08

CHAPTER EIGHT

CONCLUSION

8.1
ENVIRONMENTAL IMPACT ASSESMENT

The EIA proved to be an appropriate method to evaluate the treatment of waste water as it provides a holistic overview for unique, specific projects which needs to be approved by appointed environmental consultants.

The following Environmental Impact Assesment report was compiled by the author. Environmental water specialist engineer, Coert Welman and waste specialist engineer, Nico Coetzee assessed and approved the EIA as a preliminary feasibility study. The principals of the water treatment process diagram (Figure 7.1) was approved by the environmental specialist and permission was hypothetically given to continue with the design of the facility.

8.2
THE SUSTAINABILITY BUILDING ASSESSMENT TOOL

The SBAT sustainable rating tool has been included for comparative research purposes to conclude the dissertations rating according to sustainability standards. The graph in Figure 8.1 indicates a low rating for the materials used in the project,yet the technical resolution of the project sets out to use recycled materials, steel off-cuts and renewable resources. The SBAT rating system is for residential application, but lacks adaptability and the understanding that each project has unique potential.

8.3
CONCLUSION

The months of research and exploration has led to an understanding of the extent of contamination entering our environment from the industrial and mining sector. The author's consultation with the environmental specialists Coert Welman and Nico Coetzee revealed the need for interventions such as the water treatment and research facility proposed by the author. The specialists recognized the academic contribution as valuable and advised that the project has potential to be used pilot plant which could be applied on larger scale at the point source. The specialists confirmed that the concept of intercepting contamination can be applied as an intensive on site remediation plan to address the more complex issue of contaminated groundwater.

Summarised Water Treatment and Research Facility with Community Development Interface Environmental Impact Assessment Information 21 October 2016

(Compiled as a planning document for early the Feasibility Phase assessment activity and discussion with Environmental Consultant Specialists – which are still to be appointed – ***Document For Internal use only)***

Section 1 – Information describing the project	Details
☐ **Purpose and physical characteristics of the property**	**Water Treatment and Research Facility with Community Development Interface** **Location:** North western quadrant of the intersection of the R42 and R57, Vanderbijlpark **Site:** 12.9 Hectare, Facility: 3768sqm **Objective:** Removal of heavy metals from industrial effluent – pilot facility for onsite water remediation for large industries. The facility is a small scale specialised environmental rehabilitation water treatment facility which intercepts and treats water (historically) known to be contaminated by industrial effluent containing heavy metals. The project allows for the collection of water which flows along natural storm waterway canals from contaminated land/ water sources), thus preventing known contaminated water from entering the Vaal River system. The site earmarked for the facility is situated at the intersection of the R42 and R57 in Vanderbijlpark.
☐ **Proposed access and transport arrangements**	New ring road access from existing R42 and R57 as well as adjoining Municipal roads will be included into the project. These access options are ideal for the initial Construction Phase and eventual operation of the overall facility on completion of the project. Public transport infrastructure options will provided and be utilised for the Construction and eventual operation phase of the development.
☐ **Numbers to be employed**	**Construction phase:** approximately 200 Employees at peak periods **Operating of the facility:** approximately 92 employees
☐ **Land use requirements and other physical features of the project**	The site is a proclaimed road reserve which has been rezone to a municipal servitude. There is evidence that landscape has been slightly disturbed, due to the proclaimed road excavations and back filling done a few decades back, but never completed. A portion of the facility's footprint sits on the disturbed landscape. Provincial and Municipal planning departments have indicated that there are no existing further plans with the current earmarked site.
☐ **Production process and the operational features of the project**	The facility will use an established algae treatment process as well as a natural wetland water treatment method (situated along the spine of the facility). The production of silk within the facility supplies fabric medium for the algae biofilm and forms part of the intended Community Development Interface.
☐ **Type and quantities of raw materials, energy and other resources consumed**	Methane (biogas) produced on site by the bio digesters will be used for cooking and heating requirements for the site. Construction materials include steel, concrete and gabion walls.
☐ **Residues and emissions by type, quantity, composition and strength**	The removal of heavy metals will be performed by the algae. Chromium, Lead and Copper have been identified and will be removed. The algae biofilms will be placed into an anaerobic bio digester generating Bio gas. Water from the sludge thickening process will enter the algae process again. Sludge containing traces of heavy metals will be removed and taken off site to be incinerated. Air Emissions need to comply with Section 8.1 of Air emissions act. *Note: The Feasibility Phase of the Project will consider the Waste Hierarchy options ensure waste disposal at a hazardous waste site is considered as a last option for this project.*
☐ **Main alternative sites and alternative processes considered**	An alternative site was considered closer to the industrial area, yet the flat topography didn't allow for gravity flow of the industrial effluent through the treatment processes. The current site's sloped gradient facilitates natural movement of the water is ideal for this project. Heavy metal removal through phytoremediation was considered as an alternative method, yet flash floods and storm water flow would wash all the heavy metals into the river network.
Section 2 – Information describing the site and its	**Details**

Summarised Water Treatment and Research Facility with Community Development Interface
Environmental Impact Assessment Information
21 October 2016

(Compiled as a planning document for early the Feasibility Phase assessment activity and discussion with Environmental Consultant Specialists – which are still to be appointed – ***Document For Internal use only)***

environment	
Physical features	
☐ **Population – proximity and number**	Currently uninhabited
☐ **Flora and fauna – in particular protected species and habitats**	High diversity, no protected species found
☐ **Soil – agricultural quality, geology and geomorphology**	Unknown
☐ **Water – aquifers, water courses and shorelines**	Existing natural wetland and stormwater canals
☐ **Air – climatic factors, air quality, etc.**	Airshed Priority Area in terms of the National Environmental Management Act (39/2004) – See Air Quality Act requirements listed at www.environment.gov.za
☐ **Architectural and historic heritage, archaeological sites and features**	None
☐ **Landscape and topography**	Natural gradient towards the river – via natural existing storm waterways
☐ **Recreational uses**	None
Policy framework	
Information considered in this section should include all relevant statutory designations such as sites of special scientific interest, areas of outstanding natural beauty, national parks, green belts, scheduled ancient monuments and listed buildings, etc. *Reference should also be made to national, regional and local planning policy, and relevant EC directives.*	The site's wetland is currently performing environmental tasks of water filtration and purification, yet the heavy metals remain untreated and are potentially entering the Vaal River network. The project intends to protect the existing wetland as well as the established natural diversity.
Section 3 – Assessment of effect	**Details**
Including direct and indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the project.	
Effects on humans, buildings and man-made features	
☐ **Change in population arising from the development**	The water treatment and research facility has an important focus on Community Development. The facility intends to create work for the women of the community through the production of silk on site. The facility has a community auditorium and exhibition hall, yet these are daily visitors/employees and not permanent residents.
☐ **Visual effects of the development on the surrounding area and landscape**	The facility has been submerged into the disturbed landscape. The landscaped architectural form has been designed to be modest and simple. The roof level of the facility does not exceed the existing tree's heights of 10meters.
☐ **Levels and effects of emissions from the development during normal operation**	Incineration of the sludge with traces of heavy metals will take place off site according to regulation. The latest Technology (meeting all the requirements of the Air Quality Act) may allow for onsite incineration facility, which provides the benefit of utilising the onsite bio gas as fuel gas. This will be determined during the Feasibility phase of the Project.
☐ **Levels and effects of noise from the development**	Minor noise from the fabrication of silk. The facility is within close proximity to the R42 and R57. The nearby township of Bophelong township's edge is 1km from the facility.
☐ **Effects of the development on local roads and transport**	A new road has been proposed which links the original town of Vanderbijlpark to the facility. The new road claims an unmanaged series of parks 500meters from R42 and R57 intersection. An existing service road is widened for two way traffic to the facility. The facility will make provision for transport infrastructure on site for employees and community access to the public facilities & spaces on the site.
☐ **Effects of the development on buildings, architectural and historic heritage, archaeological feature and human artefacts**	None
Effects on flora, fauna and geology	

Summarised Water Treatment and Research Facility with Community Development Interface
Environmental Impact Assessment Information
21 October 2016

(Compiled as a planning document for early the Feasibility Phase assessment activity and discussion with Environmental Consultant Specialists – which are still to be appointed – ***Document For Internal use only)***

☐ **Loss of, and damage to, habitats and plant and animal species**	The site is 12.9 hectare. 2.6 hectare or 20% of the site has been disturbed. The detention dam (7600sqm) and portion of the facility (3768sqm) will be constructed on disturbed land. The project proposes to keep 75% of the site as conservation area for natural biodiversity. Which leaves the remainder for the optional development of the public facilities, a clinic and an agricultural land remediation centre.
☐ **Loss of, and damage to, geological, paleontological and physiographic features**	None
☐ **Other ecological consequences**	The intention is for the existing ecology to be strengthened by the facility – the facility eventually becoming a micro ecosystem with organisms, plants and insects which uses natural systems to support the process of removal of heavy metals.
Effects on land	
☐ **Physical effects of the development**	The facility is located on the edge of a low lying wetland basin and requires a diversion berm and cut off berm to protect it from extreme flooding conditions.
☐ **Effects of chemical emissions and deposits on site and surrounding land**	Heavy metal hazardous waste will be removed from site and treated according to regulations as a last resort. *Note: Waste Hierarchy viable options will assessed during Feasibility.*
Effects on water	
☐ **Effects of the development on drainage pattern in the area**	The industrial effluent containing heavy metals flowing in the open storm canals will be intercepted and stored in a detention dam before treatment. The stormwater from the eastern residential area and south east Vaal Mall will be directed into the existing wetland via gabion canal.
☐ **Changes to hydrographical characteristics**	Improvement of the quality of water entering the Vaal River via existing natural water ways
☐ **Effects on coastal or estuarine characteristics**	None
☐ **Effects of pollutants, waste, etc. on water quality**	Improvement of the quality of water entering the Vaal River as well as removal of water contaminants
Effects on air and climate	
☐ **Level and concentration of chemical emissions and their environmental effects**	None on site
☐ **Particulate matter**	None – All processes will meet Air Quality Act
☐ **Offensive odours**	None
☐ **Any other climatic effects**	None
Other indirect and secondary effects associated with the project	
☐ **Effects from traffic related to the development**	Unknown :Early logistics study to be done for Feasibility Phase
☐ **Effects arising from the extraction and consumption of materials, water, energy or other resources by the development**	Consumption of Materials The onsite fabrication of silk for the algae biofilm improves the environmental footprint of the treatment facility. A renewable, biodegradable material. Water The monthly rainwater is harvested to use directly for washing of hands, cooking and drinking. Clean raw water from the treatment process and the site grey water will enter the treatment wetland and flow into river network. Clean raw water will be used for the flushing of toilets and cleaning of equipment. Any domestic solid waste from the site will be handled according to Municipal requirements. Energy The methane from the bio digesters is used for the staff canteen and heating requirements. All organic waste is fed into the bio digester. Minimal Electrical power would have to be established to manage and

Summarised Water Treatment and Research Facility with Community Development Interface
Environmental Impact Assessment Information
21 October 2016

(Compiled as a planning document for early the Feasibility Phase assessment activity and discussion with Environmental Consultant Specialists – which are still to be appointed – ***Document For Internal use only)***

	control the overall facility. An option to generate electrical power on site by using Bio gas remains an option for this project.
☐ **Effects of other developments associated with the project**	impact on the environmental issues of contaminated land, water and community health will be addressed through developing the agricultural soil remediation centre and Bophelong clinic.
Section 4 – Mitigating factors	**Details**
Where significant adverse effects are identified, a description of the measures to be taken to avoid, reduce or remedy those effects	
☐ **Site planning**	Will be dealt with during EIA planning, activities and interaction with the District community communication sessions.
☐ **Technical measures:** – Process selection – Recycling – Pollution control and treatment – Containment	All these aspects of Technology Selection and alternative options according to the Waste management Hierarchy will be addressed during the Feasibility phase to ensure the Project as a whole is sustainable and successful for the community of Bophelong as a whole.
☐ **Aesthetic and ecological measures:** – Mounding – Design, colour, etc. – Landscaping – Tree planting – Measures to preserve habitats – Recording of archaeological sites – Measures to safeguard historic buildings	Final design and aesthetic options will be presented to the Client – to all decision making & assessment at the end of the Feasibility Phase.
Section 5 – Risk of accidents and hazardous developments	**Details**
When the proposed development involves materials that could be harmful to the environment in the event of an accident, the environmental statement should include an indication of the preventative measures that will be adopted so that such an occurrence is not likely to have a significant effect.	Full formal Project and Technical Risk studies will be undertaken during the early stages of the Feasibility Phase (for the entire Water Treatment and Research Facility with Community Development Interface). Risk reports will be communicated to Client, Local and Provincial Environmental Departments – to ensure all are informed and approvals and support for this positive environmental remediation type project is expedited.

Document assembled by: Jani Grala, Peter Grala (Process and Project Management Engineer), Nico Coetzee (Waste Treatment Specialist Engineer), Coert Welman (Environmental Water Act Specialist Engineer)

SUSTAINABLE BUILDING ASSESSMENT TOOL RESIDENTIAL

1.04

Achieved

SB SBAT REPORT 4.7

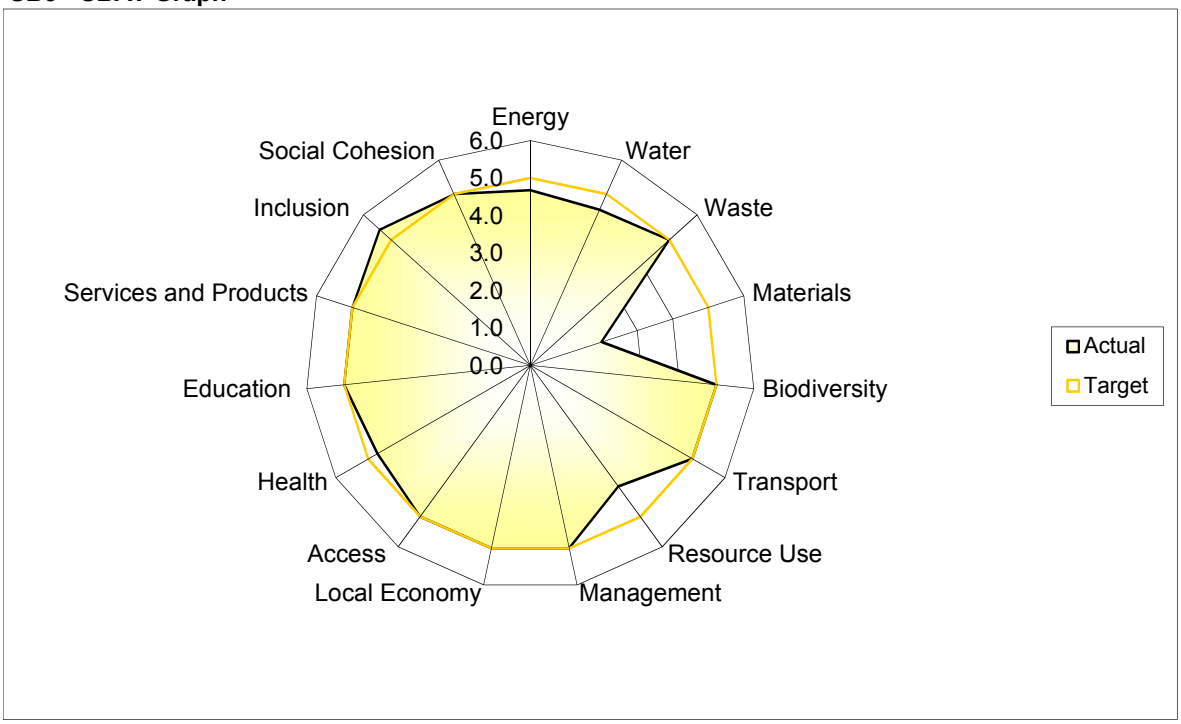
SB1 Project

Water Treatment and Research Facility with Community Development Interface

SB2 Address

North western quadrant of the intersection of the R42 and R57, Vanderbijlpark

SB3 SBAT Graph



SB4 Environmental, Social and Economic Performance	Score
Environmental	4.2
Economic	4.8
Social	5.0
SBAT Rating	4.7

SB5 EF and HDI Factors	Score
EF Factor	4.4
HDI Factor	5.0

SB6 Targets	Percentage
Environmental	85
Economic	96
Social	101

Figure 8.1: SBAT rating for the water treatment facility. (Author,2016)

8.4
LIST OF FIGURES

CHAPTER 5 - PROGRAMME

CHAPTER 6 - DESIGN DEVELOPMENT

CHAPTER 7 - TECHNICAL EXPLORATION

CHAPTER 8 - CONCLUSION

8.5
BIBLIOGRAPHY

Amoroso, N. 2010. The exposed city: mapping the Urban Invisibles. Grafos SA, Barcelona, Spain

BDLive: report questions steel firm ArcelorMittal's social responsibility. 2013. Online:www.bdlive.co.za/business/industrials/2013/11/29/report [accessed 20 April 2016]

Bergstedt, M. 2013. ChEnG: Rotating Algal Biofilm Reactor. Online: www.aiche.org [Accessed 26 August 2016]

Brockett, L. 1996. The History of planning South African new towns: Political influences and social principles adopted. Department of Town and Regional Planning, University of Witwatersrand. Online: dspace.nwu.ac.za/bitstream/handle/10394/5351/No_40 (1996 [Accessed 14th of April 2016]

Central Sericultural Research & Training Institute (CSRTI) :Women in Sericulture. Online: http://www.csrtimys.res.in/women-sericulture (Accessed 22 October)

Chemical Forum: Sizing of Anaerobic Digester Online: http://www.chemicalforums.com/index.php?topic=36925.0 [Accessed 08 September 2016]

ChEnected: Rotating Algal Biofilm Reactor. Online: http://www.aiche.org/chenected/2013/11/rotating-algal-biofilm-reactor-on-location. (Accessed 22 October 2016)

Climate-Data.Org. Climate: Vanderbijlpark. Online: http://en.climate-data.org/location/27392/ (Accessed 21 April 2016)

Divisare: Institute for forestry and nature research. Online: http://divisare.com projects/16701 (Accessed May 2016)

DotMap: Mapping South Africa with dot distribution. Online: https://dotmap.adrianfrith.com/ (Accessed 20 February 2016)

Emfuleni Local Municipality. 2014. Emfuleni Spatial Development Framework 2014/15 Online:http://www.emfuleni.gov.za/index.php/documents-77289/list-of-documents/spatial-development-framework-sdf.html [Accessed 24th of February 2016]

Emfuleni Local Municipality. Online: http://www.emfuleni.gov.za/ (Accessed 02 March 2016)
Engineering News: Anaerobic digestion in wastewater treatment. Online: http://www.engineeringnews.co.za/article/anaerobic-digestion-in-wastewater-treatment-2012-03-30 (Ac-cessed 20 August)

Environmental Affairs and Tourism. 2007. The Vaal Triangle Priority area baseline

assessment findings and proposed air quality management interventions. Online: http://www.deat.gov.za.vaal [Accessed 24th of February 2016]

Fazal, S. 2013. Conceptualizing Peri-urban Interface: land use dynamics in a developing country: regional perspectives from India

Gibbons, D. Consultancy to the Mekong Wetlands Biodiversity Program

Groenewald, M. 2000. Bioaccumulation of metals and the general health of fish from the Vaal dam and Vaal river barrage. Magister scientiae in zoology in the Faculty of Science, Rand Afrikaans University.

Hallowes, D. Toxic Futures: South Africa in the Crises of Energy, Environment and Capital

Health Budget Speech: MEC for Health MS QEDANI MAHLANGU AT THE GAUTENG LEGISLATURE. 2015

John, G., Clements-Croome, D. & Jeronimidis, G. 2005. Sustainable building solutions: a review of lessons from the natural world. Building and Environment, 40(3), pp.319-328.

Kiron, M. 2011. Textiles: Characteristics of Silk Fabrics| Properties of silk fabrics. Online: textilelearner.blogspot.co.za [Accessed 26 August 2016]

Littman, J. 2009. Regenerative Architecture: A Pathway beyond Sustainability. Masters Theses. University of Massachusetts

Lucas, R. 2016, Research Methods for Architecture, Laurence King Publishing: London, p.45
Malik, A. 2004. Environmental International: Metal bioremediation through growing cells. Department of applied chemistry, faculty of engineering, utsunomity University. Issue 30 (261-278)

Meadows, D. 2009. Thinking in systems a primer. Online: http://www.ess.inpe.br/courses/lib/exe/fetch.php?media=wiki:user:andre.zopelari:thinking_in_systems_a_primer.pdf [Accessed 05 October 2016]

Meadows, D., Meadows, D.L. & Randers, J. 2004. A Synopsis Limits to Growth the 30 year update. Online: http://www.donellameadows.org/wp-content/userfiles/Limits-to-Growth-digital-scan-version.pdf [Accessed 05 October 2016]

Munnik, A. 2012. Discursive power and Environmental justice in the new South Africa: the steel valley struggle against pollution. University of the Witwatersrand.
O'Flaherty, P. 2015. IOL: The hard reality about SA steel industry. Online: www.iol.co.za/business/opinion [Accessed 17 April 2016]
Online: Engineering http://news.mit.edu/2016/silk-based-filtration-material-breaks-barriers-0623 [Accessed 24 July 2016]

Orandi, S. 2012. Biofilm establishment and heavy metal removal capacity of an indigenous mining algal-microbial consortium in a photo-rotating biological contactor. Online: http://www.ncbi.nlm.nih.gov/pubmed/22644382 [Accessed 02 September 2016]

Peres, E. 2016. The translation of ecological resilience theory into urban systems. University of Pretoria

Planet trading. Online: https://www.4colored.com/en/content/10-silk (Accessed 07 October 2016)

Priority area baseline assessment findings and proposed air quality management interventions. 2007
Quodlibet, G. 2005. Manifesto del Terzo Paesaggio, Macerata

Rahmathulla, V. 2012. Journal of Entomology: management of climatic Factors for Successful Silkworm (Bombyx Mori) crop and higher silk production: A Review. Online: www.hindawi.com [Accessed April 2016]

ResearchGate: Use of Algae for Removing Heavy Metal Ions From Wastewater: Progress and Prospects. Online: https://www.researchgate.net/publication/7473476_Use_of_Algae_for_Removing_Heavy_Metal_Ions_From_Wastewater_Progress_and_Prospects (Accessed 22 October 2016)

Saier, M. 2010. Phytoremediation. Water, Air and soil pollution, supplement Issue 205 (61-63)
SANS 10400 : South African Standard Code of Practice for the National Building Regulations. 2011. THE COUNCIL OF THE SOUTH AFRICAN BUREAU OF STANDARDS

Siderwicz, M. 2016. Silk-based filtration material breaks barriers: Engineers find Nano sized building blocks of silk hold the secrets to improved filtration membranes.

The Bench Marks Foundation. 2013. Steel at any cost: a community voice perspective on impacts of ArcelorMittal's operations in Vanderbijlpark, South Africa. Online: http://www.bench-marks.org.za/press/arcelor_mittal_report_nov2013.pdf [Accessed April 2016]

The RIBA President's Medals Student Awards: The Living dam. Online: http://www.presidentsmedals.com/Entry-36301 (Accessed May 2016)

Typical soil properties. Online: https://elibrary.asabe.org/data/pdf/7/sd2009/chap3_cdfiles/Guidelines_for_spreadsheets.pdf (Accessed 24 October 2016)

Vaal Environmental Justice Alliance, 2015. Women Paying the Price for Stolen Tomorrows – The impacts of mineral based industrialization in the Vaal.

Vaal triangle Air shed Priority Area Air Quality Management Plan _Final Plan Government Gazette, 28 May 2009 No.32263

Van der Ryn, S., Cowan, S. 1996. Ecological Design. Washngton, DC:Island Press

Wang, R. 2015. Ecotoxicology and Environmental Safety: evaluation of silkworm excrement and mushroom dreg for the remediation of multiple heavy metal/metalloid contaminated soil using pakchoi. Issue 124 (239-247)

Watkins, D. Shaft No.2: Rescripting the future of Johannesburg's 3rd landscape's through Architecture of the Terraine Vague. Faculty of Art, Design and Architecture University of Johannesburg.

WebMD: Serrepeptase, 2009. Online: www.webmd.com [Accessed April 2016]

*ANNEXURE A_*
USER'S ACCOMODATION SCHEDULE

Silkworm Rearers (6 trays per a person)
1st Instar (3-4days): 18 trays (50dfl each) – 3 workers
2nd Instar (2-3days): 54 trays – 9 workers
3rd instar (2-3days): 108 trays – 18 workers
4th instar (3-4days): 180 trays – 30 workers
5th instar (6-8days): 360 trays – 60 workers
Total – 60 workers for highest work load
The Rearers will also be responsible for the mulberry plantation.
Biofilm Fabrication
2 cocoon sorters
2 boilers
5 reelers
2 waste removal
1 fabrication manager
Total permanent staff – 11 people
Algae and Wetland System
5 biofilm workers
3 waste removal workers
1 manager
Total permanent staff - 8 people
Researcher Department
1 Algae Culturist Laboratory
1 Silkworm Geneticist Laboratory
1 System Ecologist Laboratory
1 Hydrologist Laboratory
1 Receptionist
Total permanent staff – 5 people
Canteen/Leisure
1 Receptionist
3 Canteen Staff
4 Cleaners
Total permanent staff – 8 people
Auditorium
Max 50 Student visitors/ Students attending lectures/ Community members attending lectures

Size of the Detention dam calculation

	June	July	August	September	October	November	December	January	February	March	April	May
Ave Temperature - Celsius	9.4	9.6	12.5	16.6	19.2	20.0	21.0	21.5	21.3	19.8	16.3	12.7
Base flow - industrial run off												
Daily	400	400	400	400	400	400	400	400	400	400	400	400
Month	12000	12400	12400	12000	12400	12000	12400	12400	11200	12400	12000	12400
Rainfall												
mm	8	10	6	24	67	98	105	114	88	75	52	23
Catchment area m2	704384	704384	704384	704384	704384	704384	704384	704384	704384	704384	704384	704384
Total ave Daily rainfall m3	187.8	234.8	140.9	563.5	1573.1	2301.0	2465.3	2676.7	2066.2	1761.0	1220.9	540.0
Ground & Catchment absorption of rainfall 50%	93.9	117.4	70.4	281.8	786.6	1 150.5	1 232.7	1 338.3	1 033.1	880.5	610.5	270.0
Evaporation 2%-10% based on heat pattern	4.0	5.1	4.0	21.3	68.6	104.6	117.7	130.8	100.0	79.2	45.2	15.6
	-97.9	-122.5	-74.4	-303.0	-855.2	-1 255.1	-1 350.3	-1 469.1	-1 133.1	-959.7	-655.7	-285.6
Ave Daily rain run off entering dam	90	112	66	260	718	1 046	1 115	1 208	933	801	565	254
Ave Daily total water entering dam	490	512	466	660	1 118	1 446	1 515	1 608	1 333	1 201	965	654
Processing Capacity												
9 hours processing time @100% capacity												
18 min to fill/empty system=36min	469.88	469.88	469.88	469.88	469.88	469.88	469.88	469.88	469.88	469.88	469.88	469.88
Daily 2.5 cycles per day	1174.7	1174.7	1174.7	1174.7	1174.7	1174.7	1174.7	1174.7	1174.7	1174.7	1174.7	1174.7
Daily water storage requirment												
Only positive amounts require storage	-685	-662	-708	-514	-57	271	340	433	158	27	-209	-520
Excess/(adtional processed) water in the month	-21 228.64	-20 535.19	-21 956.18	-15 940.39	-1 760.28	8 407.31	10 549.54	13 417.99	4 909.59	822.64	-6 493.38	-16 128.47
Total cumulative water in system	-	-	-	-	-	8 407.31	18 956.85	32 374.84	37 284.43	38 107.07	31 613.70	15 485.22

Size of detention dam (m3) **7 621.41**

Summary	June	July	August	September	October	November	December	January	February	March	April	May
Daily ave Base flow - industrial run off	400	400	400	400	400	400	400	400	400	400	400	400
Daily ave Rainfall	188	235	141	564	1 573	2 301	2 465	2 677	2 066	1 761	1 221	540
Daily ave total water entering dam	490	512	466	660	1 118	1 446	1 515	1 608	1 333	1 201	965	654
Daily ave processing capacity	1 175	1 175	1 175	1 175	1 175	1 175	1 175	1 175	1 175	1 175	1 175	1 175
	June	July	August	September	October	November	December	January	February	March	April	May
Excess water processing capacity	21 228.64	20 535.19	21 956.18	15 940.39	1 760.28	-	-	-	-	-	6 493.38	16 128.47
Dam capacity	15 485.22	-	-	-	-	8 407.31	18 956.85	32 374.84	37 284.43	38 107.07	31 613.70	15 485.22

Rain Water Havesting Information

	June	July	August	September	October	November	December	January	February	March	April	May
Ave Temperature - Celsius	9.4	9.6	12.5	16.6	19.2	20.0	21.0	21.5	21.3	19.8	16.3	12.7
Area of roof catchment												
Planted roof (Noth)	349	349	349	349	349	349	349	349	349	349	349	349
Planted roof (South)	288	288	288	288	288	288	288	288	288	288	288	288
Silk fabrication	238	238	238	238	238	238	238	238	238	238	238	238
Canteen	277	277	277	277	277	277	277	277	277	277	277	277
Rearing hall (North)	190	190	190	190	190	190	190	190	190	190	190	190
Rearing hall (South)	236	236	236	236	236	236	236	236	236	236	236	236
Labs (North)	285	285	285	285	285	285	285	285	285	285	285	285
Labs (South)	285	285	285	285	285	285	285	285	285	285	285	285
Rainfall Data												
mm	**8**	**10**	**6**	**24**	**67**	**98**	**105**	**114**	**88**	**75**	**52**	**23**
Total roof Catchment area m2	2148	2148	2148	2148	2148	2148	2148	2148	2148	2148	2148	2148
Total ave Daily rainfall m3	0.57	0.72	0.43	1.72	4.80	7.02	7.52	8.16	6.30	5.37	3.72	1.65
Planted roof absorption of rainfall 50% m3	0.08	0.11	0.06	0.25	0.71	1.04	1.11	1.21	0.93	0.80	0.55	0.24
Evaporation 2%-10% based on heat pattern m3	0.02	0.03	0.02	0.13	0.42	0.64	0.72	0.80	0.61	0.48	0.28	0.10
	-0.11	-0.14	-0.09	-0.38	-1.13	-1.68	-1.83	-2.01	-1.54	-1.28	-0.83	-0.34
Ave Daily rain harvested in tanks m3	0.46	0.58	0.34	1.33	3.67	5.34	5.69	6.15	4.76	4.09	2.90	1.31
Ave Daily total harvested m3	0.46	0.58	0.34	1.33	3.67	5.34	5.69	6.15	4.76	4.09	2.90	1.31
Water Demand Requirements												
Water consumption based on per person usage m3	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14	1.14
Daily water excess/(shortage)												
Only positive amounts require storage	-0.67	-0.56	-0.80	0.20	2.53	4.20	4.55	5.02	3.62	2.95	1.76	0.17
Excess water in the month	-20.91	-17.34	-24.69	6.08	78.41	130.22	140.98	155.51	112.18	91.53	54.48	5.26

ANNEXURE D_
USER'S WATER DEMAND

KOHLER.

Home : Water Calculators : Commercial Water Calculator

Commercial Water Calculator

This calculator will assist in estimating your commercial building's water usage in comparison to the U.S. average and the LEED baseline. This tool is for illustration purposes only.

Building Information

Choose your calculation unit:	Liters
Days per year the building is occupied:	250
Number of male occupants:	50
Number of female occupants:	42

	Your Building	US Average	LEED Baseline
Toilets			
Liters per flush:	4.2	7.6	6.1
Flushes per person per day (men):	1	1	1
Flushes per person per day (women):	3	3	3
Water use (liters/day):	739.2	1,337.6	1,073.6
Urinals			
Liters per flush:	0.49	5.7	3.8
Uses per males per day:	2	2	2
Water use (liters/day):	49.0	570.0	380.0
Bathroom Sink Faucets			
Liters per minute:	1.9	7.6	1.9
Minutes per person per day:	.5	.5	.5
Water use (liters/day):	87.4	349.6	87.4
Showers			
Liters per minute:	N/A	7.5	9.5
Average shower duration per person (min.):	0.0	0.0	0.0
% of staff using showers:	0	0	0
Water use (liters/day):	0.0	0.0	0.0
Kitchen/Dining Area Faucets			
Liters per minute:	5.7	7.6	8.3
Minutes per person per day:	.5	.5	.5
Water use (liters/day):	262.2	349.6	381.8

	Your Building	US Average	LEED Baseline
Calculation Results			
Liters per person per day:	12.4	28.3	20.9
Liters per day:	1,137.8	2,606.8	1,922.8
Liters per month:	34,608.5	79,291.0	58,485.8
Liters per year:	284,450.0	651,700.0	480,700.0
% Reduction vs. average:	56.4%		
% Reduction vs. LEED Baseline:	40.8%		

In accordance with Regulation 4(e) of the General Regulations (G.57) for dissertations and theses, I declare that this thesis, which I submit for the Master of Architectural (Professional) at the University of Pretoria, is my own work and has not been submitted by me for a degree at this or any other institution.

I further state that no part of my thesis has already been or is currently being, submitted for any degree, diploma or other qualification.

I further declare that this thesis is my own work. Where reference is made to the work of others, the extent to which that work has been used is indicated and fully acknowledged in the text and list of references.

I further declare that the information in this document is recorded as perceived by the author and combine in its various parts to create a narrative of a polluted environment with no specific mention of the polluter, rather refering to the polluter as the collective heavy industry.

Jani Grala
2016