Botanical & Ecological Assessment for the TjaNaledi sand mine on a portion of the farm Woodlands 407, Parys district Free State Province

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EXECUTIVE SUMMARY

This document provides a botanical assessment as well as a management plan for invasive alien plants present at the sand mine on a portion of the farm Woodlands 407, Parys, Free State Province. There are a number of acts playing a role in the management of alien invasive species. These are the Conservation of Agricultural Resources Act (Act No. 43 of 1983), the National Environmental Management: Biodiversity Act, 2004 (Act no. 10 of 2004), Alien and Invasive Species Lists, 2016 and the Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947).

The document provides a summary of the status of indigenous as well as invasive alien plants on the project site. It also provides control guidelines, including specific measures that should be taken during different phases of the project to ensure that new alien species do not become established on site and to control the ones already present on the site. The document also includes a brief guide to control methods, including mechanical, chemical and biological control, as well as the advantages and disadvantages of each. Habitat management to ensure that invasive alien plants do not become established on site is very important and recommendations are provided. It is also important to protect the employees who will be doing the control. An outline of safety standards and guidelines, specifically for the handling of herbicides as well as for the use of Personal Protective Equipment is also provided. Monitoring of the cleared areas is critical. The monitoring requirements for early detection of invasive alien plants on site as well as to evaluate the success of clearing operations is presented. The monitoring covers the mining and rehabilitation phases.

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1. INTRODUCTION

This document presents the Botanical overview and Alien Management Plan for the sand mine on a portion of the farm Woodlands 407, Parys District, Free State Province. The Environmental Impact process and mine permit is being handled by Greenmined Environmental Consultants. In accordance with the Environmental Authorisation (EA), an Alien Management Plan has been compiled that will be included in the final EMPr.

1.1 Purpose of the Alien Management Plan

The purpose of the alien management plan is:

- to ensure that alien plants do not become established on site;
- to ensure that alien plant species do not become dominant in all or parts of the landscape;
- to implement a monitoring programme to detect the presence of alien plant species as well as to monitor the success of the alien management plan.

1.2. Legislative framework

Acts such as those listed below (Table 1.2.1), ensure the protection of ecological processes, natural systems and natural beauty as well as the preservation of biotic diversity in the natural environment including the control of alien invasive species.

Table 1.2.1: List of relevant legislation

Title of legislation, policy or guideline	Applicability to the project	Administering authority	Date
National Environmental Management: Biodiversity Act (10 of 2004): Amendments, 2014	Protected species may occur on site	Department of Economic, Small Business Development, Tourism and Environment Affairs (DESTEA)	2014
National Environmental Management: Biodiversity Act, 2004 (Act no. 10 of 2004), Alien and Invasive Species Lists	Control and management of alien invasive species	Department of Economic, Small Business Development, Tourism and Environment Affairs (DESTEA)	2016
Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947).	Control and management of chemicals used on farms	Department of Agriculture, Forestry and Fisheries (DAFF)	1947
Free State Nature Conservation Ordinance 8 of 1969	Protected species could occur on the proposed site	Department of Economic, Small Business Development, Tourism and Environment Affairs(DESTEA)	1969
Mineral And Petroleum Resources Development Act (MPRDA) (Act 28 of 2002)	Regulates the mining of minerals	Department of Mineral Resources (DMR)	2002

1.2.1 Discussion on the National Environmental Management: Biodiversity Act, 2004 (Act No.10 of 2004)

The National Environmental Management: Biodiversity Act (NEMBA) regulates all invasive organisms in South Africa, including a wide range of fauna and flora. Regulations have been published in Government Notices R.506, R.507, R.508 and R.509 of 2013 under NEMBA. According to this Act and the regulations, any species designated under section 70 cannot be propagated, grown, bought or sold without a permit. Below is an explanation of the three categories:

- Category 1a: Invasive species requiring compulsory control. Any specimens of Category 1a listed species need, by law, to be eradicated from the environment. No permits will be issued.
- Category 1b: Invasive species requiring compulsory control as part of an invasive species control programme. Remove and destroy. These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government sponsored invasive species management programme. No permits will be issued.
- Category 2:Invasive species regulated by area. A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed as Category 2 plants. No permits will be issued for Cat 2 plants to exist in riparian zones.
- Category 3: Invasive species regulated by activity. An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species. No permits will be issued for Cat 3 plants to exist in riparian zones. It is important to note that alien species that are regulated in terms of the Conservation of Agricultural Resources Act (Act 43 of 1983) (CARA) as weeds and invader plants are exempted from NEMBA. This implies that the provisions of the CARA in respect of listed weed and invader plants supersede those of NEMBA.

1.2.2 Discussion on the Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947)

Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947). According to Government Notice No. 13424 dated 26 July 1992, it is an offence to "*acquire, dispose, sell or use an agricultural or stock remedy for a purpose or in a manner other than that specified on the label on a container thereof or on such a container*". Contractors using herbicides need to have a valid Pest Control Operators License (limited weeds controller) according to the Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947). This is regulated by the Department of Agriculture, forestry and Fisheries.

1.3 Responsible persons

Effective management of alien plant species during the mine's operational phase will be dependent on a number of project personnel. These are listed below:

1.3.1 The operator of the mine

This refers to the project proponent, TjaNaledi (Pty) Ltd. They will be responsible for the following:

1. Ensure that the requirements set out in this management plan are adhered to and implemented;
2. Allocate the responsibilities assigned to the Environmental Control Officer (ECO) to an independent suitably qualified individual to coordinate and monitor the alien invasive control activities on site; and
3. Provide all principal contractors, working on the alien invasive control programme, with a copy of this management plan to allow the contractors to cost for its requirements within their respective contracts.

1.3.2 The Environmental Control Officer (ECO)

The ECO is responsible for monitoring and verifying the implementation of the management plan during the mining phases of the project. To effectively implement the management plan, the ECO must be aware of the findings, mitigation measures and conclusions of this management plan.

1.3.3 The Contractor or mine manager

The contractor or mine manager, being any directly appointed company or person undertaking the implementation of works, will be responsible for complying with the management plan at all times during the mining and rehabilitation phases.

2. SITE DESCRIPTION

2.1 Description of the broader study area and project site

2.1.1 Location

The TjaNaledi sand mine is on a portion of the farm Woodlands 407, Parys district, Free State Province (Figures 3.1, 3.2 and 3.3). The project site falls within the quarter degree square **2627DC**.

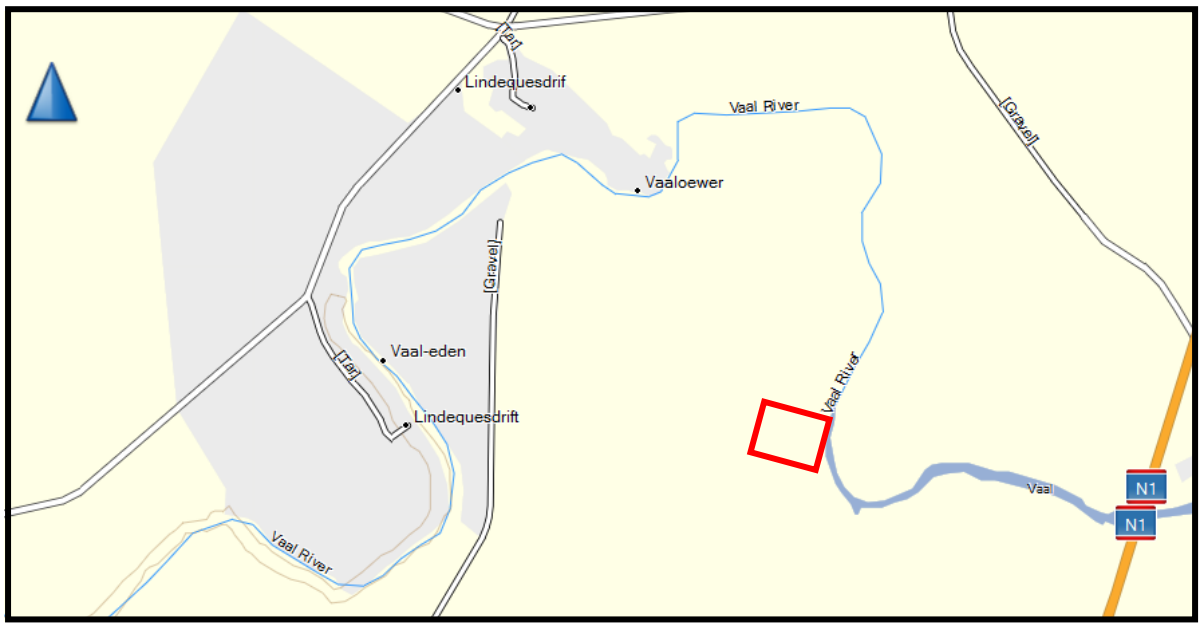


Figure 2.1: Locality map of the project site area (red polygon).

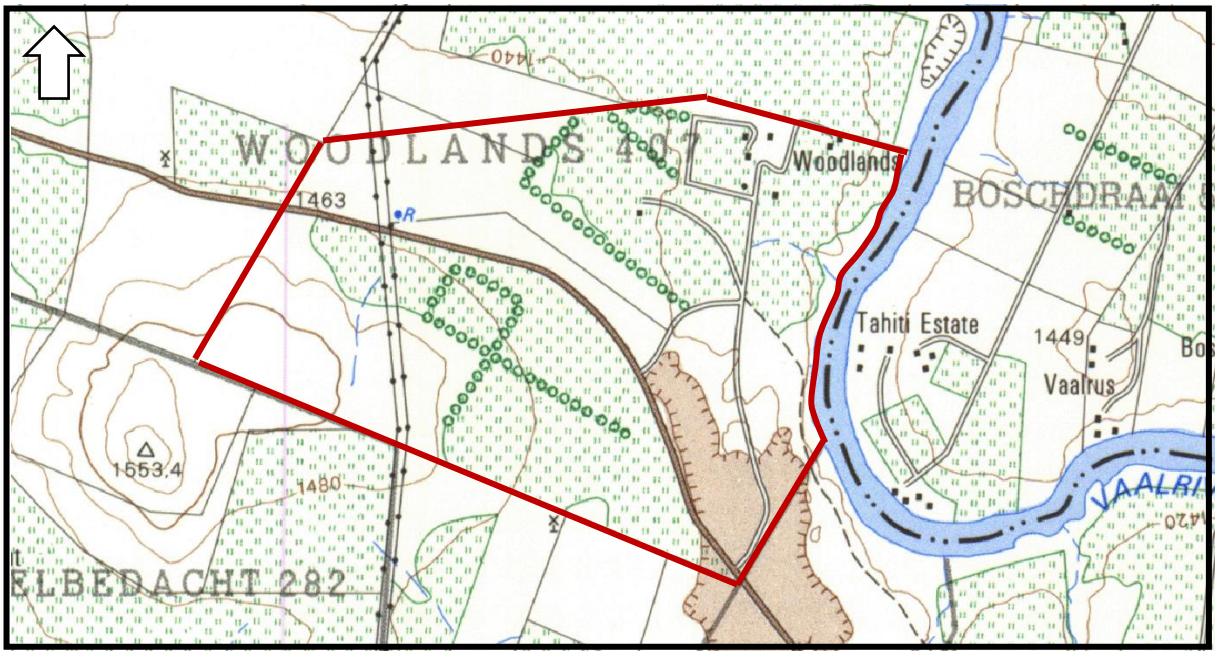


Figure 2.2: A topographic map of project sites (red polygon).

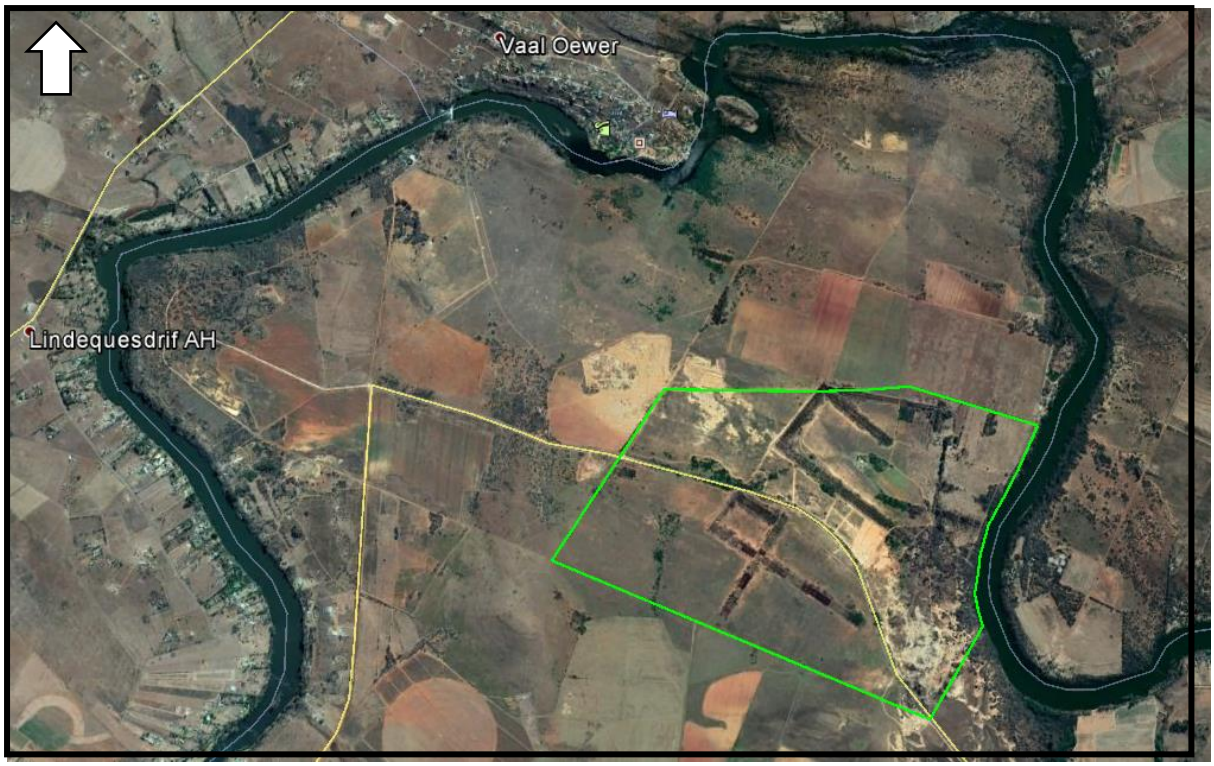


Figure 2.3: A satellite image of the project site (green polygon)(Google Earth).

Figure 2.4: A close-up satellite image of the project site (green polygon)(Google Earth).

2.1.2 Broad vegetation types

The most recent description of the broader study area's vegetation is the general description by Mucina & Rutherford (2006) relating to the vegetation which is considered to be the "Vegetation of South Africa, Lesotho and Swaziland" as well as its accompanying map of the

country by (Mucina *et al.*, 2005). This memoir contains species information and a comprehensive conservation assessment of all vegetation types.

According to Mucina & Rutherford (2006)(Fig 2.5), the vegetation type is present at the project site, namely Soweto Highveld Grassland (Gm 8).

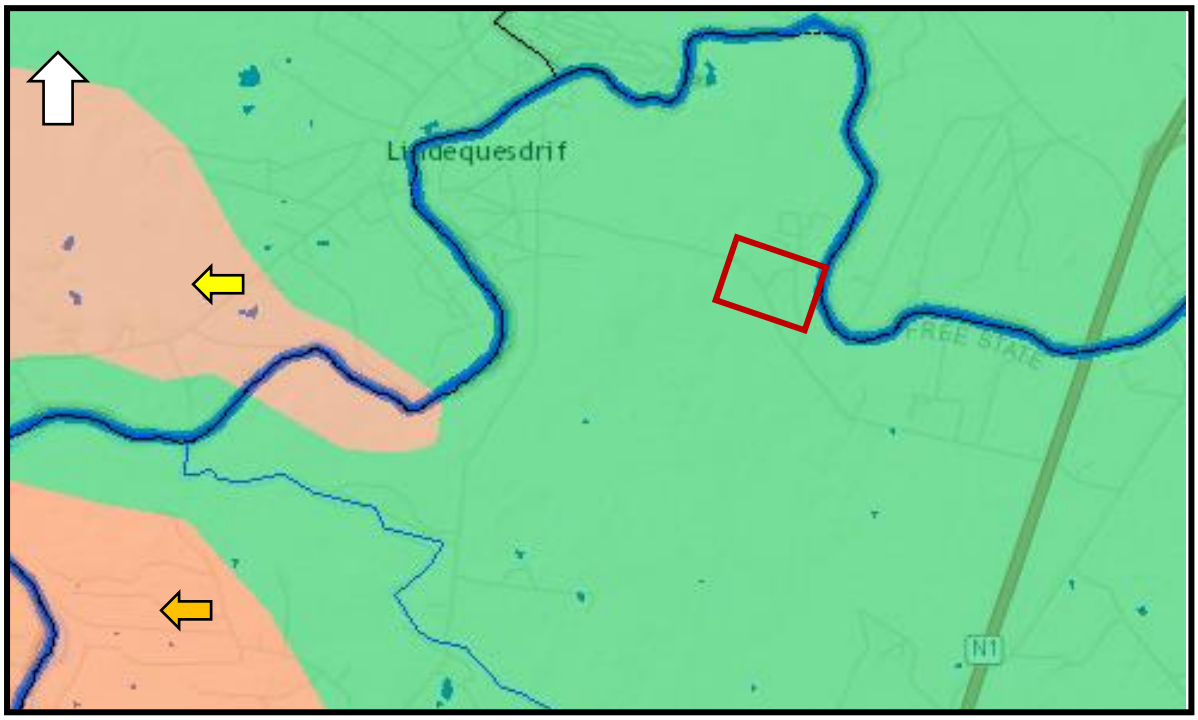


Figure 2.5: The vegetation map of the project site (red polygon) and the surrounding area.

- Green area – Soweto Highveld Grassland (Gm 8)
- Pink area (yellow arrow) – Andesite Mountain Bushveld (SVcb 11)
- Orange area (orange arrow) – Gold Reef Mountain Bushveld (SVcb 9)

(Mucina & Rutherford, 2006).

2.1.3 National List of Threatened Terrestrial Ecosystems for South Africa (2011)

The National threatened ecosystem classification is based on Mucina & Rutherford's map of 2006. The vegetation types of South Africa have been classified according to their conservation status which is, in turn, assessed according to the degree of transformation and rates of conservation. The status of a habitat or vegetation type is based on how much of its original area still remains intact relative to various thresholds. On a national scale these thresholds are as depicted in the table below, as determined by best available scientific approaches (Driver *et al.* 2005). The level at which an ecosystem becomes Critically Endangered differs from one ecosystem to another and varies from 16% to 36% (Driver *et al.* 2005).

Table 2.1: Determining ecosystem status (from Driver *et al.* 2005). *BT = biodiversity target (the minimum conservation requirement.

Habitat remaining (%)			
	80–100	least threatened	LT
	60–80	vulnerable	VU
	*BT–60	endangered	EN
	0–*BT	critically endangered	CR

Threatened ecosystems which are in need of protection (GN1002 of 2011), was published under the National Environment Management: Biodiversity Act (Act No. 10 of 2004). It lists national vegetation types that are afforded protection on the basis of rates of transformation. The threshold for listing in this legislation is higher than in the scientific literature, which means there are fewer ecosystems listed in the National Ecosystem List versus in the scientific literature.

The National Environmental Management: Biodiversity Act (Act 10 of 2004)(NEMBA) provides for listing of threatened or protected ecosystems, in one of four categories: critically endangered, endangered, vulnerable or protected. Threatened ecosystems are listed in order to reduce the rate of ecosystem and species extinction by preventing further degradation and loss of structure, function and composition of threatened ecosystems. The purpose of listing protected ecosystems is primarily to conserve sites of exceptionally high conservation value (SANBI, BGIS).

Table 2.2: Conservation status of the vegetation types occurring in and around the study area.

Vegetation Type	**Target (%)**	**Conserved (%)**	**Transformed (%)**	**Conservation Status**	
				Driver *et al*., 2005; Mucina & Rutherford, 2006	National Ecosystem List (NEM:BA)
Soweto Highveld Grassland (Gm 8)	24%	3%	50%	Endangered	Listed

The National threatened ecosystem classification is based on Mucina & Rutherford's map. According to the National List of Threatened Terrestrial Ecosystems (2011) the project site **does** fall in a threatened ecosystem although the project site is in a transformed state due to anthropogenic influences.

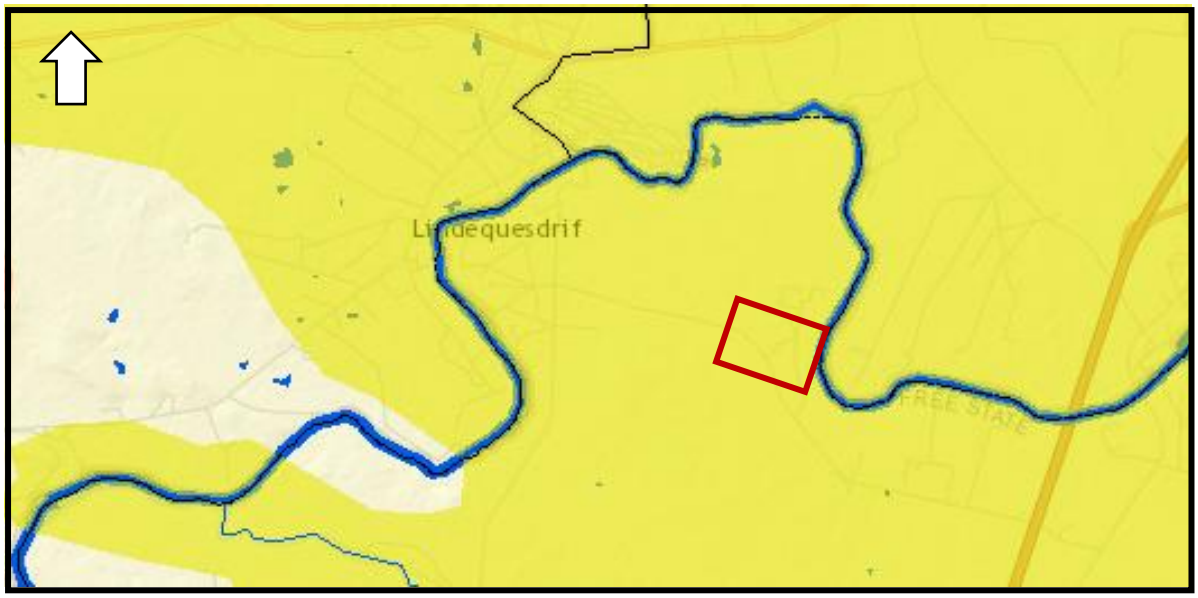


Figure 3.6: The vegetation map of the project site (red polygon) in relation to the threatened vegetation type (yellow area).

- Yellow area - Soweto Highveld Grassland (Gm 8)(Mucina & Rutherford, 2006).

2.1.4 Vulnerable ecosystems and habitats

Invasive alien plants threaten three main components of the landscape:

- agricultural potential of the land;
- biodiversity value of the land;
- water quality and quantity.

Some habitats are more vulnerable to invasion by alien plant species than others and are therefore more likely to become problematic areas with respect to management of alien plant species. In addition, some parts of the site will be subject to greater levels of disturbance than others, which will promote conditions suitable for invasion by alien plant species. Although any parts of the site could become invaded by alien plants, the areas on site that are most likely to be problematic from the point of view of invasion by alien plants are as follows:

- drainage lines and watercourses;
- areas with deeper soils, including primarily valley bottom areas;
- areas immediately adjacent to any disturbance due to mining activities;
- areas prone to increased runoff following mining activities, for example spoil material;
- areas of prolonged disturbance, for example, construction camps and laydown areas.

2.1.5 Major vegetation units present on project site

This section provides an outline of the existing status of the site with respect to alien invasive plant species. The purpose is to provide a tool to identify the alien invasive species and how to control them.

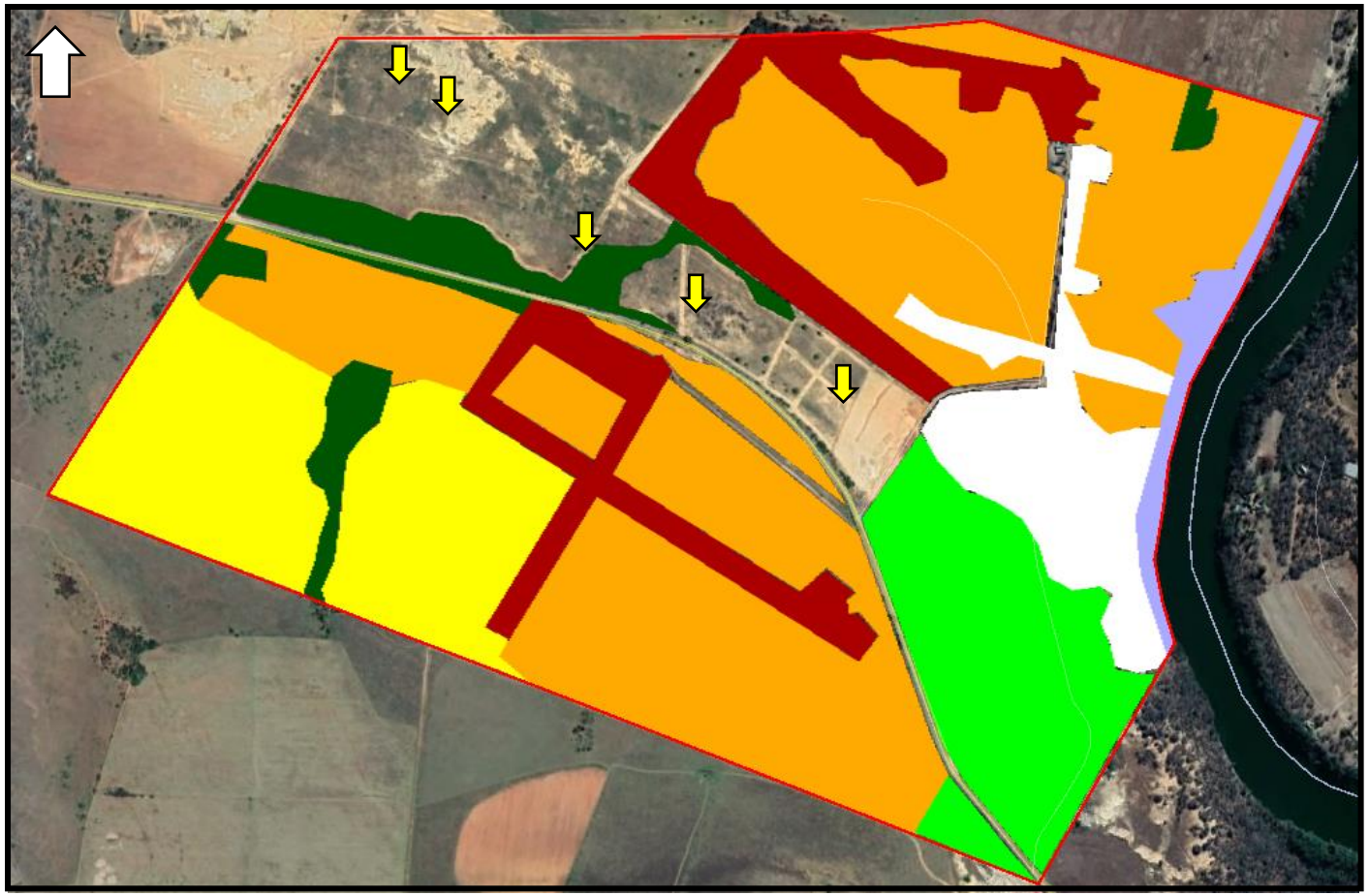


Figure 3.7: The project site (green polygon) in relation to the various major vegetation units present on site. Arrows indicate current mine areas

- Yellow areas - Natural grassland
- Dark green areas - Natural shrubland
- Red-brown areas - Bluegum plantations
- Light blue area - Riparian vegetation invaded by alien invasive species
- Light green areas - Rehabilitated mine areas
- White areas - Disturbed areas invaded by various exotic tree species

3. SPECIES PRESENT ON SITE

A survey of the project site was undertaken which covered the basic footprint of the property. During this survey, several declared alien invader plant species and few other exotic species were found on site. The general disturbance of natural vegetation is the main reason for this high diversity of alien invasive species. The project will be disturbed further as the mining of sand progresses. These activities may promote conditions that will lead to the introduction and / or spread of invasive exotic species.

3.1 Listed of alien invader species observed on the project site

Table 3.1: Other exotic species noted on site but which are not declared weeds

Common name	**Scientific name**
Black Ironbark Gum	*Eucalyptus sideroxylon*
Black Jack	*Bidens bipinnata*
Chicory	*Chichorium intybus*
Common chenopodium	*Chenopodium album*
Common peach	*Prunus persica*
Cordyline	*Colyline australe*
Deodar Ceder	*Cederus deodara*
Italian Cypress	*Cupressus sempervirens*
Khaki Bush	*Tagetes minuta*
Little Khaki Bush	*Schkuhria pinnata*
Weeping willow	*Salix babylonica*

These species in Table 3.1 can be eradicated but it is not compulsory to manage these species.

The couple of species below are listed species in terms of the National Environmental Management: Biodiversity Act, 2004 (Act no. 10 of 2004), Alien and Invasive Species Lists. These species are listed because they are aggressive invaders and species which change the character and functioning of the ecosystems. These species must be managed in order to lower their number and eventually completely eradicate them from the project site.

Common Name	**Scientific name**
Sweet prickly pear	*Opuntia ficus-indica*
Status: Declared invader (Category 1b)	
Impact: Invades savanna and dry grassland. Propagates easily from the seeds and leaf-pads (cladodes). Even a small piece lying on the ground can produce roots and flourish.	
Control: Chemical control is possible with several herbicides, such as MSMA and glyphosphate. However, continues to be kept under control by the use of the Cactoblastis moth and a cochineal insect, *Dactylopius opuntiae*. Special control measures are rarely required. Cochineal insects are not very mobile so isolated plants must be inoculated manually by placing an infected cladode on top of the plant to be controlled.	

Common Name	**Scientific name**
Creeping prickly pear	*Opuntia stricta*
Status: Declared invader (Category 1b)	
Impact: Invades savanna and dry grassland. Propagates easily from the seeds and leaf-pads (cladodes). Even a small piece lying on the ground can produce roots and flourish.	
Control: Chemical control is possible with several herbicides, such as MSMA and glyphosphate. However, continues to be kept under control by the use of the Cactoblastis moth and a cochineal insect, *Dactylopius opuntiae*. Special control measures are rarely required. Cochineal insects are not very mobile so isolated plants must be inoculated manually by placing an infected cladode on top of the plant to be controlled.	

Common Name	**Scientific name**
Common prickly pear	*Opuntia robusta*
Status: Declared invader (Category 1a)	
Impact: Invades savanna and dry grassland. Propagates easily from the seeds and leaf-pads (cladodes). Even a small piece lying on the ground can produce roots and flourish.	
Control: Chemical control is possible with several herbicides, such as MSMA and glyphosphate. However, continues to be kept under control by the use of the Cactoblastis moth and a cochineal insect, *Dactylopius opuntiae*. Special control measures are rarely required. Cochineal insects are not very mobile so isolated plants must be inoculated manually by placing an infected cladode on top of the plant to be controlled.	
	

Common Name	Scientific name
American Agave / Garingboom	*Agave americana*
Status: Declared invader (Category 1b)	
Impact: Invades dry habitats, rocky outcrops, drainage lines. Agave Americana forms an impenetrable barrier because the leaves are tipped with a spine. The plant is still used as a barrier. Cultivated worldwide as an ornamental plant.	
Control: Can be controlled with the direct injection of concentrated MSMA into the basal stem. When the plants have dried out they can be cleared by burning. Physical removal is restricted to the use of bulldozers.	

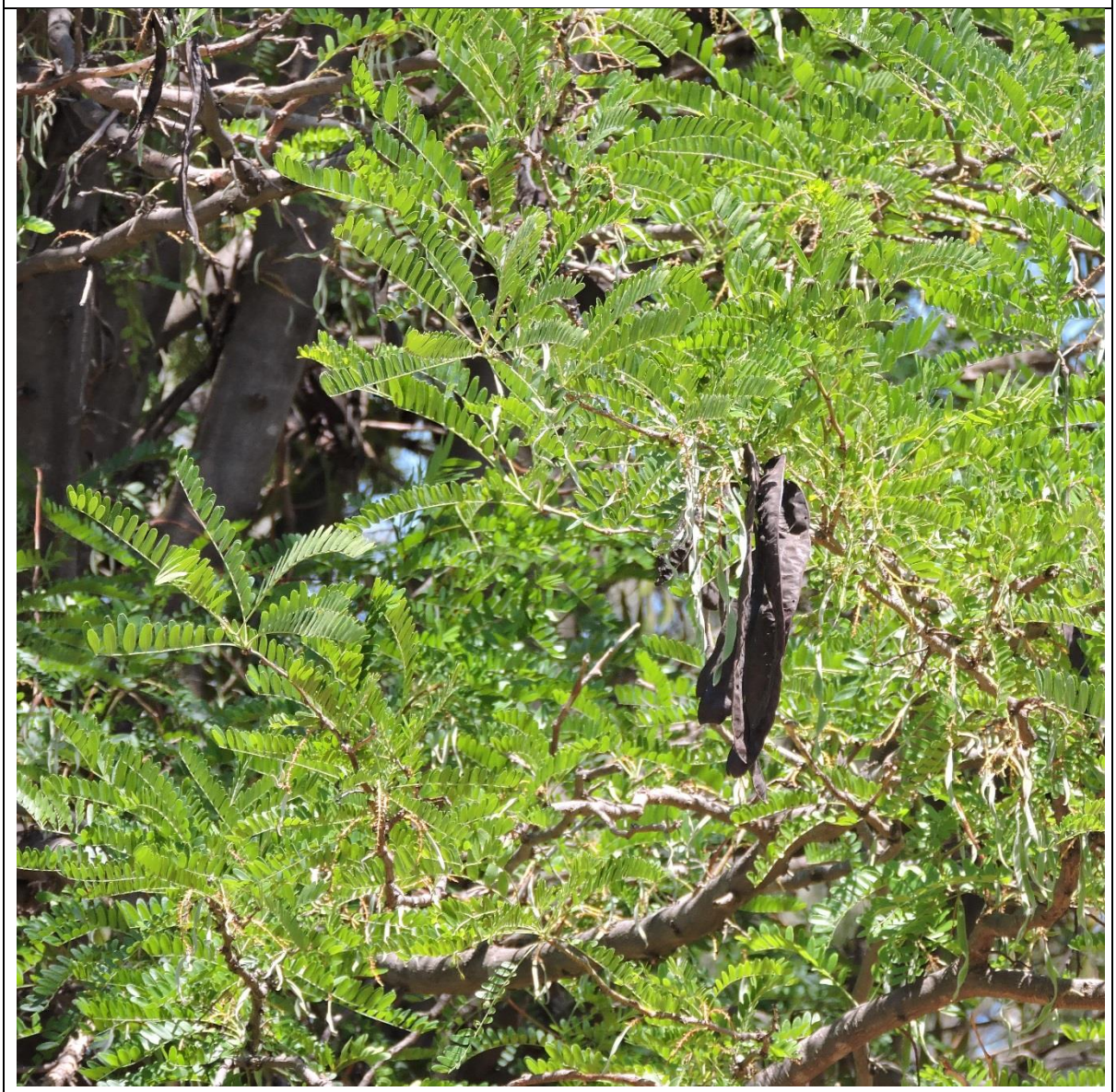
Common Name	Scientific name
Red River Gum	*Eucalyptus camuldulensis*
Status: Declared invader (Category 1b). Listed as 1b when occurring in riparian vegetation	
Impact: Invades riverine habitats, drainage lines. Red River Gum forms dense stands especially when they become multi-stemmed after the main stem has been cut. The plant is still used as a wind -barrier. Cultivated worldwide.	
Control: Can be controlled by cutting and treatment of the cut stem with herbicide. Care must be taken to kill the stem and root system because it coppices (resprouts) easily.	

Common Name	Scientific name
Black Locust	*Robinia pseudo-acacia*
Status: Declared invader (Category 1b).	
Impact: Invades any habitat. Black Locust forms dense stands especially when they become multi-stemmed after the main stem has been cut. This tree spreads easily by seed as well as coppicing (resprouts)	
Control: Can be controlled by cutting and treatment of the cut stem with herbicide. Care must be taken to kill the stem and root system because it coppices (resprouts) easily.	

Common Name	Scientific name
Tree of Heaven / Hemelboom	*Ailanthus altissima*
Status: Declared invader (Category 1b). Listed as 1a when occurring in riparian vegetation	
Impact: Invades any habitat. The Tree of Heaven spreads as it forms new shoots from its root system. Dense stands usually forms especially when they become multi-stemmed after the main stem has been cut. The plant grows and start to produce wind-dispersed seed at a young age.	
Control: Can be controlled by cutting and treatment of the cut stem with herbicide. Care must be taken to kill the stem and root system because it coppices (resprouts) easily if left untreated.	

Common Name	**Scientific name**
Grey Poplar	*Populus x canescens*
Status: Declared invader (Category 2). Listed as 1b when occurring in riparian vegetation	
Impact: Invades any habitat especially riverbanks and drainage lines. The Grey Poplar forms dense stands by forming new shoots from its root systems. The plant grows and start to produce wind-dispersed seed at a young age.	
Control: Can be controlled by cutting and treatment of the cut stems with herbicide. Care must be taken to kill the stem and root system because it coppices (resprouts) easily if left untreated.	

Common Name	**Scientific name**
Honey Locust	*Gleditsia triacanthos*
Status: Declared invader (Category 1b).	
Impact: Invades any disturbed habitat especially riverbanks and cropfields. The Honey Locust spreads easily because cattle and goats feed on the pods and the seeds get spread by the animals. The tree grows fast.	
Control: Can be controlled by cutting and treatment of the cut stems with herbicide. Care must be taken to kill the stem and root system because it coppices (resprouts) easily if left untreated.	



Common Name	**Scientific name**
Seringa Tree	*Melia azadarach*

Status: Declared invader (Category 1b).

Impact: Invades any habitat especially riverbanks and drainage lines. The Seringa Tree forms dense stands in riparian vegetation. The plant spread easily by means of its yellow berries. Birds and monkeys are effective spreaders of the seed.

Control: Can be controlled by cutting and treatment of the cut stems with herbicide. Care must be taken to kill the stem and root system because it coppices (resprouts) easily if left untreated.

Common Name	Scientific name
Bailey's Wattle	*Acacia baileyana*

Status: Declared invader (Category 3). Listed as 1b when occurring in riparian vegetation

Impact: Not an aggressive invader. The Bailey's Wattle can form dense stands in riparian vegetation. The plant spread by means of it seed.

Control: Can be controlled by cutting and treatment of the cut stems with herbicide. Care must be taken to kill the stem and root system because it coppices (resprouts) easily if left untreated.

Common Name	Scientific name
Yellow Cotoneaster	*Cotoneaster franchettii*

Status: Declared invader (Category 1b).

Impact: Invades any habitat especially riverbanks and drainage lines. The Yellow fire-thorn forms dense stands in riparian vegetation. The plant spread easily by means of its yellow berries. Birds and monkeys are effective spreaders of the seed.

Control: Can be controlled by cutting and treatment of the cut stems with herbicide. Care must be taken to kill the stem and root system because it coppices (resprouts) easily if left untreated.

Common Name	**Scientific name**
Common Privet	*Ligustrum vulgare*
Status: Declared invader (Category 3).	
Impact: Invades any habitat especially riverbanks and drainage lines. The Yellow fire-thorn forms dense stands in riparian vegetation. The plant spread easily by means of its yellow berries. Birds and monkeys are effective spreaders of the seed.	
Control: Can be controlled by cutting and treatment of the cut stems with herbicide. Care must be taken to kill the stem and root system because it coppices (resprouts) easily if left untreated.	

Common Name	Scientific name
Ink berry	*Cestrum laevigatum*

Status: Declared invader (Category 1b).

Impact: Invades shaded areas. Forms a dense undergrowth under larger trees and shrubs. The plant is poisonous especially to livestock. Its seeds are bird dispersed. Seeds geminates easily

Control: Can be controlled by cutting and treatment of the cut stems with herbicide. Care must be taken to kill the stem and root system because it coppices (resprouts) easily if left untreated.

Common Name	**Scientific name**
Large Thorn Apple	*Datura ferox*
Status: Declared invader (Category 1b).	
Impact: Invades wastelands, cultivated lands, roadsides, riverbanks, riverbeds. Declared as weeds not only because they are poisonous, but also because of their tall and aggressive growth habit. Difficult to control and contaminate crops such as maize. One seed per 10 kg can cause rejection of maize crop.	
Control: Being deep germinators, these weeds are not adequately controlled by many pre-emergence herbicides. In annual crops, it is best to delay treatment as long as possible in order to catch late germinating individuals. Eradicate before the plants form flowers and seed	

Common Name	Scientific name
Blue Thistle	*Argemone ochroleuca*

Status: Declared invader (Category 1b).

Impact: Invades wastelands, cultivated lands, roadsides, riverbanks, riverbeds. Declared as weeds because of their aggressive growth habit. Difficult to control and contaminate crop fields and disturbed areas.

Control: Being deep germinators, these weeds are not adequately controlled by many pre-emergence herbicides. In annual crops, it is best to delay treatment as long as possible in order to catch late germinating individuals. Eradicate before the plants form flowers and seed

Common Name	Scientific name
Common bind weed	*Convovulus arvensis*

Status: Declared invader (Category 1b).

Impact: Invades wastelands, cultivated lands, roadsides, riverbanks, riverbeds. Declared as weeds because of their aggressive growth habit. Difficult to control and contaminate crop fields and disturbed areas.

Control: Being deep germinators, these weeds are not adequately controlled by many pre-emergence herbicides. In annual crops, it is best to delay treatment as long as possible in order to catch late germinating individuals. Eradicate before the plants form flowers and seed

Common Name	**Scientific name**
Blue Verbena	*Verbena bonariensis*
Status: Declared invader (Category 1b).	
Impact: Invades wetlands, depressions, riverbanks, and riverbeds. Declared as weeds because of their aggressive growth habit. Difficult to control and contaminate crop fields and disturbed areas.	
Control: Being deep germinators, these weeds are not adequately controlled by many pre-emergence herbicides. In annual crops, it is best to delay treatment as long as possible in order to catch late germinating individuals. Eradicate before the plants form flowers and seed	

4. CONTROL GUIDELINES

This section provides an outline of the overall approach that should be adopted at the site in order to minimize the probability of invasive alien plants becoming established and ensuring that any outbreaks are managed quickly to ensure that they do not become a long-term problem on site. The establishment of any dense infestations is and will be expensive to eradicate and will require more complex control measures than would be necessary for low density invasions.

4.1 Prevention

A prevention strategy should be considered and established, including regular surveys and monitoring for invasive alien plants, effective rehabilitation of disturbed areas and prevention of unnecessary disturbance of natural areas. Prevention could also include measures such as washing the working parts and wheels of earth-moving equipment prior to it being brought onto site, visual walk-through surveys every three months and other measures, as listed in the section below ("Habitat management").

4.2 Early identification and eradication

Monitoring plans should be developed which are designed to catch Invasive Alien Plant Species shortly after they arrive in the project area. Keeping up to date on which weeds are an immediate threat to the site is important, but efforts should be planned to update this information on a regular basis. When new Invasive Alien Plant Species are spotted an immediate response of locating the site for future monitoring and either hand-pulling the weeds or an application of a suitable herbicide should be planned. It is, however, better to monitor regularly and act swiftly than to allow invasive alien plants to become established on site.

4.3 Containment and control

If any alien invasive plants are found to become established on site, action plans for their control should be developed, depending on the size of the infestations, budgets, manpower considerations and time. Separate plans of control actions should be developed for each location and/or each species. Appropriate registered chemicals and other possible control agents should be considered in the action plans for each site/species. The key is to ensure that no invasions get out of control. Effective containment and control will ensure that the least energy and resources are required to maintain this status over the long-term. This will also be an indicator that natural systems are impacted to the smallest degree possible.

4.4 Mining phase activities required

The following management actions are required to minimize soils and vegetation disturbance during the mining phase, as well as reducing the probability that invasive alien plants will become established on site:

Table 4.1: Management actions during the mining phase

Action	Frequency
The Environmental Control Officer (ECO) is to provide permission before any natural vegetation is to be cleared for mining.	Daily / when required
Clearing of vegetation must be undertaken as the work front progresses. Mass clearing is not to be permitted unless the entire cleared area is to be rehabilitated immediately thereafter.	Weekly
Should revegetation not be possible immediately, the cleared areas must be protected with packed brush or appropriately battered with fascine work (fixing horizontal branches along the ground using vertical pegs to create resistance to down-slope flow of water/materials). Alternatively, jute (Soil Saver) may be pegged over the soil to stabilize it.	Weekly
Organic matter used to encourage regrowth of vegetation on cleared areas should not be brought onto site from foreign areas. Brush from cleared areas should be used as much as possible. Arid areas generally have low organic content in the soil and the use of manure or other soil amendments should not be used as this would encourage invasion.	Weekly
Care must be taken to avoid the introduction of alien invasive plant species to the site. Particular attention must be paid to imported material such as building sand or dirty earth-moving equipment. Stockpiles should be checked regularly and any weeds emerging from material stockpiles should be removed.	Weekly
ECO to survey site once a month to detect aliens and have them removed.	Monthly
Alien vegetation regrowth must be controlled throughout the entire site during the mining period.	Monthly
The alien plant removal and control method guidelines should adhere to best practice for the species concerned. Such information can be obtained from the Working for Water website as well as herbicide guidelines.	Monthly
Clearing activities must be contained within the affected zones and may not spill over into adjacent no-go areas. No-go areas should be clearly demarcated prior to mining.	Daily

4.5 Rehabilitation phase activities required

The following management actions are aimed at preventing invasion by invasive alien species of revegetated areas created during decommissioning activities.

Table 4.2: Management actions during the rehabilitation phase

Action	Frequency
All damaged areas shall be revegetated upon completion of activities.	Once-off
Revegetation with indigenous, locally occurring species should take place in disturbed areas. Reseed with locally sourced seed of indigenous grass species that were recorded on site prior to mining.	Once off, with annual follow-up revegetation, if necessary
Maintain alien plant monitoring and removal programme for 3 years after rehabilitation.	Biannually for 3 years

5. CONTROL METHODS

This section provides an outline of existing control measures that have published for the various alien plant species that could potentially occur on site. The section is a summary of control measures – there are more detailed publications for control measures. Some of these publications are referenced. There are various means of managing invasive alien plants:

5.1 Mechanical Control

This entails damaging or removing the plant by physical action. Different techniques could be used, e.g. uprooting, felling, slashing, mowing, ringbarking or bark stripping. This control option is only really feasible in sparse infestations or on small scale, and for controlling species that do not coppice (resprout) after cutting. Species that tend to coppice, need to have the cut stumps or coppice growth treated with herbicides following the mechanical treatment. Mechanical control is labour intensive and therefore expensive, and could cause severe soil disturbance and erosion.

Table 5.1: Advantages and disadvantages of mechanical control

Advantages	Disadvantages
Effective method in areas with low infestation.	Not an effective method for dense infestations, as the cost of clearing is extremely high, with little or no impact.
High job creation and associated poverty alleviation potential.	Time consuming.
No contamination of water with herbicides.	If no herbicides are used then the manual control techniques must be very well executed to ensure success.

5.2 Chemical Control

Chemical control should only be used as a last resort, since it is hazardous for natural vegetation. It should not be necessary if regular monitoring is undertaken, which should be effective for controlling invasive alien plants. Chemical control involves the use of registered herbicides to kill the target weed. Managers and herbicide operators must have a basic understanding of how herbicides function. The use of inappropriate herbicides and the incorrect use of the appropriate herbicides are wasteful, expensive practices and often do more harm than good, especially when working close to watercourses. Some herbicides can quickly contaminate fresh water and/or be transported downstream where they may remain active in the ecosystem.

Contractors using herbicides are required to have a permit according to Fertilizer, Farm Feeds, Agricultural Remedies and Stock Remedies Act (Act No. 36 of 1947). Herbicides are either classified as selective or non-selective. Selective herbicides are usually specific to a particular group of plants, e.g. those specified for use on broad leaf plants, but should not kill narrow-leaf plants such as grasses. Non-selective herbicides can kill any plant that they come into contact with and are therefore not suitable for use in areas where indigenous vegetation is present. Chemical application techniques include foliar (leaf) application, stem applications (basal stem, total frill, stem injections) and stump applications (cut stump, total stump, scrape and paint):

Table 5.2: Advantages and disadvantages of chemical control

Advantages	**Disadvantages**
Complements mechanical control methods, increasing the effectiveness of control activities.	May kill non-target plants or species. This is a very important consideration and poses risks for remaining natural areas on site.
Achieve results over short period (within 6 weeks of application).	Herbicides are expensive.
Large areas can be treated quickly.	The use of herbicides may contaminate sites used for drinking water, for washing and for fishing, and can therefore threatened human and animal health. Specialized training and certification is required for use of herbicides.

5.3 Biological Control

Biological weed control consists in the use of natural enemies to reduce the vigour or reproductive potential of an invasive alien plant. Biological control agents include insects, mites, and micro-organisms such as fungi or bacteria. They usually attack specific parts of the plant, either the reproductive organs directly (flower buds, flowers or fruit) or the seeds after they have dropped. The stress caused by the biological control agent may kill a plant outright

or it might impact on the plants reproductive capacity. In certain instances, the reproductive capacity is reduced to zero and the population is effectively sterilized. All of these outcomes will help to reduce the spread of the species. To obtain biocontrol agents, provincial representatives of the Working for Water Programme or the Directorate: Land Use and Soil Management (LUSM), Department of Agriculture, Forestry and Fisheries (DAFF) can be contacted.

Table 5.3: Advantages and disadvantages of biological control

Advantages	**Disadvantages**
Most environmentally friendly and most sustainable of all control methods.	Generally slow, especially initially.
Usually does not require high or long-term maintenance.	Low levels of infestation, with occasional outbreaks, will remain a feature of systems under biological control.
Relatively low cost implication over the long term.	Any use of chemicals around biocontrol agent colonies may adversely affect the potency of this control method.
	Cannot be used where the biocontrol agent would threaten commercial populations of the target species that may exist nearby.
	Biocontrol agents are not available for all target species.

6. HABITAT MANAGEMENT

The best way to prevent invasion by alien invasive plant species is to manage the natural vegetation in such a way as to reduce the opportunity for these plants becoming established. The general principle is to not disturb any areas beyond the footprint of the proposed mine site and to also ensure that the natural processes that maintain vegetation patterns are not disrupted.

6.1 Post-removal follow-up and rehabilitation

Re-establishment of indigenous vegetation needs to be undertaken to reduce the probability of re-emergence of invasive alien plants and to reduce the risk of soil erosion where the soil surface is poorly vegetated. In most soils, the seeds and other propagules of the plants of the former natural habitat still survive. So natural regeneration without the need for planting may be possible in many cases. However, if natural regeneration is not likely due to the length of time since disturbance or if the soil has been disturbed to such a degree that seeds and propagules no longer survive then planting or seeding may be required. Rehabilitation should follow these steps:

1. Monitor cleared areas on a regular basis (monthly during mining and three-monthly during rehabilitation phase) for emergent seedlings of invasive alien species and remove these (hand pulling or chemical control).

2. All areas of exposed soil should immediately be protected by placing packed brush on the slope, or creating erosion control barriers using branches, sticks or logs placed horizontally across the slope at 1m intervals (the steeper the slope the closer the barriers should be placed to one another). If topsoil has been lost, rehabilitation of indigenous vegetation will be a difficult and expensive process.

3. If the soil remains relatively undisturbed and the area has some indigenous vegetation left intact, the natural regeneration process of the indigenous vegetation on the site should be managed. This involves regular follow-up to remove emerging invasive alien plants and protecting the area from other forms of disturbance (heavy grazing, trampling, disturbance by vehicles, etc.) while the vegetation re-established naturally.

4. If required, indigenous vegetation can be planted on the cleared areas. This can be in the form of a seed mix or plants rescued from previous clearing.

7. SAFETY STANDARDS AND GUIDELINES

Safety is of the utmost importance when working with invasive alien plant control. Staff are likely to be working in remote areas with potentially dangerous equipment and chemicals. Proper safety training and equipment is therefore required.

7.1 Herbicide safety

Herbicides must be stored in a dedicated storeroom. The Herbicide Storeroom needs to comply with national Occupational Health and Safety standards. Some important safety rules are as follows:

- A herbicide storeroom must have adequate ventilation. If the air is stagnant or there is a smell of herbicides when opening up the storeroom then it is a good indication that there is not enough ventilation.
- Clean water needs to be available in close proximity to the storeroom.
- The floor must be non-porous. This is important because when the floor is cleaned (which must be done regularly), no residue of herbicides must remain. Place herbicide containers on wooden pallets to increase ventilation and make mopping up after spillage easier.
- ‘No Smoking’ and ‘No Fire’ signs should be posted on the door of the storeroom as well as a sign stating that it is a chemical store and who the responsible person is for the store.
- Keep the storeroom locked to prevent herbicide getting into the wrong hands.
- A spill kit needs to be kept in the storeroom to mop up any spill. The spill kit must contain a bucket with sand and a spade. The sand is to be placed on the spill to absorb the liquid. Once the sand has absorbed the spill, it is to be collected and disposed of where it cannot contaminate the environment. It is preferable to keep contaminated sand in a container and dispose of it with empty containers at a certified chemical recycling plant.

- Obtain the Material Safety Data Sheet from the supplier of the herbicide and ensure that you are familiar with the product before using it. Keep the Material Safety Data Sheet in the storeroom in case of an emergency.
- Always store herbicides in the original labelled container to avoid confusion with other products. Do not store other products in the store, such as protective clothing, food, etc., as they can become contaminated.
- All empty herbicide containers, or herbicides that have reached their expiry date, need to be safely disposed of. This can be done at a registered chemical recycling company. It is important that all empty containers are spiked before disposal. This ensures that they cannot later be used for carrying drinking water, food, etc.
- The contact number for the nearest Poison Control Centre should be posted nearby.

7.2 Personal Protective Equipment (PPE)

The use of Personal Protective Equipment (PPE) by staff controlling invasive alien plants in the field is required by law. The PPE specifications differ for the different types of control. Mechanised control includes the use of chainsaws and brush cutters and will therefore require slightly different PPE from someone using manual control (slasher, knapsack sprayer, etc.). PPE required for manual control is as follows:

Table 7.1: Personal Protective Equipment (PPE) required to control alien invasive species

Item	Specification
Overall	100% cotton, two-piece overalls are best for absorbing perspiration, they last longer and are cooler.
Rubber gloves	Standard, wrist-length rubber gloves are sufficient.
Leather gloves	Standard wrist-length leather gloves are appropriate.
Safety boots	Gumboots or standard safety boots, which support the ankles, are sufficient. Steel toecaps are recommended for workers that are working with heavy equipment or large trees.
Hat	If working with large trees, on steep gradients or if any other safety risk may be present, then wearing a hardhat is advisable. Otherwise a wide-brim hat can be used to protect the worker from the sun.
Safety glasses	Large, clear safety glasses, which allow air to pass through, are acceptable.
Face mask	A face mask which covers the nose and mouth is essential when mixing herbicides and for foliar spraying.

8. MONITORING PROGRAMME

In order to monitor the impact of clearing activities, follow-ups and rehabilitation efforts, monitoring must be undertaken. This section provides a description of a possible monitoring programme that will provide and assessment of the magnitude of alien invasion on site as well as an assessment of the success of the management programme. In general, the following principles apply for monitoring:

- Photographic records must be kept of areas to be cleared prior to work starting and at regular intervals during initial clearing activities. Similarly, photographic records should be kept of the area from immediately before and after follow-up clearing activities. Rehabilitation processes must also be recorded.
- Simple records must be kept of daily operations, e.g. area/location cleared, labour units and, if ever used, the amount of herbicide used.
- It is important that, if monitoring results in detection of invasive alien plants, that this leads to immediate action.

8.1 Mining phase

Table 8.1: Monitoring Actions, Indicators and timeframes to be applied during the mining phase

Monitoring Action	Indicator	Timeframe
Document alien species distribution and abundance on site	Alien species distribution maps	Annually
Document alien plant control measures implemented & success rate achieved	Records of control measures and their success rate.	Annually
Document rehabilitation measures implemented and success achieved in problem areas	Decline in vulnerable bare areas over time	Annually

8.2 Rehabilitation phase

Table 8.2: Monitoring Actions, Indicators and timeframes to be applied during the rehabilitation phase

Monitoring Action	Indicator	Timeframe
Monitor newly disturbed areas where infrastructure has been removed to detect and quantify any aliens that may become established for 3 years after decommissioning and rehabilitation.	Alien species distribution maps	Biannually until natural vegetation has recovered sufficiently to resist invasion

Monitor re-vegetated areas to detect and quantify any aliens that may become established for 3 years after decommissioning and rehabilitation.	Alien plant surveys and distribution map	Annually
Document rehabilitation measures implemented and success achieved in problem areas	Decline in vulnerable bare areas over time	Biannually for 3 years
Document alien plant control measures implemented & success rate achieved	Records of control measures and their success rate.	Annually for 3 years

9. REFERENCES

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