buildings_in_developing_countires.pdf

Discussion of design, construction, and maintenance requirements for schools in developing countries.

School / Shelter Hazard Vulnerability Reduction Resource Page, Caribbean Disaster Mitigation Project implemented by the Organization of American States Unit of Sustainable Development and Environment for the USAID Office of Foreign Disaster Assistance and the Caribbean Regional Program, 2001 - http://www.oas.org/cdmp/schools/schlrcsc.htm

Summarizes a long-term project to develop national plans to reduce vulnerability of school buildings to natural hazards in Latin America and the Caribbean. The project included a survey of existing school buildings to create vulnerability profiles and the development of school maintenance plans. In the Caribbean pilot project, a master manual of standards for the retrofitting or construction of schools/shelters and for estimating the costs was developed, as were individual reports describing results of property surveys in Anguilla, Antigua and Barbuda, Dominica, Grenada, and St. Kitts.

Sekkei Keikaku and World Education-Benin, "*Manuel de maintenance et d'entretien des infrastructures scolaires* (Manual for School Maintenance and Upkeep)", created for the "Projet de Construction d'Ecoles Primaires en République du Benin", 2004.

This manual, written in French, describes construction and maintenance techniques for primary schools in Benin.

Whitby, Garry, *Primary Community School Construction*, Appropriate Technology, Vol. 25, No. 1, June 1998, pp. 30 – 32.

A short case study on a rural school building programme in Malawi focusing on planning, building technologies, site selection, design and layout, community participation, tendering, gender strategy and training, and capacity building.

School Sanitation and Hygiene Education

IRC International Water and Sanitation Centre, School Sanitation and Hygiene Education (SSHE) Theme - http://www.irc.nl/page/114

School Sanitation and Hygiene Education (SSHE) focuses on the responsibility to provide children with an effective and healthy learning environment. It includes lists of publications, case studies, news, and links for sanitation and hygiene education in schools.

Snel, Mariëlle, *WELL Fact Sheet: School Sanitation and Hygiene Education*, 2003 - http://www.lboro.ac.uk/well/resources/fact-sheets/fact-sheets-htm/ssahe.htm

This fact sheet gives an overview on issues which arise in school sanitation and hygiene education (SSHE).

UNICEF, In-depth case study: school sanitation and hygiene promotion in Malawi. http://www.unicef.org/wes/index_case_study.html

UNICEF, *A Manual on School Sanitation and Hygiene*, 1998 - http://www.unicef.org/wes/Sch_e.pdf.

PART I is on School Sanitation and Hygiene Education at District and National Level. PART II School Sanitation and Hygiene Education at the School and Community Level includes a chapter on construction and maintenance of school facilities with useful discussion of early community involvement in design and the development of maintenance plans **prior** to construction.