Sustainable Wastewater Treatment for Schools

BORDA - ZAMBIA
Plot 2130 Mwambeshi road, Northmead,
P.O.Box 33493, Lusaka, Zambia
Website: www.borda-sadc.org

WASAZA
Plot 2130 Mwambeshi road, Northmead,
P.O.Box 33493, Lusaka, Zambia
Website: www.wasaza.org.zm
Case Study: Pestalozzi Zambia
Children’s Trust School

Challenge
The Pestalozzi Zambia Children’s Trust (PZCT) planned to expand their educational activities in Zambia in 2009 with the construction of a new school and children’s village in Ibex Hill, Lusaka. A core pillar of the PZCT education philosophy is social and environmental awareness, and accordingly integration of energy savings and water conservation systems was a priority for the design of the new school.

Solution
PZCT was introduced to BORDA and WASAZA through the German Toilet Organisation (GTO). This partnership gave way to the development of an innovative, environmentally friendly wastewater treatment solution: the first Decentralized Wastewater Treatment Solution (DEWATS) system implemented in Zambia. The innovative DEWATS system treats wastewater to a much higher standard than a conventional septic tank. Additionally the system allows for recovery of biogas energy and reuse of treated wastewater for school based agriculture. The DEWATS system functions purely biologically and through gravitational means and therefore requires no chemical additions or energy inputs.

Concept

Project Objectives
The partners implementing the DEWATS system had various objectives. The PZCT needed an on-site wastewater treatment solution as no centralised sewer existed in the area. PZCT additionally wanted an environmentally friendly sanitation solution that would prevent contamination of groundwater. They also saw the DEWATS system as an opportunity to provide the school with clean, renewable cooking energy and reuse of water resources, which would result in long-term cost savings and create a unique hands-on learning opportunity for the students. For BORDA and WASAZA the project provided an opportunity to implement a DEWATS demonstration project to showcase and promote innovative sanitation technologies in Zambia.

Facts & Figures

Location
Ibex Hill, Lusaka, Zambia

Purpose
On-site treatment of boarding school wastewater

Cost
USD $33,000 USD
• 20m³ BG: $6,000 USD
• ABR: $12,000 USD
• PGF: $5,000 USD
• 40m³ BG: $10,000 USD

Beneficiaries
220 boarding students + staff
160 day students + day staff

Funded by
German Toilet Organisation (GTO) and Pestalozzi Zambia Children’s Trust

Owner / Operator
Pestalozzi Zambia Children’s Trust

Construction Period
2009 (+40m³ BG addition in 2013)

Infrastructure Layout
• User Interface - flush toilets
• Conveyance - sewer pipeline

Treatment
• 20m³ Biogas Digester (BG-20)
• 40m³ Biogas Digester (BG-40)
• 100 m³ Anaerobic Baffled Reactor (ABR-20),
• 100 m² Horizontal Planted Gravel Filter (PGF)

Wastewater Source & Amount
Toilets, Bathroom, Kitchen

Amount of Wastewater
• Black + Grey Water (Flush Toilets, Bathroom, Kitchen); partial grey water separation
• 23m³/day
Sanitation Infrastructure

The original DEWATS built in 2009 consisted of three treatment modules: a biogas digester, anaerobic baffled reactor (ABR) / anaerobic filter (AF) and horizontal planted gravel filter (PGF). The system was originally designed for 140 full-time boarding students. However, by 2013 the school had expanded to over 220 full-time boarding students and an additional 160 day students. Therefore in 2013 the project partners renewed their collaboration to build an additional 40m$^3$ digester integrated in series with the original digester to provide added wastewater treatment capacity and increased gas production.

**Primary Treatment** is provided by the 40m$^3$ and 20m$^3$ biogas digesters which allow for settling of organic solids. As these organic solids decompose within the anaerobic conditions of the digester, biogas (a mixture of methane and carbon dioxide) is produced. Supplementary agricultural and organic kitchen waste is also added to the digesters to increase gas production. The biogas is piped back to a school kitchen for cooking use on a gas stove and a modified brick rocket stove, which previously used only firewood as cooking fuel.

**Secondary Treatment** is provided by a 100m$^3$, nine chamber anaerobic baffled reactor and anaerobic filter. The liquid effluent overflow from the biogas digesters is directed in an up and down motion through the chambers of the ABR forcing the wastewater through a layer of biologically active sludge which accumulates in the bottom of each chamber. The last three chambers of the ABR are anaerobic filters filled with varying sizes of stones as filter material. This filter material provides a surface on which microorganisms grow thus

---

**Biogas Source & Utilization**
- Domestic sewage and kitchen waste
- Biogas used for cooking in school kitchen

**Energy recovery**
- 3.3m$^3$ biogas recovered per day
- (78% methane content)
  Equivalent to:
  - 6,000kg of firewood savings
  - 17 tonnes of CO$_2$ (GHG emissions reduced per year
  - 3,350 ZMW ($5560 USD) financial savings per year

**Effluent Reuse**
Sub-surface irrigation in fruit orchard

**Project Partners**
- BORDA – Technical Experts
- WASAZA – Technical Experts; health and hygiene education
- GTO – Co-financing; health and hygiene education
- Pestalozzi Zambia Children’s Trust Co-financing and construction

---

**Biogas Source & Utilization**
- Domestic sewage and kitchen waste
- Biogas used for cooking in school kitchen

**Energy recovery**
- 3.3m$^3$ biogas recovered per day
- (78% methane content)
  Equivalent to:
  - 6,000kg of firewood savings
  - 17 tonnes of CO$_2$ (GHG emissions reduced per year
  - 3,350 ZMW ($5560 USD) financial savings per year

**Effluent Reuse**
Sub-surface irrigation in fruit orchard

**Project Partners**
- BORDA – Technical Experts
- WASAZA – Technical Experts; health and hygiene education
- GTO – Co-financing; health and hygiene education
- Pestalozzi Zambia Children’s Trust Co-financing and construction

---

**Primary Treatment** is provided by the 40m$^3$ and 20m$^3$ biogas digesters which allow for settling of organic solids. As these organic solids decompose within the anaerobic conditions of the digester, biogas (a mixture of methane and carbon dioxide) is produced. Supplementary agricultural and organic kitchen waste is also added to the digesters to increase gas production. The biogas is piped back to a school kitchen for cooking use on a gas stove and a modified brick rocket stove, which previously used only firewood for cooking fuel.

**Secondary Treatment** is provided by a 100m$^3$, nine chamber anaerobic baffled reactor and anaerobic filter. The liquid effluent overflow from the biogas digesters is directed in an up and down motion through the chambers of the ABR forcing the wastewater through a layer of biologically active sludge which accumulates in the bottom of each chamber. The last three chambers of the ABR are anaerobic filters filled with varying sizes of stones as filter material. This filter material provides a surface on which microorganisms grow thus
Further reducing the organic content of the wastewater.

**Tertiary Treatment** is provided by a 100m² PGF filled with 10-20mm stone filter material. This treatment step provides both anaerobic and aerobic treatment as well as partial nutrient removal provided by the reeds, canna and other water-loving plants growing in the filter material.

3.3m³ of biogas is recovered on a daily basis (YR: 2014), equivalent to an overall annual reduction of 6000kg firewood, 17 tonnes of CO₂(eq) GHG emissions, and a cost-savings of $560 USD per year.

**Water Reuse** - upon discharge from the DEWATS, the treated effluent is used to provide irrigation of a banana orchard through French Drains (sub-surface irrigation system, which distributes water horizontally in top, biologically active soil layer. This prevents direct contact with the effluent and allows the remaining nutrients and contaminants in the effluent to be absorbed by the fruit trees and filtered through the top soil layer thus preventing direct contamination of groundwater, as would occur in a conventional vertical soak-away system.

**Overall the DEWATS treatment system reduces organic content (COD) by 76%**.

**Operations and Management**

The DEWATS system runs purely through biological and gravitational processes, thus requiring no added chemicals or energy inputs. However, operations and maintenance is still critical to the performance of the system. The digesters, ABR and AF will need to be desludged periodically. The PGF requires regular removal of old plant material to prevent premature blockages. Additionally, the gas stoves must be cleaned maintained for maximum performance. WASAZA and BORDA provide support to PZCT and also have trained PZCT on O&M tasks so these tasks can be done as much as possible in-house.

---

**Bremen Overseas Research & Dev Association (BORDA)**

BORDA is specialist organization active in the fields of poverty alleviation and sustainable protection of natural resources. Since 2001, BORDA has concentrated on development-oriented cooperation projects and services in the field of Basic Needs Services (BNS). These projects are geared towards the development and dissemination of sustainable, decentralized service models with the intent of improving the supply of Basic Needs Services.

**Water & Sanitation Association of Zambia (WASAZA)**

WASAZA is a NGO registered in 1999. The goal of WASAZA is to harness sector expertise, competencies, promote best practice and provide overall professional support to water and sanitation to develop the sector and improve service delivery. WASAZA's role in civil society is to contribute towards access to modern, affordable and appropriate water and sanitation processes and technologies for urban, peri-urban and rural communities.