Designing a Water and Sanitation Centre Prototype for Monwabisi Park, Cape Town

An Interactive Qualifying Project submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science

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Abstract

The World Health Organization recognizes poor sanitation as one of the world's most common preventable risks leading to mortality, particularly in informal settings like Monwabisi Park, Cape Town. By researching the global context and current conditions, comparing sanitation system options, and defining system parameters, we created a final proposal for an experimental sanitation centre at the Indlovu Project that outlines a dry composting scheme, a facility floor plan, and specifications for on-site management, community education, and future sustainable adaptations.

This project report is part of an ongoing research program by students of the WPI CTPC to explore and develop options for sustainable community development in the informal settlements of South Africa. For more information please go to: http://www.wpi-capetown.org/

The following is an executive summary of a full project report that has been implemented as a website available at: http://wpi-capetown.org/projects/2009/water-sanitation/

Problem Statement

The World Health Organization recognizes inadequate or unsafe water supply and poor sanitation as one of the most common "preventable risks" leading to mortality across the globe (World Health Organization, 2009). Cape Town, South Africa is not exempt from this global epidemic of inadequate water infrastructure. As the apartheid era came to a close, rural South Africans began to migrate to the major cities in order to exercise their hard earned rights for equal opportunity. This massive influx of people led to an over-saturated job market and the swell of temporary "squatter camps" such as Monwabisi Park, located within the larger Khayelitsha township. In the absence of significant large-scale efforts to either improve or relocate these communities, Monwabisi Park and similar settlements have gradually evolved into permanent domiciles severely lacking in structured water or sanitation planning and the provision of even the most basic services (Granfone *et al*, 2008).

Background

In the spirit of newfound equality, the post-apartheid Bill of Rights declared "the rights of access to basic water supply and basic sanitation" for all (Republic of South Africa, 1996) as prescribed by the water and sanitation service ladder policies (City of Cape Town, 2008). The municipalities of this fragile fledgling government were then faced with the unprecedented task of introducing water and sanitation services into informal, unstructured environments like Monwabisi Park.

The City of Cape Town has made significant efforts to improve service provision in Monwabisi Park and the 220 informal settlements in Cape Town, bringing municipal water supply and some toilet provision. The Water and Sanitation Department has installed "pour-flush" toilets in the park, yet these toilets are located on the outskirts of the park and approximately three quarters of them are now nonfunctioning. As an alternative, residents must defecate openly or construct rudimentary pit latrines which pose construction difficulties due to limited space, often emit strong odors, contribute to the contamination of the region's soil and ground water supply, and are consistently unsanitary for the user. Other informal settlements have been offered a similarly unsanitary solution of City "black buckets", or 20-25 litre buckets distributed to the settlement and removed and replaced weekly by municipal workers (Goldberg, 2009). The residents of Monwabisi Park refused this primitive service and thus remain in the lowest bracket of sanitation services as defined by the City for all informal settlements (City of Cape Town, 2008). The City also provides free, clean water to Monwabisi Park via municipal water taps. Many of these taps, however, are broken due to vandalism and misuse, leading to the overuse of the remaining functional taps and promoting leakages that cause erosion and further tap failure. Contamination of the clean city water due to unsanitary practices at the taps is also a problem, as personal hygiene practices like hand washing are not frequently advocated or applied. When coupled with the lack of proper sanitation provisions, these unsanitary practices have led to a proliferation of diarrheal diseases within the park.

Though the City recognizes the need for new, more effective and sustainable approaches to service provision, the department is operating with very limited resources. Fortunately, the sanitation situation faced by the people residing in Monwabisi Park and other informal settlements has attracted the interest of organizations beyond the responsible local governments. The Shaster Foundation for Community Development, a Cape Town PBO founded in 1993 by Di Womersley, has established their principal project within Monwabisi Park's C-Section. The Indlovu Project is a comprehensive, integrated development plan based on the principles of sustainability, conservation, and the concept of an Eco-

Village. This community-led initiative including a crèche, a soup kitchen, youth centre, guest house, and backpackers' lodge "forms the heart of the Monwabisi Park informal settlement" (Shaster Foundation, 2008). WPI piloted its project-based partnership with the Shaster Foundation in 2007 through the design and construction of a communal laundry facility. Since then, project teams from WPI have collaborated with the community, the City, and the University of Cape Town to document the current water and sanitation conditions within the Park and propose both individual designs for improved infrastructural components as well as a comprehensive Model Sanitation Facility (Granfone *et al*, 2008). In addition, case studies of water and sanitation conditions across the globe, ranging from infrastructure after rapid urbanization in Cambodia (Chen & Solon, 2004) to a pilot free-standing ablution facility in the suburbs of Cape Town (Mels *et al*, 2008), document useful parallels to Monwabisi Park. These studies, which evaluate the efforts of a wide range of government and aid organizations, provide a solid experimental basis for redevelopment within informal settlements.

Despite the work that has already been done in Monwabisi Park, there is still a desperate need for immediate water and sanitation services. Thousands of citizens continue to follow unsafe sanitation practices, largely due to the lack of available alternatives. The law requires a family-to-toilet ratio of 5:1, and yet even if all toilets are assumed functional 69 families must still share a single stall. Water contamination still exists within the park, and the alarming 2005 Khayelitsha infant mortality rate of 34.72% indicates that hygiene practices have not sufficiently improved to prevent the spread of disease (Granfone *et al*, 2008). Previously gathered information on the conditions of Monwabisi Park and possible methods of providing clean water and sanitation to its residents may have set the stage for improvement, but have provided little to date in terms of tangible change for the community.

Mission and Objectives

The goal of this project was to devise an integrated and sustainable plan that would promote proper water sanitation and hygienic health practices as well as improve the general availability of toilets within Monwabisi Park. Specifically, we aimed to design an experimental Sanitation Facility to service the "Redevelopment Seed" (2008 Atlas) of C-Section and provide a working blueprint for similar facilities elsewhere. Several main objectives were identified in order to achieve this goal, including familiarizing ourselves with the Park's sanitation history and current conditions, researching the successes of past and present redevelopment efforts, defining the user population and priority components of a sanitation centre, and mapping the facility's dimensions within the new row housing plan. Finally, by integrating the results of these objectives, we aimed to design the facility and to plan for its use as an experimental research site by future WPI teams, the University of Cape Town, and other collaborators.

Methodology

We began to address our objectives by acquainting ourselves with the current water and sanitation conditions within the park and their development. Granfone *et al* (2008) and Carbonneau *et al* (2009) provided much of this preliminary research, and further communications with City of Cape Town officials, water and sanitation specialists, and the Indlovu Centre community once in Cape Town served to solidify this basis for our work. Such research was an important step in determining what had been successful or unsuccessful in the past and what resources were available to us. We also conducted further research on global parallels to the situation within Monwabisi Park. These case studies, ranging from examples of poorly defined infrastructure to community-led upgrading, all provided additional valuable considerations for our planning.

Once familiarized with the current conditions, we began to define system parameters for the sanitation facility. This process was again contingent on further communications with city authorities, professionals, and community members, as well as the constraints of the facility's experimental nature, to assess the target population for our work and their expectations for the services provided by the facility.

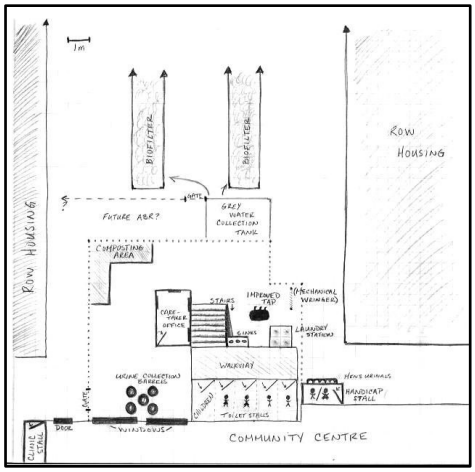
Defining user load and priority services allowed us to begin designing an appropriate sanitation system and corresponding facility floor plan. The remaining key considerations for these designs then became centralized versus decentralized systems, water-borne versus waterless systems, commercial versus "do-it-yourself" designs, and the spatial planning of the available space. Important criteria for evaluating these options included spatial requirements, financial investment, maintenance expectations, and health risk control, which were explored based on system descriptions and vendor responses to our "Request for Proposal", or RFP. With these elements in mind, we integrated the sanitation system and priority facility components into a functional community space.

In order to achieve successful facility operation and significant improvements to health and sanitation, a caretaker position for the centre was defined. City and local interest in involvement was analyzed, and preliminary job descriptions, salary recommendations, training programs, and caretaker responsibilities were mapped out. Appointment of the caretaker was outlined as a selection process with sensitivities to community politics and personal levels of responsibility.

We recognized that we possessed neither the skills nor the time on site required to complete this facility ourselves, so we defined who would manage the construction, who would provide the physical labor, and how the community would be involved in the process. In conjunction with the WPI Gardens team, we also created a plan for the testing and maintenance of the compost in order to monitor the effectiveness of the system and to prevent community exposure to contaminated compost. Similarly, we incorporated a plan for testing the quality of grey water effluent in order to control the contamination of soil and ground water. We planned to continue our collaboration with the University of Cape Town, the City of Cape Town, and the Shaster Foundation in order to examine the outcome of this facility and address the possibility of its replication in other areas of Monwabisi Park.

Results

Based on the spectrum of extensive research conducted over the course of our project, each facility component and operational system was integrated into a comprehensive Sanitation Centre plan. The site blueprint, pictured to the right, was designed to aesthetically accommodate all priority elements within the row housing scheme of the Redevelopment Seed. These plans also reflect considerations for experimentation and future sustainable adaptations.



Method of Sanitation

After much research into both "wet" and "dry" sanitation techniques, we decided to implement a urine divergent dry composting system for our facility. We based this decision on the particular benefits that a dry compost system had to offer within this area of Monwabisi Park, including the independence from a water source, the possibility of producing useable compost for the community, and the relative simplicity of the working parts.

Design Parameters

We designed the toilet facility and waste processing method to handle a 200 person user capacity. We calculated the daily expected waste quantities to be 24 Kg of feces, 220 L of urine, and 3500 L of grey water. Using these numbers we designed a facility to fit within the housing redevelopment scheme. The best location was determined to be between the proposed row housing in a low profile area abutting the Community Centre. The standard spatial requirements of average toilet stalls are approximately 0.9 meters in width and 1.7 meters in length, allowing for five adjacent stalls within the allotted space as well as the potential for future expansion.

Odor control within these stalls is also a major design consideration. The collection containers will be located in an airflow-controlled environment to assure no foul odors advance into the stall. The airflow will also be controlled using carefully placed electric fan powered vent pipes.

Grey Water Management

Grey water will be collected from the on-site sinks, taps, and the laundry facility and run into a holding tank for testing. The water will then travel through a reed bed gravel biofilter and will be collected in a secondary holding tank for further testing. Initially, the water will be run into soakaways under nearby roads and footpaths, with the goal that this grey water will be recycled back to the facility and to local agriculture pending extensive future testing.

Hand Washing

In order to encourage good hygiene around the toilet stalls, a hand washing station is also included in the facility designs. Three basins with raised taps will be fixed to the facility's outer wall. These sinks will be volume-release controlled, and will also be located in close proximity to the caretaker's office to allow for the caretaker to simultaneously act as repair person, overseer for vandalism prevention, and educator on hygienic practices.

Laundry Station

The plans for a laundry station in conjunction with the rest of the Water Centre designs are largely the same as the station installed by the 2007 Cape Town IQP team and burnt down in the 2008 Indlovu Centre fire. Due to the enormous volume of water used and grey water produced through laundry washing, the previous four-basin structure will be reinstituted to further limit water use, with the possible provision of a drying rack or fabric ringer to aid in the drying process.

Caretaker

One of the toughest challenges to this project beyond the design and construction of the Sanitation Centre is the social integration of the new concepts and ideas that go along with it. The success of the facility is contingent on proper user education, as well as community instruction on beneficial sanitary practices. We recommend that the City and Indlovu Project jointly appoint a caretaker with a strong sense of personal responsibility and community rapport to fulfill this didactic role, while also holding responsibility for composting operations and routine facility upkeep and cleaning. The facility will also be gated to prevent possible vandalism during non-operational hours. Through our experiences with the MobiSan case study (Mels *et al*, 2008), we recognized that residents will accept shared public composting

toilets if kept scrupulously clean and free from vandalism. Thus the facility should only be open while the caretaker is on duty.

Collection and Composting

Solid waste from urine divergent toilets will be collected in a container directly beneath each toilet stall. We will initially use 200 litre drums to collect the waste; however a box, bucket, or similar container may be substituted. Urine will be diverted and collected in separate 200 litre drums. The containers will be well ventilated during collection, then moved to a secondary treatment area. The waste will be fully composted in this separate location using a form of pasteurization to assure pathogen removal. This area will be well ventilated and positioned to absorb maximum sunlight. Similarly, urine will be collected in 200 litre drums, stored, and dispersed through the grey water biofilters till future testing can confirm its efficacy as a sustainable resource.

Conclusions and Recommendations

In light of the complexities encountered in the structural designs and the dry composting process of our sanitation centre designs, physical site construction was postponed beyond our stay in Cape Town. We hope, however, that our compilation of research precedents and original designs will provide the completed site plan necessary to erect a functional, sustainable, and socially acceptable sanitation centre to service the Monwabisi Park, C-Section community.

In addition to these designs, alternate avenues of research during our work led us to a few key recommendations for the future. These include:

1. *Waterborne "Flush Toilet" Systems*: Future teams should further develop our preliminary research on Anaerobic Baffled Reactors for on-site, closed loop wastewater treatment in informal settlements.
2. *Waste Reuse Process:* After waste has been fully composted and tested for safety, it may be applied to local gardens as fertilizer. Initially, these gardens should contain only non-edible plants until testing can confirm the necessary quality of compost required for edible plants. Any separated urine may be contained and rested, then diluted with water in a ratio of at least 1:8 (Germer, 2009) and used to fertilize gardens.
3. *Data and Testing:* This site is also designed as an experimental research facility. Recorded data will be used by future WPI students and research partners to make recommendations and advance the sustainable design of the sanitation facility. We have initiated partnerships with students and faculty from the University of Cape Town to collaborate on developing the facility and related research opportunities, and also encourage the City of Cape Town to take advantage of these pilot schemes while planning for future redevelopment projects.

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