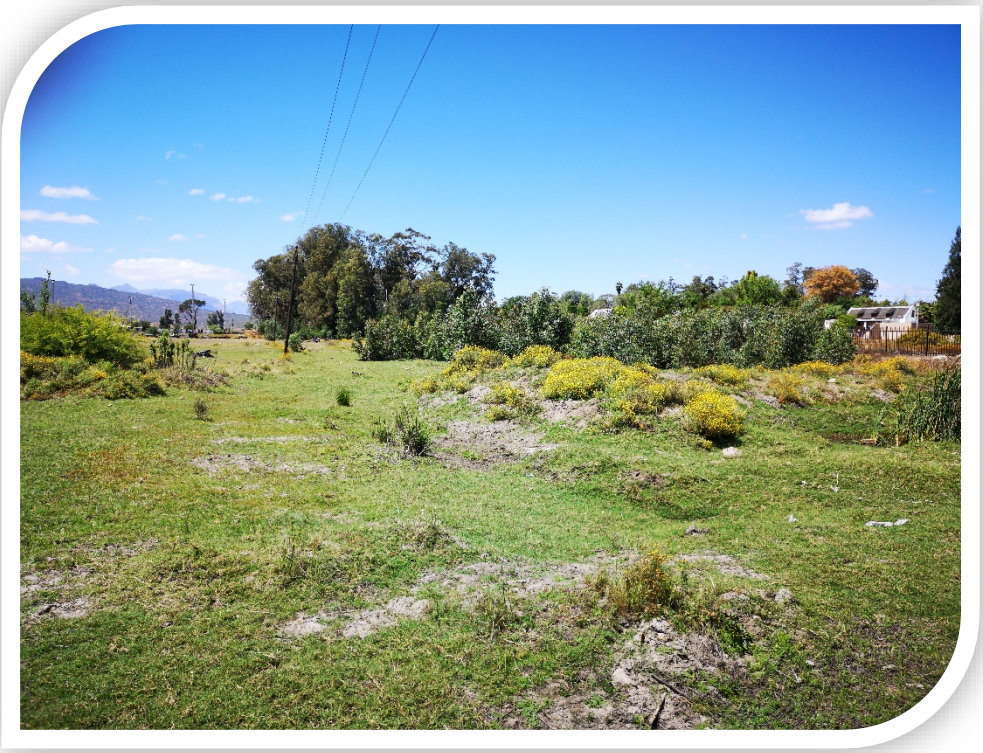

Report:

Cederberg municipality invasive alien plant monitoring, control & eradication plan

Reference: CMIAP122020

Prepared for: Cederberg Municipality

Revision: Revision 1

11 January 2021

Report details

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Document control				
Report title		Cederberg municipality invasive alien plant monitoring, control & eradication plan		
Report status		Final document	**Report number**	CMIAP122020
Client		Cederberg Municipality	**Client contact**	Danné Joubert
Rev	**Date**	**Author**		
1	**11 January 2021**	Paul Buchholz		

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1. Introduction

The National Environmental Management Biodiversity Act, 10 of 2004 (NEMBA), Section 76, states that all organs of state are required to draw up an invasive and alien monitoring, control and eradication plan for the land under their control. Such a plan must include:

a) a detailed list and description of any listed invasive species occurring on the relevant land.
b) a description of the parts of that land that are infested with such listed invasive species.
c) an assessment of the extent of such infestation.
d) a status report on the efficacy of previous control and eradication measures
e) the current measures to monitor, control and eradicate such invasive species; and
f) measurable indicators of progress and success, and indications of when the control plan is to be completed.

In terms of Section 4(2)(a) of the NEMBA, all municipalities are required to manage and conserve biological diversity. This includes taking steps to control and eradicate Invasive Alien Plants (IAPs) in areas that they own or manage. The purpose of this document is to respond to this obligation and to coordinate the Municipality approach in this regard to reduce future IAPs control costs and improve the integrity of the natural areas and ecosystems in Cederberg Municipality (Figure 1: Map showing municipal properties).

The Cederberg Municipality (the Municipality) is responsible for the management of hundred and fifty-one (151) properties (management units) covering a surface area of approximately 1268 hectares and are distributed among the following towns/settlements (Figure 1):

- Clanwilliam
- Citrusdal
- Graafwater
- Elandsbaai
- Lambertsbaai

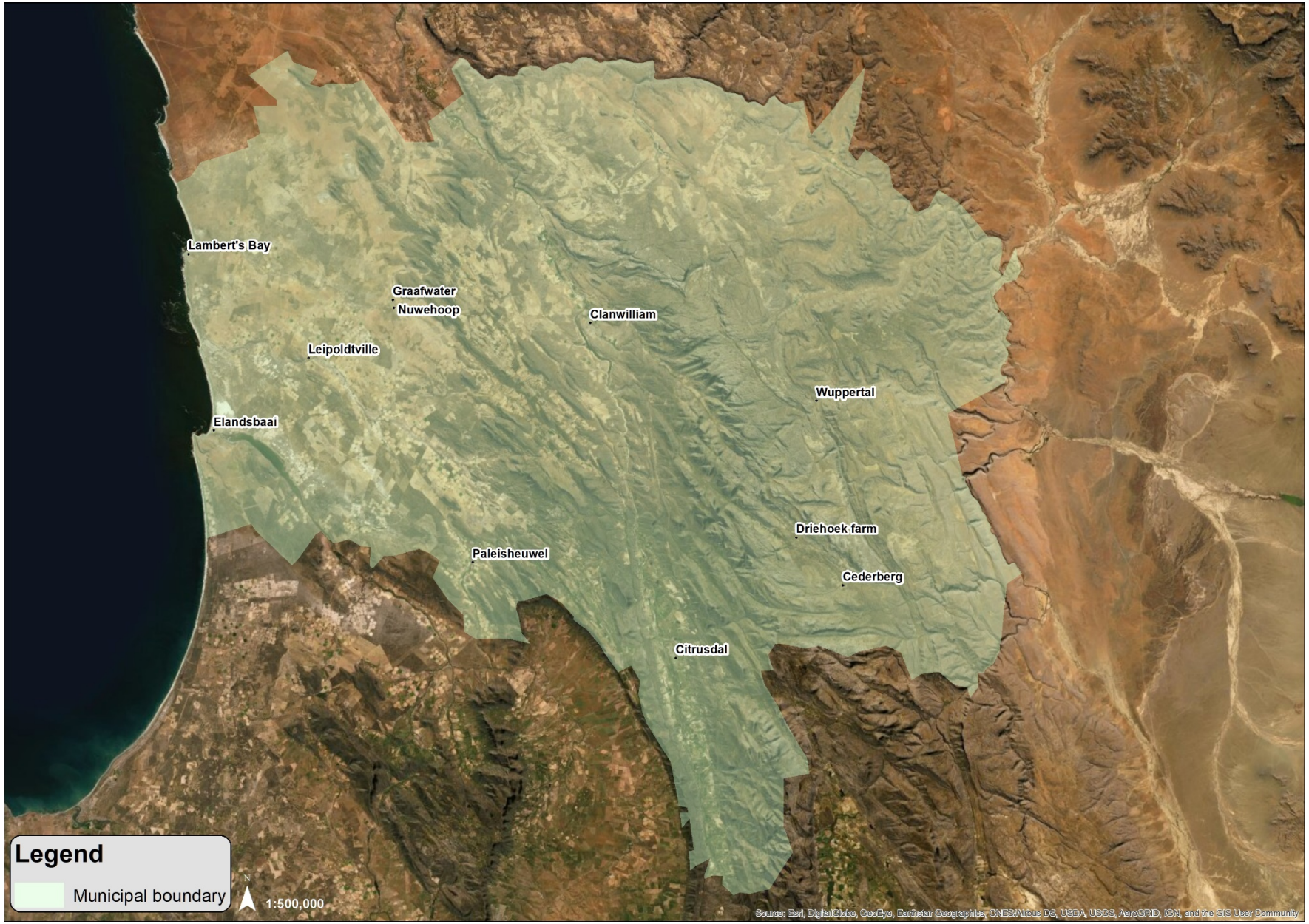

Figure 1: Map showing the Cederberg municipality boundary

2.1. Description of the project area

The Cederberg Municipality is in an extremely biodiverse area within a global biodiversity hotspot (the Cape Floristic Region) two hours from Cape Town. The municipal area also has a variety of landscapes and cultures and an important economic centre in the region with a rapidly increasing human population. Urban expansion, agriculture and invasive alien plants are key threats to the loss of habitat and native biodiversity and have negative impacts on ecosystem services.

2.2. Invasive species impacts

Invasive alien plants (IAPs) refer to plants brought to South Africa from other countries, both intentionally and unintentionally, that cause human, environmental or economic harm. Invasive alien plants have negative impacts on ecosystems, affecting both biodiversity and ecosystem functioning. The successful control of IAPs can ameliorate these impacts.

Without natural enemies, invasive alien plants can reproduce and spread rapidly, taking valuable water and space from indigenous vegetation. Many IAPs consume more water than local plants, depleting valuable underground water resources and create additional fuel for veld fires.

Many invasive alien plants are adapted to fire and can sprout after a fire or re-establish from large soil-stored seed banks that can stay viable for more than 20 years. After a fire, many IAPs will germinate from soil-stored seeds creating dense stands of young plants that if left uncontrolled will create an invasive alien plant forest increasing fuel loads and thereby increasing veld fire risk.

Invasive alien plants do not affect either the weather or the frequency and distribution of fire ignitions, but they can drastically change the structure of the vegetation, changing both the amount and the type of fuel available to support fires. As a result, they can introduce fires into areas where fires did not occur historically, and by increasing the mass of plant material in fire-prone vegetation such as fynbos, they can make fires more intense and challenging to control.

In an increasingly urbanised world, urban biodiversity and ecosystem services are not only threatened by the expansion of urban areas and the proliferation of anthropogenic features such as land cover change, but also by IAPs. Valuable services from healthy ecosystems in a town include filtering the air, reducing noise, draining rainwater and attenuating overland flow, flood protection, regulating the micro-climate, increasing property values and a suite of cultural services, including recreation. Restoring invaded ecosystems in towns has the potential to benefit inhabitants by helping to ensure the sustained delivery of these ecosystem goods and services.

2.3. Invasion pathways

Municipal properties are vulnerable to the introduction of invasive alien plants. The processes that lead to the introduction of alien species have been termed the pathways of introduction. These pathways are numerous

and involve both the intentional and accidental introduction of invasive alien plants. For example, biological control agents are intentionally introduced to manage invasive species from their native range, while invasive alien plants are often accidentally introduced when plants are imported from other countries.

Most invasive alien plants in the region were deliberately introduced and subsequently escaped cultivation. Managing invasive alien plants once they have been introduced is difficult and costly, and it is often more efficient and cost-effective to prevent their introduction. Information on how and/or why invasive alien plants are introduced is used to identify the pathways of introduction and prioritise these pathways for interventions. Once the information has been gathered, adequate pathway-specific policies and interventions that target priority pathways can be developed, implemented and enforced, and their effectiveness monitored.

The Convention on Biological Diversity (United Nations Environment Programme) recognises the following six pathways of introduction:

- Release in nature
- Escape from confinement
- Transport contaminant
- Transport stowaway
- Corridor
- Unaided

Release in nature refers to the intentional introduction of an alien organism into the natural environment for human use (e.g. trout for angling purposes). An escape from confinement refers to the movement of an alien organism kept in confinement into the natural environment (e.g. Horticulture and aquaculture species). Transport contaminant involves the unintentional introduction of an alien organism with an intentionally imported commodity (e.g. pests on imported food, animals or plants) while transport stowaway refers to the introduction of an alien organism attached to transport vessels or their associated equipment and media (e.g. marine organisms introduced with the release of ballast water by ships).

Corridor involves the natural dispersal of alien organisms into a new region through human-constructed transport infrastructure while unaided refers to the natural spread of an alien organism from an area where it was previously introduced, through the pathways mentioned above, to another region where it is not native.

Pathway-based control measures focus on reducing the risks of transporting invasive alien plants to new areas outside of their natural ranges. Pathway-specific control measures focus on identifying the actual mechanism by which species can arrive in a new area. A pathway-centred approach is often more effective and uses information on how or why invasive alien plants are introduced to develop preventative strategies, early detection methods and develop regulations that target the most active pathways of introduction.

Small towns may also present a greater risk of spreading invasive alien plants to their surrounding environments than large cities. Small towns have a large edge-to-area ratio, meaning that most areas of the town are proportionately close to the surrounding natural areas. Invasive alien plants on the peripheries of properties are

more likely to escape into the surrounding semi-natural areas. The relative distance to the urban-wildland interface is low for many properties in a small town (as opposed to ones in a city, which may be several kilometres from natural areas).

Municipal properties are vulnerable to the intentional and unintentional introduction of invasive alien plants, and the risk of invasion may be attributed to several factors. Invasive alien plants species occur on properties because of the unintentional introduction of seeds through on-site maintenance work. Also, vehicles entering the properties for educational or recreational purposes pose a risk for the accidental introduction of IAPs. Due to the proximity of municipal properties to gardens and other undeveloped areas, they can be re-infested or invaded by new emerging weeds. In addition, horticultural strains of indigenous plant species may also escape from gardens adjacent to Municipal properties and threaten the genetic diversity of naturally occurring specimens and endemic populations

The following pathways are important for invasive species introductions into Municipal properties:

- Road network
- Garden escapees
- Illegal dumping
- Recreational activities
- Rivers

These pathways of invasive alien plant introduction and dispersal must regularly be monitored to prevent new IAPs from establishing in Municipal properties.

2. Invasive alien plant management objectives

The overarching objectives of the Cederberg municipality invasive alien plant monitoring, control & eradication plan is for the Municipality to become compliant with NEM:BA and associated Invasive Species Regulations. The following strategic objectives of the invasive alien plant monitoring, control & eradication plan applies to all the municipal properties and provide guidance/direction on the fulfilment of the overall aim of being compliant with the NEM:BA and Invasive Species Regulations.

2.1 Strategic Objective 1: Prevention

The Cederberg municipality must put measures in place to prevent the introduction of new NEMBA listed invasive alien plants onto municipal properties and invasive alien plants from spreading from the properties to neighbouring properties. The following preventive measures must be implemented:

- No listed invasive alien plant species will be planted.
- Areas bordering onto neighbouring properties, particularly along ecological pathways, i.e. river valleys & remnant indigenous vegetation, will be prioritised for control to prevent existing invasive alien plants from spreading beyond the boundaries of the property, and the maintenance of firebreaks.
- The prevention measures must be communicated to all users of the property (where applicable).

2.2 Strategic Objective 2: Early detection and rapid response (EDDR)

The Cederberg municipality must put measures in place whereby new and secondary invasive species are detected early and removed before establishing sustainable populations and start spreading. Category 1 invasive alien plants will typically fall in this category.

Emerging species refer to those species that appear after clearing an area. These species are normally not present before the clearing but emerge afterwards and have the potential to become the next problem if they are not controlled as soon as they appear. Emerging species refer to those invasive alien species with the potential to become important problems without timely intervention. When the management option of early detection and rapid response (EDRR) is implemented, the new or emerging species can be locally eradicated before they produce seeds/increase by growing vegetatively or producing offspring. The following EDRR measures must be implemented:

- Regular surveys of municipal properties must be undertaken to detect any new or emerging listed invasive alien plants.
- Category 1a species must be reported immediately to the Department of Environment, Forestry and Fisheries and ask for assistance for the control of the species.
- Emerging or new species must not be allowed to produce seeds or offspring, or start growing vegetatively and must be removed immediately.
- The invasive alien plant control plan must be updated by including these species and indicate where on the property they were located.
- Areas that have been cleared must be checked regularly to remove re-sprouting plants or seedlings quickly.

2.3 Strategic Objective 3: Restricted activities and Duty of Care

The Cederberg municipality must adhere to restrictive activities and Duty of Care as determined by NEMBA and Regulations concerning invasive alien plants. The NEM:BA and Regulations list certain restricted activities for the different categories of invasive alien plants: 1 (definitions); 65(2) – alien species; 66(2) – exempted species; 67(2) – prohibited species; 71(1) – listed species & Regulation 6 (a-g). The NEM:BA and Regulations place an obligation on a person to exercise Duty of Care when it comes to invasive alien plants. Sections 69 & 73 of the Act. The following Duty of Care actions must be implemented when controlling invasive alien plants:

- Comply with the permit conditions for permitted species in terms of Section 65(1) & 71(1).
- Take all the required steps to minimise the harm to biodiversity, including sensitive riparian areas.
- Notify the competent authority, in writing, of the listed invasive alien plants that occur on the property.
- Take all the required steps to control and eradicate the listed invasive alien plants on the property and prevent it from spreading.

2.4 Strategic Objective 4: Appropriate means and methods to control

The Cederberg municipality must ensure the means and methods of control are appropriate to the species and environment. The methods must be implemented in such a way that it minimises the risk to biodiversity and the environment. Where invasive alien plants occur within sensitive riparian & wetland areas, areas with steep

slopes and Critical Biodiversity Areas low impact manual (no heavy machinery such as back actors) control methods with limited use of herbicide must be used.

The Fertilizer, Farm Feeds, Agricultural & Stock Remedies Act (Act 36 of 1947), governs the use and application of herbicide. The Act includes the following requirements:

- Al herbicide applications are to be made under the direct supervision of a registered Pest Control Operator.
- All persons applying herbicide are to be trained in their use.
- Correct Personal Protective Equipment must be worn when applying herbicide (listed on herbicide label).
- Only registered herbicides may be used.

2.5 Strategic Objective 5: Fire prevention and preparedness

Invasive alien plants increase fuel loads and thereby the risk and intensity of vegetation fires. There are currently dense stands of invasive alien plants on several municipal properties (75) that create a high fire risk. Once control projects are implemented large stacks of cut plant material will be present that also poses a fire risk.

The landowner must, therefore, put measures in place that prevent the starting and spreading of vegetation fires on the property to neighbouring communities and properties. The landowner must implement the following fire prevention and preparedness actions:

- Manage invasive alien plant fuel loads by implementing effective invasive control methods and removing (chipping, transport to a legal dumpsite, community firewood etc.) cut biomass.
- Prepare and maintain firebreaks around the property and infrastructure.
- Ensure that the removal of biomass and the preparation of firebreaks do not cause soil erosion.

2.6 Strategic Objective 6: Implement the control plan

The Cederberg Municipality must bring invasive alien plants under control through systematic, integrated and appropriate control methods as stipulated in the control plan. Sufficient funding must be allocated to ensure the long-term control of invasive alien plants.

3. Legislative context

The legislation that is relevant to the Cederberg municipality is briefly outlined below. These environmental requirements are not intended to be definitive or exhaustive but serve to highlight key environmental legislation and responsibilities only.

The Constitution of South Africa of 1993 regulates the responsibilities and legislative competence of each sphere of government. Municipal responsibilities include the delivery of a range of basic services such as access to water and sanitation (Section 73 of the Municipal Systems Act) to residents in a sustainable manner, promoting economic development and safe, healthy environments. The environment is placed at the National

and Provincial level of legislative competence, and thus local government prioritises service delivery over environmental aspects, such as invasive species control. However, municipalities play an important role in environmental planning and management but are not structured or mandated to perform their environmental responsibilities. Currently, the NEM:BA delegations are not devolved to municipalities.

The role of the South African Local Government Association (SALGA) is to ensure that municipalities are aware of the new legislation relevant to them and provide assistance by unblocking compliance challenges. According to NEMBA Section 76(3), the minister may appoint the South African National Biodiversity Institute (SANBI) to assist municipalities with compiling management plans and status reports that report back on the efficacy of control measures. As such, SALGA acts as an essential link between DEA, SANBI and municipalities to assist and guide municipalities.

The National Environmental Management Act (NEMA, Act 107 of 1998), as amended makes provision for the identification and assessment of activities that are potentially detrimental to the environment and which require Environmental Authorization for the competent authority (in this case, the National Department of Environmental Affairs, DEA). Section 28 of NEMA provides for the Duty of Care principles that requires every person who causes, has caused or may cause significant pollution or degradation of the environment to take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such harm to the environment is authorised by law or cannot reasonably be avoided or stopped, to minimise and rectify such pollution and degradation of the environment. "Reasonable measures" include measures to investigate, assess and evaluate the impact on the environment; cease, modify or control any act causing pollution or degradation and remedying the effects of pollution or degradation.

National Environmental Management: Biodiversity Act, 10 of 2004 (NEM:BA) places a ‘Duty of Care’ (Section 73 (2) [as amended]) on all landowners, whether private or public, to control invasive species on their land. Section 76(2a) determines that all Organs of State at all spheres of government (from National through to Local Government) must compile area management plans for land under their control; Section 76(4 a–f) of the Act states the requirements of these plans.

For Organs of State to become compliant with the NEM:BA regulations, they need to develop, submit for approval and implement area management plans, report back (Section 76[4][d]) and provide measurable indicators showing progress and timeframes for completion to the national government (Department of Environment, Forestry and Fisheries). The guidelines for the development of these plans have been published (DEA 2015) and are available on DEA’s website. The completed area management plans were required to be submitted by the end of September 2016 (1 year after the publication of the guidelines for management plans (NEM:BA Regulations [2] [b]). Plans must be drawn up for all land under the control of Organs of State.

Area management plans must include a description of the land parcels in question, detailed lists and descriptions of all the listed species found on each of the land parcels, the extent of invasion and the efficacy of previous control and eradication measures. These plans should be included in the municipal Integrated Development Plans (IDPs) (Section 76 [2][b]), to ensure subsequent implementation and budget allocation.

Furthermore, the NEM:BA Act (Section 77[1]) states that all Organs of State managing protected areas are required to submit a status report 'at regular intervals', reporting on the progress made towards achieving the set targets.

National Environmental Management: Biodiversity Act, 10 of 2004 (NEM:BA), regulates all invasive organisms in South Africa. 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. Categories listed are:

- **Category 1a**: Invasive species requiring compulsory control. Any specimen of a Category 1a listed species must, by law, be eradicated.
- **Category 1b**: Invasive species requiring compulsory control as part of an invasive species control program. These species must be removed and destroyed.
- **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.
- **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. No permits will be issued for Category 3 plants to exist in riparian zones.

The Conservation of Agricultural Resources Act (CARA) (Act 43 of 1983) provides for the regulation of control over the utilisation of natural agricultural resources to promote the conservation of soil, water and vegetation and provides for combating weeds and invader species.

The National Water Act (NWA) (Act 36 of 1998) was instituted to ensure that sustainability and equity are identified as central guiding principles in the protection, use, development, conservation, management and control of water resources. The NWA places a strong emphasis on the protection of water resources in South Africa, especially against its exploitation, and the insurance that there is water for social and economic development in the country for present and future generations

The project implementing entity must be in possession of a valid Pest Control Operators Licence (limited weeds controller) according to the Fertilizers Farm Feeds, Agricultural Remedies and Stock Remedies Act, Act No. 36 of 1947 when working with herbicides to control invasive alien plants. This is regulated by the Department of Environment, Forestry and Fisheries (DEFF).

Invasive alien plants increase fuel loads and thereby increase the risk and intensity of vegetation fires that pose a threat to life and infrastructure. The National Veld and Fire Forest Act (Act 101 of 1998) imposes the following duties on landowners:

- May not start a wildfire (s 18(1)).
- May only start a fire, including a cooking or braai fire, in a designated area.
- A landowner must have equipment available to fight wildfires (s 17(1)).
- A landowner must have trained personnel available to fight wildfires (s 17(1).

- A landowner must have a person on the property who keeps a lookout for fires (s 17(2)).
- Establish a system of firebreaks (s 12).
- May not burn firebreaks or carry out controlled burns when the Fire Danger Index is high
- A landowner must manage the fuel load on land under your control. This includes the removal of invasive alien vegetation from the area, as well as other vegetation that creates unwanted fuel loads.

To ensure a safe and healthy working environment, all people involved in the control of invasive alien plants must comply with the Occupational Health and Safety Act, Act 85 of 1993.

4. Management Units

The Cederberg municipalities have hundred and fifty-one (151) properties (management units). After delineating and naming the management units, baseline data was collected as prescribed by the National Environmental Management: Biodiversity Act (NEM:BA) Section 76. (Annexure A: Cederberg municipality invasive alien plant distribution map & Annexure B: Cederberg municipality invasive alien plant database)

5. Invasive species present

The national Working for Water Program's mapping standards has been used to capture invasive alien plant distribution data for each management unit. The IAPs present in each unit were listed according to their taxonomic group, scientific and common names, age class (mature, adult, young). The extent of each species was estimated per management unit and expressed as percentage cover and the NEM:BA listed category was assigned. The following eight (8) invasive alien plants have been recorded (Annexure B: Cederberg municipality invasive alien plant database):

Nr	Species name	Common name	NEMBA category
1	Acacia cyclops	Red eye	• 1b
2	Acacia saligna	Port Jackson	• 1b
3	Prosopis glandulosa	Mesquite	• 1b
4	Myoporum insulare	Manatoka	• 3
5	Opuntia ficus-indica	Sweet Prickly Pear	• 1b
6	Casuarina cunninghamiana	Beefwood	• 1b in riparian areas, Protected Areas, ecosystem identified Bioregional Plans, Fynbos, Grassland, Savanna, Albany Thicket, Forest and Indian Ocean Coastal Belt biomes • 2 in plantations, woodlots, bee-forage areas, windrows, and the lining of avenues
7	Arundo donax	Giant Spanish Reed	• 1b

Nr	Species name	Common name	NEMBA category
8	Eucalyptus grandis	Saligna gum	• 1b in riparian areas, Protected Areas, ecosystem identified Bioregional Plans, Fynbos, Grassland, Savanna, Albany Thicket, Forest and Indian Ocean Coastal Belt biomes • 2 in plantations, woodlots, bee-forage areas, wind-rows and the lining of avenues • Not listed within cultivated land that is at least 50 meters away from untransformed land but excluding within any area listed above • Not listed within 50 meters of the main house on a farm but excluding within any area listed above • Not listed in urban areas for trees with a diameter of more than 400 mm at 1000 mm height

Table 1: Cederberg municipality invasive alien plant list

6. Efficacy of previous control and eradication methods

The efficacy of control methods is reflected through the decrease in IAPs density, cost per hectare, time and effort required (person-days and person-day cost) reflected before every control intervention. The efficacy of control methods will be determined through workload assessment before every control operation and by analysing the data to provide an annual update of infestation levels. Invasive alien plants on municipal properties are currently not controlled in a sustained, systematic and prioritised manner. Once the implementation of the control plan commences the efficacy of control and eradication methods must be determined through workload assessments.

7. Prioritisation of control projects

Resources for invasive alien plant control are limited and restoring invaded vegetation is labour-intensive and expensive. It is therefore essential that the Cederberg municipality prioritise invasive alien plant control actions to achieve invasive alien plant control objectives as efficiently and effectively as possible.

It is impossible to control IAPs everywhere and tolerate inefficiency that would fail to stem the spread of IAPs, despite the investment of resources. Ultimately, this will lead to the erosion of ecosystem goods services, notably water resources, biodiversity-based ecosystem use, including resource harvesting and tourism. It is also critically important to adhere to best practice to improve efficiencies, making the most of the limited resources that are available.

The following factors must be considered when planning the implementation of invasive alien plant control projects:

- Aliens must be cleared in a manner that reduces the risk of cleared areas being reinvaded by other invaded areas. For example, the upstream area should be cleared before downstream areas if the river transports the seeds.
- The ability and resources available for follow up operations should determine the size and location of the initial clearing operation. It critically important that a balance is maintained between clearing new areas and follow-up operations on previously cleared areas. Once the invasive plants have been removed from an area (initial control) resources must first be allocated for at least three (3) follow-up treatments (treating seedlings and sprouting plants that might appear after the initial control operation) before a new area is cleared. If resources are taken away from existing control projects before they have reached maintenance level, it can result in invasive alien plant densities increasing again requiring additional investment to bring it back to a maintenance level.
- Prevention is cheaper than clearing, and therefore un-invaded areas must be protected from invasion. Several municipal management units (276) are un-invaded, and they should be kept clear of invasive alien plants (Annexure A: Cederberg municipality invasive alien plant distribution map & Annexure B: Cederberg municipality invasive alien plant database)
- The economic benefits of clearing areas with high tourism, biodiversity, productivity or water yield potential are necessary to maintain the support for the continuation of the clearing project. In other words, the benefits of clearing, other than merely the cost must be carefully considered. Several municipal management units (198) contain riparian and wetland areas and clearing the dense stands of invasive in the will improve the water yield potential of river systems. Critical Biodiversity Area 1 & 2 areas are located within some municipal management units (169), and it is, therefore, essential to control invasive alien plants in these areas to prevent the further loss of biodiversity. (Annexure A: Cederberg municipality invasive alien plant distribution map & Annexure B: Cederberg municipality invasive alien plant database)
- If a management unit is affected by a vegetation fire, it must be targeted as a high priority for control. especially if the management unit was infested with species that create large soil stored seedbanks such as Black Wattle. The infestation level does not have to be very high and a few individual mature trees located on the property can create a large soil stored seed bank that will germinate after a fire. The fire stimulates the germination of the soil stored seed and the seedlings can be controlled relatively cheaply with herbicide. Should the invasive alien plants on the management unit left untreated and be allowed to reach maturity the control cost can triple.
- IAPs that pose a fire risk to life and infrastructure should be targeted as a priority. Several municipal management units have a high fire risk (175). (Annexure A: Cederberg municipality invasive alien plant distribution map & Annexure B: Cederberg municipality invasive alien plant database)
- Effective firebreaks must be created where woody (fire-prone) IAPs are in dense stands near houses, settlements, power lines etc. Currently, very few municipal properties have firebreaks.
- Areas with young, less dense trees, which have smaller seed banks and a potentially high rate of spread, should be targeted first. Focusing on these areas requires fewer resources and will prevent

further invasion and the build-up of seed banks. Dense mature stands should be left for last, as they most probably won't increase in density or pose a more significant threat than they are now. But if they pose a fire risk to life and infrastructure, they must be targeted as a priority.

- The ability and resources available for follow up operations should determine the size and location of the initial clearing operation.

The following criteria were used to prioritise the implementation of invasive alien plant control projects on the municipal management units:

- The 2017 Western Cape Biodiversity Spatial Plan (WCBSP)
- Fire risk

The development and implementation of the WCBSP is a core output for the Provincial Biodiversity Strategy and Action Plan (2017) which is aligned to the Aichi Targets for the United Nations Convention on Biological Diversity as well as the National Biodiversity Strategy and Action Plan (2015). The WCBSP provides stakeholders with strategic and practical guidance on how to ensure that planning and decision-making build the resilience of ecological infrastructure.

The WCBSP is a spatial tool that comprises the Biodiversity Spatial Plan Map (BSP Map) of biodiversity priority areas, accompanied by contextual information and land-use guidelines that make the most recent and best quality biodiversity information available for land use and development planning, environmental assessment and regulation, and natural resource management. The BSP Map covers both the terrestrial and freshwater systems, as well as major coastal and estuarine habitats and delineates Critical Biodiversity Areas and Ecological Support Areas (ESAs), which require safeguarding to ensure the continued existence and functioning of species and ecosystems, including the delivery of ecosystem services.

Critical Biodiversity Areas (CBAs) are areas required to meet biodiversity targets for species, ecosystems or ecological processes and infrastructure. These include:

- All areas required to meet biodiversity pattern (e.g. species, ecosystems) targets;
- Critically Endangered (CR) ecosystems (terrestrial, wetland and river types);
- All areas required to meet ecological infrastructure targets, which are aimed at ensuring the continued existence and functioning of ecosystems and delivery of essential ecosystem services; and
- Critical corridors to maintain landscape connectivity.

Ecological Support Areas are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of Protected Areas or CBAs, and are often vital for delivering ecosystem services. ESAs need to be maintained in at least a functional and often natural state. ESAs need to be maintained in at least a functional and often natural state, in order to support the purpose for which they were identified, but some limited habitat loss may be acceptable. A greater range of land uses over wider areas is appropriate, subject to an authorisation process that ensures the underlying biodiversity objectives and ecological functioning are not compromised.

CBAs need to be kept in a natural or near-natural state, with no further loss of habitat or species. Degraded areas should be rehabilitated to natural or near-natural condition. Only low-impact, biodiversity-sensitive land uses are appropriate. Forty-nine (49) Municipal properties contain Critical Biodiversity Areas 1 & 2 (CBA1 & 2) and twenty-nine (29) Ecological Support Areas 1 where IAPs must be controlled (Annexure A: Cederberg municipality invasive alien plant distribution map & Annexure B: Cederberg municipality invasive alien plant database)

Human activities are continually and more widely encroaching along the edge of vegetation areas where there is enough plant litter, dead branches, and fine plant material to sustain a fire. Fuel accumulation increases the likelihood that fires will become uncharacteristically large and intense. Invasive alien plants do not affect either the weather or the frequency and distribution of fire ignitions, but they can drastically change the structure of the vegetation, changing both the amount and the type of fuel available to support fires.

As a result, they can introduce fires into areas where fires did not occur historically, and by increasing the mass of plant material in fire-prone vegetation such as fynbos, they can make fires more intense and difficult to control. Veld fires in invasive alien plant infested areas are on average about 65% more damaging than in fynbos fires.

The purpose of the National Veld and Forest Fire Act is to prevent and combat veld, forest and mountain fires throughout South Africa and to provide methods and practices for achieving this purpose. After the devastating Knysna fire of June 2017 and the 2018 George fire it is crucial for the Cederberg municipality to comply to the National Veld and Forest Fire Act that requires all landowners on whose land a veld fire may start or burn or from whose land it may spread must prepare firebreaks on their side of the boundary if there is a reasonable risk of veld fire. Hundred and seventy-five (175) Municipal properties have a high fire risk. (Annexure A: Cederberg municipality invasive alien plant distribution map & Annexure B: Cederberg municipality invasive alien plant database)

Invasive alien plants especially trees, severely degrade riparian habitats in the Southern Cape. These invasions reduce water yields from catchments and affect riverine functioning and biodiversity. Riparian vegetation provides habitat, stabilises riverbanks and filters sediments and nutrients from the surrounding catchment. River ecosystems are highly prone to invasion by IAPs because of their dynamic hydrology and opportunities for recruitment following floods.

Many invasive alien plants in riparian areas are tall trees with higher water consumption than the indigenous vegetation. Alien invasive plants increase above-ground biomass and evapotranspiration and thereby decrease both surface water runoff and groundwater recharge. The increased biomass and evapotranspiration rates associated with invasive alien plants arise because of their greater height, root depth and senescence, compared to the native species that they replace.

A priority matrix was developed for the Cederberg municipality to prioritise the implementation of invasive alien plant projects (Table 2: Cederberg municipality invasive alien plant control priority matrix). The priority rating for

each management unit is included in the Cederberg municipal invasive alien plant distribution map & invasive alien plant database that allows for the quick selection of the various priority classes (Annexure A: Cederberg municipality invasive alien plant distribution map & Annexure B: Cederberg municipality invasive alien plant database)

			Fire risk categories and codes (0,1,2)		
			No fire risk to life or infrastructure	Fire risk to life and infrastructure	Fire risk to infrastructure
			0	**1**	**2**
Critical Biodiversity Areas categories and codes (A, B, C, D)	Critical Biodiversity Areas 1 (CBA 1)	**A**	0A	1A	2A
	Critical Biodiversity Areas 2 (CBA 2)	**B**	0B	1B	2B
	Ecological Support Areas 1 (ESA 1)	**C**	0C	1C	2C
	No Critical Biodiversity Areas present	**D**	0D	1D	2D

Table 2: Cederberg municipality invasive alien plant control priority matrix

Based on the priority matrix the following priority classes have been identified:

- **0A**: Invasive alien plant management units contain CBA 1 areas with no fire risk
- **0B**: Invasive alien plant management units contain CBA 2 areas with no fire risk
- **0C**: Invasive alien plant management units contain ESA1 areas with no fire risk
- **0D**: Invasive alien plant management units contain no critical biodiversity areas and pose no fire risk
- **1A:** Invasive alien plant management units contain CBA 1 areas and pose a fire risk to life and infrastructure
- **1B**: Invasive alien plant management units contain CBA 2 areas and pose a fire risk to life and infrastructure
- **1C**: Invasive alien plant management units contain ESA1 areas and pose a fire risk to life and infrastructure
- **1D**: Invasive alien plant management units contain no critical biodiversity areas but pose a fire risk to life and infrastructure
- **2A**: Invasive alien plant management units contain CBA 1 areas and pose a fire risk to infrastructure
- **2B**: Invasive alien plant management units include CBA 2 areas and pose a fire risk to infrastructure
- **2C**: Invasive alien plant management units contain ESA1 areas AND pose a fire risk to infrastructure
- **2D**: Invasive alien plant management units contain no critical biodiversity areas but pose a fire risk to infrastructure

8. Monitoring and evaluation

Monitoring and evaluation will involve repeated field surveys to track progress/success and determine the efficacy of control methods. The following factors must be monitored to track project implementation progress:

- The effectiveness of control methods being used to control invasive alien plants
- Do the levels of invasive alien plant infestations decrease in areas where control projects are being implemented?

- What is the level of indigenous vegetation recovery in areas that have been cleared of invasive alien plants?
- How much herbicide is being used for each control project being implemented

Field observation and relevant project data (workload assessments, photographs, herbicide volumes etc.) must be captured in a structured spatially explicit (Geographic Information System) project implementation database to track progress/success and determine the efficacy of control methods. Data collection requirements, as determined by NEM:BA (species, description and extent), must be achieved through workload assessments completed before every control operation. These assessments must then be collated, analysed and reported every quarter.

Monitoring of the efficacy of control methods as required by NEM:BA Section 76 will be achieved through analysing the extent of invasion annually. Monthly reports must be compiled to track the implementation success of control projects, and an annual report will reflect the progress against implementation targets for the year.

Photographic records must be kept of areas to be cleared before control work starts and at regular intervals during the initial clearing activities. Similarly, photographic records should be kept off the area from immediately before follow-up clearing activities, and after. Rehabilitation efforts must also be recorded.

Records must be kept of daily operations, e.g. area/location cleared, the number of labour units and the amount of herbicide used. This will assist with planning as each site will require work, once or twice a year, for several years and of evaluating the costs against the benefits of the work.

Should the survey results indicate that the targeted invasive alien plants have not been adequately controlled then the specific control method and intervals that were used must be investigated to determine what caused the ineffectiveness of the control methods used. Once the specific problem has been identified in the control method, it must be rectified, e.g. if high levels of re-sprouting have occurred after applying herbicide the herbicide mixture and application method must be corrected.

Field surveys before and after each control project must also record the diversity of indigenous vegetation before and after each project that will indicate to what extent indigenous vegetation has recovered. If the recovery of indigenous vegetation is poor after clearing invasive alien plants, the clearing methodology and interval must be reviewed to ascertain if this might have led to the poor recovery. The incorrect application of herbicide, for example, might have led to indigenous vegetation also being treated with herbicide and would require appropriate training for herbicide applicators to ensure only invasive alien plants are treated with herbicide.

Invasive alien plants can replace indigenous vegetation entirely and once they have been cleared from a project area no or very little indigenous vegetation will be present. In cleared areas where very little indigenous vegetation remains active (seed sowing, planting of seedlings and cuttings) or passive (natural recovery of

indigenous vegetation and reduce environmental stressors such as grazing) restoration interventions must be considered and implemented where applicable.

Accurate records must be kept of all herbicide used during the implementation of control projects to track usage over time. Analysing the herbicide usage data over time trends in quantities for different infestation levels and species can be determined that will increase the success rate of control projects where the herbicide is used. The data will also assist in compiling accurate project budgets.

The Cederberg municipal invasive alien plant database must be updated annually through regular field surveys to ensure the species distribution data is up to date. If a vegetation fire has burnt down a portion of or the complete management unit the unit must be surveyed six months after the fire to ascertain what the post-fire invasive alien plant densities are. Post-fire invasive alien plant densities might be higher than before the fire due to the stimulation and germination of soil stored seed that can stay viable for up to 20 years.

9. Methods to be employed in the control plan

Invasive plants will be controlled by integrating mechanical, manual and chemical control in compliance with NEM:BA section 75 (1-3) Duty of Care Guidelines:

- Means and methods must be appropriate to the species
- Conducted in such a way that it causes the least harm to biodiversity and the environment
- IAPs offspring will be targeted (follow-up operations)

9.1 Planning for invasive alien plant control projects

Proper planning and preparations are fundamental to achieving cost-effective and successful invasive alien plant control. Once there is a formalised work plan for clearing IAPs, preparation for clearing can begin. These preparations include procuring the required equipment and materials, having staff undergo the required training, and ensuring that the relevant land-owners and neighbours are notified of the clearing activities before they are undertaken.

The following planning factors must be considered before implementing control projects:

- The ability and resources available for follow up operations should determine the size and location of the initial clearing operation. It critically important that a balance is maintained between clearing new areas and follow-up operations on previously cleared areas. Once the invasive plants have been removed from an area (initial control) resources must first be allocated for at least three (3) follow-up treatments (treating seedlings and sprouting plants that might appear after the initial control operation) before a new area is cleared. If resources are taken away from existing control projects before they have reached maintenance level, it can result in invasive alien plant densities increasing again requiring additional investment to bring it back to a maintenance level.
- Invasive trees located away from any structures or roads can be ring-barked, poisoned and left standing rather than felled to reduce control costs. Invasive alien trees located next to infrastructure (roads,

houses, powerlines etc.) or found on steep slopes/cliffs must be removed by specialist contractors explicitly trained to remove invasive alien plants in these high-risk areas.

- To avoid the threat of soil erosion when clearing dense infestations of IAPs on steeper slopes, work should progress horizontally along the contours. IAPs should be cut in bands of approximately 3m in width along the slope contour. This will help to slow down water run-off.
- On gentle gradients, clearing should start from the outside of a management unit and move inwards towards the centre, to assist in containing potentially invasive plant material and seeds within a confined area.
- Disposal of the cut invasive alien plant material (biomass) needs to be carefully considered. Options may include burning on-site, chipping and composting, use of the woody biomass for biochar/energy production or transportation of the material to a garden refuse or landfill site for disposal. Whatever disposal method is selected it must meet all legal requirements and must not create risk for residents and infrastructure. Note that the burning of some types of IAPs stimulates seed release or rapid seed germination and follow-up treatment of burnt areas must be treated a high priority.
- If a management unit has been affected by a vegetation fire it must be allocated a high priority for control interventions especially if the management unit was infested with species that create large soil stored seedbanks such as Black Wattle. The infestation level does not have to be very high and a few individual mature trees located on the property can create a large soil stored seed bank. The fire stimulates the germination of the soil stored seed and the seedlings can be controlled relatively cheaply with herbicide. Should the invasive alien plants on the management unit left untreated and be allowed to reach maturity the control cost can potentially triple.
- Identify the clearing methods that are best for the specific project site and target species, as well as the associated field equipment and personal protective equipment (PPE) required.
- Identify the correct herbicides for IAPs present on the management unit if chemical control is to be used. Only herbicides registered for use on the target species may be used.
- Identify training needs for project workers and supervisors based on the nature of the area to be cleared, the target IAPs and identified clearing methods. This may include invasive alien plant identification to ensure indigenous vegetation is not targeted, safety training for use of specialised equipment, such as chainsaws and specialised training for working in difficult or sensitive terrain. A qualified specialist contractor should clear invasive alien plants located on dangerous terrain such as steep slopes or cliffs and trees located next to infrastructure.
- If the area where invasive alien plant clearing will take place is not municipal-owned land, the landowner needs to be notified of the clearing activities that will be taking place. If there are neighbours that may be negatively affected by noise, road and pathway closures, or herbicide spraying associated with the clearing activities, they should also be notified before any work commences.
- Herbicides, equipment and PPE should be procured and be on-site before any the work commences.
- A safe storage area for the herbicides must be established which is bunded to contain any leaking containers. Herbicide storage areas must be secured to ensure that children and animals cannot access the chemicals and that the chances of theft are minimised (Annexure D: Cederberg municipality correct handling and application of herbicide guideline).

- A site camp may be set up to accommodate vehicles bringing workers onto the site, herbicide and equipment storage areas, ablutions and changing areas for workers. The site camp must be located outside of sensitive natural areas, must not restrict access routes or points for residents and businesses, and must not damage private property. If the site camp is on private property, the land-owner must have given permission for use of this area.
- All necessary staff and worker training must be completed before the clearing activities commence.

9.2 Follow-up and rehabilitation

There will always be some measure of regeneration of the cleared IAPs after the initial clearing work has been done. Proper follow-up work is thus essential and should be conducted regularly. If follow-up clearing is not done, the progress made in the initial clearing exercise will be lost within a few years as the IAPs become re-established.

Research has shown that if follow-up invasive alien plant clearing is executed properly and consistently, the costs and time expended on each consecutive follow-up reduces drastically. The maintenance stage can then be reached, where regular monitoring will be required for any seedlings that may have germinated. Where dense stands of IAPs have been cleared, the re-establishment of indigenous vegetation needs to be supported to help reduce the reemergence of IAP species and to reduce the risk of soil erosion where the soil surface is poorly vegetated.

In most soils, the seeds from the plants of the former natural habitat that occupied the area before invasive alien plant infestation still survive. Natural regeneration without the need for planting may be possible in many cases. However, if natural regeneration is not likely owing to the length of time the invasive alien plant infestation has been in place, or if the soil has been disturbed so that the natural seed stocks are destroyed, indigenous vegetation planting/seeding is required.

It is important to use only plants that have been properly hardened off from a nursery production system to minimize the loss of plants. Plants used for rehabilitation purposes must be sourced from within 50km of the rehabilitation site to ensure that the genetic composition of the introduced plants is not significantly different from that of naturally occurring indigenous plants in/around the rehabilitation area. For complex restoration projects (for example, involving the stabilization of major erosion areas and wetland rehabilitation projects involving the construction of weirs), it is necessary to contract the services of a specialist environmental rehabilitation professional to provide a plan and guidance on implementation.

In terms of follow-ups cleared areas should be monitored regularly for emergent seedlings and remove these (hand pulling or chemical control). Maintenance work should be done in late summer when seedlings can be seen amongst the other plants and follow-up work undertaken on a 3 to 6 monthly basis, depending on the rate of re-growth.

All areas of exposed soil should immediately be protected by placing the 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 each other).

If the soil remains relatively undisturbed and the area has some indigenous vegetation left intact, the natural regeneration processes of the indigenous vegetation on the site should be managed. This involves regular follow-ups to remove emergent IAPs and protecting the area from other forms of disturbance (uncontrolled fire, heavy grazing/ browsing pressure, vehicles accessing the area, etc.) while the vegetation re-establishes naturally.

9.3 Invasive alien plant control methods

It is critically important to Identify the clearing methods that are best for a specific project site and target species, as well as associated field equipment and personal protective equipment (PPE) required. Invasive alien plant control methods can be grouped into the following three categories:

- Mechanical control
- Chemical control
- Biological control

9.3.1 Mechanical control

Mechanical control involves the physical destruction or total removal of plants. Mechanical methods are generally appropriate for sparse infestations and for species that do not coppice after cutting and include the following methods:

- **Hand pulling**
  Hand pulling is the removal of plants by hand, ensuring that the root is also removed. Hand pulling is only recommended when an area is sparsely invaded, the soil should ideally be damp or soft, and sandy soils; and the plants are small enough to be pulled out successfully with the roots intact. Hand pulling does create soil disturbance, but if the area is sparsely invaded such disturbances are unlikely to be ecologically damaging.
- **Manual removal using hand tools**
  Manual removal using hand tools such as tree loppers and slashers can be used to remove IAPs. The use of hand tools is probably the most widely adopted, and often the most effective, of all the methods. This method is labour intensive and can, therefore, create numerous jobs. Methods of cutting the plants include the following:

  Ring-barking: Useful for killing large trees. An axe is used to remove the tree's bark and cambium, in a horizontal band about 30cm wide (about 50cm from the ground). Herbicide, if used, should be applied immediately after ring-barking on the cut area.

  Cut-stumping: Plants with a stem/trunk diameter larger than 10mm can be cut as low to the ground as possible with a saw. Herbicide, if used, should be applied to the cut surface immediately after cutting.

Slashing: The seed stalks/branches of annuals (plants that die each year after they set seed) can be slashed with a cane knife, mattock, bill hook or slasher before the seeds have matured. This is an effective method significantly reducing the presence of viable seeds that will germinate in the new season. Costs are generally low for controlling annuals in this way, as no herbicide is required.

Strip-barking: With the use of a cane knife or axe, the bark of large trees can be stripped completely, from waist height down to the base of the trunk. Herbicide, if used, should be applied to the stripped surface immediately after strip-barking. This is an effective but time-consuming method.

Frilling: Small trees can be frilled by cutting an angled groove into the bark and cambium, right the way around the tree trunk. This can be achieved with either a cane knife or axe, depending on how hard the bark and cambium layers of the tree are. The herbicide is then applied into the groove, which kills the tree as it seeps into the cambium tissue. This is the preferred method of killing small trees, as it is usually much quicker and therefore more cost-effective than ring-barking or strip-barking.

Advantages	**Disadvantages**
An effective method in areas with low infestations	Not an effective method for dense infestations, as the cost of clearing is exceptionally high, with little or no impact
High job creation and associated poverty alleviation potential	Time-consuming and may be slower to complete than other forms of control
No contamination of water with herbicides as these are applied directly to the tree	If no herbicides are used, then the manual control techniques must be very well executed to ensure success

Table 3: The advantages and disadvantages of the manual removal of IAPs using hand tools

- **Manual removal using mechanised tools**

  A variety of mechanised tools can be used to clear IAPs and include the following methods:

  Brush-cutter: Heavy-duty motorised brush-cutters that are usually powered by a small two-stroke engine are popular for controlling low-growing thickets of IAPs. Importantly, a suitable blade must be fitted to the brush-cutter, for example, fitting a steel blade will allow for cutting of thicker stems. Herbicide application to the cut stems should follow immediately after cutting.

  Chainsaw: A chainsaw is ideal for felling large trees and can be used to cut logs and branches into shorter lengths. Common target species for felling include large specimens of Syringa, Pine, Gum and Wattle. Training for chainsaw operators is essential. Operators need to understand the techniques of felling, i.e. ensuring that the tree falls in the desired direction. Each operator must also understand and be able to apply the necessary safety precautions during the felling process. Understanding the effective use and operation of the chainsaw itself is critical. The operator should also have the means and knowledge to undertake any required onsite servicing of the motor and sharpening of the chain.

Advantages	Disadvantages
Dense stands of IAPs can be cleared.	The cost of the equipment, fuel and servicing. This may be balanced by reduced labour costs.
It may be possible to clear very large areas of IAPs faster than without mechanised tools	Requires specialised training and more safety equipment than non-mechanised methods
	Possible pollution caused by fuel and oil

Table 4: The advantages and disadvantages of the manual removal of IAPs using mechanised tools

10.3.2. Chemical control

Chemical control of IAPs involves the use of herbicides to kill targeted plants. Managers and herbicide operators must have a basic understanding of how herbicides function, as this will guide the correct selection of herbicides for different purposes and plants.

The use of inappropriate herbicides and the incorrect use of the appropriate herbicides are wasteful and expensive practices. They often do more harm than good. This is especially problematic when working near watercourses. Some herbicides can quickly contaminate freshwater systems and/or be transported downstream where they may remain active in the ecosystem. This is especially the case for herbicides with a high soil residual effect, i.e. herbicides that remain active after contact with soil.

Herbicides are classified as either selective or non-selective. Selective herbicides are usually specific to a particular group of plants, e.g. those specified for use on broadleaf plants will be effective on most broadleaf plants but should not kill narrow-leaved species such as grasses. Non-selective herbicides can kill any plant they come into contact with and are therefore not suitable for use in areas where indigenous plants are present.

Contractors that will be using herbicides to control invasive alien plants must have a valid Pest Control Operators Licence (limited weeds controller) according to the “Fertilizers Farm Feeds, Agricultural Remedies and Stock Remedies Act”, Act No. 36 of 1947. This is regulated by the Department of Environment, Forestry and Fisheries (DEFF).

Protective gear must be used at all times and applicable guidelines for mixing and storing of herbicides must be adhered to. Herbicide applicators should have completed a certified training course. Herbicide applicators need to understand the implications of splash and drift. When a plant is sprayed with herbicide, it is almost certain that excess herbicide will leave the target area (Annexure D: Cederberg municipality correct handling and application of herbicide guideline).

This might not be problematic in areas of high-density infestations because excess herbicide will either drift or drip onto other target IAPs, it is, however, problematic when there are many non-target species close in close proximaty. The misting effect, where tiny droplets drift via a breeze to non-target species, often occurs when using high-velocity nozzles. Ideally, low velocity and high-volume nozzles should be used for drenching, while high velocity, low volume nozzles should be used for misting.

The following aspects must be considered when planning to implement a chemical control project (Annexure D: Cederberg municipality correct handling and application of herbicide guideline):

- Only use herbicides that are registered for use on the specific species to be treated.
- Spray only in suitable weather conditions. Milder temperatures and higher humidity are best. No wind or light winds are preferable to minimise the risk of herbicide drift on non-target species.
- Spray plants during the active growing period. When leaf colour starts to turn for winter, it is too late to apply herbicides.
- Spray plants before the seeds are produced.
- Avoid using herbicides on drought-stressed or diseased plants or in extremely hot or cold conditions.
- Herbicide should not be applied during wet conditions, before or after rain. If it rains after application, it is crucial to monitor the effect as one may need to re-apply.
- Carefully read and understand the instructions on the label before initiating chemical control.
- Always store herbicides in the original container and in secure storage areas out of reach of children and animals.
- All persons must wear the required personal protective equipment when working with herbicides.
- Avoid skin contact with herbicides and avoid breathing in the vapour.
- Herbicide should always be applied immediately after the selected mechanical control method. Once the stem has dried, it will not absorb the herbicide.
- Keep herbicide in the shade at the worksite to keep it cool.
- To avoid spills, keep herbicide containers on a waterproof tarpaulin, or inside a big plastic bucket. When mixing herbicides, ensure that a funnel is used to prevent spilling. Should the herbicide spill, it can be poured back into the container from the plastic bucket.
- Containers containing mixed herbicide should be clearly marked (e.g. ‘glyphosate mix’). Likewise, containers filled with water to be used for mixing herbicide should also be marked to ensure that people do not drink from them.
- Always use a measuring jug to measure the correct quantity required.
- To mix herbicides, half fill the appropriate size container with water and then add the herbicide using the measuring jug. Secondly, close the container and shake, and then fill the rest of the container with water.
- Keep the herbicide away from food.

Chemical application techniques include the following methods:

- Foliar application,
- Stem applications (basal stem, frilling, stem injection)
- Stump applications (cut stumping, scrape and paint).

Foliar application: This method uses a knapsack sprayer to spray IAPs below 1 metre in height. Leaves are sprayed to the point of run-off. Correct training and certification are essential before a team member uses this method. Foliar spraying is generally regarded as a cheaper method than cut stump treatment because fewer people

are required to treat larger areas. It does, however, require large amounts of clean water (for mixing with herbicides), and therefore only practical where water is available.

Cut stumping: To use these methods clear the area around the base of the stem, then cut the stem horizontally as close to the ground as possible, using secateurs, loppers, bush saw, or chain saw. It is important that the cut is horizontal to avoid runoff of herbicide, and sharp-angled cuts may also present an injury risk. The herbicide is then applied as soon as possible (preferably within 10 seconds) to the exposed surface before the plant's cells close up and inhibit the entry of the herbicide. On larger stems focus herbicide application on the sapwood and not the heartwood, as the herbicide will not be translocated through the stump by the heartwood and will be wasted. It is easiest to have two people for this process, one to cut and one ready to apply the herbicide as soon as possible. This approach, though reliable, does not always provide a 100% kill rate, and ongoing follow-up and monitoring of treated plants will be required.

Frilling: An axe is used to make angled cuts down into the cambium layer through the bark in a ring. The cuts must go around the entire stem and apply herbicide into the cuts.

Basal stem: This method involves mixing an oil-soluble herbicide in diesel and spraying the full circumference of the trunk or stem. Basal bark spraying is often used to treat thinly barked woody weeds and undesirable trees. It is an effective way to treat saplings, regrowth and multi-stemmed shrubs and trees. This method works by allowing the herbicide to enter the weed's underground storage organs, slowly killing it. The stem or trunk needs to be reasonably free of mud or dust and should be reasonably dry. It should be sprayed or painted with herbicide solution from ground level. The height to be covered varies with the species and maturity of the plant being treated. Check with local authorities for recommended coverage. Basal bark spraying is a useful method in difficult terrain and usually works well, provided bark is not too thick for the solution to penetrate

Scrape and paint: This method is helpful on vines and scrambling plants with a woody stem. Using a knife and starting from the base, scrape 20 mm to 1 m of the stem to expose the sapwood and apply herbicide to the scraped area within 10 seconds. Do not ringbark the stem. Scrape about one-third of the stem diameter. Larger stems (>10 mm) can be scraped on two sides. Vine 'curtains' can be cut at chest level and again at about 300 mm above the ground. Scrape or cut and paint these lower stems and spray new growth. Pulling vines out of trees may cause a lot of damage to tree foliage or bark and it may be better to leave the vine to die in the tree after treatment. As with all herbicide, methods avoid using cut and swab or scrape and paint and similar methods if rain is expected. Herbicide labels have information on

the amount of time needed after application before rain for the chemical to still be effective

Stem injection: The aim is to get herbicide into the sapwood tissue of woody weeds and Cactus species so that it will be transported throughout the plant. This method targets individual plants and the risk of off-target damage is diminished. Use a cordless drill or spike to make holes around the base of the plant. Holes should be drilled at an angle of 45 degrees and be made no more than 50 mm apart right around the stem. This angle will aid herbicide retention in the hole, increasing absorption by the plant and reducing the risk of spillage. Herbicide must be injected in the holes within 10 seconds of the hole being made. Holes should not be overfilled because excess herbicide will run down the stem and contaminate the environment. Injection guns enable you to deliver a precise amount of herbicide to each hole. A squeeze bottle with a firmly fixed tube to dispense the herbicide or veterinary syringes may also be useful.

Handheld spraying: Handheld spraying is a means to apply herbicide to the stump once the plant has been cut down mechanically (cut-stumping) or after ringbarking, frilling and strip-barking. The most common and convenient handheld sprayer has a 1.5-litre capacity and a nozzle that can be set to achieve the correct spray width. Handheld sprayers are cheap, and the application of herbicide is accurate.

Aerial spraying: Application of herbicides from a fixed-wing craft, or helicopter is primarily used for spraying very high densities IAPs present in areas that might otherwise be difficult to reach or control. The results are good, but aerial spraying is expensive, and selectivity is impossible. Aerial spraying is only used in severe cases of infestation. Careful consideration of the herbicide type and mix are essential, given the risks of contaminating water and the impacts to fish and other aquatic biodiversity as well as impacts on human health.

The following factors must be considered when choosing the most appropriate herbicide for a specific project:

- Each herbicide has a chemical compound or active ingredient that makes it effective. Herbicides sold under different brand names may have the same active ingredient. A herbicide with the correct active ingredient must be selected. The concentration of the active ingredient can also differ from one product to the next. As such, the mixing ratios may differ. It is critical that the recommended mixing ratios are adhered to and the guideline document and label supplied with the product should always be consulted prior to calibration.
- The residual effect is the length of time that a herbicide will remain active once in the soil. Some herbicides denature immediately on contact with soil, while others can remain active in the soil for up to two years. The shorter the residual effect of a herbicide, the less likely it is that non-target species will be killed. The residual effect of a herbicide should be checked before purchasing.
- Dye must be mixed with herbicides to ensure a clear visual indication of which plants have been treated and which have not. This allows workers to see where they have applied the herbicide and allows for

easy inspection of work a few days later. Some herbicides contain a pre-mixed dye that eliminates the need for on-site mixing of dye. If a dye must be added, ensure that it is of good quality and that it is chemically compatible with the active ingredient and adjuvant. The use of different colour dyes for different herbicides is a useful approach. It makes it very easy for workers to differentiate which herbicide to apply to which plants where such a distinction is required.

- Some herbicides require the use of a wetter, or adjuvant, to be effective. Always check if a product has a recommended adjuvant or if an adjuvant must be added for targeting specific IAPs. Herbicides applied to leaves by foliar application often require a specific adjuvant, as do those applied to trees with very waxy stems. Always check with the manufacturer if there is any uncertainty regarding adjuvants.
- Either water or diesel can be used as a carrier for certain herbicides. However, water is the preferred carrier, because diesel is expensive and can have very negative impacts on the natural environment. There is also often a risk of diesel theft. Diesel should never be used for foliar applications due to its very negative impact on the environment. Diesel should only be used in direct application to stems, and run-off is to be minimised.

The following factors must be considered when applying herbicide in riparian areas:

- The use of herbicides and herbicide additives near waterways, or in situations where herbicides may eventually enter waterways, requires very careful consideration and special care. If at all possible, it is best to avoid herbicide use in these situations because of the potential risk to aquatic life and other users of water. If herbicides are to be used, they must be registered for use near waterways or in aquatic situations and label instructions need to be strictly adhered to. Special permits may be required from state or territory environment protection authorities to use herbicides near or on waterways.
- High volume foliar spray applications increase the chances of direct or indirect contamination of waterways. Consider alternatives such as knapsack spraying, basal bark application, wick wiping or cut stump/stem injection to reduce contamination risks.
- It is better to treat riparian weed infestations (situated near a waterway or water body) progressively rather than in one large-scale operation. This will reduce the risks of stream bank destabilisation and habitat loss. A progressive process will allow native vegetation to regenerate or revegetation to become established. Of course, as with all weed work, ongoing follow-up and vigilance will be required.
- Select herbicides that have the lowest tendency to leach, are persistent in the environment for the shortest time and have the lowest toxicity that will still be effective against the target weed.
- Mixing of chemicals and cleaning of equipment should be done well away from waterways in situations from which runoff will not directly enter waterways.
- Avoid spraying weeds that overhang waterways and wherever possible direct spray away from waterways

Advantages	Disadvantages
Achieve results over a short period (within six 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 fishing, and can therefore, threaten human and animal health.
Complements mechanical control methods, increasing the effectiveness of IAP control activities.	May kill non-target plants or species
	Specialised training and certification is required to use herbicide

Table 5: The advantages and disadvantages of chemical control

10.3.3. Biological control

Invasive alien plants can spread very rapidly due to the lack of natural enemies (e.g. browsers or pathogens) that might occur in their land of origin. Biological control, or bio-control, is the introduction of these natural enemies to remove the plants' competitive advantage and reduce population vigour to a level comparable to that of the natural vegetation. These natural enemies are termed 'biological control agents' and most include insects, mites and micro-organisms such as fungi or bacteria. Biological control agents usually attack specific parts of the plant.

They can either attack the reproductive organs directly, e.g. on the parent plant (flower buds, flowers, or fruit) or the seeds after they have dropped. The 'stress' caused by a bio-control agent may kill a plant outright, or it might impact on the plant's reproductive capacity. In certain instances, the reproductive capacity is reduced to zero, and the population is thus effectively sterilised. All these outcomes will help to reduce rates of spread of the species.

Advantages	Disadvantages
Most environmentally friendly and most sustainable of all invasive alien plant 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. This includes community woodlots.

Table 6: The advantages and disadvantages of biological control

10. Project budget & scheduling

There have been few cases where entire invasive populations have been eradicated because it is extremely costly and not always viable. However, the clearing of invasive alien species in some areas will lead to an increase in the delivery of ecosystem goods and services and an increase in biodiversity. The control of invasive alien plants and restoration plays an essential role in ensuring the sustainable provision of ecosystem services and the long-term conservation of biodiversity.

The Cederberg municipality invasive alien plant control budget was calculated using the national Working for Water Programme (Expanded Public Works Programme) costing model and person day per hectare norm. The successful functioning of the costing model requires the following input data that was collected during field surveys of the management units:

- The size in hectares of each management unit
- The growth form of the recorded invasive alien plant:
    - Aquatic weed
    - Cactus
    - Creeper
    - Grass
    - Herbaceous
    - Non-sprouting tree
    - Sprouting tree
    - Seedling
- Name of invasive alien plant species
- The percentage density cover of each recorded invasive alien plant within the management unit
- The size class of each recorded invasive alien plant species:
    - Seedling
    - Young
    - Adult
- The treatment stage of each management unit:
    - Initial treatment: the first control project within a management unit where no previous control actions have been implemented
    - Follow-up treatment: once the initial treatment has been completed regular follow-up operations must be implemented until the maintenance (invasive alien plants have been completely removed or are at such low densities that it requires one person walking through the management unit once a year to treat the individual plants) has been reached
- Control methods:
    - Foliar spray
    - Hand pulling
    - Lopping or pruning
    - Bark Strip
    - Basal stem treatment and diesel

    - Cut below the ground
    - Stem injection
    - Ring barking
    - Felling
    - Frilling
    - Cut stump
    - Bark strip
    - Spray from a boat (aquatic weeds)
    - Spray from the shore (aquatic weeds)
    - Cut and spray
- The underfoot conditions within the management unit:
    - Easy
    - Moderate
    - Difficult
- The height of obstructive vegetation within the management unit:
    - Head height
    - Chest height
    - Knee height
- The density of obstructive vegetation within the management unit:
    - Slight
    - Moderate
    - Dense
- Walk time from the closest safe parking area at the management unit to the centre of the management unit (minutes one way)
- Drive time from the furthest pick-up point (home, central pick-up point) to the closest safe parking area at the management unit
- Slope in degrees
- Indicate whether the management unit contains riparian areas

The above-mentioned data for each management unit is captured in the costing model and combined with the Working for Water Programmes person day per hectare matrix (how long will it take one person to control a specific invasive alien plant species) calculate how much it will cost to control the invasive alien plants within each management unit. The cost is calculated for a standard Working for Water Programme team that has the following composition:

- 1 Contractor
- 1 Chainsaw operator
- 2 Herbicide applicators
- 1 Health and Safety representative
- 1 Qualified First Aider
- 6 General workers

Walking time, drive time, underfoot conditions, height of obstructive vegetation, the density of obstructive vegetation, and slope data is included into the budget calculation to accommodate the impact that these factors might have on the budget and duration of the various control projects (Annexure C: Cederberg municipality invasive alien plant control budget). For example, difficult underfoot conditions, head height and dense obstructive vegetation will increase the effort (time & cost) for a contractor to control the invasive alien plants within a management unit. Steep slopes and long walking/drive times will also increase the time and cost to control invasive alien plants.

The herbicide volume, type and cost for each management unit was estimated based on the species and density classes present in each management unit (Annexure C: Cederberg municipality invasive alien plant control budget, Annexure E: Cederberg municipality herbicide database).

Based on the Working for Water Program costing model, the following additional cost estimates have been included in the control budget (Annexure C: Cederberg municipality invasive alien plant control budget):

- Compensation for Occupational Injuries and Diseases contribution
- Unemployment Insurance Fund contribution
- Personal Protective Equipment (PPE) contribution (the funds are used to replace or purchase PPE)
- Equipment fund contribution (the funds are used to replace, repair or purchase equipment)
- Transport cost (transport cost for a bakkie and trailer)
- Administrative support cost (the cost to cover administrative tasks such as invoicing and payments)

Research has shown that if follow-up invasive alien plant clearing is executed properly and consistently, the costs and time expended on each consecutive follow-up reduces drastically. The ability and resources available for follow up operations should determine the size and location of scheduling initial clearing operation. It critically important that a balance is maintained between clearing new areas and follow-up operations on previously cleared areas.

Once the invasive plants have been removed from an area (initial control) resources must first be allocated for at least three (3) follow-up treatments (treating seedlings and sprouting plants that might appear after the initial control operation) before a new area is cleared. If resources are taken away from existing control projects before they have reached maintenance level, it can result in invasive alien plant densities increasing again requiring additional investment to bring it back to a maintenance level.

Urban areas are complex environments, where perceptions on the value of particular properties typically need to consider social equity, economic development and environmental conservation. Managing invasive alien plants are often controversial in such settings. The challenge in prioritising areas for invasive alien plant control projects is to weigh considerations relating to biodiversity conservation, social trade-offs and diverse “benefit to society” issues (refer to the section in the report dealing with the *Prioritisation of control projects*). Such decisions need to be transparent and must consider opinions of a wide range of stakeholders involved in urban

land-use and ecosystem management decisions. When vegetation can be restored to the benefit of society, projects are more likely to gain general support and be funded.

Although invasive alien plant control projects can be costed and the implementation scheduled for up to 20 years into the future it is unrealistic to expect a municipality with all its other priorities (housing, supplying clean water etc.) to have all the financial and human resources to implement the project within the shortest period of time. In the case of the Cederberg municipality, it would require multiple contractor teams working simultaneously over a period of two years to implement only the initial control projects.

It should also be kept in mind that if a municipality allocates resources in a given financial year to control the invasive alien plants in some high priority management units the invasive alien plant densities will increase and age classes (seedling, young, mature) change in the remaining management units that are not actively being cleared during the given financial year. Invasive alien plant densities and age classes have a significant impact on the calculation of invasive alien plant control costs and scheduling implementation.

For example, if the original invasive alien plant age class was captured as seedlings in 2020 then in 2021 the age class will change to young if it is not controlled in 2020. In 2020 the seedlings could have been treated with herbicide relatively cheaply and in a short period of time but in 2021 the young plants are too tall to safely spray with herbicide and they must first be cut down mechanically and depending on the density the individual stems must be treated with herbicide (low infestations) or the contractor must wait (6 months or more) until the cut stems have sprouted (calve height) and then apply herbicide (high infestations).

Some management unit might also require multiple treatments in one year, depending on the invasive alien plant species present. The requirement for a second treatment within the same year can only be determined once the initial control project has been completed. This scenario will require that a municipality update the complete invasive alien plant control plan in terms of priorities, budget and implementation schedule. A vegetation fire can also have a huge impact on the implementation of an invasive alien plant control plan. A vegetation fire will remove all the invasive alien plants on the affected management units and depending on the species that were present in the management unit, it might reduce or increase control costs. For example, after the devastating Knysna fire in 2017 areas that only had a handful of mature Black Wattle trees before the fire ended up being 100% infested within a few months after the fire due to the germination of ground stored seed banks.

A better approach would for the municipality to take into account all its current commitments, invasive alien plant control priorities (budget included) and available resources (financial and human) to decide which high priority management units can be realistically controlled in year 1 (initial treatment). Resources must be allocated at the same time for the follow-up treatments for the selected management units. Once the municipality has selected the management units a realistic project schedule can be compiled that can be monitored and evaluated to track progress. The project implementation schedule must be updated every year as resource availability and municipality priorities change. It will also require the municipality to visit each management unit once a year to update the invasive alien plant database in terms species, densities and age classes.

11. Responsibilities and reporting requirements

The Cederberg Municipality will be responsible for the implementation of the invasive alien plant monitoring, control & eradication plan. Based on the monitoring and evaluation data regular reports must be submitted to track the implementation progress and the success of the plan.