UMGENI WATER

Proposed Darvill Constructed Wetland, Pietermaritzburg

DRAFT ENVIRONMENTAL MANAGEMENT PROGRAMME

Issue Date: March 2017
Revision No.: 1
Project No.: 13396

CONTENTS

1 INTRODUCTION 1

2 AIM AND OBJECTIVES OF THE EMPR 1

3 COMPLIANCE WITH APPLICABLE LAWS 2

4 COMPLIANCE WITH THE EMPR 3

4.1 CONTRACTOR 3
4.2 IMPLEMENTATION AND COMPLIANCE WITH THE EMPR 3

5 DETAILED SCOPE OF EMPR 3

5.1 CONDITIONS OF CONTRACT / ROLES AND RESPONSIBILITIES 3

6. PRE-CONSTRUCTION (SITE SET-UP OR ESTABLISHMENT) PHASE 5

6.1 ACCESS TO THE SITE 5
6.2 PREPARATION OF METHOD STATEMENTS AND/OR MANAGEMENT PLANS 5
6.3 OFFICER PERMITS REQUIRED 5
6.4 PROVISION OF BULK SERVICES 6
6.5 LAYOUT OF CONSTRUCTION CAMP 6
6.6 ENVIRONMENTAL AWARENESS & TRAINING 7
6.7 STORM WATER MANAGEMENT 7
6.8 SOIL MANAGEMENT 7
6.9 CONSERVATION OF NATURAL RESOURCES 8
6.10 SECURITY FENCING AND LIGHTING 8
6.11 NOISE IMPACTS AND DESIGNATED WORKING HOURS 8
6.12 CULTURAL HERITAGE ENVIRONMENT 9

7 CONSTRUCTION PHASE 9

7.1 ACCESS TO THE SITE AND HAULAGE ROADS 9
7.2 MAINTENANCE OF THE CONSTRUCTION CAMP 9
7.3 ABLUTION & EATING FACILITIES 10
7.4 PROVISION FOR CAMP WASTE DISPOSAL & SET-UP OF WASTE MANAGEMENT PROCEDURES 10
7.5 VISUAL IMPACTS 11
7.6 STAFF CONDUCT 11
7.7 DUST/AIR POLLUTION 11
7.8 NOISE ASSOCIATED WITH CONSTRUCTION ACTIVITIES 12
7.9 SOIL EROSION 12
7.10 STORM WATER CONTROL 13
7.11 WATER QUALITY MANAGEMENT 14
7.12 WATER AND SOIL CONTAMINATION 16
7.13 STOCKPILE MANAGEMENT 16
7.14 GENERAL & HAZARDOUS SUBSTANCES AND MATERIALS 17
7.15 RISKS ASSOCIATED WITH MATERIALS ON SITE 19
7.16 HANDLING OF HAZARDOUS MATERIALS 19
7.17 WASTE MANAGEMENT 20
7.18 VEGETATION 21
7.19 AVI-FAUNAL 21
7.20 TRAFFIC 22
7.21 SOCIAL IMPACTS TO THE NEIGHBOURING RESIDENTS 22
7.22 COURTESY 23
7.23 THEFT AND POACHING 23
7.24 FIRE CONTROL 23
7.25 WELDING 23

8 OPERATIONAL EMP 23
8.1 SOCIAL RESPONSIBILITY 23
8.2 STRUCTURES 24
8.3 STORMWATER RUNOFF ALONG THE HARDENED SURFACES OF THE CONSTRUCTED WETLAND (SOIL WASH) 24
8.4 DISTURBANCE OF THE LINEAR FLOW CHANNEL 24
8.5 CHANGE IN SUBSURFACE WATER MOVEMENT 24
8.6 POLLUTION OR CONTAMINATION RISK 24
8.7 AIR QUALITY 25
8.8 WATER QUALITY MANAGEMENT DURING THE OPERATION OF THE CONSTRUCTED WETLAND 25
8.9 MONITORING OF WETLAND HEALTH 25
8.10 EMERGENCY PROCEDURES AND EMERGENCY SITUATIONS 25
8.11 SPILL MANAGEMENT PLAN 26
9 AMENDMENTS TO THE EMPR 27

LIST OF TERMS USED

Contaminated water:
Means any water contamination by the Contractor's activities, e.g. concrete water and run-off from plant / personnel wash areas.

Contractor:
Persons/organisations contracted by the Developer to carry out parts of the work for the planned development. The Contractor must ensure compliance with this EMPr of his entire team and any sub-contractors appointed. The contractor is responsible for the site and is liable should he or any of his sub-contractors contravene any portions of the EMPr and associated environmental legislation. The contractor must request advice from the Environmental Control Officer where considered appropriate.

Construction Phase:
The Construction Phase is the period of commencement of physical disturbance to the land, excluding rehabilitation activities, such as re-vegetation and replacing of topsoil.

Demolition:
The removal of unwanted existing infrastructure and associated materials.

Environment:
The surroundings within which humans live and that consist of:

- the land, water and atmosphere of the earth;
- micro-organisms, plant and animal life
- any part or combination of (i) and (ii) and the interrelationships among and between them; and the physical, chemical, aesthetic and cultural properties and conditions of the foregoing that influence human health and well-being.

Environmental Audit:
A systematic, documented verification process of objectively obtaining and evaluating evidence to determine whether specified environmental activities, events, conditions, management systems, or information about these matters conform with audit criteria, and communicating the results of this process to the client.

Environmental Control Officer:
The person appointed by the Developer who will provide direction to the Project Engineer concerning the activities within the Construction Zone, and who will be responsible for conducting the environmental audit of the project during the construction phase of the project according to the provisions of the Environmental Management Programme as well as the conditions of the Environmental Authorisation.

Environmental Management Programme: A legally binding working document, which stipulates environmental and socio-economic mitigation measures that must be implemented by several responsible parties throughout the duration of the proposed project.

Groundwater:
All subsurface water that fills voids between highly permeable ground strata comprised of sand, gravel, broken rocks, porous rocks, etc. and move under the influence of gravitation.

Hazardous substance:
A substance which can have a deleterious effect on the environment, as defined in the Regulations for Hazardous Biological Agents, 2001.

Interested and Affected Parties (I&AP's):
Those individuals or organisations who have an interest in the proposed development or will be directly affected by the activities of the development, as identified in the environmental impact assessment process.

Landscape Philosophy:
The landscaping design ethic, style and standard that is commensurate with ecological sustainability including the conservation and rehabilitation of the local landscape and the promotion of the aesthetics of the built environment by complementing the architectural style of the development. It is determined by a number of elements including the client's brief and the Provincial and Local Authority requirements.

Method Statement:
A method statement is a written submission by the Contractor to the Engineer in response to the specification or a request by the Engineer, setting out the plant, materials, labour and method the Contractor proposes using to carry out an activity, identified by the relevant specification or the Engineer when requesting a Method Statement. It contains sufficient detail to enable the Engineer to assess whether the Contractor's proposal is in accordance with the Specifications and/or will produce results in accordance with the Specifications.

Pollutant:
A contaminant at a concentration high enough to endanger the environment or the public health.

Pollution:
National Water Act, 36 of 1998:
"Water pollution means the direct or indirect alteration of the physical, chemical or biological properties of a water resource so as to make it –

less fit for any beneficial purpose for which it may reasonably be expected to be used; or
harmful or potentially harmful –

(aa) to the welfare, health or safety of human beings;
(bb) to any aquatic or non-aquatic organisms;
(cc) to the resource quality; or
(dd) to property".

National Environmental Management Act, No. 107 of 1998:-
"pollution means any change in the environment caused by –

- *substances;*
- *radioactive or other waves; or*
- *noise, odours, dust or heat*
- *emitted from any activity, including the storage or treatment of waste or substances, construction and the provision of services, whether engaged in by any person or an organ of state, where that change has an adverse effect on human health or well-being or on the composition, resilience and productivity of natural or managed ecosystems, or on materials useful to people, or will have such an effect in the future."*

Project Engineer:
Person/organisation appointed by the developer to oversee the work of the Contractor. The Project Engineer must liaise with the Environmental Control Officer.

Rehabilitation:
Rehabilitation is defined as the return of a disturbed area to a state which approximates the state (wherever possible) which it was before disruption.

1 INTRODUCTION

SiVEST Environmental Division were appointed by Umgeni Water, to conduct an **Environmental Impact Assessment Process** in terms of Regulations **21 to 24** of the Regulations compiled in terms of Chapter 3 of the **National Environmental Management Act, 1998** (Act 107 of 1998) as amended **2014**. The project will be registered with the National Department of Environmental Affairs (DEA). In addition a Water Use License is also being applied for. This EMPr serves as an Environmental Management tool by providing a generic structured plan of mitigatory measures, which serves as a guide to assist in minimising the potential environmental impact of the activities that may arise during the pre-construction, construction and operational phases of this development.

This EMPr provides a set of guidelines for the Environmental Management of all works executed by the Developer, Project Engineer, Contractor and Subcontractor/s to have a minimum impact on the environment in accordance with all relevant legislation, policies and standards.

In this context it should be viewed as a dynamic or 'living' document, which may require updating, or revision during the life-cycle of the development to address new circumstances as the need arises. It is essentially, a written plan of how the environment must be managed in practical and achievable terms.

The effectiveness of the EMPr is limited by the level of adherence to the conditions set forth in this report by the Developer, the Contractor and Sub-contractors. It is further assumed that compliance with the EMPr will be monitored and audited as set out in this EMPr and contractual clauses.

2 AIM AND OBJECTIVES OF THE EMPr

The aim of the EMPr is to:

- Identify those construction activities identified for the proposed development that may have a negative impact on the environment;
- Outline the mitigation measures that must be taken and the steps necessary for their implementation; and
- Describe the reporting system to be undertaken during construction.

The objectives of the EMPr are to:

- Identify a range of measures which could reduce and mitigate the potential adverse impacts to minimal or insignificant levels;
- Provide a pro-active and practical working mechanism to enable the measurement and monitoring of environmental performance on site, i.e. to provide guidance for the environmental auditing of the project;
- Provide management structures that address the concerns and complaints of I&AP's pertaining to the development;
- Ensure that the environmental specifications are identified, effective and contractually binding so as to enable compliance on site.

3 COMPLIANCE WITH APPLICABLE LAWS

The supreme law of the land is “The Constitution of the Republic of South Africa”, which states: “Every person must have the right to an environment which is not detrimental to his or her health or well-being”.

Laws applicable to the protection of the environment in terms of Environmental Management (and relating to construction activities) include but are not restricted to:

- Atmospheric Pollution Prevention Act, No 45 of 1965
- Aviation Act, No 74 of 1962
- Conservation of Agricultural Resources Act, No 43 of 1983
- Environmental Conservation Act, No 73 of 1989
- Explosives Act, No. 26 of 1956
- Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, No 36 of 1947
- Forest and Veld Conservation Act, Act No 13 of 1941
- Hazardous Substances Act, No 15 of 1973
- KwaZulu-Natal Health Act, No 4 of 2000
- KwaZulu-Natal Planning and Development Act No 5 of 1998 (re: soil conservation)
- Land Survey Act, No 9 of 1921
- Machinery and Occupational Safety Act, No. 6 of 1983
- Mines and Works Act, No. 27 of 1956
- Minerals Act, No 50 of 1991
- Mineral Development Draft Bill
- National Environmental Management Act, No. 107 of 1998
- National Environmental Management: Air Quality Act(AQA), No 39 of 1994
- National Environmental Management Biodiversity Act, No 10 of 2004
- National Forests Act, No 84 of 1998
- National Heritage Resources Act, No. 25 of 1999
- Natal Nature Conservation Ordinance 15 of 1974
- National Water Act, No 36 of 1998
- National Water Act (amendments)
- National Veld and Forest Fire Act, No 101 of 1998
- Occupational Health and Safety Act, No 85 of 1993
- Provincial and Local Government Ordinances and Bylaws
- Soil Conservation Act, Act No 76 of 1969
- Sub-division of Agricultural Land Act Repeal Act 64 of 1998 (re: soil conservation)
- Water Services Act No 108 of 1997

and all regulations framed there-under and amendments there to.

Of particular importance is **Section 28 (1) of the National Environmental Management Act, Act No. 107 of 1998** (NEMA) which places an obligation on all individuals to take due
care of the environment and to ensure remedial action is instituted to minimize and mitigate environmental impact.

The EMPr forms part of the Contract Documentation and is thus a legally binding document. In terms of this Act an individual responsible for environmental damage must pay costs both to the environment and human health and the preventative measures to reduce or prevent additional pollution and/or environmental damage from occurring. This is referred to as the *Polluter Pays Principle*.

4 COMPLIANCE WITH THE EMPr

4.1 Contractor

The Contractor is deemed not to have complied with this generic EMPr if:

- Within the Darvil Constructed Wetland site, during the Construction Phase, adjacent areas and haul/ access roads there is evidence of contravention of clauses;
- If environmental damage ensues due to negligence;
- The Contractor fails to comply with corrective or other instructions issued by the Local Authority, Project Engineer or Environmental Consultant within a specified time; and
- The Contractor fails to respond adequately to complaints from the public.

Application of a penalty clause will apply for incidents of non-compliance. The penalty imposed will be per incident. Unless stated otherwise in the project specification, the penalties imposed per incident or violation will be:

Failure to demarcate working areas	R10 000
Working outside of the demarcated area	R30 000
Failure to strip topsoil with intact vegetation	R50 000
Failure to stockpile topsoil correctly	R30 000
Failure to stockpile materials in designated areas	R10 000
Pollution of water bodies and/or groundwater (incl. increased suspended solid loads)	R20 000
Failure to implement storm water management provisions during construction	R20 000
Failure to control storm water runoff	R30 000
Downstream erosion	R30 000
Failure to provide adequate sanitation	R10 000
Unauthorised removal of indigenous vegetation	R50 000
Failure to erect temporary fences	R10 000
Failure to provide adequate waste disposal facilities and services	R50 000
Nuisance to neighbours by Construction staff	R10 000
Failure to reinstate disturbed areas within the specified time-frame	R50 000
Failure to rehabilitate disturbed areas within the specified time-frame	R50 000
Any other contravention of particular (general) environmental specification	R10 000

Such fines will be paid by the Contractor to the Developer and will be used in rehabilitation and/ or landscaping.

4.2 Implementation and Compliance with the EMPr

The Developer is responsible for the implementation of the EMPr and for compliance monitoring of the EMPr. The EMPr will be made binding on all contractors (including sub-contractors) operating on the site and will be included as part of the Contract. Non-Compliance with, or any deviation from, the conditions set out in this document constitutes a failure in compliance.

5 DETAILED SCOPE OF EMPr

5.1 Conditions of Contract / Roles and Responsibilities

The Project Engineer and Contractor must be responsible for ensuring compliance with the provisions contained in the EMP, and will be held accountable in terms of the EMPr.

5.1.1 Duties and powers of the Developer

The Developer has overall responsibility for compliance with the EMPr as it is a fundamental component of the authorisation requirements for the project.

This means that the Developer must:

- Ensure that the professional team and the Contractors are appropriately briefed and that their appointment includes environmental requirements as relevant.
- Ensure that he is kept fully informed of the performance of the project against the requirements of the EMPr.
- Ensure that appropriate action is taken where consistent incidents of non-compliance are taking place.
- Ensure that any corrective action required by the authorities (DEA) is implemented.

5.1.2 Duties and powers of the Project Engineer

The Project Engineer is also responsible for ensuring compliance with the Environmental Management Programme.

The Project Engineer:

- Enforces the EMPr on site.
- Monitors compliance with the requirements of the EMPr.
- Assesses the Contractor's environmental performance in consultation with the Environmental Control Officer.

5.1.3 The Environmental Control Officer

The Environmental Control Officer (ECO):

- Must be appointed by the Developer to visit the site on a **monthly basis** (or as stipulated in the EA) once the first activities start on site.
- Undertake induction training and briefs the Project Engineer and the Contractor about the requirements of the Environmental Management Programme.
- Advises the Project Engineer about the interpretation, implementation and enforcement of the Environmental Specification and other related environmental matters.
- Attends site meetings, as necessary.
- Monitors the Contractor's compliance with the EMPr by undertaking an environmental audit at the start of the construction phase, then monthly thereafter until all works on site have been completed, and then a close-out audit must be undertaken after construction is complete.
- Reports on the performance of the project in terms of environmental compliance with the EMP to be submitted to the Project Engineer, Local Municipality and DEA on a **monthly basis** or as stipulated in the EA.
- Provides technical advice relating to environmental issues to the Project Engineer.
- Acts as liaison with DEA and other environmental organisations or stakeholders as necessary.
- Maintains a register of complaints and queries by members of the public at the site office.

5.1.4 Extent of the Contractor's Obligations

The Contractor is required to:

- Supply method statements and management plans, prior to the commencement of the activity, for all activities requiring special attention as specified and/or requested by the Project Engineer or Environmental Control Officer for the duration of the Contract; These method statements must form part of the pre-contract documents from the contractor;
- Be conversant with the requirements of the Environmental Management Programme;

- Brief staff about the requirements of the Environmental Management Programme as part of induction and toolbox talks;
- Comply with requirements of the Environmental Control Officer in terms of this EMPr;
- Ensure any sub-contractors/ suppliers who are utilised within the context of the contract comply with the environmental requirements of the EMPr. The Contractor will be held responsible for non-compliance on their behalf;
- Bear the costs of any damages/ compensation resulting from non-adherence to the EMPr or written site instructions;
- Comply with all applicable legislation in terms of section 3 above;
- Ensure that the Project Engineer is timeously informed of any foreseeable activities that will require input from the Environmental Control Officer.

The Contractor will conduct all activities in a manner that minimises disturbance to directly affected residents and the public in general, and foreseeable impacts on the environment.

6. PRE-CONSTRUCTION (SITE SET-UP OR ESTABLISHMENT) PHASE

Pre-Construction EMPr activities are those relating to the preparation of the site prior to the start of the Construction Phase.

6.1 Access to the Site

This site must have strict access control to reduce the risks associated with vehicular transportation and pedestrian access on the site. This is especially relevant to the proposed Darvill site which at present has high numbers of foot traffic passing the proposed site. The Contractor must be made aware of this requirement by the Developer prior to construction commencing on site.

6.2 Preparation of Method Statements and/or Management Plans

Method Statements and / or Management Plans shall be submitted by the Contractor to the ECO and Engineer, for approval prior to activities being undertaken. Further these method statements will guide and be incorporated into the EMPr and therefore must be strictly adhered to by the Contractor and Project Engineer. These method statements through their inclusion in the EMPr will become contractually binding and will be audited and subjected to the same non-compliance criteria as the EMPr. The following activities, but not exclusively, will require method statements.

- Water and storm water management requirements,
- Traffic requirements;
- Solid waste management requirements;
- Fuel storage and the filling and dispensing of fuel (diesel and petrol);
- Hydrocarbon spills;
- Contaminated water treatment;
- The storage of hazardous materials;
- Standard emergency procedures;
- Biohazard control; and
- Cement/concrete batching.
- The Environmental Control Officer shall monitor the implementation of the Statements and Management Plans. All copies of the statements and plans shall be submitted to the appointed Environmental Control Officer

6.3 Officer Permits required

The necessary permits must be obtained by the Developer prior to the commencement of construction and sufficient time must be allowed to obtain such permits, for activities such as:

- The sourcing of borrow material which if required, must constitute Mining Right Permits from the Department of Mineral Resources (DMR);
- The disposal of effluent on site;
- The management of storm water on site; and
- Impacting on water sources, must constitute a water use licence from the Department of Water and Sanitation (DWS).

Permits must be made available to the ECO if requested and included in the Environmental Site File for record keeping purposes. The Environmental Site File will be audited on a **monthly** basis or as stipulated in the EA, during the regular audit cycle by the independent ECO.

6.4 Provision of Bulk Services

The Project Engineer must confirm if the existing services on site are sufficient for the demands of operating plant, such as water and electricity. This must be obtained by the contractor/developer and presented to the ECO during compliance monitoring and auditing.

6.5 Layout of Construction Camp

A site camp position must be identified on site, be at least 50 meters away from any water body and agreed by the Applicant, ECO and Site Engineer, and fulfils the environmental and construction requirements. The site camp may not be able to connect into all Municipal Services. At establishment, temporary services will be required and the details thereof are to be furnished by the contractor to the ECO. The construction site camp must be outside of the environmental buffer zones.

The construction camp usually comprises the following:
- A site office;
- Ablution facilities;
- A designated first aid area;
- Eating areas;
- Staff lockers and showers;
- Storage areas;
- Batching plant;
- Refuelling areas;
- Maintenance areas; and
- Crushers.

The size of the camp should be kept to a minimum (especially where natural vegetation or grassland has to be cleared for its construction). Parking for staff and visitors must be adequately provided. The Contractor must also ensure that drainage on the camp site is such to prevent standing water and/or sheet erosion from taking place.

A Complaints Register must be maintained on site by the foreman for all complaints. This must form part of the Environmental File that must be maintained on site. The minimum composition for this file should be as follows:
- Copy of the Environmental Authorisation and EMPr;
- Complaints register;
- Waybills receiving;
- MSDS sheets;
- SHEQ File; and
- Hazardous substances register
- Permits

6.6 Environmental Awareness & Training

The Contractor must ensure that the construction team and all sub-contractor/s are familiar with the EMPr requirements and have a basic level of environmental awareness training. The Environmental Control Officer must undertake environmental awareness induction training prior to the start of construction activities on site.

Topics to be covered by the training should include:

- Explanation of what is meant by "environment" and why the environment must be protected and conserved;
- Training on the protection of wildlife and snakes;
- How construction activities can impact on the environment, and what measures can be taken to mitigate against these impacts;
- Awareness of emergency and hazardous spills response provisions;
- Prevention of pollution and litter control and the minimization of disturbance to sensitive areas;
- Social responsibility during construction. This entails being considerate to local residents. Construction Workers must be made aware that they are not to make excessive noise (e.g. shouting/hooting) as the site borders residential properties;
- The need for a "clean site" policy also must be conveyed to construction workers;
- Worker conduct on site which encompasses a general regard for the social and ecological well-being of the site and adjacent areas. Workers must be made aware of the following general rules of behaviour;
- No alcohol/drugs to be present on site and no firearms permitted on site or in vehicles transporting staff to /from site, (unless used by security personnel);
- Prevention of noise and unsocial behaviour;
- Bringing pets on site is forbidden, and no harvesting of firewood from the site or from areas adjacent to it;
- Workers are to make use of facilities provided for them, as opposed to ad-hoc alternatives (e.g. the use of surrounding bush as a toilet facility is forbidden; fires for cooking);
- Driving under the influence of alcohol is prohibited;
- Trespassing on private/commercial properties bordering the site is forbidden; and
- Other than pre-approved security staff, no workers will be permitted to live on site unless deemed necessary due to the specific project.

It is also important that the Project Engineer/ECO is on hand to explain more complex/technical issues and to answer questions. It is recommended that an Environmental Officer (EO)/CER is appointed by the Developer or Contractor who will be responsible for the execution of the listed activities on the development site as per the EMPr requirements.

6.7 Storm Water Management

On-site storm water controls must be implemented prior to commencing any construction on site. A Storm Water Management Plan will be submitted by the Contractor and approved by the Project Engineer. The contractor will ultimately be responsible for storm water management during the construction phase and the developer will be responsible for storm water management during the operational phase.

The increase in storm water run-off resulting from construction activities must be estimated and the drainage system assessed accordingly to prevent storm water damage.

6.8 Soil Management

The Contractor must ensure that wind screening and storm water management controls should be undertaken to prevent soil loss during site establishment. This may involve erection of shade cloth fencing around the site perimeter, where considered necessary by the Engineer.

The time that stripped areas are exposed should be minimised wherever possible. The contractor must ensure that lead times are not excessive.

Procedures, such as stockpiling and demarcating the topsoil along with mitigation measures to conserve and, prevent the soil from washing/ blowing away, must be applied during the site establishment and construction phases. I.e. topsoil must be conserved while providing access to the site and setting up the camp.

Prior to site establishment, the Contractor must strip topsoil to a depth of 150 meters and stockpile all soil within the works area for subsequent use. Stockpiled soil must not be in excess of 2 m in height, and must be protected from wind and rain with the use of tarpaulins where necessary. The area stripped of soil must be surfaced, and it is unlikely that the stripped soil will be required for rehabilitation purposes. Stockpiles must be positioned at least 100 meters away from water-courses or storm water drainage lines to prevent soil eroding directly into any water courses and drains nearby. Stockpiles must be positioned in an area that will prevent dust particles being blown onto the residents and road users. The Environmental Consultants in conjunction with the contractor and project engineer should identify the relevant areas for stockpiling that are both environmentally sound and will prevent double handling of material.

Soil management measures must be implemented by the contractor and audited by the ECO.

6.9 Conservation of Natural Resources

This section is applicable to site establishment outside the proposed property boundaries.

No natural vegetation may be cleared during the site establishment without the prior permission of the Engineer and Environmental Control Officer. The ECO must be given an opportunity to mark vegetation such as indigenous trees (where applicable) that are to be conserved before the Contractor starts to clear the site.

Care must be taken to avoid the introduction of alien plant species to the site and surrounding areas. Any invasive alien vegetation that may emerge within the proposed site or stockpiles must be removed and disposed of appropriately. Particular attention must be paid to imported material. Poaching and theft of fauna and flora is prohibited.

Conservation of Natural Resources must be controlled by the contractor and audited by the ECO.

6.10 Security Fencing and Lighting

During site establishment the site should be secured if necessary to minimize the opportunity for criminal activity in the locality of the site. The site should be fenced and manned on a 24 hour basis. The erection of lighting must be undertaken in such a manner as to preclude the lighting from becoming intrusive. Lighting positions must take cognisance of night time vehicular movement and ensure that it does not cause temporary blindness of any vehicle operators.

Security fencing and lighting must be implemented by the contractor and audited by the ECO.

6.11 Noise Impacts and Designated Working Hours

Construction vehicles are to be fitted with Standard silencers prior to the start of construction. Should the vehicles or equipment not be in good working order, the Contractor may be instructed to remove the offending vehicles or machinery from site. Equipment that is fitted with noise reduction facilities (e.g. side flaps, silencers etc.) will be used as per operating instructions and maintained properly during site operations.

Designated working hours will be restricted to 7 am-5 pm on weekdays and 8 am-1 pm on Saturday. These times and working days are restricted, due to the relatively close proximity of surrounding dwellings, and in accordance with the Department of Labour Gazetted Guidelines.

6.12 Cultural Heritage Environment

Before construction commences, all staff must know what possible archaeological or historical objects of value may be present and to notify the Engineer/Contractor should such an item be unearthed. This will be covered during the environmental awareness training process when the contractor and their staff establish on site. Should any archaeological material be uncovered or discovered on the site the ECO and Amafa KwaZulu-Natal must be notified immediately and construction work stopped.

As pointed out in the Heritage Specialist Report, the proposed construction of the Darvill Constructed Wetland may proceed in terms of heritage values as no archaeological or heritage sites or features were observed to occur on the proposed development footprint.

Protection of cultural artefacts must be controlled by the contractor and audited by the ECO. Should any artefacts be unearthed during construction, construction must cease immediately and contractor must contact the ECO immediately. The ECO will thereafter contact Amafa regarding a site visit and whether the artefacts unearthed will be required to be removed and / or a destruction permit applied for and granted by Amafa KZN/ Heritage KZN.

7 CONSTRUCTION PHASE

Construction EMPr activities are those relating to the Construction Phase as defined.

7.1 Access to the Site and Haulage Roads

Access to other properties shall be prohibited, and enforced by the Contractor.

All access and haulage roads within the property must be maintained in a good condition by addressing problems associated with construction traffic such as potholes, corrugations and storm water damage as soon as these are apparent. This should be conducted on a weekly basis or after heavy rains by the Project Engineer.

Unnecessary compaction of soil on site by heavy vehicles must be avoided as far as possible and construction vehicles must be restricted to demarcated access, haulage routes and turning areas.

Construction of the access road must be undertaken by the contractor and audited by the ECO.

7.2 Maintenance of the Construction Camp

This covers various areas for inspection on a regular basis. The Contractor must monitor and manage drainage and runoff from the camp site to avoid standing water and soil erosion.

Weekly servicing of the chemical toilets on site must be practiced by the supplier and service records are to be filed on site with the environmental site file. Toilets on site must be kept in a clean and hygienic state. It is required by law that for every fifteen labour employed there is one (1) portable toilet. Portable toilets which require weekly servicing will only be in use during the construction period.

The Contractor must ensure that all litter is collected daily from the work and camp areas. Similarly, all bins and/or skips should be regularly emptied and their waste disposed of at a registered landfill site. All waybills are to be filed on site. The Contractor must ensure that the camp site, working & eating areas are maintained in a clean, hygienic and orderly state.

Maintenance of the construction camp must be implemented by the contractor and audited by the ECO.

The construction camp must be decommissioned after use and the following undertaken during decommission:

- All building material must be disposed of at an appropriate registered waste disposal site.
- All hazardous waste must be removed from the site and disposed at a registered hazardous waste disposal site.
- Chemical toilets must be removed by the responsible contractor
- Any hard surfaces such a cement bays, must be broken up and removed off the site.
- No refuse or waste material is to be disposed of by burying or burning.
- All fuel, oil or hydraulic fluid spills are to be immediately reported to the Engineer and Environmental Control Officer, and must be disposed of in a permitted landfill site for hazardous substances.
- All asbestos material shall be disposed of according to the Asbestos Regulations 2001, as per Government Notice. R: 155, dated 10 February 2002, promulgated under the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993).

All construction sites must be cleared of foreign material associated with the construction site and the sites, where vegetation cover was cleared must be rehabilitated using locally appropriate indigenous vegetation under the supervision of the ECO.

7.3 Ablution & Eating Facilities

Where waterborne sewerage is not available, temporary chemical toilets must be supplied and approved by the Engineer. These toilets must be available to all site staff, both at the camp site, and on site as agreed by the Engineer. 1 Toilet per 15 staff members must be provided. Toilets should be no nearer than 100 m from any wetlands or natural drainage lines.

Chemical ablution facilities shall be located adjacent to the Site Establishment Office (containers) and shall occur at a minimum ratio of 15 workers per toilet. The construction of “long drop” toilets is forbidden. Under no circumstances may neighbouring open areas or the surrounding bush be used as a toilet facility.

Provision should be made for additional employee facilities, including shelter and washing facilities. The Contractor should designate eating areas to the approval of the Engineer. Strict control shall be enforced to ensure that no waste is left in these demarcated areas.

The construction of “long drop” toilets is forbidden. Under no circumstances may neighbouring open areas or the surrounding bush be used as a toilet facility.

Maintenance of the Ablution and Eating Facilities must be implemented by the contractor and audited by the ECO.

7.4 Provision for Camp Waste Disposal & Set-up of Waste Management Procedures

Bins and / or skips must be supplied at convenient intervals on site for disposal of waste within the construction camp. The bins should have liner bags for easy control and safe disposal of waste. The contractor should recycle waste if possible, with separate drums provided for paper and cardboard; glass; plastics; metals and organic waste.

The excavation and use of rubbish pits on site is forbidden. The burning of waste is forbidden. The area demarcated for the sorting and disposal of waste must be fenced off. The provision of separate skips for different waste types (i.e. “household” type refuse; building rubble) must be provided. Concrete bags must be stored separately prior to disposal and disposed of at the relevant disposal sites.

No vehicles must be washed on site.

Waste disposal and waste management measures must be implemented by the contractor and audited by the ECO. The relevant waybills and or substantiating documentation for waste disposal must be placed in the environmental file for the ECO to audit the procedures are being correctly adhered to.

7.5 Visual Impacts

Storage facilities, elevated tanks and other temporary structures on site must be located such that they are visually un-obtrusive to the local residents. The construction camp must be screened with the use of shade cloth prior to the start of construction as considered necessary by the Engineer. Screening of highly reflective material should be given particular attention.

Reducing visual impacts must be controlled by the contractor and audited by the ECO.

7.6 Staff Conduct

The Contractor must monitor the performance of workers to ensure compliance with good environmental practices and general conduct as explained in section 6.6 of this EMPr. It is during this phase that the employees undergo their environmental awareness induction training.

Staff conduct must be controlled by the contractor and audited by the ECO.

7.7 Dust/Air Pollution

Vehicles travelling back and forth on the construction site must adhere to speed limits so as to avoid generating excessive dust. A speed limit of 45 km / hour must be adhered to on site on all un-surfaced roads.

The Contractor will be responsible for minimising the generation of dust as a result of construction works, operations and activities to the satisfaction of the Environmental Control Officer. The site must be dampened with a water bowser or sprinklers, as necessary to minimise dust problems. In addition, the Contractor must ensure that the fence-line consisting of the wooden poles/supports and shade cloth structure is maintained in good condition to act as a screen to minimize dust pollution.

Stockpiles must be managed in accordance with the guidelines as per Section 7.10. Vehicles and machinery are to be kept in good working order and should excessive emissions be noted, the Contractor must have equipment serviced as soon as possible.

No fires are to be permitted on site except for the burning of firebreaks. Should burning be required the necessary written approval must be obtained from the local Fire Chief and all the necessary precautions taken to avoid any potential damage to surrounding land owners or their personage.

With regard to the utilisation of the roads to and from the site, travel should be reduced as much as possible, through limiting the number of vehicle trips into and out of the proposed construction area.

Vehicles must be well maintained to ensure that they are not billowing smoke and their emissions are within the acceptable CO_2 emission standards.

In terms of the site, any large exposed areas must be damped regularly during high wind events. Exposure of the soils to the elements should be as limited as possible through the correct programming of tasks that require undertaking.

The Environmental Health Division at the Msunduzi Municipality Compliance recommend compliance with the **National Dust Control Regulations** in that no dust nuisance to be created during construction phase.

Dust and air pollution must be controlled by the contractor and audited by the ECO.

7.8 Noise Associated with Construction Activities

Construction vehicles must be fitted with standard silencers prior to the start of construction. Should the vehicles or equipment not be in good working order, the Contractor may be instructed to remove the offending vehicle or machinery from site. Equipment that is fitted with noise reduction facilities (e.g. side flaps, silencers etc.) will be used as per operating instructions and maintained properly during site operations.

Designated working hours, times and week-end activities are restricted, unless permission from nearest neighbours is sort to allow works to continue beyond normal hours. However, should any neighbour complain about disruptive noise impacts, the times and durations of construction activities shall be reconsidered by the Engineer.

Blasting, piling or other 'noisy' activities must take place during normal working hours. The adjacent landowners must be notified 7 days prior to any planned activities that will be unusually noisy. These activities could include, but are not limited to, blasting and piling. It is suggested that a Bulletin Board on site in a visible location be considered.

The Environmental Health Division at the Msunduzi Municipality recommend compliance with the **noise regulations R2544**, in that no noise nuisance or disturbing noise to be created during construction phase.

Noise must be controlled by the contractor and audited by the ECO.

7.9 Soil Erosion

Clearing activities, including removal of vegetation and heavy earthworks, must only be undertaken during agreed working times and permitted weather conditions as agreed upon with the ECO. If heavy rains are expected clearing activities must not be commenced with. The unnecessary removal of groundcover from slopes must be prevented, especially on steeper slopes. Following the clearing of an area, the surfaces of all exposed slopes must be roughened to retain water and increase infiltration (especially important during the wet season). Any steep or large embankments that are expected to be exposed during the 'rainy' months should either be armoured with fascine like structures or grassed immediately with strip sods established at regular intervals (50-100 cm) down the bank with hydro-seeding between the strip sods. These areas will be restricted to the cut embankments that will be formed as a result of the cut to fill exercise that will be undertaken during the earthworks phase of construction.

Once an area has been cleared of vegetation, the top layer (nominally 150 mm) of soil should be removed and stockpiled in the designated areas, which have been identified approved by the engineer and ECO. Vegetation must be stripped in a sequential manner as the work proceeds so as to reduce the time that stripped areas are exposed to elements. Top-soiling and re-vegetation must start immediately after the completion of an activity and at an agreed distance behind any particular work front.

Storm water control and wind screening should be undertaken to prevent soil loss from the site. The battering of all banks shall be such that cut and fill embankments are no steeper than previous natural slopes unless otherwise allowed by the Engineer. Cut and fill embankments steeper than previous ground levels must be re-vegetated immediately. All embankments, unless otherwise directed by the Engineer, shall be protected by a cut off drain to prevent water from running down the face of the embankment and resulting in erosion.

The above anti-erosion measures must be taken to ensure the longevity of the structures, the infrastructure, as well as, that of the environment. Soil erosion must be controlled by the contractor and audited by the ECO.

Further to this the Wetland report recommends the following mitigation with regards to Enhanced erosion potential and compaction impacts:

- To minimize the loss and damage to vegetation and to minimize compaction during construction, the construction camp should be kept to a minimum and all activities must be restricted to a demarcated servitude.
- To prevent erosion and sedimentation, construction activities should be undertaken during the dry season when flows will be substantially reduced.
- The construction camp should be located more than 100m from all watercourses.
- All stockpiles and spoil material should be located on even surfaces, and more than 100m from watercourses so as not to cause sediment wash into the system;
- Sediment controls measures (e.g. hay bales, silt fences, sedimentation ponds, etc.) should be put in place should stockpiles show potential to wash away;
- The construction area should be clearly identified including access roads, stockpile or excavation areas, storage facilities and parking areas.
- Topsoil stripped from the construction footprint must not be spoiled but stockpiled and preserved for use in rehabilitation. Top-soil and sub-soil stockpiles and spoil sites to be placed on opposite sides of the entrance path as this is where they will cause the least impact.
- Vehicles should be parked out of the flood line and buffer when not in use in order to prevent compaction of the soil profile.
- Topsoil should be replaced in the correct order it was extracted and erosion prevention measures be put in place on areas with a steep gradient (such as geo-textiles).
- Any excess subsoil must be removed from the site and spoiled at an agreed spoil site.
- Excess flows from open surfaces and increased slope areas need to be controlled by an erosion control measure.

7.10 Storm Water Control

During site establishment, storm water culverts and drains are to be located and covered with metal grids to prevent blockages if deemed necessary by the Project Engineer. Provision should be made during the set up phase for all polluted runoff to be treated to the Engineer's approval before being discharged into the storm water system (this will be required for the duration of the project).

The Contractor must not in any manner modify or damage the banks or bed of streams, rivers, wetlands, other open water bodies and drainage lines adjacent to or within the designated area, unless as part of the construction project specification, other than approved by the DEA in the Environmental Authorisation and DWS WUL conditions.

Earth, stone and rubble must not be placed in storm water channels, drainage lines or rivers. Periodic checking of the site's drainage system must be conducted by the Engineer and ECO to ensure that it is unobstructed. It is important to ensure that the storm water management plan/system implemented is functioning as intended and that the peak storm water discharge from the site has not increased with the development of the site.

Further principles that should be followed include:

- The avoidance of the use of high velocity storm water pipelines in favour of open, high friction, semi-permeable channels wherever feasible;
- The construction of a number of smaller storm water outfall points instead of a few large outfall points, and;

- The design of storm water outfalls should facilitate reduced flow velocity, minimize, and avoid stream banks and soil erosion through design features such as reno-mattresses or splitter blocks.

Furthermore physical measures that can be taken to prevent storm water pollution include:

- Where necessary rock pitched diversion ditches or berms are to be used to divert water runoff away from exposed soil or construction areas. Silt fences may also be used.
- Separate storm water collection areas and interceptors at fuel storage areas, batching plants and other potentially polluting activities must be constructed.
- The use and storage of all materials, fuels and chemicals, which could leach into the ground, must be controlled. Adequate spillage containment measures must be implemented, such as cut off drains, berms, etc. Fuel and chemical storage containers must be set on a concrete plinth with 110% containment capacity to be provided by the bund walls.
- Any residue from spillages must be removed from site by appropriately qualified hazardous material disposal contractor. Handling, storage and disposal of excess or containers of potentially hazardous materials must be in accordance with the requirements of the adjudicating authority or any other relevant department.
- All spillages must be recorded in an incidents register and reported to the environmental representative on site as well as the ECO.
- No storage of any materials whatsoever will occur on or near 100m the drainage system.
- Clearing activities must only be undertaken during agreed working times and permitted weather conditions. If heavy rains are expected clearing activities should be put on hold. In this regard, the contractor must be aware of weather forecasts.
- Silt fences, sandbags and spoil rock must be on hand at all times to assist in establishing temporary runoff control measures and should be used wherever necessary to proactively control erosion and trap sediment.
- Silt traps and sandbags must be used to reduce the energy of surface runoff and capture sediment along the sloping portions of the running track within and outside the wetland units.
- Erosion gullies and rills within the construction Right of Way (ROW) must be rehabilitated immediately and the root cause of the erosion dealt with immediately.
- Only vegetation within the demarcated construction ROW must be cleared.
- Natural and artificial preferential flow paths (e.g. channels, culvert outlets, etc.) within the wetland units must be respected and should be flumed / piped across the trench and running track corridors to avoid erosion issues.
- <u>It is important that all of the above-listed mitigation measures are costed for in the construction phase financial planning and budget so that the contractor and/or developer cannot give financial budget constraints as reasons for non-compliance. Proof of financial provision of these mitigation measures must be submitted to the ECO prior to construction commencing.</u>

Control of storm water must be implemented by the contractor and audited by the ECO.

7.11 Water Quality Management

The treatment of contaminated water on site requires a Method Statement that is approved by the Engineer and Environmental Control Officer.

Storage areas that contain hazardous substances must be bunded with an approved impermeable liner. Spills in bunded areas must be cleaned up, removed and disposed of safely from the bunded area as soon after detection as possible to minimize pollution risk and reduced bunding capacity. The requirements for a bunded area are listed below:

The following environmental protection is required for each tank installed:

- The bunding will be 110% of the capacity of the tank;

- The bunding must be constructed of a concrete foundation with brick walls, and must have an impermeable lining (e.g. epoxy coating on internal surfaces);
- The containment bund must be sloped to a low point;
- A gate valve to be installed at the low point in the wall to allow for the release of excess storm water in the event of excessive rainfall;
- In the event of a build-up of rainwater within the bund, the level of contamination of the said rainwater must be assessed by the ECO. The contaminated water must be pumped into storage drums and disposed of at an appropriate treatment facility.

Provision should be made during set up for all polluted runoff to be treated to the Engineer's approval before being discharged into the storm water system. This will be required for the duration of the project.

Contaminated water storage facilities must not be allowed to overflow and appropriate protection, such as 110% volume bunds and undercover from rain and flooding must be implemented.

No vehicles must be washed on site.

According to the recommendations of the specialist aquatic study, the following should be adhered to:

- Regular vehicle and machinery maintenance must be carried out to ensure that accidental spills are avoided.
- No washing of construction equipment and vehicles should be allowed from the watercourses.
- To prevent spillages, no fuel or oil should be kept onsite or within the demarcated watercourse boundaries. Absorbent materials such as "Drizit" must be readily available in the event of any accidental spills, and all contaminated material including soil must be disposed of at a registered waste disposal site.
- In locations were cement is required to be used, cement must be mixed in lined containers to prevent contamination.
- All chemicals should be appropriately stored and handled. Storerooms must be more than 100m from watercourse zones and have appropriate concrete flooring and bunding.
- Any remnant rubbish, spoil, machinery and contaminants need to be removed from the development area.
- Vehicles or machinery must not be serviced or re-fuelled within 100m of the watercourse zones.
- Appropriate ablution facilities need to be put in place more than 100m from a watercourse, with no effluent released into the soil or the river.
- Rubbish bins need to be placed on site so that no litter or food waste is left around the development.

The geo-hydro specialist report further recommends the following mitigation with regards to water quality management:

- A limited number of shallow (< 10 m deep) monitoring wells should be installed around the western, northern and eastern perimeter of the proposed Darvill Constructed Wetland at locations to be based on the final design and footprint of the wetland, and once construction has been completed, so that they are not damaged by construction plant. Further to this, at least one (1) up-gradient and one (1) down-gradient deep (> 30 m deep) monitoring borehole should be installed to monitor the deep aquifer underlying the site. It is imperative that the design and installation of the shallow and deep monitoring boreholes be undertaken by, and supervised by, a qualified and experienced geo-hydrologist, so that cross-contamination of the shallow and deep aquifers does not occur.

- The installed shallow monitoring wells should be subjected to slug tests, whilst the deep monitoring wells should be subjected to either a slug test or a pump test (depending on their yield) under the supervision of a qualified and experienced geo-hydrologist. This will allow for the acquisition of hydraulic conductivity values for the shallow and deep aquifers underlying the site,

which can in turn be utilised to determine groundwater travel times in shallow and deep aquifers underlying the site.

Protection of water quality must be implemented by the contractor and audited by the ECO.

7.12 Water and Soil Contamination

Every precaution must be taken to ensure that any chemicals or hazardous substances do not contaminate the soil, surface water or groundwater on site.

For this purpose the Contractor must:

- Ensure that the mixing /decanting of all chemicals and hazardous materials should take place on a tray or impermeable surface;
- Waste generated from these should then be disposed of at a registered landfill site;
- Ensure all storage tanks are properly designed and managed in order to prevent pollution of drains, groundwater and soils;
- Construct separate storm water collection areas and interceptors at storage tanks, and other associated potential pollution activities;
- Ensure that use and storage of fuels and chemicals that could potentially leach into the ground be controlled by setting them on a concrete plinth. The containment capacity must be equal to the full amount of material stored, plus 10%;
- The contractor must remove any residue from spillages from site. Handling, storage and disposal of excess or containers of potentially hazardous materials must be in accordance with the requirements of the Hazardous Substances Act, No 15 of 1973 and Occupational Health and Safety Act, No 85 of 1993;
- All hazardous substances must be placed on drip trays during on-site usage;
- Ensure that used oils/lubricants are disposed of in receptacles that must be removed from site and to the nearest approved hazardous waste disposal site. Proof of safe disposal must be kept in the environmental file. The contractors purchasing these materials must understand the liability under which they must operate. Ensure that potentially harmful materials are properly stored in a dry, secure environment, with concrete or sealed flooring. The Environmental Control Officer will ensure that materials storage facilities are cleaned / maintained on a regular basis, and that leaking containers are disposed of in a manner that allows no spillage onto the bare soil or surface water. The management of such storage facilities and means of securing them must be agreed;
- Site staff must not be permitted to use any stream, river, other open water body or natural water source adjacent to or within the designated site for the purposes of bathing, washing of clothing or for any other construction or related activities. Municipal water or another source approved by the Engineer should rather be used for all activities such as washing of equipment, dust suppression, concrete mixing and compacting.

Groundwater and soil contamination must be prevented by the contractor and any signs thereof identified during the site audit by the ECO.

7.13 Stockpile Management

A general requirement for stockpiles is that they should be situated in an area that should not obstruct the natural water pathways on site. Topsoil stockpiles will be kept separate from other stockpiles, must not be compacted, and must not exceed 1.5 height unless otherwise allowed by the Engineer. If they are exposed to windy conditions or heavy rain, they could either be protected by re-vegetation using an indigenous grass seed mix or cloth, depending on the duration of the project. The construction of a berm consisting of sand bags or a low brick wall can be placed around the base of the stockpile for retention purposes. They should be maintained free of alien vegetation and weeds by regular weeding. Stockpiles

must be kept free of any contaminants whatsoever, including paints, building rubble, cement, chemicals, oil, etc.

Subsoil and topsoil stockpiles will be moved to areas of final utilisation as soon as possible to avoid unnecessary erosion. Stockpiles not utilized within three months of the initial stripping process (or prior to the onset of seasonal rains) will be seeded with appropriate grass seed mixes, including indigenous grasses normally found in grasslands or brush-packed to further avoid possible erosion. Stockpiles must be positioned at least 50 meters away from water-courses or storm water drainage lines to prevent soil eroding directly into any water courses and drains nearby. Stockpiles must be positioned in an area that will prevent dust particles being blown onto the adjacent residents and road users.

Stockpiles must be managed by the contractor, approved by the engineer and audited by the ECO.

7.14 General & Hazardous Substances and Materials

Storage areas should can be hazardous, unsightly and can cause environmental pollution if not designed and managed carefully. They should be located at 100m away from watercourses. The selection of the site for the storage of materials must consider the prevailing winds, distance to water bodies and general on-site topography. These areas must be designated as per the camp layout plan, demarcated and fenced if necessary. They should be secure so as to reduce the risk of crime and safe from access from children and animals.

Fire prevention facilities must be present at all storage facilities. It is important that the storage areas for hazardous chemicals are positioned away from the neighbouring residential or business properties (where applicable). The Contractor must maintain storage of all potentially polluting materials, and shall undertake potentially polluting operations as far away as practically possible from drainage areas, and topsoil/subsoil stockpiles. The Contractor will ensure that additional supervisory time is spent to monitor such works. Such materials/operations include (but are not limited to):

- Batching, storing of cement, concrete and mortar;
- Petrol, oil and chemical storage and transfer;
- Washing, ablution and toilet facilities; and
- Plant storage.

Hazardous materials to be stored on site are those that are potentially poisonous, flammable, carcinogenic or toxic. These materials include diesel, petroleum, oil, bituminous products; cement; solvent based paints; lubricants; explosives; drilling fluids; pesticides and herbicides and Liquid Petroleum Gas (LPG). Material Safety Data Sheets (MSDS's) must be readily available on site for chemicals and hazardous substances to be used on site. MSDS's should also include information on ecological impacts and measures to minimize negative environmental impacts during accidental releases or escapes. A spill kit must be provided near the hazardous chemical storage area and staff trained on how to use it.

Furthermore hazardous storage and refuelling areas must be bunded with an approved impermeable liner to protect groundwater quality. A Method Statement is required for the filling of and dispensing from fuel storage tanks should such tanks be required. All necessary approvals with respect to fuel storage and dispensing (if required on site) must be obtained from the appropriate authorities. The Contractor must submit a Method Statement to the Engineer and ECO for approval. Fuel tanks must meet relevant specifications and be elevated so that leaks can be easily detected. These areas must be clearly signed. All staff working with these materials/substances must be aware of their potential impacts and follow the appropriate safety measures.

The Contractor must submit a Method Statement and plans for the storage of hazardous materials including emergency procedures. Should a spill occur within these bunded areas it must be cleaned up, removed and disposed safely from these areas as soon as possible after detection in order to minimize pollution risk and reduced bunding capacity. A designated, bunded area must be set aside for vehicle

washing and maintenance. Materials collected in this area must be disposed of at a suitable waste site or as directed by the Engineer.

All oils and lubricants that are unopened must be stored in the workshop store on site. Used oils/lubricants will be put into drums and recycled. Proof of safe disposal/recycling must be obtained and kept in the environmental file. The Contractor must be responsible for ensuring that these used oils/lubricants are not disposed of on/near the site, and that contractors purchasing these materials understand the liability under which they must operate. The Contractor and Environmental Control Officer must be responsible for reporting the storage/use of any other potentially harmful materials to the relevant department.

All imported materials (e.g. sand) as well as materials excavated from the site must be stockpiled within the site boundary / Construction Zone. Sand and excavated material stockpiles should be protected against wind using temporary screens, and from water erosion using tarpaulins where necessary.

In the event that the concrete requirements are transported to site as “ready mix” certain precautions must be taken. To prevent spillage onto roads, “ready mix” trucks must rinse off the delivery chute into a suitable sump prior to leaving the Site.

If a concrete batching plant is required on site, the environmental specifications detailed below are to be employed:

- Shade cloth around the batching plant to prevent the cement dust being dispersed across the site;
- A sump for the collection of water over flow from the batching process;
- A method statement from the contractor must be drawn up to deal with overruns in the batching of concrete, i.e. 5 m^3 is batched, but only 4.5 m^3 is utilised, what will happen to the 0.5 m^3 unused.

Cement / concrete must not be mixed directly on the ground. Mixing boards, mixing trays and impermeable sumps must be used at all mixing and supply points. Unused cement bags are to be stored so as not to be effected by rain or runoff events. Used cement bags must be stored in weatherproof containers to prevent windblown cement dust and water contamination. Used cement bags must be disposed of on a regular basis via the solid waste management system, and must not be used for any other purpose.

All visible remains of excess concrete must be physically removed on completion of the plaster or concrete pour section and disposed of. Washing the remains into the ground is not acceptable as groundwater contamination could occur. All excess aggregate must also be removed. With respect to exposed aggregate finishes, the Contractor must collect all contaminated water and fines and store it in sumps for disposal at an approved waste site.

Hazardous chemical substances (as defined in the Regulations for Hazardous Chemical Substances) used during construction must be stored in secondary containers. The relevant Material Safety Data Sheets (MSDS) must be available on Site. Procedures detailed in the MSDS must be followed in the event of an emergency situation.

No paint products may be disposed of on site.

The Environmental Control Officer and Contractor must be responsible for ensuring that potentially harmful materials are properly stored in a dry, secure environment, with concrete or sealed flooring and a means of preventing unauthorized entry. The Environmental Control Officer must further ensure that materials storage facilities are cleaned / maintained on a regular basis, and that leaking containers are disposed of in a manner that allows no spillage onto the bare soil. The management of such storage facilities and means of securing them must be agreed. A ledger of all hazardous materials stored on site must be maintained and a record of the people that have accessed the materials kept as part of the

safety system of the materials. In addition, this system will ensure that the correct people are accessing these materials and therefore they will be well versed in their usage and the precautions required.

All fuel and oil must be stored within a demarcated area on site. Areas for storage of fuels and other flammable materials must comply with standard fire safety regulations and may require the approval of the Local Municipal Fire Prevention Officer. Safety and fire prevention precautions must be strictly adhered to. Fuels and oils must be stored in tanks or drums with lids that remain firmly closed and shielded from the elements, and kept under lock and key.

All asbestos material must be disposed of according to the Asbestos Regulations 2001, as per Government Notice. R: 155, dated 10 February 2002, promulgated under the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993).

Control of General & Hazardous Substances must be managed by the contractor and audited by the ECO.

7.15 Risks Associated with Materials on Site

Material stockpiles or stacks such as pipes, must be stable and well secured to avoid collapse and potential injury to site workers and/or local residents. Flammable materials should be stored as far as possible from adjacent residents / landowners. Similarly, no materials are to be stored in unstable or high risk areas such as steep slopes or floodplains. Firefighting equipment should be present on site at all times as per OSHA. Obstruction to drivers' line of site due to stockpiles and stacked materials must be avoided, in particular at intersections and sharp corners. All I & AP's should be notified in advance of any known potential risks associated with the construction site and the activities thereon.

7.16 Handling of Hazardous Materials

A number of considerations relating to the use of these materials must be adhered to. These include:

- The mixing of all concrete must occur on a designated, impermeable surface;
- No vehicles transporting concrete to the site are to be washed on site;
- No vehicles transporting, placing or compacting asphalt or any other bituminous product may be washed on site;
- Lime and other powders must not be mixed during very windy conditions;
- Similarly the spraying of herbicides or pesticides should not occur under windy conditions and must comply with OSHA regulations and other chemical handling laws;
- All substances required for vehicle maintenance and repair must be stored in sealed containers until they can be disposed of/removed from the site;
- Hazardous substances/materials are to be transported in sealed containers or bags;
- The Contractor must submit a Method Statement for the dealing of accidents / spillages of hazardous materials.
- In particular a Method Statement for the Management of Hydrocarbon Spills must be prepared by the Contractor.
- The site must have a ready supply of absorbent material available to absorb any emergency hydrocarbon spills, and where possible, be designed to encapsulate minor hydrocarbon spillage.
- Drip trays must be used to reduce spillage.
- The quantity of such materials available must be able to absorb / deal with a minimum of 200 litres of hydrocarbon liquid spill.
- The source of the spillage must be isolated.
- The Contractor must contain the spillage using sand berms, sandbags, pre-made booms, sawdust or absorbent materials, and the area must be cordoned off.
- The Engineer must be immediately notified.

Hazardous materials must be managed by the contractor and audited by the ECO.

7.17 Waste Management

Waste receptacles such as skips/bins must be provided at intervals along the work front and in the construction camp area. Regular waste disposal must be practiced for these containers. Non-hazardous waste generated on site must be disposed of at a registered landfill site and waybills submitted on a monthly basis proving disposal for audit purposes. Hazardous waste generated must be collected and disposed of by an approved Waste Contractor.

Similarly the chemical toilets on site must be regularly serviced by the supplier on a weekly basis. Construction rubble must be disposed of at a registered landfill site. There should be recycling of waste practiced with separate drums provided for paper and cardboard; glass; plastics; metals and organic waste. Construction rubble must be disposed of in pre-agreed demarcated spoil dumps that have been approved by the Engineer and ECO, or at a registered disposal site. No waste, including spoil material, may be stored on site for more than 90 days.

All vehicles and equipment must be maintained in a good condition in order to minimize the risk of leakage and possible contamination of the soil or storm water by fuels, oils and hydraulic fluids. Sufficient quantities of suitable hydrocarbon absorption or remediation materials must be present on site at all times. Absorbent spill-mop-up products must be readily available. All fuel, oil or hydraulic fluid spills are to be immediately reported to the Engineer and Environmental Control Officer, and disposed of in a permitted landfill site for hazardous substances. A sump (earth or other) must be created for concrete waste. The contractor must ensure that the sump is de-sludged at least once per month or sooner if required so as to ensure no spillages occur, and the cement waste must be removed to a waste disposal site as approved by the ECO.

For the purposes of this EMPr, refuse includes all construction rubble, debris and waste (e.g. food waste, vegetation and tree stumps, building rubble, etc.), including hazardous waste (e.g. oils);

- The Contractor must be responsible for the refuse removal control system that is acceptable to the Environmental Control Officer, the Project Engineer and the Local Authority. Refuse removal should be managed as part of the daily waste management activities.
- Transport of all waste on site must be undertaken by a reputable, registered waste contractor, approved by the local authority.
- Hazardous waste such as fuel, oils and chemicals must be disposed of at a licensed hazardous waste disposal site.
- The Contractor must keep the site clean, tidy and litter free at all times. Strict control and management of the refuse generated by the employees, such as in the eating areas, must be enforced. The Contractor must take steps to ensure that littering by construction workers does not occur and must collect litter from the site and immediate surroundings, including litter accumulating at fence lines.
- No refuse or waste material is to be disposed of by burying or burning.
- All vehicles and equipment must be maintained in a good condition in order to minimize the risk of leakage and possible contamination of the soil or storm water by fuels, oils and hydraulic fluids.
- Sufficient quantities of suitable hydrocarbon absorption or remediation materials must be present on site at all times. Absorbent spill-mop-up products must be readily available.
- All vehicles requiring servicing or which are parked on site overnight are to make use of a drip tray to prevent accidental spillage of oils and fuels.
- A suitable leak proof container for the storage of oiled equipment (filters, drip tray contents and oil changes, etc.) must be established.
- All fuel, oil or hydraulic fluid spills are to be immediately reported to the Engineer and Environmental Control Officer, and must be disposed of in a permitted landfill site for hazardous substances.
- All asbestos material must be disposed of according to the Asbestos Regulations 2001, as per Government Notice. R: 155, dated 10 February 2002, promulgated under the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993).

Waste Management must be controlled by the contractor and audited by the ECO.

7.18 Vegetation

The clearance of vegetation to make way for construction must be kept to a minimum and, where clearance of indigenous vegetation has occurred beyond the development footprint, the rehabilitation using locally indigenous species must be implemented.

A plant rescue plan must be put in place to remove all protected species where possible and relocate them within the local area, in positions that mimic their current situations. The following steps must also be enforced:

- Wetlands must be protected by the contractor and audited by the ECO;
- Avoid wetland habitats and buffers;
- Place construction materials well outside wetland habitats and wetland buffers;
- Waste materials should be stored according to best practice guidelines and recommendations to prevent contamination. Accidental spills should be remedied immediately according to specifications contained in the EMPr;
- Construction vehicles should not drive through wetland habitat and buffers;
- Control alien invasive plants within the development footprint, as well as adjacent to the site, to prevent the spread of alien invasive propagules;
- Adjacent sensitive areas (including riparian zones) should be demarcated and avoided;
- Protected plant species should be rescued and translocated to a suitable habitat, a plant permit form *Ezemvelo* KZN Wildlife will need to be obtained;
- Rehabilitate degraded grasslands on site, that fall outside of the development footprint;
- Move development footprint out of sensitive habitats;
- Keep vegetation clearance to a minimum;
- Sensitive areas should be demarcated and avoided;
- Protected plant species should be rescued or avoided;
- Place herbicides/fungicides in demarcated safety zones only;
- Herbicides/fungicides should be disposed according to the Standard Operating Procedures for chemical usage and Health and Safety policy.

The following mitigation measures are provided in the Vegetation Specialist Report:

- The clearing of vegetation during construction, the operation of earth moving equipment, machines and vehicles in and next to the footprint, the creation of stockpiles and increased movement and activity by people (including possibly hand digging) creates opportunities for alien plant establishment. Alien plan management should be exercised to prevent further spread.
- Checks must be carried out at regular intervals to identify areas where erosion is occurring. Appropriate remedial action, including the rehabilitation of the eroded areas should be undertaken;
- **If possible, the development footprint should avoid destroying the more favourable indigenous plants such as the *Scadoxus puniceus*.** If they are required to be removed, they should be transplanted elsewhere on site so that they may re-establish.

7.19 Avi-faunal

- The Avi-faunal specialist recommends that consideration should be given to enhancing the diversity of wetland habitats and waterbirds present at the maturation ponds by controlling the growth of emergent vegetation and increasing the extent of exposed mudflats and shorelines.
- The absence of hides or viewing platforms is another limiting factor to the popularity of the site.
- No disturbance at existing maturation ponds as far as possible so as not to disturb birds;
- Bird hides and viewing plants forms not to be disturbed and if disturbed must be fixed or replaced;

7.20 Traffic

The Contractor must ensure that all construction vehicles are in a road-worthy condition. No materials may be transported off site without the load being secured under a tarpaulin or similar, in order to prevent possible danger to other road users from materials falling from the back of vehicles.

All un-surfaced roads on site must be damped down on a regular basis as considered necessary by the Engineer and/or ECO, as often as is necessary under prevailing climatic conditions, to reduce the levels of dust created by construction vehicles operating on the un-surfaced roads. Furthermore, dust can be an aesthetic nuisance for adjacent landowners as well as a significant health hazard.

Construction signs must be utilised to warn road users travelling along the district roads of the construction access and exit points and to slow down. If necessary, the speed limit should be reduced at these points.

Deliveries by large trucks to and from the construction site should be undertaken in periods where traffic volumes are not peaking, i.e. between 8:30 AM and 3:30 PM. This process will require management and it must be controlled by the Stores Manager who should not accept deliveries outside of these prescribed times. All suppliers will be notified of such and must comply or otherwise their vehicles will be turned away and only off-loaded once the delivery window opens.

Traffic measures must be implemented by the contractor and audited by the ECO.

7.21 Social Impacts to the Neighbouring Residents

Regular communication between the Contractor, Engineer and the I&AP's is important for the duration of the contract and will be started during the Site Establishment/pre-Construction Phase. The Engineer and Contractor are responsible for on-going communication with the I&AP's. A Complaint's register should be kept at the site office. This should be in a duplicate format, with numbered pages. The I&AP's must to be made aware of the register and the methods of communication available to them. The Contractor must appoint a staff member(s) to act as liaison officer for formal consultation with I&AP's in order to handle questions and explain the construction process and what it will entail. This register must be tabled during monthly site meetings. Any queries or complaints that arise must be handled by the ECO following a set protocol.

There are a number of areas that must be monitored in this respect.

- The disruption and safety of access to the local road network for the local residents must be minimized at all costs and have the Engineer's permission.
- The Contractor must inform the neighbours in writing of disruptive activities at least 24 hours beforehand. Leaflets can be circulated in post boxes giving the Engineer's and Contractor's details or other method of communication can be used that is approved by the Engineer.
- It is important that the Contractor's activities and movement of staff are restricted to the designated construction areas.
- Notice of particularly noisy activities such as jackhammers, blasting, drilling must be given to residents adjacent to the construction site at least 72 hours prior to the activity taking place.
- Noisy activities must be restricted to the times given in the project specification or General Conditions of Contract.

Local residents must be given preference in the hiring of skilled and unskilled construction workers.

Social aspects must be managed by the contractor and developer. A Labour role should be maintained on-site to provide information pertaining to the employment of individuals and where they have been sourced from.

7.22 Courtesy

All contractors and their employees must at all times be courteous towards land owners, tenants and the local community.

Activities that may cause conflict with land owners, tenants, the local work force or the local community must be avoided. Should conflict arise it must be immediately reported to the project manager or co-ordinator.

7.23 Theft and Poaching

- Theft and poaching will not tolerated.

7.24 Fire Control

- All fire requirements must be carried out as contained in the National Building Regulations SABS 0400 and the safety code of the N.F.P.A.
- The Contractor must take all reasonable and active steps to avoid increasing the risk of fire through their activities on site.
- The Contractor must ensure that basic fire-fighting equipment is to the satisfaction of the Local Fire Services.
- The Contractor must designate a Fire Control Officer.
- The Contractor must ensure that all the correct fire-fighting equipment is available on site and within easy access.
- No fires for heating or cooking must be permitted.
- The disposal of any matter by burning is prohibited.
- Fire control measures must be implemented and managed by the contractor and audited by the ECO.

7.25 Welding

- The Contractor must take precautions when working with welding or grinding equipment near potential sources of combustion.
- Precautions for welding must be undertaken by the contractor and audited by the ECO.

8 OPERATIONAL EMP

This section details specifications to be adhered to by the Developer / Umgeni Water Project Engineer during the Operational Phase.

8.1 Social Responsibility

- It is suggested that labour be sourced locally where possible and supports the local economy in the first instant;
- Labour intensive practices should be encouraged where possible;
- BBBEE and equality must be promoted to ensure just labour practice;
- Labour and recruitment policy formulation by contractors is needed to avoid recruitment on the site;
- A skills development plan should be formulated to guide the incubation and skills development programme.

8.2 Structures

- Spillways, and water control structures should be inspected on a regular basis and immediately after any unusual flow event (e.g. storm events)
- There should be no trees on earthen berms or 20m from the earthen berms
- No grazing allowed on earthen berms

8.3 Stormwater runoff along the hardened surfaces of the constructed wetland (Soil Wash)

- Following completion of the construction activities and replacement of the stockpiled soil, removal of excess soil and re-vegetation of any bare areas must be undertaken.
- Compacted soil must be ripped or scarified and seeded with an appropriate vegetation species to stabilize the soil.
- Vegetation should be inspected regularly and invasive species should be removed. If the alien species have become established during the construction period then these must be removed and indigenous species planted.
- Do not translocate soil stockpiles from areas with alien plants.

8.4 Disturbance of the linear flow channel

A change in the flow regime due to the construction of supporting structures at the entrance of the constructed wetland may cause a change in the linear channel flow and channel bed. This, as well as rubble, may alter the watercourse bed and flow regimes.

The following mitigation must be implemented as per the aquatic specialist to avoid disturbance of the linear flow channel:

- Regular maintenance of inlet structures should be undertaken.
- The banks of the wetland should be visually inspected **every month** for signs of excessive loss of riparian vegetation and bank collapse.

8.5 Change in subsurface water movement

The development of the pathways deeper than the upper soil profile may cause sub-surface water movement to be diverted and potentially concentrated resulting in inundation areas. The following mitigation is recommended as per the aquatic specialist regarding the above:

- Inundation areas that occur above confining layers need to be managed.
- Precaution should be taken to avoid sub-surface seepage which may contaminate the groundwater reserves.

8.6 Pollution or contamination risk

Greater human/vehicle movement will take place through the site during the operational phase. This will lead to an increase of maintenance vehicles during operation, which in turn may lead to further pollution such as plastics, cans and glass. The following mitigation must be implemented:

- All substances required for vehicle maintenance and repair must be stored in sealed containers until they can be disposed of / removed from the site.
- Provide adequate solid waste/litter disposal facilities (i.e.: bins) along the maintenance access roads at regular intervals with adequate signage to encourage proper waste disposal.

- A Spill Management Plan for the operational phase must address measures to prevent and mitigate the spillage of hazardous materials in the operation of the site. A key issue comprises detergents, which have significant impacts on amphibians and fish; detergents interfere with their membranes, causing mortality. There are various spill management mitigation discussed through this EMPr which must be adhered to.
- Regular water quality checks should be done in alignment with existing water quality monitoring strategies.

8.7 Air Quality

The Environmental Health Division at the Msunduzi Municipality recommends that compliance with S**ection 35** of the National Environmental Management: Air Quality Act must be ensured, in that all reasonable steps must be taken to avoid odours during the operational phase.

8.8 Water quality management during the operation of the constructed wetland

- It is recommended that the water resources in the vicinity of the Darvill Constructed Wetland be monitored once it is built. The Msunduzi River upstream and downstream of the proposed Darvill Constructed Wetland should be sampled regularly, with the collected samples analysed at a SANAS-accredited laboratory according to a suite as determined by a professional hydrologist.

- Baseline groundwater samples should be collected before the wetland is built, and every six (6) months thereafter, for submission to a SANAS-accredited laboratory for analysis according to the SANS 241: 2015 suite of determinants. This will aid in determining whether or not the shallow aquifer is being impacted upon by the wetland (once built).

8.9 Monitoring of Wetland Health

- The wetland should be checked periodically to observe general site conditions and to detect major adverse changes, such as erosion or growth of undesirable vegetation.
- Vegetation should be monitored periodically to assess its health and abundance.
- Rehabilitate disturbed areas as quickly as practically possible following completion of construction activities in an area The rehabilitation plan should be followed as per Appendix A of this EMPr

8.10 Emergency procedures and emergency situations

The Contractor/Umgeni water compile and maintain environmental emergency procedures during the operational phase of the project to ensure that there will be an appropriate response to unexpected or accidental environment-related incidents, e.g. during routine maintenance and servicing.

These plans should include the following:

- A list of key personnel, including responsibilities, accountability and liability.
- Details of emergency services.
- Internal and external communication plans, including prescribed reporting procedures where required by legislation.
- Actions to be taken in the event of different types of emergencies.
- Incident management plans for the site.
- Incident recording, progress reporting and remediation measures required to be implemented.
- Information on hazardous materials, including the potential impact associated with each and measures to be taken in the event of accidental release.
- Training plans and testing exercises and schedules for effectiveness.

8.11 Spill Management Plan

Chemical spill / Toxic fume leak

- Avoid skin contact with the chemical and remove all ignition sources from within the area.
- Clear all persons from the immediate area. Where applicable, remain upwind of the spill to avoid inhaling any fumes.
- For a toxic fume leak, follow the evacuation procedure and proceed to the assembly point.
- Notify the responsible management member or Emergency Coordinator. Provide incident information, including details regarding injured persons.
- The Emergency Coordinator, with ER Team members will:
- Ascertain the nature, extent and cause of spillage - Refer to the Hazardous Materials Information Chart for information in this regard.
- Assess the situation in terms of life and safety issues i.e. identify the associated hazards and symptoms.
- Determine how the spill may be neutralized (see MSDS for the respective spilt chemicals)
- **ER Team:** Order evacuation of personnel where necessary, cordon off area and prohibit unauthorised entry.
- **ER Team:** Assess the situation and arrange for containment and clean-up of the spill – chemical spill kits are available on site (Refer to the next page for Hazardous Chemical Substance information).
- Emergency Coordinator: Notify the UW BCM Coordinator. Dependent on the nature and extent of the spill, a decision will be made to inform the Crisis Management Team Leader.
- Dependent on the extent of the spill, relevant management members will notify other relevant parties e.g. Municipal Disaster Management Services, Department of Health, local community, other authorities, UW Regional Office etc.

If there is chemical contact with skin

- Remove all contaminated clothing.
- Locate the nearest emergency shower and soak for at least 15 minutes or immediately flush with cool water for at least 15 minutes.
- If there are no visible burns, remove all jewellery and soap the area.
- Have someone contact a First Aid member.
- Seek immediate medical attention.

If there is chemical contact with eyes

- Irrigate eyes for at least 15 minutes with tempered water from emergency eyewash station.
- Remove contact lenses if possible.
- Notify a First Aid member.
- Seek immediate medical attention.

Refer to Appendix B of this EMPr for more Hazardous Chemical Substance Information.

Fuel spill

- Always use leak trays to protect the environment from spills.
- Immediately report the spill to the responsible management member or Emergency Coordinator.
- The ER Team (specifically those members that have received spill response training) shall:
- Surround the area with the barrier tape.
- Using appropriate PPE, try and contain the spill by placing Peat Sorb around the affected area making sure that it does not enter a water drain of any sorts.
- If the spill is too large to clean up using the on-site materials (Peat Sorb), inform the Emergency Coordinator that external assistance is required.
- Check if anyone has come into contact with the spilled material. If so, consult the MSDS for First Aid requirements.

- Incident termination: Collect all the absorbent material and contaminated soil where possible and place it into a properly labelled leak-proof container.
- The Waste Services will collect the waste and contaminated materials for disposal and provide the certificate.

9 AMENDMENTS TO THE EMPr

Any major issues not covered in the EMPr as submitted must be addressed as an addendum to the EMPr, submitted for approval prior to implementation.

SiVEST Environmental Di**vision**
VCC Estate, North View Building,
170 Peter Brown Drive, Montrose, Pietermaritzburg, 3201
PO Box 707, Msunduzi, 3231
South Africa

Tel + 27 33 347 1600
Fax +27 33 347 5762
Email info@sivest.co.za
www.sivest.co.za

Contact Person: Tarryn Curtis
Email: tarrync&@sivest.co.za

APPENDIX A:

REHABILITATION PLAN

DARVILL CONSTRUCTED WETLAND REHABILITATION PLAN

Final Report

Issue Date: August 2016
Revision No.: 1
Project No.: 13396

SPECIALIST REPORT DETAILS

This report has been prepared as per the requirements of Section 32 of Government Notice No. R. 983 dated December 2014 (Environmental Impact Assessment Regulations) under sections 24(5), 24M and 44 of the National Environmental Management Act, 1998 (Act 107 of 1998).

I, declare that this report has been prepared independently of any influence or prejudice as may be specified by the Department Economic Development, Tourism and Environmental Affairs (EDTEA).

Signed:… … …… …… Date: 19th August 2016

Date:	August 2016
Document Title:	**Darvill Constructed Wetland Rehabilitation Plan Draft Report**
Authors:	Liandra Bertolli
Revision Number:	# 1
Checked by:	Stephen Burton
Approved:	Tarryn Curtis
Signature:	
For:	**SiVEST Environmental Division**
"COPYRIGHT IS VESTED IN SiVEST IN TERMS OF THE COPYRIGHT ACT (ACT 98 OF 1978) AND NO USE OR REPRODUCTION OR DUPLICATION THEREOF MAY OCCUR WITHOUT THE WRITTEN CONSENT OF THE AUTHOR"	

PROPOSED CONSTRUCTED WETLAND, DARVILL WASTE WATER TREATMENT WORKS, PIETERMARITZBURG, KWAZULU-NATAL
REHABILITATION PLAN

CONTENTS **PAGE #**

1. INTRODUCTION 1

2. BACKGROUND & MOTIVATION 1

3. DEFINITION OF REHABILITATION 1

4.1 Broad Rehabilitation Objectives 3

4. SPECIFICS OF THE PROPOSED IMPLEMENTATION OF REHABILITATION PLAN 3

5.1. Proposed Sequence of Rehabilitation 3

5.2. Management of Working Area During Construction 3

5.3. Re-establishment of Graminoid Assemblage 5

5.3.1. Hydraulic seeding / Hydro-seeding 5
5.3.2. Plugs 5
5.3.3. Hand Seeding 6
5.3.4. Geotextiles 6
5.3.5. Vegetation Species Composition 7

5.4. Riparian area 10

5.4.1. Description of current scenario 10
5.4.2. Objectives of riparian restoration & rehabilitation 11
5.4.3. Planting Methodology 11

5.5. Alien Plant Control 13

5.6. CONCLUSION 13

TABLES:

Table 1.A list of alien species recorded during the vegetation survey with their relevant Categories and Growth forms. 8
Table 2.Grass Species selected for the baseline Graminoid assemblage, proportions and position in the landscape. 8
Table 3. Categories and treatment types for the various Alien Plant Management requirements as identified on site 17
Table 4.Description of the various categories of trees based on stems diameter (trunk) or a combination of height and Stem diameter. 18
Table 5. No stacking 18
Table 6. Stacked 18
Table 7. Frill, no stacking 19
Table 8. Frill, Fell & Stack 19
Table 9.Multi-stems, no stacking 20
Table 10. Predominantly herbaceous, no stacking 20
Table 11. Predominantly herbaceous, stacking 21

FIGURES:

Figure 1: The various types of Geotextile fabrics commonly utilised in soil stabilisation and their position and application within the landscape at for which they are best suited. 7
Figure 2: Overview map indicating the proposed development boundary on the ox-bow. 10
Figure 3. A schematic diagram representing the proposed planting methodology to be adopted when rehabilitating wetland areas (Kinvig, 2011). 12
Figure 3: Schematic representation of six techniques used to remove alien invasive plant species. .. 16

Glossary of Important Terms

Biodiversity: The number and variety of living organisms on earth, the millions of plants, animals, and micro-organisms, the genes they contain, the evolutionary history and potential they encompass, and the ecosystems, ecological processes, and landscapes of which they are integral parts.

Ecology: The scientific study of the relations that living organisms have with respect to each other and their natural environment.

Ecotone: A region of transition between two different biological communities.

Gabion: A structure made of wire mesh baskets filled with regularly sized stones, and used to prevent and/ or repair erosion. They are flexible and permeable structures which allow water to filter through them. Vegetation and other biota can also establish in/around the habitat they create.

Graminoid: Technical term for grasses.

Habitat: The natural home and range of species of plants or animals.

Rehabilitation: Refers to re-instating the driving ecological forces (including hydrological, geomorphological and biological processes) that underlie a wetland, so as to improve the wetland's health and the ecological services that it delivers.

Temporary wetland zone: Hygrophilous to semi-terrestrial grassland. Saturated for 3 to 5 months of the year. Dominated by water tolerant grasses and some sedges.

Wetland: Land that has water on the surface or within the root zone for long enough periods through the year to allow for the development of anaerobic conditions. These conditions create unique soil conditions (hydromorphic soils) and support vegetation adapted to these flood conditions.

PROPOSED CONSTRUCTED WETLAND, DARVILL WASTE WATER TREATMENT WORKS, PIETERMARITZBURG, KWAZULU-NATAL
DRAFT REHABILITATION PLAN

1. INTRODUCTION

SiVEST Environmental Division has been appointed by Umgeni Water (PTY) LTD, to provide a Rehabilitation Plan for the proposed construction, in terms of the Regulations compiled in terms of Chapter 3 of the Environmental Impact assessment Regulations (2014) of the National Environmental Management Act, 1998 (Act 107 of 1998) as amended December 2014. The Competent Authority (CA) for this project will be the Department of Environmental Affairs (DEA).

A project of this nature requires a slow and methodical approach to ensure that all aspects of the project are correctly undertaken, and that the implementation and eventual outcomes are aligned with the vision that was conceived when the project was authorised, and construction commenced.

2. BACKGROUND & MOTIVATION

The Darvill Waste Water Treatment Plant (WWTP) in Pietermaritzburg, KwaZulu-Natal (Appendix 1), is currently being upgraded. However, the completed upgrade of the WWTP will still be unable to accommodate the periodic high storm water flow volumes. To alleviate the impacts associated with these storm flow events, Umgeni Water (UW) have considered the use of wetland habitat to partially treat the overflows from the storm flow storage dam. The proposed constructed wetland is 17 hectares in extent.

3. DEFINITION OF REHABILITATION

The act of returning land to some degree of functioning by implementing best management practices without the intention of fully restoring it to the existing levels of ecosystem functioning, prior to perturbations and land use changes having taken place.

Rehabilitation therefore is the act of trying to return the land cover / vegetation at a level that superficially mirrors what was there prior to the construction of the wetland.

This is extremely pertinent as it is not possible to fully restore an ecosystem. The act of restoration ecology[1] is a new science which is fundamentally an ideological approach to trying to obtain a successional level and functional level which is superior to the previous functional level, prior to the perturbation. The reason that restoration is not being pursued is that the receiving environment, in particular the vegetation, is considered to be disturbed and will be continually disturbed as it falls along existing conduits of disturbance (the river). Further, the area small by ecological standards and therefore would have limited functional value. Maintaining high levels of biodiversity and areas of conservation value would require significant management and reserves in terms of financial inputs and commitments. All of which will not provide any significant value given the nature of the receiving environment and adjacent land use. These areas will be managed with regards to alien plant control and will be used as rescue areas for indigenous flora and fauna.

The three (3) key elements proposed in this rehabilitation process will be:

1) Objective Identification & Management to Achieve Objective:

Identify the vegetation architecture, structure and composition which are currently in existence. Active and dynamic management will be required to change the successional path of the site if the vegetation type is not the ideal end point in terms of

- the rehabilitation,
- the benefits accrued by its current state will not contribute towards the Ecological Goods and Services
- and the biodiversity of the site

In other words, if the project area is currently under alien invasive vegetation, then it would not be best practice or ideal to return this area to said cover. The professional team would need to look at the surrounding areas and based on experience and land form select the correct vegetative cover to be utilised in the rehabilitation process.

2) Rescue:

Indigenous plant and desired animal species will be rescued from these areas on an on-going basis and stored / housed in appropriate conditions until they can be relocated to suitably rehabilitated areas on the site. Should it be identified that there are significant[2] plant species or species that are afforded

[1] *"**Restoration Ecology** is a process of repairing damage caused by natural or anthropogenic forces to the diversity and dynamics of indigenous ecosystems. The science of Restoration Ecology is focused on developing the tools and practices necessary to help rehabilitate impaired ecosystems and return them to a level of greater ecological functioning. To achieve this, an interdisciplinary approach is necessary which incorporates several areas of study including hydrology, soil science, plant and animal ecology, forestry, conservation biology, and landscape ecology. Because it is difficult to predict exact outcomes, restoration ecology in itself becomes an actual experiment".*

[2] The species may be rare, endemic, of limited distribution and is not covered by legislation, but is deemed conservation worthy, they must be protected.

protection by provincial or national legislation, they must be uplifted prior to the commencement of clearing and / or construction, and housed in an area of protection for re-introduction post construction.

3) Alien plant removal and control:

This may be defined as the removal, monitoring and ongoing maintenance control of alien plants which fall within the areas designated as rehabilitation areas. A full description of the method, and legislative requirements of this phase of the project can be found in **Section 5.5** below, and **Appendix A**.

4.1 Broad Rehabilitation Objectives

- Removal of alien vegetation, within the project area;
- Replace crop lands once construction is complete;
- In waste areas select the correct vegetation type and select plant species equivalent with the vegetation type;
- Utilise, where necessary, mechanical means to reduce erosion and to remediate erosion at the project area;
- Dove tail the use of vegetation and eco-friendly techniques to ensure best practice and reduced costs in terms of the rehabilitation effort;
- Plant trees, plant and grass species to ensure that erosion is minimised, and the systems disturbed by constructed wetland are rehabilitated to create a diverse self-sustainable indigenous vegetation composition that provides tangible ecosystem goods and services.

4. SPECIFICS OF THE PROPOSED IMPLEMENTATION OF REHABILITATION PLAN

5.1. Proposed Sequence of Rehabilitation

The Programme for the proposed rehabilitation will follow a number of steps.

- Management of the working area during construction;
- Preliminary planting of graminoid base cover;
- Restoration of wetlands, (unless planted to sugar cane), will be carried out using approved wetland restoration procedures to return hydrological functionality;
- Alien Plant Control.

5.2. Management of Working Area During Construction

In order to ensure that the rehabilitation to be undertaken post construction is effective, it is paramount that the working area is managed correctly during the construction phase. The most important aspect

of this management will be the careful preservation and management of soil stockpiles, the correct method of which is detailed below, and should be implemented from the start of the project.

Soil samples will be taken to determine the depth of topsoil. It is expected to usually be 150mm deep. Topsoil must be removed from the full construction area and is not to be spoiled. Top and sub-soil stockpiles to be on adjacent sides of the trench. Top- and subsoil stockpiles must not be stockpiled within 100m or within the 1:100 year floodplain of a water course.

Naturally occurring vegetation removed by site clearance operations may be grubbed in with the topsoil for stockpiling. The topsoil shall not be buried or rendered in any other way unsuitable for future use. All precautions must be taken to prevent unnecessary handling and compaction of the topsoil. Topsoil stripping shall not occur in wet weather. During stripping and stockpiling, the topsoil shall not be subject to a compaction force greater than 1 500kg/m² and shall not be pushed for more than 50 m. Topsoil shall also only be handled twice, once to strip and stockpile, and secondly to replace, level, shape and scarify.

The top soil stockpiles must be protected against erosion and a record shall be kept of all top soil quantities and should there be shortfalls of topsoil required for rehabilitation, adequate replacement material from commercial sources should be obtained as approved by the Engineer (preferably from areas identified with sourced excess topsoil). Conversely, excess topsoil shall be landscaped and stabilized in accordance to the requirements of the Engineer and in consultation with the Contractor's Land Rehabilitation Specialist.

Topsoil stockpiles shall preferably not be stockpiled for longer than 3 months. Should this be unavoidable, these will need to be enriched or upgraded prior to replacement to ensure its effectiveness for rehabilitation. The objective of enhancement shall be to ensure that the condition of the topsoil replaced should correspond as closely as possible to pre-construction conditions in terms of soil profiles, soil chemistry and soil microbiology, as determined for the varying conditions along the route in the pre-construction survey. The Contractor shall consult with the Engineer with regards to matching preconstruction conditions or existing adjacent conditions.

All stockpiles left for extended periods of time shall be stabilized using approved vegetation cover or other erosion control measures. Topsoil stockpiles may not exceed 2m in height. Subsoil must be removed and stockpiled separately from topsoil stockpiles and these stockpiles must be adequately demarcated as such. Subsoil stockpiles may not be permitted to overflow and contaminate topsoil stockpiles. All stockpiles must be kept free of invasive vegetation.

Any excess subsoil must be removed from site and spoiled at an agreed spoil site (spoil sites to be agreed between landowner, ECO and Engineer).

5.3. Re-establishment of Graminoid Assemblage

The preparation of the soils is as important as the application of the intended re-vegetation methodology. Within these areas, the use of machinery in land preparation is possible and advisable. This will result in a rapid rate, and a potentially more accurate method, of preparation.

The soil should be ripped to a depth of 150mm. This will ensure that the soil is not compacted and no plough sole exists that may impact on the rooting potential and survival of the replanted material. Once the soil has been ripped, a pad foot roller should be utilised to nominally compress and homogenise the soil surface by removing any high points that may impact on seed distribution. Grass seed will be used as the basis for the establishment of the grassland areas (**Table 2** below).

There are several methods / techniques available for employment in re-establishing the graminoid base layer. Through understanding the site and the problems posed, options have been identified as the correct methods to employ graminoid re-establishment. The three methods are expanded upon below. Please note that re-vegetation planting must be undertaken in spring to ensure that establishment is successful. Oats may be used as a winter crop to stabilise areas that require immediate rehabilitation.

5.3.1. Hydraulic seeding / Hydro-seeding

This method of seeding is quick and effective especially on steep, critical slopes and inaccessible areas that cannot practically be seeded by other methods. Hydro-seeding includes seed, water, fertilizer and a small amount of mulch in a slurry transported in a tank, either truck or trailer mounted and sprayed over prepared ground in a uniform layer. A tracking dye may be included to visually aid uniform distribution. The mulch in the hydro-seed mixture helps maintain the moisture level of the seed and seedlings, thus resulting in improved germination rates.

Although hydraulic planting is more expensive than manual seeding and mulching, it has many benefits. With hydraulic planting, the seed blend can be distributed uniformly, the added mass increases accuracy and throw distance, especially in exposed, windy areas, while pre-soaking and water accelerates germination and enhances the chance of survival.

5.3.2. Plugs

Plugs should be applied where immediate cover is required for stabilisation. Particular candidates are drainage channels and very steep slopes.
Plugs should be:

- Planted at 10 centimetre centres (100 plugs/m^2)
- Over a pegged artificial mesh (e.g. a light polypropylene, UV stabilised mesh with about 20mm openings) in areas of very high water velocity;

- Watered immediately to enhance establishment;
- Watered regularly for the first seven days or as required to effect establishment.

In areas where steep slopes require stabilisation a requirement may arise for the soils to be stabilised through the use of Geotextiles. Ideally, vegetation is the best form of erosion control, with Geotextiles only used for temporary stabilization purposes until this can establish. In coastal areas, Geotextiles are only superior to hydro-mulching in the following situations:

- When the growing season is short or unfavourable and plants cannot stabilize a slope quickly;
- When surfaces are so unstable or contours so channelled that a heavy rain could result in significant and costly erosion damage.

5.3.3. Hand Seeding

Compared to hydro-mulching, manual mulching and seeding is better suited to flatter land. Like other forms of seeding it should be carried out in suitable weather conditions.

5.3.4. Geotextiles

Geotextiles (also referred to as erosion control blankets or mats) are any permeable textile material that is used to holding seed, fertilizers and/or topsoil in place, or holding disturbed soil on steep slopes and graded sites, in order to prevent erosion.

Good surface preparation is critical, as the soil surface should be relatively smooth and without projections. The blanket or mat should extend beyond the edge of the area to be covered, with the top end buried in a trench at least 10cm deep by 20cm wide. The mat or blanket will need to be further secured with stakes. There must be maximum soil contact to prevent erosion underneath.

Although Geotextiles have historically been made of natural plant materials, Geotextiles are increasingly made from a synthetic polymer or a composite of natural and synthetic material. We do not support the usage of synthetic Geotextiles. Plant fibre-based Geotextiles are subject to decomposition and have a limited durability. However they may be left in place to form an organic mulch to help in establishment of vegetation. Different fibres will degrade at different rates.

Coir Geotextiles degrade in 2-3 years while jute degrades in 1-2 years. Coir is therefore useful in situations where vegetation will take longer to establish, and jute is useful in low rainfall areas because it absorbs more moisture. One of the recommended products is BioJute™, which is produced by a company called *Maccaferri*.

Precautionary Note: Geotextiles can be ineffective when flows can get beneath the blanket/mat, and they may also mask slope failures until erosion is too far advanced to effectively and cheaply remediate the slope. In contrast with hydraulic applications where fail damage is visible early.

Figure 1: The various types of Geotextile fabrics commonly utilised in soil stabilisation and their position and application within the landscape at for which they are best suited.

The insets are the differing geofabrics, and are named from left to right as follows (MacMatTM, BioJuteTM, BioMacTM, MacMatTMR) with a plate of their successful utilisation below each sample plate. (Representation courtesy of Maccaferri, Promotional Literature, 2003).

5.3.5. Vegetation Species Composition

It was determined that the species assemblage comprised of degraded grassland, some natural riparian areas interspersed with pockets of alien vegetation scrub.

Of the alien species identified, some are more significant in terms of their invasive potential, whilst others are not as invasive. However, as they are alien, they and will require effort to remove them. A list of alien invasive species is included below in **Table 1**. Please be aware that other species may be

present, and have not been included, but once they are identified during the implementation phase of the project they will be removed.

Table 1.A list of alien species recorded during the vegetation survey with their relevant Categories and Growth forms.

Species name	**Common name**	**Status**	**Growth form**	**Category**
Tithonia rotundifolia (Mill.) S.F.Blake	Red Sun Flower	Alien	Shrub	1
Solanum mauritianum Scop.	Bugweed	Alien	Tree	1
Ricinus communis L. var. *communis*	Castor oil plant	Alien	Shrub	2
Populus L. sp.	Poplar	Alien	Tree	2
Passiflora subpeltata Ortega	Wild granadilla	Alien	Climber	1
Morus alba L. var. *alba*	White mulberry	Alien	Tree	3
Melia azedarach L.	Syringa	Alien	Tree	1
Macfadyena unguis-cati (L.) A.H.Gentry	Cats claw creeper	Alien	Creeper	1
Lantana camara L.	Tick berry	Alien	Shrub	1
Cirsium vulgare (Savi) Ten.	Spear Thistle	Alien	Herb	1
Cardiospermum grandiflorum Sw.	Balloon vine	Alien	Creeper	1
Cannabis sativa L.	Native Hemp	Alien	Herb	1
Canna indica L.	Canna	Alien	Herb	1
Argemone ochroleuca Sweet	Mexican poppy	Alien	Shrub	1
Argemone mexicana L.	Mexican poppy	Alien	Herb	1
Ageratum houstonianum Mill.	Garden Ageratum	Alien	Shrub	1
Ageratum conyzoides L.	Billy goat-weed	Alien	Herb	1
Achyranthes aspera L.	Burweed	Alien	Herb	1

Table 2.Grass Species selected for the baseline Graminoid assemblage, proportions and position in the landscape.

GRASS SPECIES	**PROPORTIONS**	**Kgs/hectare**	**LANDSCAPE POSITION**
Bothriochloa insculpta	10%	3	
Melinis repens	7.5%	2.25	
Themeda triandra	20.00%	6	
Eragrostis capensis	10.00%	3	
Imperata cylindrica	15.00%	4.5	Ecotone & Wetland Areas Only
Melinis nerviglumis	10.00%	3	
Monocymbium ceresiiforme	7.5%	2.25	
Sporobolus africanus	10%	3	
Miscanthus capensis	10%	3	Ecotone & Wetland Areas Only
Total	**100%**	**30**	

Some of the above mentioned species are not commonly available commercially, and therefore the sourcing of the seed is going to be difficult but not insurmountable. It is possible to source seed from companies such as Top Crop Nursery that prepare plugs, which may be required in difficult terrain which is steep and requires instant cover.

Should the seed mix stated above not be available, the following species may be included, as they are commercially available.

- *Eragrostis tef* 3kg/ha
- *Digitaria eriantha* 6kg/ha
- *Panicum maximum* 4 kg/ha
- *Chloris gayana* 6kg/ha
- *Cynodon dactylon* 6kg/ha[3]

Note:

There is no *E. curvula* in this mix as the commercially available seed produces a steroidal, "floppy leaved" grass which shades out and kills off all surrounding grasses and looks "incorrect".

There are some provincially protected plants which occur on site, some fall within the working area or on the cusp and therefore will require some actions to protect them, relocate them or off-set their loss.

- Provincially protected
  - *Scadoxus puniceus*

Indigenous trees and large shrubs planted within the works area are to be removed unless otherwise stated. Trees and large shrubs that require removal from the works area should be replanted, where possible, outside of the works area using the following method:

- Moisten the soil around the tree thoroughly about 3 to 4 days prior to the move.
- Use a sharp spade to dig a trench around the tree's base at its roots. The trench needs to be approximately 650 mm deep.
- Dig out the tree with a spade, and leave the roots and surrounding soil intact (form a root ball). The ideal amount of root and soil is a 1 m diameter clump around the base of the trunk.
- Pull the tree out of the hole, and round out the bottom of the root ball using the spade. Cut beneath the roots as necessary to form a ball.
- Place a piece of hessian cloth large enough to wrap around the root ball underneath the upended side.
- Wrap the hessian cloth around the root ball tightly, and secure it around the base of the trunk.
- Lift and carry the tree by the root ball, not the trunk. Transport it to the identified relocation point outside the working area.
- Dig a hole in the tree's new location. The hole should be 2 to 3 times the size of the root ball.
- The depth of the hole should be approximately 600mm.
- Pack the soil into the hole and around the root ball to provide stability.
- Cut and remove the twine holding the hessian to the trunk with scissors once the hole is 2/3 full.

[3](provided that it is at least 50m from the nearest cane field as the cane farmers have problems with it invading cane fields)

- Fill in the remainder of dirt removed from the hole, ensuring that the soil level is as it was when removed, i.e. do not place soil up against the trunk of the tree to a level higher than its current level.
- Water the newly replanted tree thoroughly.
- Tree species should receive water every 10 to 14 days for a period of two months, post planting, if it has not rained.

5.4. Riparian area

5.4.1. Description of current scenario

The constructed wetland is proposed to be developed on the ox-bow of the Msunduzi River directly North of the existing Canal and settling ponds (**Figure 2** below). The ox-bow was modified historically by man-made drainage channels to alleviate high flows originating from the existing storage dam during storm events. It is evident from the alien species composition and indigenous pioneer herbaceous species present that the site is degraded, most attributable to the presence of the sewer treatment works which result in substantial leaching of nitrogen and phosphorus into the soil, both essential for plant growth. The majority of the site is comprised of degraded grassland (16.4 ha) with a small patch of woodland (0.6 ha) at the east boundary of the site. The riparian vegetation is comprised mainly of *Phragmites australis* and alien species.

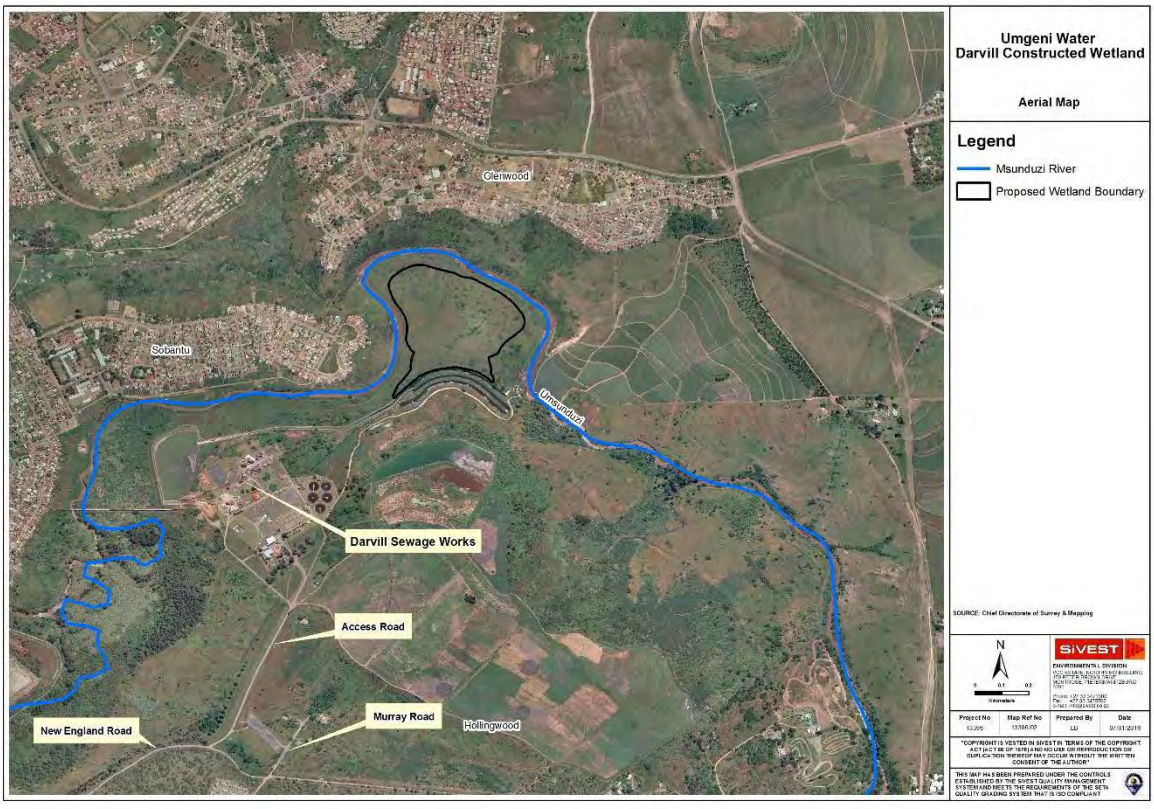

Figure 2: Overview map indicating the proposed development boundary on the ox-bow.

5.4.2. Objectives of riparian restoration & rehabilitation

The objective of the rehabilitation is to restore the riparian area to a condition as close as possible to the pre- construction state. The result of degradation, disturbance, and loss of wetland plant species, causes cumulative impacts with regards to the EG&S, which are hugely diminished or lost altogether.

Further, any physical alteration incurred as a result of the wetland being eroded, requires that significant works are required to return hydrological flow patterns and thereafter improve functionality. These will be achieved through a process of rehabilitating the area. The best chance of success in achieving the rehabilitation objective is to replace these components in their natural form. This requires that the management of wetland components during construction is planned to achieve this.

The objectives of Rehabilitation are to return or improve Ecological Goods and Services delivery, through;

- Restore indigenous vegetation;
- Reduce sediment source in the catchment;
- Minimise risk of erosion;
- Improve the vegetation component of riparian integrity;
- Deactivate the potential head-cut erosion identified;
- Improve the stability of the system,

5.4.3. Planting Methodology

With the removal of alien vegetation, it has been identified that these landscape features be returned to a scenario where they would represent their past vegetation assemblage. In order to recreate this vegetation mosaic, the following general guidelines have been adopted to drive the restoration process.

- Non-woody portions must be returned to either hygrophilous vegetation (sedges, bulrushes) or to graminoid assemblages which favour relevant specific habitats.

All plantings in riparian and wetland areas should occur in consultation with the relevant wetland and vegetation ecologists, whom have sufficient knowledge of habitat requirements of the different species to ensure best placement, within the wetland areas.

In addition to the wetland specific mitigation measures:

- Removal of existing alien species must be consistently undertaken.
- Rehabilitation of disturbed areas after the construction of the wetland must be completed as soon as possible after construction is concluded.
- If it is necessary to import soil onto the site the material; must be checked to ensure that it is not contaminated by weeds or invasive plants.

In terms of the actual design of the planting we would propose the following strategy be adopted to ensure good coverage and protection of the re-establishing wetland. **Figure 3** below illustrates what we would propose as the correct methodology for the establishment of wetland vegetation within the rehabilitated zones. In brief, we would recommend the planting of the vegetation in rows with a single plant being placed at one (1) metre centres, and ranging between 1.5 and 3 metre intervals along the wetland, depending on the position within the wetland where the planting will take place.

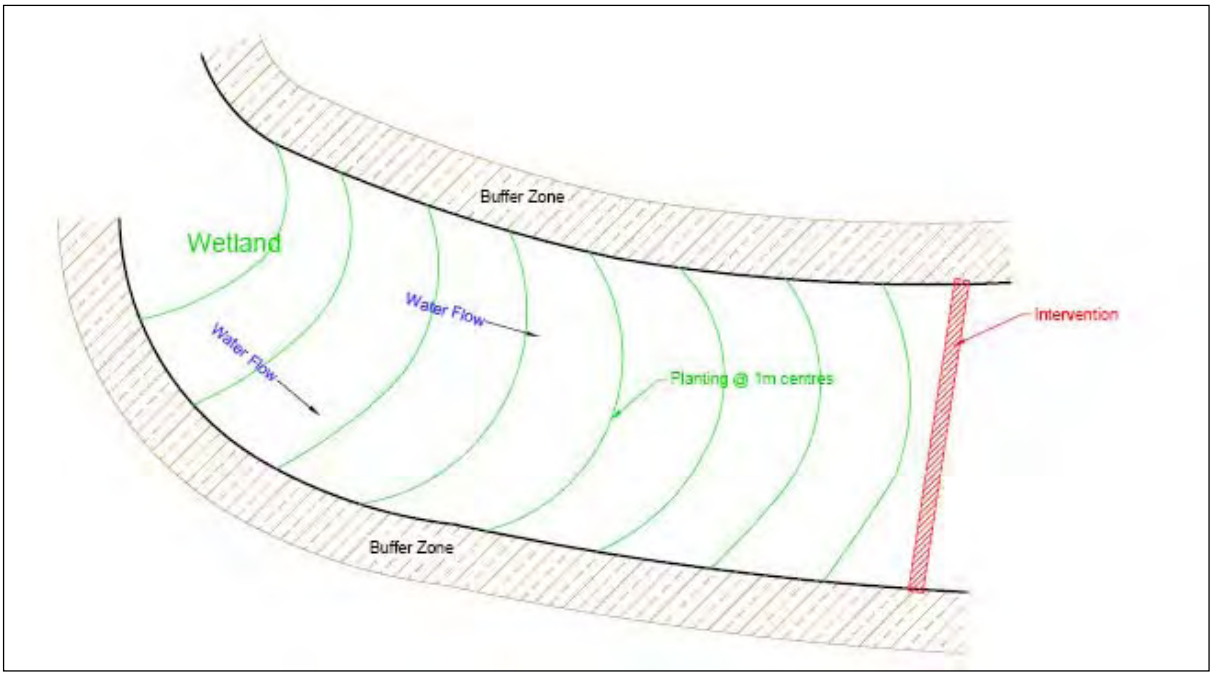

Figure 3. A schematic diagram representing the proposed planting methodology to be adopted when rehabilitating wetland areas (Kinvig, 2011).

5.5. Alien Plant Control

Invasive and other noxious plants are to be managed as per the requirements of the Conservation of Agricultural Resources Act (Act 43 of 1983, as amended in March 2001) Regulations (Notice No. R. 1048 of 25 May 1984, as amended by Government Notice No. R. 2687 of 6 December 1985) pertaining to weeds and invader plants control. As such, the following measures shall apply:

- All growth forms of **Category 1 weeds and invader plants**[4] shall actively be removed from all works areas, at all times; and
- All **Category 2 and 3 weeds and invader plants**[5] shall be actively removed all prior to flowering (See **Appendix A** for Alien Plant Removal and Control Methodology).

It must be noted however, that the maintenance period for this project is limited, and thereafter the Umgeni Water will be responsible for maintaining the site. In addition, the area to be rehabilitated is confined to the site, and any areas directly affected by construction activity, which may include but not be restricted to; lay down areas, site camps, construction camps and temporary access points.

5.6. CONCLUSION

Given that the nature of the existing vegetation that occurs at the constructed wetland site is largely alien, we feel that the above proposed rehabilitation measures will return the affected areas to natural vegetation once the project has been completed. While the rehabilitated areas may never reach climax status, the removal of alien species, and the replanting with appropriate vegetation will achieve a successional level and functional level which superficially mirrors the existing ecosystem type. This will be an improvement on some of the existing status of the alien and degraded natural vegetation units along surrounding the constructed wetland site.

[4]Section 15A of the amended Act.

[5]Section 15B and 15C of the amended Act.

Appendix A: Alien Plant Removal and Control Methodology

Identify the Alien Invasive Species and start a process of removing the individuals that occur on the site. The removal of the alien species must be in a stepwise manner and be undertaken within a single area at a time. This will ensure that all individuals are removed at the same time to reduce re-infestations. Further, the co-ordination of a single removal will mean that all seed that has not germinated will be of a similar age class when they do. This will provide significant benefit in aiding the control and management of these species. There are a number of methods that may be employed to undertake the activity of removing alien plant species and are listed in limited detail below (See **Figure 3** below).

Mechanical Methods

Hand-pulling

This method of removal is only really an option during the summer months and when the alien plant species that are requiring removal are very small, and their root system is not very well established. The only precautionary note here is that many alien plant species may look similar to indigenous species when they emerge, so the labour force must be extremely well versed in the individuals that will require removal.

Up-rooting

This method is similar to hand-pulling but is undertaken on slightly older individuals of the target species. It only has one drawback; a relatively large area can be disturbed with the soils being altered and opening the area up to re-infestation.

Lasso & Winch

This method is the upgraded version of the up-rooting, with the same principles applying, that is of trying to remove the entire plant with all the root system attached, to prevent re-growth. This can have a serious destabilizing effect on the receiving environment and should definitely not be undertaken on slopes or sandy soils.

Cutting / Slashing

This method is not a suitable method for control and long term management if used as a stand-alone technique because many of the alien plant species will simply coppice or re-sprout during the summer periods. Many, if not most, alien plants species are annual species, and through their natural life strategy (r-selected) are able to withstand disturbance, even extreme disturbance as in this instance.

Ring-barking

This involves the removal of bark in a 30 centimetre band. This technique is used to desiccate the plant through killing the phloem and xylem and thus preventing transpiration. Further it also facilitates pathogen infestation. It is very effective on large trees if undertaken correctly. This technique and two of the following techniques will be best suited for species growing within the flood plain, most notably *Melia azedarach, Schinus terebinthifolius, Eucalyptus* spp., and any other large alien invasive species, which requires removal.

Strip-barking

As with ring-barking, just at a larger scale.

Frilling / Girdling

Girdling and frilling are methods of killing standing trees that may be done with or without an herbicide. Girdling involves cutting a groove or notch into the trunk of a tree to interrupt the flow of sap between the roots and crown of the tree. The groove must completely encircle the trunk and should penetrate into the wood to a depth of at least 1.5 centimetres on small trees, and 2.5 to 4 centimetres on larger trees. Girdling can be done with an axe, panga or chain saw. When done with an axe or panga, the girdle is made by striking from above and below along a line around the trunk so that a notch of wood and bark is removed. The width of the notch varies with the size of the tree. Effective girdles may be as narrow as 2.5 to 5 centimetres on small-diameter trees, and as wide as 15 to 20 centimetres on very large-diameter trees. When a chain saw is used to girdle, two horizontal cuts between 5 and 10 centimetres apart are usually made completely around the tree when no herbicide is used and one horizontal cut is made completely around the tree when herbicide is used.

Frilling is a variation of girdling in which a series of downward angled cuts are made completely around the tree, leaving the partially severed bark and wood anchored at the bottom. Frilling is done with an axe or panga.

By themselves, girdling and frilling are physical methods to deaden trees that require very little equipment and may be done without herbicides. Both techniques require considerable time to carry out, particularly with an axe or panga. Girdling with a chain saw is much faster. The effectiveness of girdling and frilling depends on the tree species and on the size and completeness of the girdle or frill. To be effective, girdles and frills must completely encircle the tree. Because frills can heal-over more easily, girdling is usually more effective.

The effectiveness of both girdling and frilling can be increased by using herbicides. With frilling and girdling, water soluble forms of herbicides are most commonly used to get maximum movement of herbicide within the plant. When using water-soluble herbicides, the herbicide/water mixture is commonly applied by squirting it on the girdle or frill until the cutsurface is wet. Hand-held, spray bottles, such as those available at local garden stores, are ideal for applying herbicide to the girdle. Again, note that a single, rather than double chain saw girdle is used when a water soluble herbicide is to be applied.

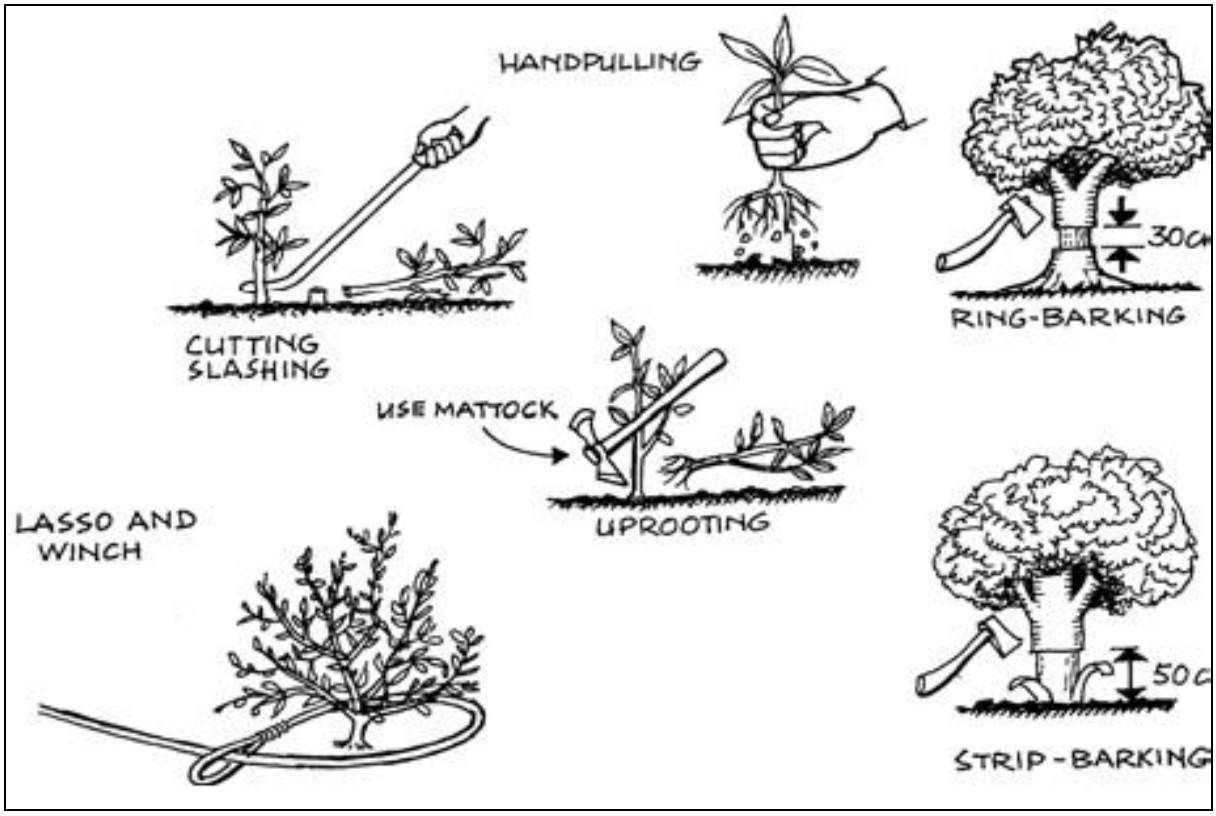

Figure 4: Schematic representation of six techniques used to remove alien invasive plant species.

Chemical Methods

The use of chemicals in controlling and removing of alien plant species should not be excluded as a possible option. Once the alien plant species are more manageable the use of chemicals should be reduced or excluded completely. The best option would be to pursue a combination of mechanical and chemical control in the early stages, especially when dealing with species such as *Solanum mauritianum*, *Schinus terebinthifolius*, *Chromolaena odorata,* and the numerous creeper species. The following creeper species require significant effort and control; *Cardiospermum grandiflorum* and the *Ipomoea* spp.

The best available herbicides that are currently utilised for the control of the above species are; Ranger®, Mamba®, Hatchet® and Roundup®. The only negative impact of the use of chemicals is that if used incorrectly may result in plant species being able to develop some form of resistance to the herbicide. If herbicides are used as a foliar spray, drift will cause non-target species to be impacted upon. The only method we would prescribe is the cutting of the plants prior to the treatment of the remaining stems using a “stem painting” technique.

It is imperative that the herbicides used are dye treated or that the end-user add a dye to ensure that all stems that have been treated are easily identified. Note: the application of the chemical solution must follow directly after the cutting of the vegetation. Therefore, a small area should be selected and all cutting and stem painting be undertaken on that area prior to moving to the next area.

It must also be ensured that should chemicals be used on site they must be;

- Stored in a secure and covered area, or off-site.
- The correct protective clothing is to be used in line with manufacturer's instructions and / or the Occupational Health & Safety Act, Act 85 of 1993 (and amendments) and,
- All MSDS sheets are to be made available on site along with a Medical First Aid Kit.

The information below has been generated by the Working for Water programme, during extensive work at many sites in South Africa, and has been adapted for use in this alien eradication programme.

Person day norms have been derived based on results from the activity sampling exercises. They have been grouped into categories, based on:

- Treatment stage (initial or follow-up)
- Species type,
- Treatment type (cut stump, frill, spray etc.)

The norms below do not take local environmental constraints into account, i.e. slope, accessibility. The norm provided is the maximum number of person days it should take to clear a flat, accessible area. In areas that are unusually steep or inaccessible, local production norms must be applied. The species covered in the report is not reflective of all species currently being cleared by WFW, further activity sampling will improve on this list. Should a species in your area not be listed, but which could easily fit into, or is similar too, one of the categories provided in the tables, the production norm given in this document must be applied.

Should a species not be listed and which cannot easily fit into one of the categories or treatment methods, then local production norms should be applied.

The following categories & treatment types are covered in this report:

Table 3. Categories and treatment types for the various Alien Plant Management requirements as identified on site

CATEGORY		TREATMENT TYPED	
INITIAL CLEARING			
Herbaceous Species		Stacking	No stacking
Trees		Frill, no stacking	Frill, fell, stacking
Small Trees	Multi-stem	No stacking	Stacking
Mixed Species	Predominantly Herbaceous	No stacking	Stacking
	Predominantly Woody	No stacking	Stacking
FOLLOW-UP		Slashing & herbicide	Spray

The following is the maturity classification used:

Table 4.Description of the various categories of trees based on stems diameter (trunk) or a combination of height and Stem diameter.

TREES		
Maturity Class	**Stem Diameter (Ø)**	**Height**
Seedlings	0 – 1.5 cm	N/A
Young	1.6 – 5 cm	N/A
Adult	6 – 15 cm	<10 m
Mature Adult	16 – 30 cm	>10 m
X Large Adult	> 30 cm	>10 m

Person Day Norms – Herbaceous Species

Table 5. No stacking

Species	**Size Class**	**Number of person days per hectare**					
Chromolaena, Lantana, Rubus etc.		**Occasional**	**Very Scattered**	**Scattered**	**Medium**	**Dense**	**Closed**
	Seedling	1 (Spray)	1 (Spray)	2 (Spray)	3 (Spray)	4 (Spray)	4 (Spray)
Method:	**Young**	1	1	2	2.6	6	6
Plants are cut off at ground level and only the stem is treated. The brush is not cut up or stacked.	**Adult**	1.1	1.1	2	3	8	8
	Mature Adult	1.1	1.1	2	3	10	10

Table 6. Stacked

Species	**Size Class**	**Number of person days per hectare**					
Chromolaena, Lantana, Rubus etc.		**Occasional**	**Very Scattered**	**Scattered**	**Medium**	**Dense**	**Closed**
	Seedling	1 (Spray only)	1 (Spray only)	2 (Spray)	3 (Spray)	6 (Spray)	6 (Spray)
Method:	**Young**	1	1	2	3	6	6
Plants are cut off at ground level, the stem is treated, the brush cut up and stacked into heaps or brush lines.	**Adult**	2	2	2.7	6.8	18	18
	Mature Adult	2	2	2.7	7	20	20

Recommended Treatment Method – Herbaceous Species

Chromolaena, *Lantana* and other herbaceous species

- Plan the clearing work beforehand. Mark out what needs to be cleared in a day for the number of people in the team, depending on the density and method (see relevant table).
- Each person must carry their own small hand held herbicide applicator and must apply herbicide to cut stump of slashed plants.
- Keep the team working in a line, with the daily tasks pegged out where possible.
- Cut plants as low to ground as possible and apply herbicide to all cut surfaces and exposed roots.

When stacking:

- Stack/move the slashed brush off the stumps to aid herbicide application and re-establishment of indigenous plant species.

Person Day Norms – Trees

Table 7. Frill, no stacking

Species	Size Class	Number of person days per hectare					
		Occasional	Very Scattered	Scattered	Medium	Dense	Closed
Eucalyptus, Schinus, Acacia, Pinus, Melia, Morus, etc.	Seedlings	1 (Spray only)	1 (Spray only)	2 (Spray)	3 (Spray)	5 (Spray)	5 (Spray)
Method:	Young	1.5	1.5	3.6	10	26	26
>5 cm Frill and apply herbicide; <5 cm Slash and apply herbicide.	Adult	2.5	2.5	3.6	10	26	26
	Mature Adult	2.5	2.5	4	12	30	30
	X Large Adult	2.5	2.5	4	12	30	30

Table 8. Frill, Fell & Stack

Species	Size Class	Number of person days per hectare					
		Occasional	Very Scattered	Scattered	Medium	Dense	Closed
Eucalyptus, Schinus, Acacia, Pinus, Melia, Morus, etc.	Seedlings	1 (Spray only)	1 (Spray only)	2 (Spray)	3 (Spray)	5 (Spray)	5 (Spray)
Method:	Young	3	3	4	10	28	28
>5 cm Frill and apply herbicide; <5 cm Slash and apply herbicide.	Adult	3	3	4	12	28	28
	Mature Adult	3	3	4	12	28	28
All material must be removed from near watercourses, wetlands and 20m from any roadside. The rest of the area must be slashed and frilled.	X Large Adult	3	3	6	15	40	40

Recommended Treatment Method – Trees

- Plan the clearing work beforehand. Mark out what needs to be cleared in a day for the number of people in the team, depending on the density and method (see relevant table).
- Where possible, each person must carry their own small hand held herbicide applicator and must apply herbicide
- to cut stump of slashed plants or frilled trees.
- Send slashers through the area first and remove all the small, thin plants.
- Treat larger trees (50mm or greater) standing, frill.
- If brush cutters are used as part of the team, ensure they work a safe distance from the manual slashers.
- Keep the team working in a line, with the daily tasks pegged out where possible.
- If burning is planned, do not stack.
- If no burning is planned, stack the brush into brush lines on the contour 5m apart with a break in between each brush line
- Brush line of 5m every 20m in length. Stacking can take place underneath the frilled trees.

- Those sites where the trees must be felled, remove the brush out of the 20-year flood line from a river or 20 m from a roadside. The rest of the stand can be frilled.

Person Day Norms – Small Trees

Table 9.Multi-stems, no stacking

Species	Size Class	Number of person days per hectare					
		Occasional	Very Scattered	Scattered	Medium	Dense	Closed
Solanum, Psidium, small *Schinus* tree	Seedlings	1 (Spray only)	1 (Spray only)	2 (Spray)	3 (Spray)	5 (Spray)	5 (Spray)
Method:	Young	2	2	5	12	12	12
>5 cm frill and apply herbicide; <5 cm slash and apply herbicide	Adult	3	3	6	12	13	13
	Mature Adult	4	4	7	12	15	15

Recommended Treatment Norms – Small Trees

- Plan the clearing work beforehand. Mark out what needs to be cleared in a day for the number of people in the team, depending on the density (see relevant table).
- Send slashers through the area first, if possible, and remove all the small, thin plants.
- Keep the team working in a line, with the daily tasks pegged out where possible.
- Cut plants as low to ground as possible and apply herbicide to all cut surfaces, bark and exposed roots.
- Stack/move the slashed brush off the stumps to aid herbicide application and re-establishment of indigenous plant species
- Stack the brush into brush lines on the contour 5m apart with a break in the brush line of 5m every 20 m in length.
- If brush cutters / chainsaws used as part of the team, ensure they work a safe distance from the manual slashers.

Person Day Norms – Mixed Species

Table 10. Predominantly herbaceous, no stacking

Species	Size Class	Number of person days per hectare					
		Occasional	Very Scattered	Scattered	Medium	Dense	Closed
Mixed species, predominantly herbaceous	Seedlings	1 (Spray only)	1 (Spray only)	2 (Spray)	3 (Spray)	4 (Spray)	4 (Spray)
Method:	Young	1.1	1.1	2	2.6	7	7
Plants are cut off at ground level and only the stem is treated. The brush is not cut up or stacked. >5 cm frill and apply herbicide; <5 cm Slash and apply herbicide	Adult	1.1	1.1	2	2.6	7	7
	Mature Adult	1.1	1.1	2	2.6	7	7

Table 11. Predominantly herbaceous, stacking

Species	Size Class	Number of person days per hectare					
		Occasional	**Very Scattered**	**Scattered**	**Medium**	**Dense**	**Closed**
Mixed species, predominantly herbaceous	**Seedlings**	1 (Spray only)	1 (Spray only)	2 (Spray)	3 (Spray)	4 (Spray)	4 (Spray)
Method:	**Young**	1.3	1.3	2.7	6.8	18	18
Plants are cut off at ground level, the stem is treated, the brush cut up and stacked into heaps or brush lines. Where necessary, brush is removed from river areas and roadsides. >5 cm Frill and apply herbicide; <5 cm Slash and apply herbicide.	**Adult**	1.3	1.3	3	6.8	18	18
	Mature Adult	1.3	1.3	3	6.8	18	18

APPENDIX B:

HAZARDOUS CHEMICAL SUBSTANCE INFORMATION

Hazardous chemical substance information:

Risks of Hazardous Materials	Product Identification	Precautions
There are four ways in which material can be hazardous. **1. Ignitable or flammable material:** Can catch fire and burn easily, includes liquids with low flash points. **2. Corrosive materials**: Can eat through containers and combine with other chemicals. Can burn skin and eyes on contact, sometimes without the victim being aware of injury. **3. Reactive materials**: Can explode, cause fire or produce toxic vapours when they come in contact with air, water or other chemicals. **4. Toxic materials:** Can enter the body by being inhaled, ingested or absorbed/injected through skin. – Acute health are immediate and short term – Chronic health effects develop over time and are long term	 **Orange: Explosive -** (Clear the area)  **Green: Compressed Gas -** (Stay clear, avoid confined spaces)  **Red: Flammable Substance -** (If fire, move at least 500m)  **White: Poison** (Avoid contact, can damage tissue)  **Black and White: Corrosive -** (Avoid contact)  **Yellow: Oxidising Agent -** (Accelerates burning)  **Yellow and White: Ratio Active -** (Stay clear)	• Consider your own safety • Stay upwind/uphill • Avoid contact with material or gases • Keep all persons away • Do not smoke. Keep fires & lights away • Identify areas of possible exposure (facilities, storm water drains, waterways etc.) • Judge the situation and if necessary stop/divert all traffic (road and rail) • Send message of incident (control room, responsible HOD/supervisor, safety & environmental departments

Substance	Properties	Acute Hazard/Symptoms	Fire Fighting / First Aid	Spillage Disposal
Standard Thinner	• Clear liquid, characteristic odour	• **Flammable at temperatures below 21˚C** • Keep away from sources of ignition • Harmful – contains solvents which are irritant in contact with eyes and skin. • Vapour inhalation - eye, nose, and mouth irritation	• Dry powder, alcohol-resistant foam, halon or carbon dioxide extinguishers • Large spills / tank fires – alcohol resistant foam • In case of fire: keep drums, etc., cool by spraying with water. • Inhalation – fresh air, rest. Artificial respiration if necessary. • Skin – rinse with water for several minutes • Eyes – rinse with water or saline solution for several minutes • Ingestion – **DO NOT INDUCE VOMITING**. Dilute with water. • **First Aid – after immediate actions taken, seek medical attention.**	• Contain in a temporary bund/collect into suitable receptacle as soon as possible.
Diesel (Fuel)	• Brown, slightly viscous liquid, characteristic odour	• **Flammable**, gives off irritating or toxic fumes (or gases) in a fire • Irritating to the eyes, skin and respiratory tract. May cause effects on the central nervous system.	• Water spray, alcohol-resistant foam, dry powder, carbon dioxide. • In case of fire: keep drums, etc., cool by spraying with water. • Inhalation – fresh air, rest • Skin – rinse and wash with soap and water • Eyes – rinse with water for several minutes • Ingestion – rinse mouth, **DO NOT INDUCE VOMITING** • **First Aid – after immediate actions taken, seek medical attention.**	• Collect leaking and spilled liquid in sealable containers as far as possible. • Absorb remaining liquid in sand or inert absorbent and remove to safe place.

Substance	Properties	Acute Hazard/Symptoms	Fire Fighting / First Aid	Spillage Disposal
Grease	• Semi-solid gel, smooth texture, may contain dye	• **Unusual fire and explosion hazards: Toxic fumes/gases/vapours may evolve on burning** • Irritating to the eyes, skin, nose and throat. Ingestion may cause nausea and vomiting.	• Foam, dry chemical or water spray (fog) • Inhalation – fresh air, rest. Artificial respiration if necessary. • Skin – rinse and wash with soap and water • Eyes – rinse with water for several minutes • Ingestion – **DO NOT INDUCE VOMITING** • **First Aid – after immediate actions taken, seek medical attention.**	• Ventilate area • Contain with absorbent to prevent migration • Large spills may require pump or vacuum prior to absorbent.
Sulphuric Acid	• Clear viscous liquid	• **Extremely corrosive,** causing severe and potentially fatal burns • Highly irritating vapour	• Personal Contact – place patient under a shower & then remove clothing, keep patient under the shower for at least **1 hour** or until medical assistance arrives • Eyes – Immediately wash eyes with clean water, especially in the corners, for at least **15 minutes**, seek medical attention • Ingestion – give patient lots of water to drink, rinse mouth several times and seek medical attention. **DO NOT INDUCE VOMITING** • Inhalation – hold patient in a half-upright position and apply artificial respiration	• Wear breathing apparatus at all times • Neutralise & remove spill by washing it away
Hydrochloric Acid	• Clear visible liquid	• **Extremely corrosive,** can cause severe damage to all body tissues	• Personal contact – place patient under a shower & then remove clothing, keep patient under the shower for at least **1 hour** or until medical assistance arrives • Eyes – Immediately wash eyes with clean water, especially in the corners, for at least **15 minutes**, seek medical attention • Ingestion – give patient lots of water to drink, rinse mouth several times and seek medical attention. **DO NOT INDUCE VOMITING**	• Wearing appropriate PPE (breathing apparatus and gloves), utilise lime, crushed limestone or sodium bicarbonate to neutralise the spill • Allow neutralising agent to stand for 8 hours before clearing the spill

Substance	Properties	Acute Hazard/Symptoms	Fire Fighting / First Aid	Spillage Disposal
Acetylene	• Colourless gas dissolved in acetone under pressure	• **Extremely flammable** • **Gas/air mixtures are explosive** • Inhalation - Dizziness, headache, suffocation	• Shut off supply; if not possible and no risk to surroundings, let the fire burn itself out. • Extinguish with powder, carbon dioxide. • In case of fire: keep cylinder cool by spraying with water. • Inhalation – fresh air, rest. Artificial respiration if necessary. • Eyes – rinse with water for several minutes • **First Aid – after immediate actions taken, seek medical attention.**	• Evacuate and ventilate area • Remove all ignition sources.
Aluminium Sulphate	• Red brown to off white aqueous	• **Non- Flammable** • Corrosive to eyes, skin and respiratory tract • Swallowing may cause nausea or vomiting • Inhalation - burning sensation, shortness of breath	• Inhalation – remove patient from exposure , fresh air, rest. obtain medical attention • Skin –wash skin with plenty water **DO NOT remove clothes.** • Eyes – irrigate with clean plenty of water holding the eyelids apart for 20 minutes • Ingestion _Do not induce vomiting .wash out mouth and give 200-300ml of water to drink • **First Aid – after immediate actions taken, seek medical attention.**	• Evacuate and ventilate area • Collect leaking and spilled liquid in sealable containers as far as possible. • Absorb remaining liquid in sand or inert absorbent and remove to safe place
Liquefied Petroleum Gas (LPG)/ **Methane Gas**	• Hydrocarbon mixture in liquid or gaseous state • Gas under normal atmospheric conditions, liquid by cooling and/or compression	• **Highly flammable** • Can form explosive mixtures with air • Contact with the liquid phase - frostbite • Prolonged vapour inhalation - anaesthetic affect (asphyxiant)	• **DO NOT** extinguish fire unless the leakage can be stopped. • **DO NOT** use water jet. Use dry chemical powder, carbon dioxide or foam. • Inhalation – fresh air, rest. Artificial respiration if necessary. • Skin – on frostbite, rinse with plenty of water. • Eyes – rinse with plenty of water for several minutes • **First Aid – after immediate actions taken, seek medical attention**	• Contain the leaking liquid, with sand or earth or disperse with special water/fog spray nozzle • Allow to evaporate • Ventilate the area

Substance	Properties	Acute Hazard/Symptoms	Fire Fighting / First Aid	Spillage Disposal
Chlorine	• Greenish-yellow gas, pungent odour	• Not combustible but enhances combustion of other substances. Many reactions may cause fire or explosion • Risk of fire and explosion on contact with combustible substances, ammonia and finely divided metals • Corrosive to eyes, skin and respiratory tract. • Inhalation - dizziness, laboured breath, nausea	• In case of fire in the surroundings: use appropriate extinguishing media. • In case of fire: keep cylinder cool by spraying with water but **NO direct contact with water.** • Inhalation – fresh air, rest. Artificial respiration if necessary. • Skin – rinse with plenty of water for several minutes • Eyes – rinse with plenty of water for several minutes • **First Aid – after immediate actions taken, seek medical attention.**	• Evacuate and ventilate area • **NEVER** direct water jet on liquid. • Remove gas with fine water spray.