

Alien and Invasive Plant Species Management Plan

De Aar 2 South Wind Energy Facility near De Aar in Northern
Cape Province



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Alien and Invasive Plant Species Management Plan for the De Aar 2 South Wind Energy Facility near De Aar in Northern Cape Province

Location:

Emthanjeni Local Municipality and Renosterberg Local Municipality
within the Pixley Ka Seme District Municipality

Prepared for

Mulilo De Aar 2 South (Pty) Ltd

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10 November 2022

Report version: Final

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1. INTRODUCTION

1.1 Background

This Alien and Invasive Plant Species Management Plan (AIPSMP) has been compiled according to the requirements of the Alien and Invasive Species Regulations, 2014 of the National Environmental Management: Biodiversity Act (Act 10 of 2004), and is to be included in the update of the project's Environmental Management Plan (EMP), in line with condition 47 of the EA.

The format of this report is based on the document, "*Guidelines for Monitoring, Control and Eradication Plans as required by Section 76 of the National Environmental Management: Biodiversity Act, 2004 (Act No. 10 of 2004) (NEMBA) for species listed as invasive in terms of Section 70 of this Act, 30 September 2015*", published by the Department of Environmental Affairs (now known as the Department of Forestry, Fisheries and the Environment (DFFE)). The Guidelines have been drawn up to follow the legal requirements of the Act. Although the study area is not under the control of an organ of state, the Guidelines provide a standardized format that is useful for structuring the Plan.

The Regulations on the management of Listed Alien and Invasive Species under the National Environmental Management: Biodiversity Act were promulgated on 1 August 2014 as Regulation Gazette No. 10244 in Volume 590 of the South African Government Gazette (Publication No. 37885). These regulations came into effect on 1 October 2014.

The Listed Invasive Species were also published on 1 August 2014 as Government Notice No. 599 National Environmental Management: Biodiversity Act (10/2004): "Alien and Invasive Species List, 2014" also in Volume 590 of the South African Government Gazette (Publication No. 37886). In terms of the Act's Section 70 (1), 559 species /groups of species were listed. These Lists also came into effect on 1 October 2014.

According to Section 75 of NEMBA, "Control and eradication of listed invasive species":

- (1) Control and eradication of a listed invasive species must be carried out by means of methods that are appropriate for the species concerned and the environment in which it occurs.
- (2) Any action taken to control and eradicate a listed invasive species must be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment.
- (3) The methods employed to control and eradicate a listed invasive species must also be directed at the offspring, propagating material and re-growth of such invasive species in order to prevent such species from producing offspring, forming seed, regenerating or re-establishing itself in any manner.

According to NEMBA and the regulations published in Government Notices R.506, R.507, R.508 and R.509 of 2013, 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.

1.2 Site characteristics

This Invasive Species Plan is for study area of the De Aar 2 South Wind Energy Facility in De Aar in the Northern Cape Province (Figure 1). This site-specific management plan was developed to address the monitoring, control and eradication of all invasive plant species only for the De Aar 2 South Wind Energy Facility Project in De Aar. Currently, the site is in a mostly natural state, but this will be altered during the course of the development of the project.

The proposed final turbine layout for the project consists of up to 26 Wind Turbine Generator (WTG) connected by an internal road network (Figure 2). The infrastructure includes the following (Figure 2):

1. WTGs X 28 positions (of which up to 26 would be developed), each with 180 m hard stand buffer zone (within which the hardstand for each turbine would be located)
2. Internal roads: 6 m wide = 39.60kms, 4 m wide = 0.06 km
3. IPP Substation & building complex
5. Additional 33kV OHL (all others run parallel to internal roads)

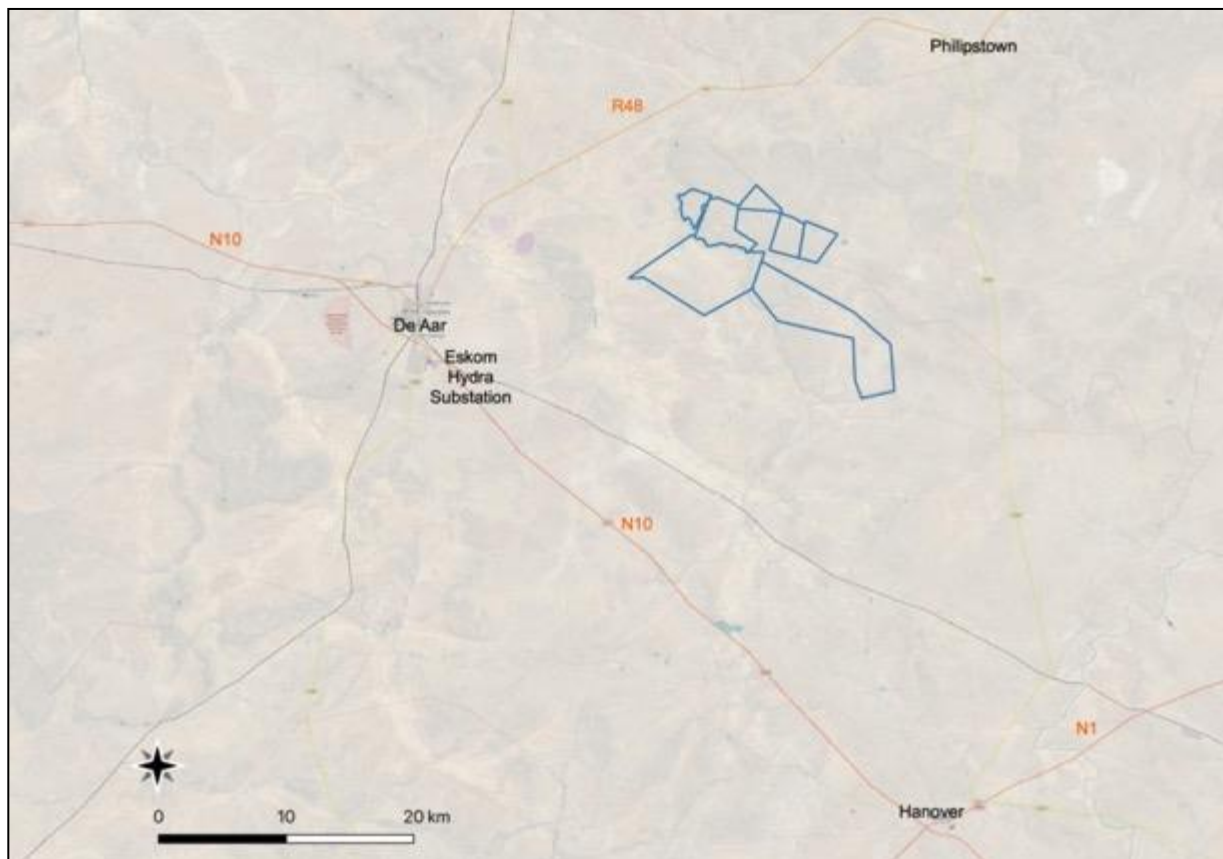


Figure 1: Location and extent of the study area adjacent to De Aar.

6. Laydown Area 1
7. Laydown Area 2
8. Laydown Area 3
9. Access road north (orange - existing road to be upgraded)

The infrastructure is located within a low mountain range. The topography is moderate to steep (Figure 3). There is an increase in elevation within the mountains from east to west, ending in an escarpment that faces south-west. The elevation on site varies from 1415, at the southern access point, to 1571 m above sea level, with all turbine locations at around 1520 - 1550 m.

Most of the site consists of natural vegetation with some localised farming infrastructure (homesteads, access roads, camps, farm dams, and other). The vegetation is in moderate condition, with some grazing impacts more prominent in some parts than others. A typical view of the vegetation on site is shown in Figure 3.

There are various natural plant communities on site that occur in relation to different slope inclination, aspect, drainage, and amount of surface rockiness. Drainage valleys have deeper soils, flatter topography and significantly lower surface rock cover. The majority of the site consists of areas with a gradient from moderate rock cover of round pebbles, to large rock-sheets, boulders and rocky outcrops and cliffs. There is a general increase in shrubs towards rockier areas, otherwise species composition is relatively similar in most areas.

Key vulnerabilities to invasion on site include the following:

1. Natural vegetation on site, which includes indigenous biodiversity within the study area;
2. Relatively low levels of disturbance on site with localised nodes of existing disturbance that act to increase the probability of alien invasive species becoming established and spreading;
3. Neighbouring wind farm that may potentially act as a source of invasive alien species on site.

Key factors that may promote establishment and spreading of invasive alien species on site include the following:

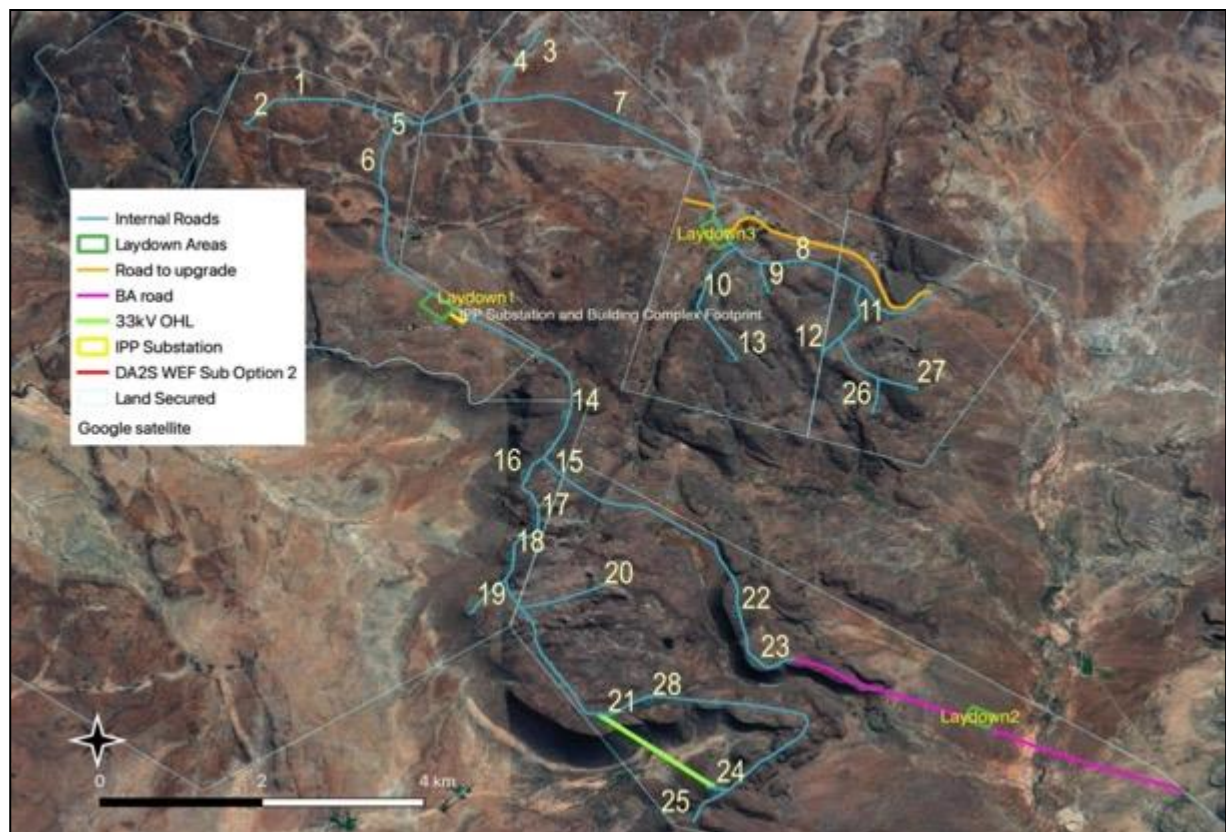


Figure 2: Layout of infrastructure.

1. High levels of disturbance anticipated in parts of the site, especially areas of proposed construction, but also various areas that will develop secondary or previously disturbed vegetation following construction.
2. Transport of propagules of alien invasive species via various vectors, primarily construction vehicles and materials.
3. A number of alien invasive species in the general geographical area that are especially problematic within arid parts of South Africa, and especially within specific habitats, such as riparian areas.

Key current advantages are as follows:

4. Low levels of existing stands of alien species on site or in neighbouring areas.

Current management of invasive alien species on site has not been required.

Management objectives are proposed to be as follows:

1. Compliance with relevant legislation;
2. Protection of existing biodiversity on site;
3. Enhancement of biodiversity value of disturbed areas, areas of secondary vegetation and rehabilitated areas;
4. Eradication and control of unwanted invasive alien species.



Figure 3: Typical habitat on site.

2. APPLICABLE LEGISLATION

2.1 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. Chapter 5 of the Act relates to species and organisms posing a potential threat to biodiversity. The purpose of Chapter 5 is:

- a) to prevent the unauthorized introduction and spread of alien species and invasive species to ecosystems and habitats where they do not naturally occur;
- b) to manage and control alien species and invasive species to prevent or minimize harm to the environment and to biodiversity in particular;
- c) to eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats;

According to Section 65 of the Act, "**Restricted activities involving alien species**":

- 1) A person may not carry out a restricted activity involving a specimen of an alien species without a permit issued in terms of Chapter 7. Restricted activities include the following:
 - a. Importing into the Republic, including introducing from the sea, any specimen of a listed invasive species.
 - b. Having in possession or exercising physical control over any specimen of a listed invasive species.
 - c. Growing, breeding or in any other way propagating any specimen of a listed invasive species, or causing it to multiply.
 - d. Conveying, moving or otherwise translocating any specimen of a listed invasive species.
 - e. Selling or otherwise trading in, buying, receiving, giving, donating or accepting as a gift, or in any other way acquiring or disposing of any specimen of a listed invasive species.
 - f. Spreading or allowing the spread of any specimen of a listed invasive species.
 - g. Releasing any specimen of a listed invasive species.
 - h. Additional activities that apply to aquatic species.
- 2) A permit referred to in subsection (1) may be issued only after a prescribed assessment of risks and potential impacts on biodiversity is carried out.

An "**alien species**" is defined in the Act as:

- a) a species that is not an indigenous species; or
- b) an indigenous species translocated or intended to be translocated to a place outside its natural distribution range in nature, but not an indigenous species that has extended its natural distribution range by means of migration or dispersal without human intervention.

According to Section 71 of the Act, "**Restricted activities involving listed invasive species**":

- 1) A person may not carry out a restricted activity involving a specimen of a listed invasive species without a permit issued in terms of Chapter 7.
- 2) A permit referred to in subsection (1) may be issued only after a prescribed assessment of risks and potential impacts on biodiversity is carried out.

An "**invasive species**" is defined in the Act as any species whose establishment and spread outside of its natural distribution range:

- a) threaten ecosystems, habitats or other species or have demonstrable potential to threaten ecosystems, habitats or other species; and
- b) may result in economic or environmental harm or harm to human health.

A "**listed invasive species**" is defined in the Act as any invasive species listed in terms of section 70(1).

According to Section 73 of the Act, "**Duty of care relating to listed invasive species**":

- 2) A person who is the owner of land on which a listed invasive species occurs must-

- a) notify any relevant competent authority, in writing, of the listed invasive species occurring on that land;
- b) take steps to control and eradicate the listed invasive species and to prevent it from spreading; and
- c) take all the required steps to prevent or minimize harm to biodiversity.

According to Section 75 of the Act, "**Control and eradication of listed invasive species**":

- (1) Control and eradication of a listed invasive species must be carried out by means of methods that are appropriate for the species concerned and the environment in which it occurs.
- (2) Any action taken to control and eradicate a listed invasive species must be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment.
- (3) The methods employed to control and eradicate a listed invasive species must also be directed at the offspring, propagating material and re-growth of such invasive species in order to prevent such species from producing offspring, forming seed, regenerating or re-establishing itself in any manner.

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.

2.2 GN No. R.598 National Environmental Management: Biodiversity Act (10/2004): Alien and Invasive Species Regulations, 2014

This Regulation provides categories of listed invasive species, defines restricted activities, describes national framework documents (including Exempted Alien Species and Invasive Species Monitoring, Control and Eradication Plans), provides a risk assessment framework and procedure and issuing, amendment and cancellation of permits. These Regulations repeal "The Alien and Invasive Species Regulations 2013, published in Government Notice No R.506, Gazette No. 33683 of 19 July 2013.

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, according to these Regulations:

2.2.1 Regulation 2. Category 1a Listed Invasive Species

- 1) Category 1a Listed Invasive Species are those species listed as such by notice in terms of section 70(1)(a) of the Act as species which must be combatted or eradicated.
- 2) A person in control of a Category 1a Listed Invasive Species must -
 - a) comply with section 73(2) of the Act;
 - b) immediately take steps to combat or eradicate listed invasive species in compliance with sections 75(1), (2) and (3) of the Act; and
 - c) allow an authorised official from the Department to enter onto land to monitor, assist with or implement the combatting or eradication of the listed invasive species.
- 3) If an Invasive Species Management Programme has been developed in terms of section 75(4) of the Act, a person must combat or eradicate the listed invasive species in accordance with such programme.

2.2.2 Regulation 3. Category 1b Listed Invasive Species

- 4) Category 1b Listed Invasive Species are those species listed as such by notice in terms of section 70(1)(a) of the Act as species which must be controlled.
- 5) A person in control of a Category 1b Listed Invasive Species must control the listed invasive species in compliance with sections 75(1), (2) and (3) of the Act.

- 6) If an Invasive Species Management Programme has been developed in terms of section 75(4) of the Act, a person must control the listed invasive species in accordance with such programme.
- 7) A person contemplated in sub-regulation (2) must allow an authorised official from the Department to enter onto land to monitor, assist with or implement the control of the listed invasive species, or compliance with the Invasive Species Management Programme contemplated in section 75(4) of the Act.

2.2.3 Regulation 4. Category 2 Listed Invasive Species

- 1) Category 2 Listed Invasive Species are those species listed as such by notice in terms of section 70(1)(a) of the Act as species which require a permit to carry out a restricted activity within an area specified in the Notice or an area specified in the permit, as the case may be.
- 2) Unless otherwise indicated in the Notice, no person may carry out a restricted activity in respect of a Category 2 Listed Invasive Species without a permit.
- 3) A landowner on whose land a category 2 Listed Invasive Species occurs or person in possession of a permit, must ensure that the specimens of the species do not spread outside of the land or the area specified in the Notice or permit.
- 4) If an Invasive Species Management Programme has been developed in terms of section 75(4) of the Act, a person must control the listed invasive species in accordance with such programme.
- 5) Unless otherwise specified in the Notice, any species listed as a Category 2 Listed Invasive Species that occurs outside the specified area contemplated in sub-regulation (1), must, for purposes of these regulations, be considered to be a Category 1b Listed Invasive Species and must be managed according to Regulation 3.
- 6) Notwithstanding the specific exemptions relating to existing plantations in respect of Listed Invasive Plant Species published in Government Gazette No. 37886, Notice 599 of 1 August 2014 (as amended), any person or organ of state must ensure that the specimens of such Listed Invasive Plant Species do not spread outside of the land over which they have control.

2.2.4 Regulation 5. Category 3 Listed Invasive Species

- 1) Category 3 Listed Invasive Species are species that are listed by notice in terms of section 70(1)(a) of the Act as species which are subject to exemptions in terms of section 71(3) and prohibitions in terms of section 71A of the Act, as specified in the Notice.
- 2) Any plant species identified as a Category 3 Listed Invasive Species that occurs in riparian areas, must, for the purposes of these regulations, be considered to be a Category 1b Listed Invasive Species and must be managed according to regulation 3.
- 3) If an Invasive Species Management Programme has been developed in terms of section 75(4) of the Act, a person must control the listed invasive species in accordance with such programme.

In summary:

- 1) 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.
- 2) Category 1b: Invasive species requiring compulsory control as part of an invasive species control programme. Remove and destroy. These plants are deemed to have a high invasive potential. No permits will be issued.
- 3) 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 Category 2 plants to exist in riparian zones.
- 4) 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 Category 3 plants to exist in riparian zones.

2.2.5 Regulation 6. Restricted activities

In addition to those activities defined in section 1 of the Act as restricted activities, the following activities are hereby prescribed as restricted activities:

- a) spreading or allowing the spread of any specimen of a listed invasive species;
- b) (b) - (g) do not apply to terrestrial plants.

2.2.6 Chapter 6, Regulations 14 to 17 Risk Assessment:

These regulations describe the framework, facilitator, procedure and report required for a risk assessment, if it becomes necessary to undertake one.

2.3 GN No. R.599 National Environmental Management: Biodiversity Act (10/2004): Notice 3: National List of Invasive Species in terms of Section 70(1)A

This Notice provides a National list of invasive terrestrial and fresh-water plant species, categorized according to GN R.598. This list was compiled in terms of Section 70(1)A, which states that "the Minister must within 24 months of the date on which this section takes effect, by notice in the Gazette, publish a national list of invasive species in respect of which this Chapter must be applied nationally.

2.4 Conservation of Agricultural Resources Act (Act No. 43 of 1983)

In terms of the amendments to the regulations under this Act, landowners are legally responsible for the control of invasive alien plants on their properties. The schedules provide a list of declared weeds and invaders, which have been divided into three categories, as follows:

- **Category 1 plants** are prohibited and must be controlled.
- **Category 2 plants** (commercially used plants) may be grown in demarcated areas providing that there is a permit and that steps are taken to prevent their spread.
- **Category 3 plants** (ornamentally used plants) may no longer be planted; existing plants may remain, as long as all reasonable steps are taken to prevent the spreading there of, except within the floodline of watercourses and wetlands.

2.5 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.

3. CONCEPTUAL GUIDELINES FOR DETERMINING PRIORITY SPECIES AND AREAS FOR CONTROL

In order to accurately identify and prioritise alien vegetation species for removal and control and to delineate subsequent management units, the invasiveness of a plant species must be assessed.

3.1 Factors that affect the risk of a species becoming invasive

There are a number of factors to take into account when evaluating the potential risk of an invasive species:

1. the impact on ecosystem processes and system-wide parameters,
2. the impact on community structure,
3. the impact on community composition,
4. the impact on individual native species,
5. the conservation value and/or significance of ecological communities and native species threatened by the invasive species,
6. the current range size of the invasive species,
7. the proportion of the current range where the invasive species is negatively impacting biodiversity,
8. the proportion of a region's biogeographical units that are invaded by the species,
9. the diversity of habitats or ecological systems invaded by the invasive species,
10. the current trend in total range of the invasive species (expanding, contracting or stable),
11. the proportion of the current range currently occupied,
12. the long-distance dispersal potential of the invasive species,
13. the local range expansion or change in abundance,
14. inherent ability to invade native habitat,
15. similar habitats invaded elsewhere,
16. reproductive characteristics of invasive species,
17. general difficulty in managing the species,
18. minimum time commitment for management of the species,
19. impacts of the management programme on native species and habitats,
20. accessibility of invaded areas.

These factors taken in combination provide some indication of the current and future potential invasiveness of a species and thus the extent to which individual invasive species should be prioritized for management.

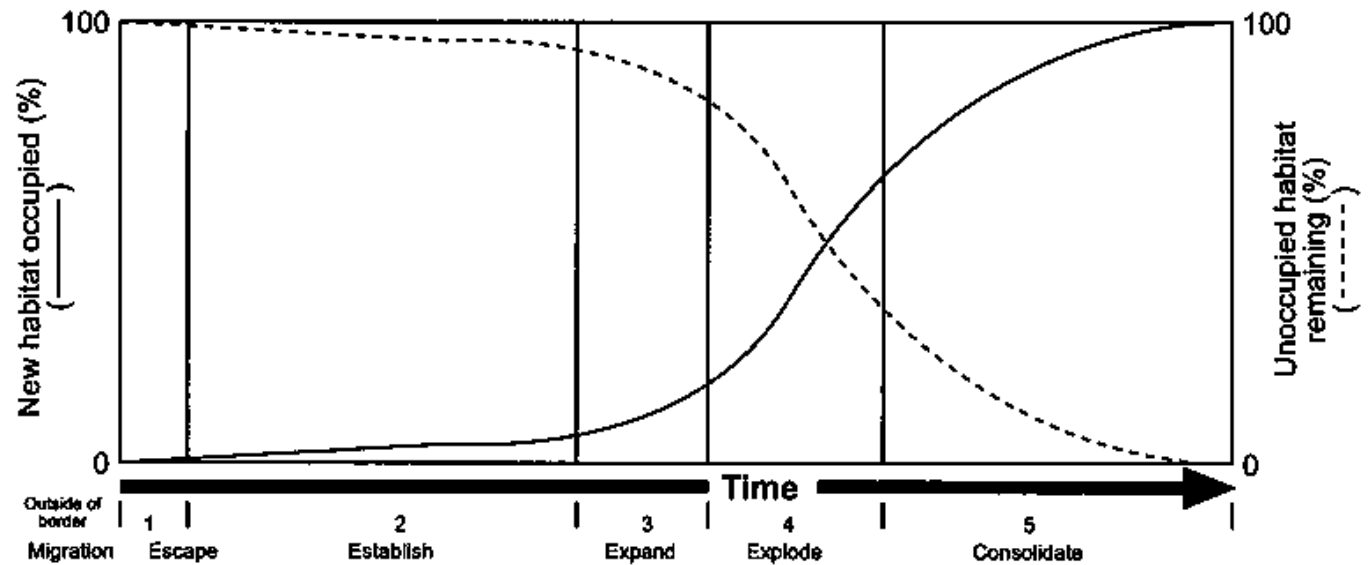
3.2 Conceptual phases in the invasion of a weed

The biological characteristics of an invasive species, as well as its ability to spread are determined by population processes that may occur over extended periods of time and which may not be immediately evident at any single point in time. These relate to the ability of a species to become established and then to become increasingly invasive. Plants may follow a number of patterns in time and space, depending on such factors as its means of dispersal, life cycle, longevity, size, fecundity, and so on. Many follow a simplified 'S' shaped pattern (Figure 3, solid line) that can be illustrated graphically as the proportion of all potential habitat occupied by the pest at any point in time.

The essential features are a long tail at the beginning of a species spread as it crosses the first series of barriers, a steep rise as it breaks through these barriers and finds suitable habitats, and then a flattening off as these

habitats are saturated. As the plant spreads, the proportion of the uninfested habitat declines at a rate defined by a 'reverse S' (Figure 3, dotted line). The process of spread may be continuous, but points are still recognisable (usually only with hindsight) where the rate of change alters markedly from the preceding period. For management purposes the 'S' shape can be idealised as stages based on the extent and rate of spread. This concept can be applied at any geographic scale, from a field to a continent.

Figure 1. Conceptual phases in the invasion of a weed through time, and the way these relate to the percentage of occupied and unoccupied land (from Williams, 1997).



3.2.1 Migration phase

The species must first reach the border of the area. Once it has arrived it may, or may not, enter, depending on a variety of factors. Where there are efficient quarantine protocols and risk management procedures it will be detected and, it is hoped, eliminated before it becomes problematic to control.

3.2.2 Escape phase

Once inside the area it may escape only occasionally, or finally become fully naturalised. The locations of these naturalisation points are likely to be associated with the pathway of introduction, e.g. in fields planted with contaminated corn, or adjacent to erosion-control plantings. They have been referred to as 'sentinel sites.'

3.2.3 Establishment phase

During this phase, the plant is able to reproduce in the new environment, and population numbers slowly begin to build up. Virtually all potential habitat is still uninfested.

3.2.4 Expansion phase

Eventually, the number of sites occupied expands beyond the initial loci. Expansion is fastest where there are multiple loci. The causes of this expansion differ among species and are not well documented. Factors are diverse, including particularly favourable growing seasons, the arrival of new pollinators or dispersers, the species becoming adapted to its new environment by the formation of new genotypes. New habitats may be created, e.g. by changes in land use. Some local areas of habitat are noticeably infested, but most potential habitat is un-infested. It is often only at this stage that the plant begins to be perceived as a pest.

3.2.5 Explosion phase

The period where the pest expands rapidly and often where it begins to attract official concern. Many potential habitats are infested during this phase.

3.2.6 Entrenchment phase

The pest slowly spreads to the last remaining habitats over its full range within the area. This does not mean that it occurs on all suitable land at any one time, but that it has a high chance of occurring there. Further spread can occur only if more suitable habitat is created, e.g. by fire. Importantly, the pest may be present only in a dormant stage of its life cycle.

3.3 Implications for management of invasive species

These potential changes in the spread of a pest have implications for weed-risk assessment imperatives:

- The most cost-effective means of avoiding pest impacts is to prevent their introduction or establishment in an area. Failing that, the greatest return for expenditure of money and effort comes from controlling a pest before it has spread.
- Once it has established and begun to spread, the ongoing effort required to eliminate it increases dramatically.
- During the earliest spread phases, when the required funds to extirpate a pest are low, these may be effectively obtained as an adjunct to other pest control programmes. Once the pests begin to spread rapidly, the effort required to obtain the funds may be orders of magnitude greater.
- Effective weed-risk assessment systems must be appropriate to:
 - whether or not a pest has established and spread;
 - the pest's biology and ecology;
 - the values being threatened;
 - the extent to which it has or has not established in an area; and
 - the technologies and resources available.

3.4 Procedure for removal of invasive species

There are four steps in developing a procedure to remove alien plants from a site:

1. Determine which species occur on site, map their occurrence and density;
2. Decide on priority species and areas to control and determine costs associated with this control;
3. Undertake clearing;
4. Follow-up with ongoing clearing of re-emergence and monitor success.

3.5 General guidelines

There are various overall strategies to be taken into consideration in compiling an eradication programme. These include the following:

1. Controlling alien invasive species, although a legal requirement, is usually a means to achieving a higher goal, such as protecting biodiversity, rehabilitating disturbed areas, restoring ecological functionality, preventing economic loss, protection of human health, etc. Alien invasive clearing should therefore be aligned with the broader biodiversity targets and strategy for the project.
2. Different species require different control methods.

3. It is important to break the reproductive cycle of a species.
4. There should always be follow-up of clearing to prevent invasive species from becoming re-established in areas that were previously cleared.
5. The size of the area being cleared should always be manageable.
6. In principle, start in the least-invaded areas and work towards the heavier infestations. This will make it possible to safeguard relatively large areas of natural habitat.
7. Clearing should always start at the highest point in the landscape and work downwards.
8. Cover any exposed soil with plant material, but ensure that this is free of seeds of the invasive species or other propagules.
9. If possible, try to clear plants before they produce seeds by cutting them back before they flower.
10. Do not transport seeds, fruits, bulbs, tubers or stems that root easily from one site to another. It is best to burn material where it is cleared, if possible.
11. Follow-up is essential. This is linked to ongoing monitoring to detect alien seedlings and remove them while they are easy to manage and also to progressively deplete the soil seed-bank.
12. Rehabilitation or restoration of cleared areas is necessary to restore ecological functionality and to create conditions that are less favourable for invasive species.

4. ALIEN INVASIVE SPECIES OCCURRING ON SITE

4.1 Legal definitions of species

It is vitally important to know which species occur on site, at what densities, in which locations and also understand the behaviour of each species on site to understand the risk of each one becoming problematic. There are two pieces of legislation applicable to control of alien invasive plants:

- Conservation of Agriculture Resources Act (CARA; Act 43 of 1983); and
- National Environmental Management: Biodiversity Act (NEM:BA; Act 10 of 2004):
 - NEM:BA Regulations August 2014 - Government Gazette Vol. 590, No. 37885.

In terms of the amendments to the regulations under CARA, landowners are legally responsible for the control of alien species on their properties. Declared weeds and invasive species had been divided into three categories in accordance with the Act. These categories are as follows:

- **Category 1:** Declared weeds that are prohibited on any land or water surface in South Africa. These species must be controlled, or eradicated where possible.
- **Category 2:** Declared invader species that are only allowed in demarcated areas under controlled conditions and prohibited within 30m of the 1:50 year flood line of any watercourse or wetland.
- **Category 3:** Declared invader species that may remain, but must be prevented from spreading. No further planting of these species are allowed.

Chapter 5 of NEM:BA deals specifically with organisms posing a threat to biodiversity. The purposes of Chapter 5 are as follows:

- Prevent the unauthorised introduction and spread of alien species and invasive species to ecosystems and habitats where they do not naturally occur.
- Manage and control alien species and invasive species to prevent or minimise harm to the environment and to biodiversity in particular.
- Eradicate alien species and invasive species from ecosystems and habitats where they may harm such ecosystems or habitats.

Section 73 (2) states that a person who is the owner of land on which a listed invasive species occurs must:

- Notify any relevant competent authority, in writing, of the listed invasive species occurring on that land.
- Take steps to control and eradicate the listed invasive species and to prevent it from spreading.
- Take all the required steps to prevent or minimise negative impacts to biodiversity.

The Regulations for this Act list the categories of alien invasive species, which are given in Table 1.

Table 1: Definitions of NEM:BA categories for alien and invasive species.

Definitions of NEM:BA Categories	
Category 1a Listed Invasive Species	Species requiring compulsory control: Species listed by notice in terms of section 70(1)(a) of the act, as a species that must be combatted or eradicated. These species are contained in Notice 3 of the AIS list, which is referred to as the National List of Invasive Species. Landowners are obliged to take immediate steps to control Category 1a species.

Category 1b Listed Invasive Species	Species controlled by an invasive species management programme: Species listed by notice in terms of section 70(1)(a) of the act, as species that must be controlled or 'contained'. These species are contained in Notice 3 of the AIS list, which is referred to as the National List of Invasive Species. However, where an Invasive Species Management Programme has been developed for a Category 1b species, then landowners are obliged to "control" the species in accordance with the requirements of that programme.
Category 2 Listed Invasive Species	Species controlled by area: Species which require a permit to carry out a restricted activity e.g. cultivation within an area specified in the Notice or an area specified in the permit, as the case may be. Category 2 includes plant species that have economic, recreational, aesthetic or other valued properties, notwithstanding their invasiveness. It is important to note that a Category 2 species that falls outside the demarcated area specified in the permit, becomes a Category 1b invasive species. Permit-holders must take all the necessary steps to prevent the escape and spread of the species.
Category 3 Listed Invasive Species	Species controlled by activity: A species listed by notice in terms of section 70(1)(a) of the act, as species which are subject to exemptions in terms of section 71(3) and prohibitions in terms of section 71A of the act, as specified in the notice. Category 3 species are less-transforming invasive species which are regulated by activity. The principal focus with these species is to ensure that they are not introduced, sold or transported. However, Category 3 plant species are automatically Category 1b species within riparian and wetland areas.
Exempted Alien Species	Exempted species: An alien species that is not regulated in terms of this statutory framework - as defined in Notice 2 of the AIS List.
Prohibited Alien Species	Prohibited species: An alien species listed by notice by the Minister, in respect of which a permit may not be issued as contemplated in section 67(1) of the act. These species are contained in Notice 4 of the AIS List, which is referred to as the List of Prohibited Alien Species.

NEMBA Sections 75 and 76 are very specific in terms of who must develop Invasive Species Monitoring, Control and Eradication Plans, what the plans must include and how they should be implemented, i.e.:

"Control and eradication of listed invasive species

75. (1) Control and eradication of a listed invasive species must be carried out by means of methods that are appropriate for the species concerned and the environment in which it occurs.

(2) Any action taken to control and eradicate a listed invasive species must be executed with caution and in a manner that may cause the least possible harm to biodiversity and damage to the environment.

(3) The methods employed to control and eradicate a listed invasive species must also be directed at the offspring, propagating material and re-growth of such invasive species in order to prevent such species from producing offspring, forming seed, regenerating or re-establishing itself in any manner.

(4) The Minister must ensure the coordination and implementation of programmes for the prevention, control or eradication of invasive species.

(5) The Minister may establish an entity consisting of public servants to coordinate and implement programmes for the prevention, control or eradication of invasive species."

4.2 Species found on site

No alien invasive species were recorded within the proposed footprint areas of the project.

There are currently four alien invasive species recorded on the adjacent wind farm site (with similar topography, environment and vegetation characteristics), namely:

- *Argemone ochroleuca* (Mexican Poppy) (Category 1b)
- *Datura ferox* (Long-spined Thorn-Apple) (Category 1b)
- *Opuntia robusta* (Nopal Tapón) (Category 1a)
- *Solanum mauritianum* (Bugweed) (Category 1b)

These are the species most likely to invade the site during construction and once construction has been completed.

The Mexican Poppy is noted to have been present at both the De Aar 2 North and the De Aar 1 Wind Energy Facilities, where it invaded at low densities along roadsides and edges of infrastructure, as well as within any other disturbed spaces. It seldom spread into the surrounding natural vegetation.

The potentially most destructive alien invasive species that has a high risk of invading on site is *Prosopis glandulosa*. This species should be prioritized for detection and control. It easily invades areas of deeper soil, where it forms dense stands that are difficult to eradicate.

4.2 Species found in nearby areas

Alien invasive species that have been recorded within 20 km proximity to the site are as follows:

- *Agave americana* (Category 3),
- *Arundo donax* (Category 1b),
- *Atriplex lindleyi* (Category 1b),
- *Cylindropuntia fulgida* (Category 1b),
- *Cylindropuntia imbricata* (Category 1b),
- *Cylindropuntia pallida* (Category 1a),
- *Eucalyptus camaldulensis* (Category 1b),
- *Melia azeradach* (Category 1b),
- *Opuntia engelmannii* (Category 1b),
- *Opuntia ficus-indica* (Category 1b),
- *Prosopis glandulosa* (Category 1b),
- *Salsola kali* (Category 1b),
- *Tephrocactus articulatus* (Category 1a),
- *Trichocereus spachianus* (Category 1b),
- *Xanthium spinosum* (Category 1b),
- *Xanthium strumarium* (Category 1b).

Some species that are known to occur in the general area are shown in Table 2, **as an example**. This table should be updated over time to provide site-specific information.

Table 2: List of alien invasive species found in the general area that could become established on site.

Taxon	Common name	Category (NEM:BA)	Category (CARA)
<i>Agave americana</i>	American century plant	Category 3 in Western Cape, not listed elsewhere	Declared invader category 2
<i>Argemone ochroleuca subsp. ochroleuca</i>	White-flowered Mexican poppy	Category 1b	Declared weed category 1
<i>Datura stramonium</i>	Common thorn apple	Category 1b	Declared weed category 1
<i>Eucalyptus camaldulensis</i>	Red river gum	Category 1b in riparian areas, protected areas, Listed Ecosystem or ecosystem identified for conservation in Bioregional Plan. Not listed within Nama-Karoo, Succulent Karoo and Desert Biomes. Category 1b in Fynbos, Grassland, Savanna, Albany Thicket, Forest, Indian Ocean Coastal Belt biomes. Category 2 for plantations, woodlots, bee-forage areas, wind-rows and the lining of avenues. Not listed within cultivated land that is at least 50 metres from any untransformed land, excluding within any area in (a) above. Not listed within 50 metres of the main house on a farm, excluding in (a) above. Not listed in urban areas for trees with a diameter of more than 400 mm at 1000 mm height at the time of the publishing of Notice, but excluding in (a) above.	Declared invader category 2
<i>Opuntia robusta</i>	Nopal Tapón	Category 1b	not listed

5. MANAGEMENT UNITS

Initially, the entire project area can be treated as a single management unit, but if alien invasive species become established on site and it becomes necessary for management purposes, the project area should be divided up into separate management units to facilitate more efficient control, based on practical criteria. The factors of greatest importance are existing biodiversity patterns on site that need to be protected, the identity and invasive potential of alien species occurring on site, and the practical issues related to management, such as connectedness, access, size of area, degree of invasion, and current activities on site. A map of the location of different management units should be compiled. These management units may need to be adjusted to reflect control targets.

It is critical that the management units' status is reviewed periodically in order to: (1) track and document the extent of any infestations; (2) that the applicant be able to report and track the efficacy of the previous control and eradication measures; and (3) measure the progress and success of the control plan.

Table 3: Assessment criteria for Alien Species Management Unit.

Text item	Description
Common Name	Assist with species identification
NEMBA category	Indicates the invasive species category, that effects the eradication priority
Estimated cover/density	Provided as a performance indicator to compare future management efficacy. Ideally annual updates to the plan should show a decrease in alien invasive cover/density
Prioritization	A score assigned to assist with prioritising alien species removal within a unit, based on its invasion and rate of spread. High prioritisation scores means that those individual species should be cleared as a priority within the general Species Management Unit.
Risk of invasion	A rating given to indicate the ability of a certain species to spread and thus lead to increases in density and cover of the invasive species if not appropriately managed. Species with a high ability to spread/invade ("Medium" or "High") should thus be further prioritised in areas where natural vegetation can be affected.

The priorities for management of alien invasive plant species on site are based on the need to (1) protect important biodiversity areas, (2) eliminate the most problematic weeds, and (3) clear aliens from areas where they occur at a high density and threatened surrounding areas.

6. CONTROL METHODS

6.1 Generic control methods

This section provides specific generic methods for controlling alien and invasive plants. It is an outline of existing control measures that have been 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. It includes physical removal methods, use of herbicides and biocontrol methods.

6.1.1 Mechanical control

Many invasive plants can be removed manually or with the help of simple tools. This entails damaging or removing the plant by physical action. Different techniques could be used, e.g. uprooting, felling, slashing, mowing, ring-barking 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 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. For the current project, there are no existing dense stands of invasive alien plants.

Advantages

Effective method in areas with low infestation.

High job creation and associated poverty alleviation potential.

No contamination of water with herbicides.

Disadvantages

Not an effective method for dense infestations, as the cost of clearing is extremely high, with little or no impact.

Time consuming.

If no herbicides are used then the manual control techniques must be very well executed to ensure success.

Seedlings

Seedling of many invasive plants appear all the time, courtesy of birds passing through. When seedlings appear, pull them out as soon as possible to eliminate costly tree felling at a later stage. It is easier to remove seedlings when the soil is moist.

Shrubs and small trees

Use a 'Tree Popper' to remove shrubs and smaller trees. Alternatively, cut off the top growth and then remove the stem and roots from the soil. It is vital that the root ball and any taproots are totally removed to prevent re-growth, as invasive plants often have roots capable of regeneration.

Large trees

If the tree is too large for physical removal, consider ring-barking the tree. This technique involves removing a ring of bark at least 25cm wide. Peel the bark down to just below ground level, pulling outwards. Bark peeling is a particularly useful method for destroying invasive *Acacia* species. Ring-barking interferes with the circulation of the tree and results in it slowly dying. If you wish to hasten the process, fell the tree to a stump that is 30cm above ground level. Then loosen the bark on the stump by hitting it with a hammer and peel the bark downwards to ground level. Any re-growth that appears must be cut off cleanly at once, to prevent nutrition from new growth reaching the roots.

6.1.2 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. Care should be taken not to impact on threatened or protected species.

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).

Advantages

Complements mechanical control methods, increasing the effectiveness of control activities.

Achieve results over short period (within 6 weeks of application).

Large areas can be treated quickly.

Disadvantages

May kill non-target plants or species. This is a very important consideration and poses risks for remaining natural areas on site.

Herbicides are expensive.

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.

Seedlings and small shrubs

Herbicides can be sprayed on plants less than 2m in height for quick results. Spray when there is no wind. This will help to avoid spray drift onto adjacent wanted plants. Some weed killers are non selective and others selective so be careful! All plants that are subjected to the spray will be destroyed.

Large shrubs and trees

Cut-stump treatment: Fell the tree, leaving a stump as flat and as close to the ground as possible, and apply a recommended herbicide.

Basal stem treatment: Paint a herbicide (mixed with diesel) onto the base of the tree trunk and any exposed roots. Paint the herbicide up to a height of 25cm above ground level. In the case of multi-stemmed trees, each individual stem should be painted. The herbicide will enter the tree's circulation and eventually kill the tree.

Foliar spraying: In the case of re-growth from stumps (otherwise known as coppicing), mix a herbicide with water and spray on the re-growth. Allow the re-growth to reach a height of 50cm before treatment. Ensure that a full cover spray is achieved. Trees with bud banks or lignotubers can be destroyed using use a herbicide after sawing off the trunk at ground level.

Resprouting plants

Known as regenerative plants, this group of resprouting invaders are designed by nature to survive ravaging veld fires. This ability means that they are impossible to eradicate simply by felling. Resprouting IAPs have a variety of survival techniques. *Eucalyptus* species have woody lignotubers capable of resprouting indefinitely. Many wattles (*Acacia mearnsii*, *A. pycnantha*, *A. saligna*, *A. melanoxylon*) and red sesbania (*Sesbania punicea*) have a section of bark situated at ground level, where the fire is coolest, which is more moist and spongier than normal bark. This section is well supplied with undeveloped buds and acts as a 'bud bank'. The bud bank extends about 4cm below the surface of the ground to the point where the roots begin to form. Due to the size of the surviving rootstock, post-fire regeneration is extremely fast, with the plant able to seed itself again usually in as little as two years.

Physical removal of the bud bank or lignotuber is quite easy to do on plants that are too big to pull up by hand, but not so big as to require sawing down. The best tool to use is a pair of long-handled clippers or loppers. Keep the blades closed, and push the clippers into the ground next to the main root. Use the clippers to widen a space large enough for the clippers to be opened. Then clip off the root below the bud bank.

Loosen the soil around the bud bank and pull out the plant. If there are lateral roots on the end, you know you've removed the whole bud bank. Without the bud bank the plant can't resprout, while the use of this method ensures that there is minimal disturbance to the soil, and so less germination of alien seeds.

Another way of destroying the bud bank of a plant that is too big to clip is to peel the bark down to just below ground level, pulling outwards. In order to have enough bark to hold on to, saw the tree off at 30cm above ground level and peel from the top.

Herbicides will destroy large plants with bud banks or lignotubers. First, saw the trunk of the plant off at ground level. Then, immediately dab herbicide onto the trunk.

6.1.3 Biocontrol

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.

South Africa has a long history of biological control of weeds, which began in 1913 with the highly-successful introduction of a cochineal insect against a prickly pear cactus (*Opuntia monacantha*). Over the succeeding 100 years of biological control use at least 73 plant species have been targets for biological control. Agents have become established on 48 of the targeted species and South Africa remains committed to expanding this area of research.

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.

Advantages

Most environmentally friendly and most sustainable of all control methods.

Usually does not require high or long-term maintenance.

Relatively low cost implication over the long term.

Disadvantages

Generally slow, especially initially.

Low levels of infestation, with occasional outbreaks, will remain a feature of systems under biological control.

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.

It should be noted that industry best practice must be followed during eradication and removal to reduce the potential negative impacts of the following:

- Impacts on surface water quality from erosion and sedimentation;
- Nuisance impacts on air quality from dust and noise during clearing;
- Impacts on surface and ground water quality from herbicide use;
- Impacts on surface and ground water flow rates from vegetation clearing; and
- Impacts on habitat and ecological functioning from vegetation clearing.

It is recommended that the project develop internal procedures to assist in the effective management of these potential impacts during eradication and removal. All contractors must also be trained in these procedures to ensure the potential impacts are minimised. Eradication and removal activities must be scheduled in the appropriate dry or wet season to reduce impacts as far as possible.

Specific methods of control for each species that may be found on site must be researched. Where available, this information includes registered herbicide options for each species, as provided by the Working for Water Programme.

7. RESPONSIBILITIES AND REPORTING REQUIREMENTS

The following are possible reporting requirements:

1. Annual reports by ECO (during operations) on progress in terms of clearing activities. This is most important during times of active clearing and monitoring in order to document activities.
2. Reports, as required, by Environmental Officer/Manager reviewing control activities and reporting on monitoring activities. The Alien Invasive Management Plan should be updated periodically to take into account new information and revised priorities, including the eventual development and adoption of broader biodiversity targets for the project and each management unit.

8. ESTIMATE OF RESOURCE REQUIREMENTS AND COSTS

The following section outlines provisional estimates for the clearing and management of the Alien Management units identified for the site. It should be noted that the figures provided are estimates only and should be verified prior to commencement. It is important that the project obtain quotes from suitably qualified contractors to ensure that the approved methods (Table 8) are implemented during alien vegetation control and eradication.

Costs associated with clearing of Invasive Alien Plants fall into one of various categories:

1. Labour costs
2. Personal Protective Gear
3. Tools and equipment
4. Transport
5. Administrative costs
6. Chemicals / herbicides

For herbaceous weeds, it is possible to treat approximately 5 hectares per day and requires the following resources (estimation):

1. Contractor supervisor
2. Herbicide applicator/mixer
3. General workers
4. Driver
5. Personal Protective Gear
6. Transport (LDV + trailer)
7. Tools & equipment
8. Administration costs
9. Chemicals & herbicides

For woody plants, additional resources required include the following:

1. Chainsaw operators
2. Additional tools & equipment
3. Size of area possible to cover in a day depends on the density of trees

The per hectare costs of clearing aliens depends on the species, the degree of invasion and the terrain in which the clearing is to take place. Rough estimates indicate that clearing moderately dense woody plants could cost anywhere from R 5,000.00 – R 15,000.00 per hectare, excluding follow-up costs, and it should be noted where heavy infestations occur the cost could be greater. Monitoring of expenditures against targets per management units should be a priority, towards improved effectiveness and cost-efficiency.

Requirements for follow-up work will be dependent on the success of the initial surveys. The costs and resources exclude requirements for monitoring, follow-up field surveys and reporting.

9. MONITORING AND EVALUATION

Monitoring is a form of assessment that provides land managers with information essential to making well-informed management decisions. Monitoring

- is conducted on a regular or systematic basis,
- follows the trend over time of an indicator or variable of the resource compared to predetermined management objectives,
- involves collecting data by sampling or on the entire resource if financially and logistically feasible.

Monitoring can play an essential role in managing invasive plants-it provides nonbiased information to make well-informed management decisions. Monitoring results can be used to demonstrate where management actions (e.g., control treatments) are effectively and successfully meeting invasive plant management objectives, and to more quickly detect and modify actions that are ineffective. Monitoring can also be used to

- detect new populations,
- determine the status and temporal trends in population sizes and distributions over time (e.g., evaluate invasiveness),
- determine effects of invasive plant species on biota and processes of the ecosystem,
- measure success of restoration and revegetation projects,
- measure success of best management practices that are meant to prevent the introduction and spread of invasive plants into and throughout a management area.

There are four types of invasive plant monitoring:

1. Monitoring for early detection,
2. Monitoring for the effect of management actions on target species of invasive plants,
3. Monitoring for the effect of management actions on non-target species and the environment,
4. Monitoring for the status and trends of target species populations.

9.1 Monitoring for Early Detection

Early detection monitoring is implemented before unwanted species have arrived in an area. It is the most cost-effective monitoring because when rapid eradication takes place, control efforts are minimal. The following factors are important:

- It is aimed at finding species when they first appear in a management area.
- It is performed on a systematic schedule; either a predetermined one (e.g., every two years) or one that is based on known events of vector transport of new species through pathways into new areas.
- It is important to sample target areas using inventory/survey methods or using information from predictive models based on ecosystem attributes, species establishment characteristics, and vectors and pathways.
- It is important to record non-infested sites during each monitoring event.
- Requires skilled field botanists to identify plant species.
- Monitoring for early detection of alien invasive plant specialist must be in accordance with the Conservation of Agriculture Resources Act (Act 43 of 1983).

9.2 Monitoring for the Effect of Management Actions on Target Species

Monitoring the effects of management actions (i.e., a control treatment) on the target invasive plant populations is implemented unless the effects of that management action are already well understood and predictable. Such monitoring helps determine the most effective control method. Considerations include the following:

- Provides information on the effectiveness of control treatments (e.g., mowing, herbicide spraying, prescribed grazing and burning) in suppressing, containing or eradicating target invasive species is quantified.
- Requires knowledge of target species characteristics and site conditions.
- Monitoring should take place before and after treatment events.
- Results from monitoring data are used to adjust management actions.

9.3 Monitoring for the Effect of Management Actions on Non-target Species and the Environment

Monitoring for the effect of management actions on nontarget species and the environment is ideally employed when management actions are being implemented. Given time and money considerations, this type of monitoring can be used when it is suspected that native species or ecological processes may be negatively impacted. It can also help determine whether it is better to leave the invasive plant species untreated rather than risk damage to the ecosystem. The following applies:

- measuring the positive or negative effects of control treatments on other species (e.g., plants, animals, fungi, microbes) or ecological processes (e.g., soil stability, water quality). An example of a negative effect is contamination of ground or surface water by herbicides that are toxic to aquatic organisms. An example of a positive effect is an increase in abundance of desired plant species. These effects would be reflected in future biodiversity footprint assessments as per the Biological Diversity Protocol.
- Requires knowledge of target species characteristics and site conditions.
- Requires knowledge of ecosystem components and processes in the area where treatments will occur.
- Requires monitoring before and after treatment events

9.4 Monitoring for the Status and Trends of Target Species Populations

The current status and trends of target species populations can be monitored when management actions are not being implemented. Such monitoring determines when a threshold has been reached for a particular population, and at which point a management action may begin (e.g., if species is increasing) or end (e.g., if species is decreasing). The following applies:

- measuring the current status or characteristics of a population parameter such as abundance or distribution
- measuring the trend or change in population abundance or vigor over a period of time

9.5 Monitoring Methods

There are numerous sampling methods one can use to monitor changes in invasive species populations (Sutter 1997). The level of monitoring that is appropriate is dependent on the information required:

- Qualitative Monitoring: this is quick, inexpensive monitoring that has a significant subjective component, is observer-dependent, provides data that can not be statistically analyzed, and can only detect changes that are dramatic. It includes the following methods:
 - mapping of populations,
 - presence/absence of population or plants,
 - estimates of individuals,

- estimates of cover, and
- photomonitoring.
- Quantitative Monitoring: this is repeatable, analyzable, but usually does not address changes in individuals, and is time-consuming and expensive. It includes measures of individuals, cover, or frequency in sampling units.
- Demographic Monitoring: this includes the strengths of quantitative monitoring with more data on individuals and the biology of the species, greater predictability, but is very time consuming and expensive. It includes following individuals over time to assess their life history characteristics and obtain demographic parameters (survival, mortality, fecundity) of the population.

Specific parameters that can be monitored are as follows:

- Abundance Parameters: numbers, density, cover, frequency.
- Condition Parameters: measures of vigor, performance, fecundity.
- Structure Parameters: size or age class information.

The parameters one chooses is determined by the biology of the species and the management objective. Exotics that occur as discreet individuals can be counted, while rhizomatous species are best measured by cover. Measures of condition are important when the process controlling an exotic species will take a long time and benchmarks are needed for short-term assessments (vigor measurements such as for plant height or reproduction).

9.6 Monitoring Plan

Elements of a monitoring plan include:

- statement of problem and invasive plant management objectives,
- monitoring objectives for target species (level of accuracy and precision),
- sampling design (to achieve monitoring objectives),
- field sampling methods,
- data management and analyses,
- evaluation of monitoring results in achieving invasive plant management objectives,
- adjustment of management actions or invasive plant management objectives if needed.

In the "Introduction" section, management objectives are proposed. These are repeated here as follows:

1. Compliance with relevant legislation;
2. Protection of existing biodiversity on site;
3. Enhancement of biodiversity value of disturbed areas, areas of secondary vegetation and rehabilitated areas;
4. Eradication and control of unwanted invasive alien species.

The objectives of monitoring are therefore to:

1. detect new invasions,
2. detect changes in density, extent, location of invasive species,
3. detect effects of invasive species on habitats,
4. detect effects of management measures on invasive species,
5. detect effects of management measures on habitats, especially their condition or quality, in line with the Biological Diversity Protocol, for biodiversity footprint assessment purposes

The following monitoring is proposed (Table 4) and should be reported for each individual management unit as well as for the site as a whole.

Table 4: Proposed monitoring plan.

Monitoring action	Indicator	Survey method	Data to be collected	Data management	Timeframe
Early detection survey	New species appearing on site. This can be reported as a list, latitude-longitude positions of new observations and observations on numbers of individuals and/or estimated density.	Rambling transects (walk-through survey) through target habitats ensuring all habitats are covered in each management unit.	Presence data (identify which species are present on site, in the form of a list), estimates of cover / numbers (GPS coordinates of individual plants and/or mapped areas of dense invasion with estimates of total numbers within mapped area), photo record (if necessary). The data collected for this Control Plan is an example of an early detection survey.	List, maps and/or data positions curated by environmental manager/officer	Every two years from the start of the Operational Phase
Document alien species present on site	Alien species list, which must be amended from time to time. Can include density information, which can be analysed and presented as bar graphs.	Rambling transects (walk-through survey) through target habitats ensuring all habitats are covered in each management unit.	As for previous point.	List can be saved as document or spreadsheet curated by environmental manager/officer	Every two years from the start of the Operational Phase
Map concentrations of invasive species	Extent of invasive species populations	Field mapping using GPS to record perimeter of invasive population.	Mapping data. Where there are stands of invasive species that can be defined as individual landscape units, these should be mapped. Mapping can be repeated after clearing activities and/or after detecting invasive species spreading (if applicable). From this the size and location of areas under cover of different invasive species can be calculated and changes documented over time.	GIS files curated by environmental manager/officer	Every two years from the start of the Operational Phase or whenever changes detected
Document and record alien control measures implemented	Record of clearing activities	Visual observation, report from clearing crew	Descriptive information	Electronic document curated by environmental manager/officer	Can be daily, weekly, monthly and/or annually from the start of the Operational Phase, depending on

					reporting requirements
Review alien control success rate	Decline in abundance of alien plant species over time	Plot, transect or targeted surveys	Density, latitude-longitude co-ordinates. Which species have been completely removed or what proportion / numbers were removed.	Electronic document curated by environmental manager/officer	Monthly or annually from the start of the Operational Phase, depending on reporting requirements

10. CONCLUSIONS

This AIPSMP should be periodically reviewed for adequacy by the independent project ECO, during their routine audits, and if needed it can be modified as control methods are activated and conditions related to invasion change on site. This requires continuous input and monitoring, including periodic collection of field data in order to analyse the status of the site and the effectiveness of management interventions, notably in terms of improving habitat condition of priority management units. This AIPSMP should feed into the EMP for the Mulilo De Aar 2 South WEF project, for implementation in the Construction and Operational phases of the project.

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Appendix 1: 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.

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.

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:

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.

Appendix 2: Field guide to alien invasive species occurring on site.

This Appendix should be populated with photographic and descriptive information to aid fieldworkers in positively identifying alien invasive species that could occur on site. If necessary, information should be provided for distinguishing species from one another, as well as from non-invasive indigenous species, where there may be similarities.

