STELLENBOSCH MUNICIPALITY

ALIEN INVASIVE PLANTS MANAGEMENT PLAN

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This document is a revision and update of the document

A Management Plan for Alien Invasive Plants on Municipal Land in Stellenbosch Municipality
(2013)

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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 (IAP) in areas that they own or manage. The purpose of this document is to respond to this obligation and to coordinate Stellenbosch Municipality's (the Municipality) approach in this regard in order to reduce future IAP control costs and improve the integrity of the natural areas and ecosystems in Stellenbosch Municipality.

2. THE SIGNIFICANCE OF THE REGION & THE THREAT OF IAPs

A primary reason for the conservation of the natural environment of the Greater Stellenbosch Municipality is that it forms an integral part of the world-renowned Cape Floral Kingdom.

The Cape Floral Kingdom is internationally recognised as one of the six Floral Kingdoms of the world (0,06% of the earth's surface). As shown by Figure 1, it is the only Floral Kingdom contained, in its entirety, within a single country. The Cape Floral Kingdom is characterised by its exceptional richness in plant species and its endemicity. More than 8 700 species are known to occur, with more than 68% of these species being confined to the Cape Floral Kingdom. Thus this Floral Kingdom compares with some of the richest floras worldwide, surpassing many tropical forest regions in its floral diversity.

The enormous diversity found in the Cape Floral Kingdom is attributed to the age of this kingdom. The last Ice Age had far less of an influence on this area that it did on the Northern Hemisphere. Plant life in the Northern Hemisphere was almost wiped out while conditions in the Western Cape were altered very little. The diversity can also be attributed to the harsh conditions and infertile soil of the area which has forced plants to adapt to ensure their survival. The Cape Floral Kingdom is of immense scientific importance, both nationally and internationally. It covers only 4% of South Africa, but contains 45% of all plant species of Southern Africa. About 75% of all plants in the South African Red Data Book are found in the Cape Floral Kingdom. Of these species, 1 700 are threatened. Many

Fynbos species are extremely localised in their distribution, with sets of such localised species organised into 'centres of endemism'[1].

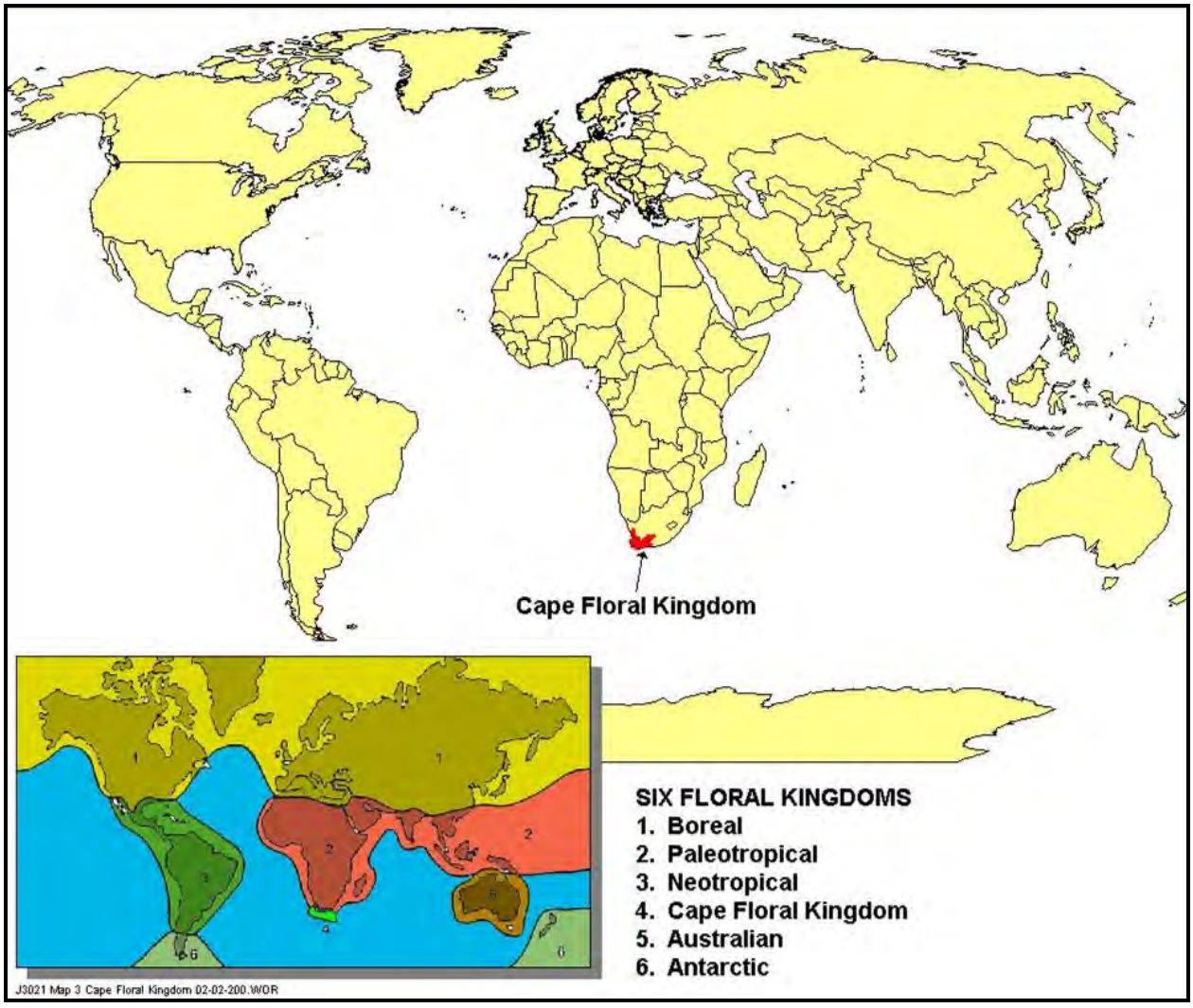

Figure 1: The Cape Floral Kingdom in International Context.

Biological invasion has become a major cause for concern worldwide. Being a result of human induced environmental change[2], biological invasion is not only threatening global biodiversity, but it plays a major factor in both global and local extinctions, as well as causing substantial economic and human health problems. Defined as exotic or non-endemic species, alien species become invasive by passing through a series of barriers and establish new populations in areas at a distance from their immediate area of introduction[3]. These barriers are geographic, environmental, reproductive, dispersal, environmental[4]. Consequently, the lack of native enemies and controlling agents enable these invasive species to out-compete native species for available resources and space while altering

1 Low & Robelo, 1996.
2 Tsoar *et al*., 2011; Vitousek *et al*, 1997.
3 Richardson *et al*, 2000; Tsoar *et al*, 2011.
4 Richardson *et al*, 2000.

the surrounding natural environment. This in turn leads to unnatural successions and the displacement of many natural vegetation communities[5]. The extent of this displacement of natural vegetation communities and thus the unnatural alteration of many native habitats has been of major concern for conservationists due to the dramatic effect they have on both native fauna and flora and, consequently, on many interactions and ecosystem structures which may have altering effects on ecosystem services that we as humans rely on[6].

3. WHAT ARE INVASIVE ALIEN PLANTS

Invasive alien plants are plant species that have been introduced, either intentionally or unintentionally, to South Africa. They can reproduce rapidly in their new environments and, as mentioned above, tend to out-compete indigenous plants. The result usually includes a variety of negative ecological, social, and economic impacts. Invasive alien species pose the biggest threat to biodiversity after direct habitat destruction.

Approximately 8 750 alien species have been introduced into South Africa, 161 of which are seriously invasive species, and is estimated to cover over 10 million hectares (almost 8%) of South Africa's land surface. Expectations are that the impact will double every fifteen years if they are left un-managed[7]. Known for its renowned fynbos biome, the Western Cape is they most severely invaded province, with the wetter catchments of the coastal mountain ranges and the broad coastal lowlands being the most effected regions. The invasion of AIPs within the fynbos biome has called for elevated levels alarm since the early decades of this century[8]. Invasive plant species such as the *Acasia saligna* (Port Jackson), *Acacia mearnsii* (Blackwattle) and *Pinus pinaster* (Cluster Pines) are found in the fynbos introduced to enhance the value of the Cape's resources, pines originated from Europe while the *Acacias* are originally from Australia. Although many of these species still support several industries, their negative impact are becoming more prominent, leading to a urgent need to protect our natural resources.

IAPs are characterised by being able to reproduce rapidly in their new environments, and this is usually due to a combination of factors, including:

- A lack of natural enemies in the new environment
- Resistance to local diseases and other plant pathogens
- Highly competitive growth and colonising strategies that provide them with a competitive edge, and an ability to out-grow local indigenous plants

IAPs can significantly alter the composition, structure and functionality of ecosystems. As a result, they degrade the productive potential of the land, intensify the damage caused by veld fires and flooding, increase soil erosion, and impact on the health of rivers and estuaries. Indigenous species may be reduced in numbers/coverage, or may be lost as a result of IAP infestations, posing a threat to South Africa's natural heritage in sensitive locations.

5 Enright, 2000; Le Maitre *et al*., 2002.
6 Le Maitre *et al*., 2002.
7 Schonegeval 2001; Versfeld, Maitre and Chapman, 1998.
8 Macdonals *et al*. 1985.

IAP infested natural habitats suffer reduced capacity to produce ecosystem services that help support a healthy and productive living environment for people. Availability of natural products, such as medicinal plants, fodder and building materials is decreased, and disease-carrying pests such as mosquitoes and rats may be more numerous due to a reduction in natural predators with declining ecosystem functioning. The aesthetic, recreational and cultural values of the natural environment are also significantly decreased where IAPs take over. IAPs also threaten local and national water security. The notable reduction of South Africa's water resources from IAP infestations has far-reaching ecological, economic and social implications.

4. LEGISLATIVE CONTEXT

4.1 CONSERVATION OF AGRICULTURAL RESOURCES ACT, 43 OF 1983

In terms of the amendments to the regulations under the Conservation of Agricultural Resources Act, 43 of 1983 (CARA), all declared aliens must be controlled. Landowners are legally responsible for the control of invasive alien plants on their property. In terms of the above act alien invasive plants are described to one of the following categories:

- Category 1: Prohibited and must be controlled.
- Category 2: May be grown in demarcated areas provided that there is a permit in place and steps taken to prevent spread.
- Category 3: May no longer be planted. Existing plants may be retained as long as all reasonable steps are taken to prevent spread, except within the flood line of watercourses and wetlands.

4.2 NATIONAL ENVIRONMENTAL MANAGEMENT: BIODIVERSITY ACT, 10 OF 2004

National Environmental Management: Biodiversity Act, 10 of 2004 (NEMBA), 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 gift ant 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 gift. No permits will be issued for Category 3 plants to exist in riparian zones.

Aliens that are regulated in terms of CARA as weeds and invader plants are exempted from NEMBA. This implies that the provisions of the CARA in respect of listed weeds and invader plants supersede those of the NEMBA.

5. ALIEN MANAGEMENT PRINCIPLES

5.1 PLANNING & PREPARATIONS

Proper planning and preparations are fundamental to achieving cost-effective and successful IAP 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 – if they are to be impacted on in any way.

5.1.1 Planning

a) Species and areas has to be prioritized and cleared according to their impact on natural resources and their potential for spreading to non-invaded areas[9]. Considerations in this regard include:
   i) Aliens must be cleared in a manner that reduces the risk of cleared areas being re-invaded by other invaded areas. For example, upstream area should be cleared before downstream areas if the river transports the seeds.
   ii) A balance needs to be maintained between clearing new area and follow-up operations on previously cleared areas.
   iii) Prevention is cheaper than clearing and therefore un-invaded areas must be protected from invasion.
   iv) 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.
   v) IAPs that pose a fire risk to houses or infrastructure should be targeted as a priority. Creating an effective “fire break” is important where woody/fire prone IAPs are located in dense stands near settlements, power lines etc.
   vi) Areas with young, less dense trees, which have smaller seed banks and a potential high rate of spread, should be targeted first. Focussing on these areas requires less 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 greater threat than they are at the moment.

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

[9] Schonegevel, 2001.

c) Invasive trees located away from any structures or roads can be ring-barked, poisoned and left standing rather than felled.
d) 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; the cut material should then be rolled back so that it forms a "frill" along the band. This will help slow down water run-off. A 2m swath of uncut material should be left before starting on the next 3m wide band. As the cut bands start to re-vegetate, work on the uncut bands can begin.
e) On gentle gradients, clearing should start from the outside of a work block and move inwards towards the centre, to assist in containing potentially invasive plant material and seeds within a confined area.
f) Disposal of the cut IAP material needs to be carefully considered. Options may include: burning on site (note this comes with serious risks that need to be managed); chipping and composting (note that this is not appropriate if the plant material contains seeds); use of the woody biomass for charcoal manufacture; transportation of the material to a garden refuse or landfill site for disposal. Whatever disposal method is selected must meet all legal requirements and must not create risk for local residents and infrastructure. Note that burning of some types of IAPs stimulates seed release or rapid seed germination.
a) Identify the clearing methods that are best for the specific project site and target species, as well as associated field equipment and personal protective equipment (PPE) required.
b) Identify the required herbicides for IAPs if chemical control is to be used. Only herbicides registered for use on the target species may be used.
c) 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: IAP identification; safety training for use of specialised equipment, such as chainsaws; specialised training for working in difficult or sensitive terrain.

5.1.2 Preparations

a) If the area where IAP clearing will take place is not municipal-owned land, the land-owner 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 prior to the work starting.
b) Herbicides, equipment and PPE should be procured and be on site before the work starts.
c) 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.
d) 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 local residents and businesses, and must not damage private property or community gardens. If the site camp is on private property, the land-owner must have given permission for use of this area.

e) All necessary staff and worker training must be completed prior to the clearing activities being started.

5.2 BUDGETING

AIP control is expensive. General items to be budgeted for include the following:

a) Labour
b) Equipment / tools
c) Herbicides
d) PPEs
e) Fuel

It should also be established to what extent follow-up action will be required so that provision in this regard can be made. If follow-up work is structured and done correctly the overall management costs should decline. If follow-up work is not done correctly, the initial investment in clearing is often lost.

Always do sufficient research into the types of weeds present. Large gum trees will require significantly more resources to clear than a few bugweed plants. As such, a survey to determine species density and distribution, together with a table that assigns approximate costs to clearing each type of IAP present, is essential. If specialised IAP clearing contractors are to be used, be sure to compare quotations and qualifications/experience. If a team is not qualified or experienced, it is unlikely that they will implement effective IAP control.

5.3 CONTROL METHODS

5.3.1 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. They include:

5.3.1.1 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, has a high rainfall (the soil should ideally be damp or soft), warm temperatures, 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.

5.3.1.2 Manual removal using hand tools

Manual removal using hand tools such as cane knives, 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 creating numerous jobs. Methods of cutting the plants include:

Ring-barking: Useful for killing large trees. A cane knife or 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 or cane knife. 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. 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**
Effective method in areas with low infestations	Not an effective method for dense infestations, as the cost of clearing is extremely high, with little or no impact
High job creation and associated poverty alleviation potential	Time consuming – 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

5.3.1.3 Manual removal using mechanised tools

A variety of mechanised tools can be used for IAP clearing. They include:

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 – although this may be balanced by reduced labour costs.
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 bar oil.

5.3.2 Chemical Control

Chemical control of IAPs involves the use of herbicides (plant poison) 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 in close proximity to watercourses. Some herbicides can quickly contaminate fresh water 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 broad leaf plants will be effective on most broad leaf 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.

The contractor also needs to 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 Agriculture, Forestry and Fisheries.

5.3.2.1 Chemical Application Training

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. This might not be problematic in areas of high-density infestations: excess herbicide will either drift or drip onto other target IAPs, it is however problematic when there are many non-target species close by. 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.

5.3.2.2 Chemical Application Techniques

Chemical application techniques include foliar (leaf) application, stem applications (basal stem, total frill, stem injection) and stump applications (cut stump, total stump, scrape and paint):

Foliar spraying: 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 is 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.

Handheld spraying: Handheld spraying is a means to apply herbicide after cut stumping, ring-barking, 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 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.

Advantages	Disadvantages
Achieve results over a short period (within 6 weeks of application).	Herbicides are expensive.
Large areas can be treated quickly.	The use of herbicides may contaminate sites used for drinking water, for washing and for fishing, and can therefore 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 for use

	of herbicides.

5.3.2.3 How to choose the correct herbicide

Choose the most appropriate herbicide by considering the following:

Active ingredient: 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. It is critical that a herbicide with the correct active ingredient is 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.

Residual effect: 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 an herbicide, the less likely it is that non-target species will be killed. The residual effect of an herbicide should be checked before purchasing.

Dye: Dye is often 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 (e.g. red dye can be selected for herbicide used to treat Lantana, and blue for Blue Gum, etc.).

Registered herbicides: A large variety of herbicides and their supporting products such as dyes, wetting agents, etc. are available on the market, which have been registered for a range of IAPs. Beware of cheap imports that do not carry a South African registration number.

Recommended Adjuvants: 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.

5.3.2.4 Choosing the correct 'carrier'

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.

In general:

- Only use herbicides that are registered for use on the specific species to be treated.
- 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 important to monitor the effect as one may need to re-apply.
- Carefully read and understand the instructions on the label prior to 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 work site 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 you use a funnel to avoid spilling. Should you spill the herbicide, 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 clearly 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.

5.3.3 Biological Control

IAPs thrive and spread in an exponential manner partly 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 sterilized. All of these outcomes will help to reduce rates of spread of the species.

Advantages	Disadvantages
Most environmentally friendly and most sustainable of all IAP 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.
	Biocontrol agents are not available for all target IAP species in the eThekwini Municipal Area

5.4 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 IAP 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 re-emergence 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 prior to IAP infestation still survive. So, 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 that IAP infestation has been in place, or if the soil has been disturbed so that the natural seed stocks are destroyed, planting/seeding is required. When planting for restoration purposes, it is not always easy to continue to access these areas to water/maintain the plants. It is thus important to use only plants that have been properly hardened off from the nursery production system to minimize the loss of plants. 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 a regular basis 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 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 in tact, 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.

If required, indigenous vegetation can be planted on the cleared areas. 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.

5.5 MONITORING

In order to assess the impact of the clearing activities, follow-ups and rehabilitation efforts, monitoring must be undertaken.

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

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

6. SAFETY STANDARDS & GUIDELINES

Safety is of the utmost importance when dealing with IAP control. Staff often work in remote areas and with potentially dangerous tools and chemicals. The proper safety training and equipment is required.

6.1 HERBICIDE SAFETY

The herbicide storeroom needs to comply with national Occupational Health and Safety standards, as well as the municipal Scheduled Trade and Occupational Bylaws. Section 'H' in the bylaw is triggered if there is "herbicide manufacture, and bulk blending, storage and commercial usage of herbicides". Contractors who trigger these requirements will therefore need to be in possession of a permit for these purposes and will need to produce evidence to the municipality that they have satisfied all the requirements of the bylaw (note that municipal staff managing clearing operations need to meet these requirements).

- A herbicide storeroom should have adequate ventilation, thus allowing fresh air to circulate within.
- Clean water needs to be available in close proximity to the storeroom.
- The floor must be non-porous. This is important so that when the floor is cleaned (which needs to be on a regular basis), no residue of herbicides remain. Place herbicide containers on wooden pallets to increase ventilation and make mopping up after spillages 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 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 bucket 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 may become contaminated.
- All empty herbicide containers, or herbicides that have reached their expiry date, need to be safely disposed of. This must 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.

6.2 PERSONAL PROTECTIVE EQUIPMENT

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

Table 1: PPE required for manual control:

Item	Specifications
Overall	100% Cotton, two-piece overalls are the best for absorbing perspiration; they last longer and are cooler. However, various cotton/polyester blends are available and suitable.
Rubber gloves	Standard rubber gloves for fieldwork are sufficient.
Leather gloves	Standard wrist length leather gloves are appropriate.
Safety boots	Investing in a good quality safety boot might save you in the long run. Gumboots or standard safety boots, which support the ankles, are acceptable. Steel toecaps are recommended for workers working with hand tools or with large trees.
Hat – (hardhat/ wide brim hat)	If working with large trees, on steep gradients or if any other safety risks may be present, then wearing a hardhat is advisable. Alternatively, 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.

Table 2: PPE required for mechanised control:

Item	Specifications
Chainsaw safety pants	Standard safety chainsaw and long pants that provide protection against the chainsaw.
Leather gloves	Standard wrist length, leather gloves.
Safety boots with steel cap	Steel toecaps are essential for safety of the workers. Safety boots, not gumboots, are to be worn as they provide support around the ankle.
Hardhat	A hardhat with a visor and earmuffs are necessary for all mechanised control.
Safety glasses	Chainsaw safety glasses provide total cover around the eye area, thus preventing wood chips, stones, etc. entering.
Raincoat	A standard two-piece raincoat. However, it is better not to use mechanised control when it is raining.

6.3 HEALTH AND SAFETY REPRESENTATIVES AND FIRST AIDERS

For every 20 people employed, one person needs to be trained as a first aider and a separate person as a health and safety representative. Appointments need to be made in writing and the person needs to clearly understand his/her responsibilities before signing. Persons appointed can be one of the workers, with these appointments bearing additional responsibilities. It is advisable to train an extra person as people can resign or be absent which leaves no first aider in field.

7. STELLENBOSCH MUNICIPALITY

7.1 CONTEXT

Stellenbosch Municipality forms part of the Cape Winelands District Municipality of the Western Cape Province of South Africa (refer to Figure 2). The Municipality adjoins the Cape Metropolitan Area to the west and the Breede Valley, Drakenstein and Theewaterskloof Municipalities to the east, south and north respectively.

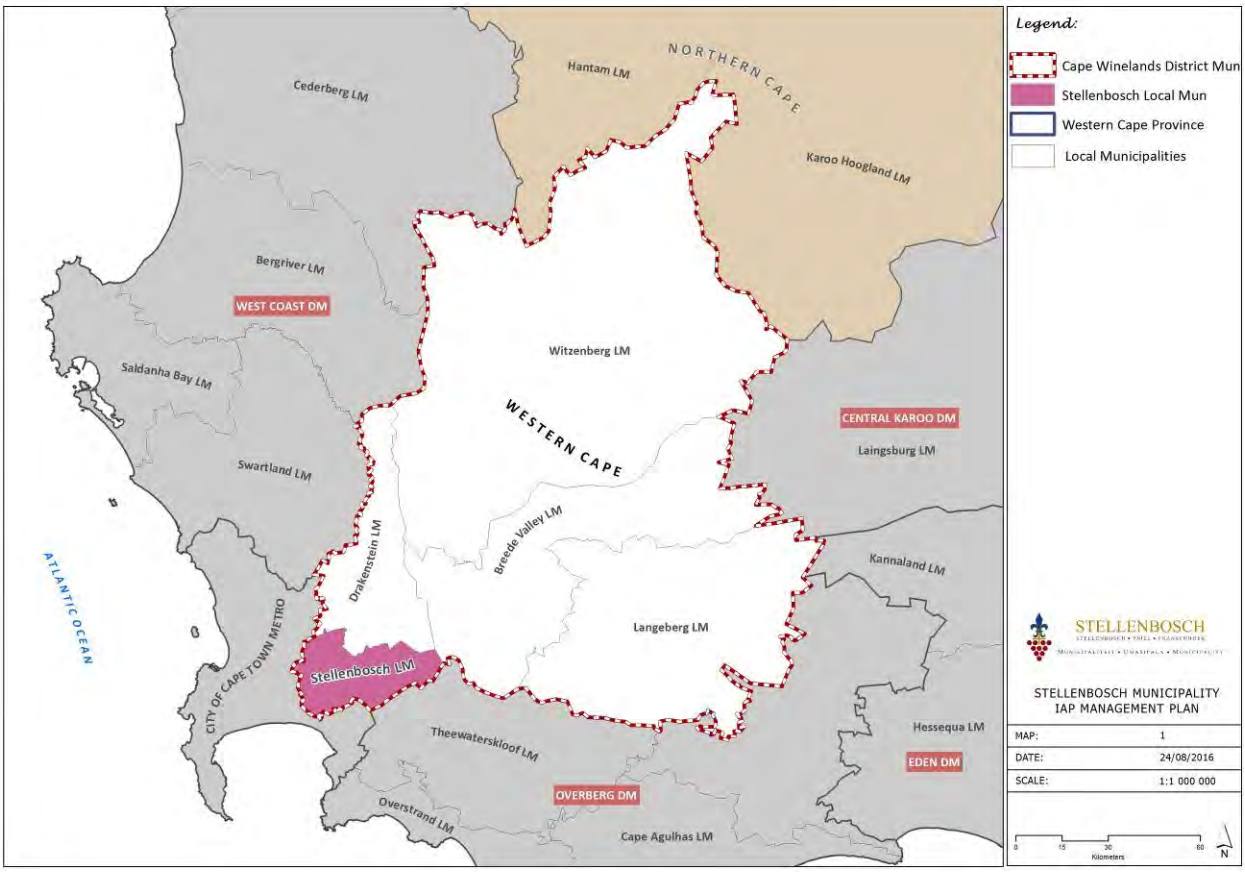

Figure 2: Location and context of Stellenbosch Municipality.

Stellenbosch Municipality is an amalgamation of the previous municipal areas of Stellenbosch, Franschhoek and Pniel as well as a major portion of the previous Winelands District Council's area of jurisdiction and constitutes a geographical area of approximately 830 km².

The Municipality is located in the heart of the Cape Winelands, which is dominated by agricultural land of his historic and aesthetic value, and globally-important natural habitats. The Municipality is bounded to the east and south by the Drakenstein, Wemmershoek and Limietberg mountain ranges. The Hottentots Holland range (i.e. Stellenbosch, Jonkershoek and Simonsberg Mountains) and the Bottelary Hills are in the immediate vicinity of the town of Stellenbosch.

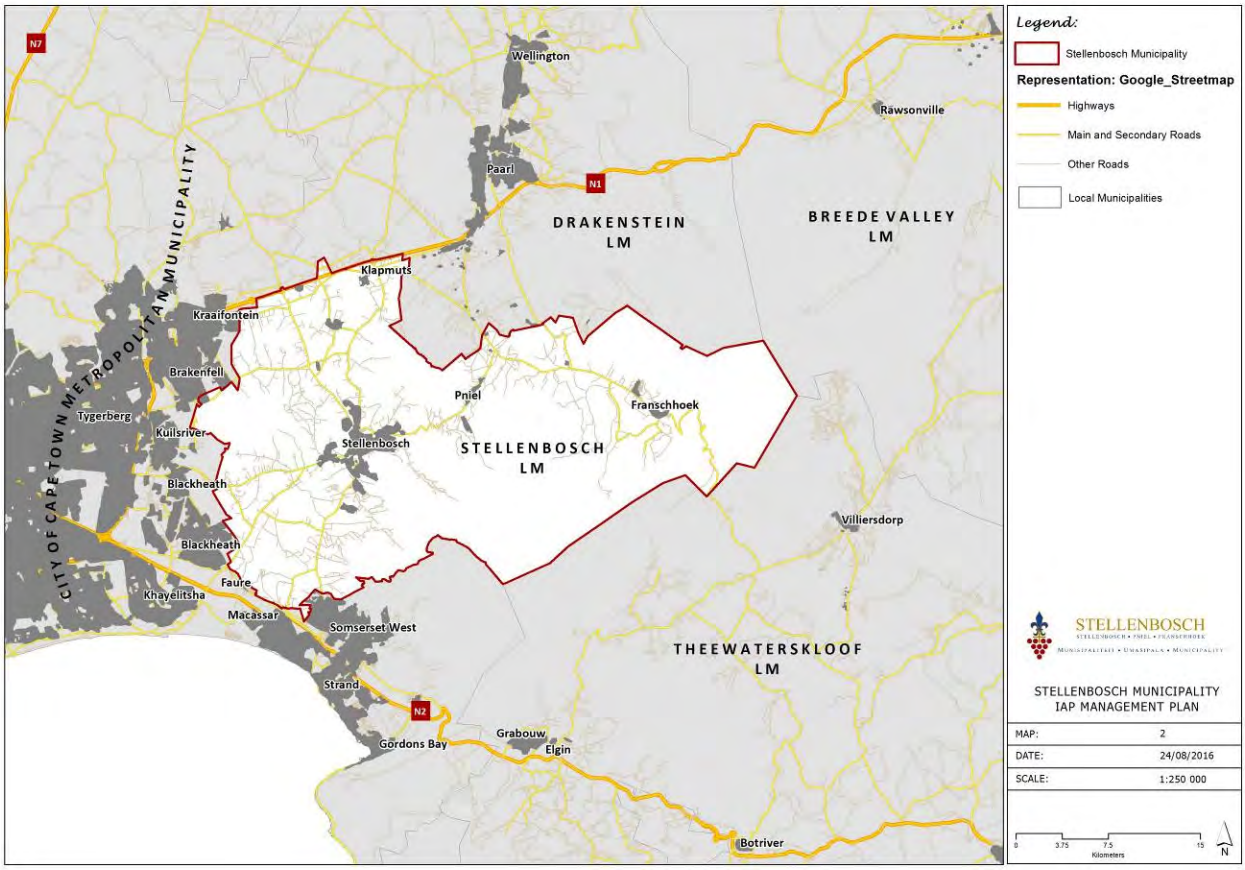

Figure 3: Local context of the Stellenbosch Municipality.

7.2 MUNICIPAL LAND FORMING PART OF THIS PLAN

Stellenbosch Municipality owns several properties with high conservation potential (Figure 4). These properties include:

- Papegaaiberg Nature Reserve
- Paradyskloof, including the areas of Stellenboschberg and Brandwacht
- Ida's Valley Dam Area
- Botmaskop
- Louwsbos Plantation
- Jonkershoek Picnic Site
- Culcattabos
- Jan Marais Park
- Mont Rochelle Nature Reserve
- Wemmershoek Wetland Area
- Purgatory Outspan

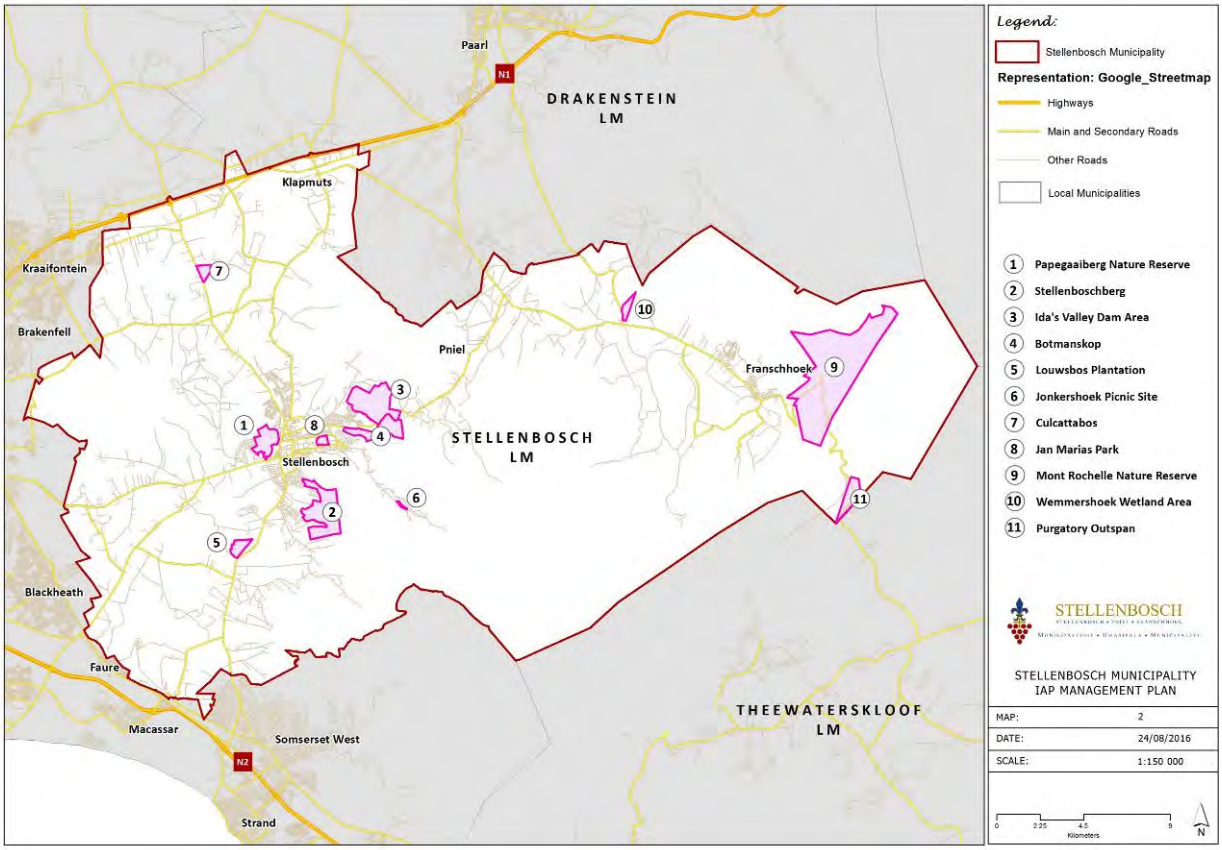

Figure 4: Stellenbosch Municipality properties that are the subject of this plan.

8. ALIEN INVASIVE PLANT SPECIES OF STELLENBOSCH MUNICIPALITY

There are several exotic plant species within the Stellenbosch region that has a negative effect on the indigenous fynbos biodiversity and ecosystems. The main invasive species are summarizes in the table below. Each species has individual as well as collective negative environmental impact which effects the health and stability of the indigenous ecosystems in which they are found. If controlling methods of these invasive species are not implemented, continues invasive effects within indigenous areas may cause a severe loss of biodiversity with severe consequences on ecosystem health and ecosystem services.

Table 3: Description and impact of AIP occurring in Stellenbosch Municipality (Bromilow, 2010 / Striton, 1978)

Species Name	Category	Description	Environmental Impact
Scientific: *Acacia implexa* **Common**: Screw-pod wattle, lightwood,	CARA Cat 1 NEMBA Cat 1a	Erect tree to 15m tall, single-stemmed or divided near ground level into 2 or 3 main stems. Leaves dark green, narrowly elliptic and sickle shaped, 7-20 cm long and 6-25 mm wide, much narrowed at the base. Bi-pinnate leaves may persist on young plants. Bark rough and greyish. Flowers arranged in globular heads, creamy to pale yellow, flowering from December to March. Pods narrow, coiled	• Fast growing • Invades agricultural lands, planted forests and disturbed areas • Can become

Species Name	Category	Description	Environmental Impact
Hickory wattle **Family**: Fabaceae		and twisted to 25 cm long, 4-7 mm wide. Seeds are dark brown, longitudinal, fleshy tissue growing from the point of attachment of a seed	highly invasive if not controlled
Scientific: *Acacia mearnsii* **Common**: Black Wattle **Family**: Fabaceae	CARA Cat 2 NEMBA Cat 2	An evergreen tree growing 5-10m high, black wattle has dark olive-green finely hairy leaves. Pale yellow or cream spherical flowers in large fragrant sprays blooming from August to September. Fruits are dark brown, finely haired pods. Black wattle has invaded grasslands, competing with and reducing indigenous species, and reducing grazing land for wild and domestic animals	• Decreases diversity of ground living invertebrates. • Decreases stream flow • Destabilizations of stream banks • Can increase erosion, but also used for land stabilization
Scientific: *Acacia melanoxylon* **Common**: Australian Blackwood **Family**: Fabaceae	CARA Cat 2	An erect, evergreen, unarmed tree from 10 to 35 m in height, with a clean bole and dance crown. The bark is rough, fibrous and usually light grey-brown. The slightly curved, 6-12 cm long phyllodes (flattened-leaf-stalk) have 3-7 prominent longitudinal veins. A few feathery compound leaves are often present at the apex of phyllodes. The flowers are creamy white occurring in rounded inflorescences and are produced at the ends of branches or in the axils of phyllodes. Flowering usually occurs from August to September. Seeds are small, black and surrounded by a dull reddish seed-stalk.	• Fast growth rate • Major invader of forests, fynbos shrubland and grasslands. • Transform native communities by replacing native non-tree vegetation
Scientific: *Acacia pygnantha* **Common**: Golden Wattle **Family**: Fabaceae	CARA Cat 1 NEMBA Cat 1b	Slender, evergreen tree 4-8m high with drooping branches and dull green, leathery, distinctly curved leaves. Bright yellow, spherical flower heads in large sprays from August to September. Brown and almost straight pods.	• Competes with and replaces indigenous species • Invades coastal and mountain fynbos, rivers and roadsides
Scientific: *Acacia saligna* **Common**: Port Jackson **Family**: Fabaceae	CARA Cat 2 NEMBA Cat 1b	An evergreen tree, growing 3-7m high, with blue-green turning bright green leaves. Bright yellow, globe-shaped flowers bloom from August to November. Brown pods with hardened, whitish margins.	• Increases the biomass • Increases litter fall • Changes nutrient chemistry in lowland fynbos. • Changes seed dispersal dynamics • Increases the

Species Name	Category	Description	Environmental Impact
			biomass • Changes size and distribution of fuel • Decreases moisture content resulting in change in fire regime • Attrition of seed banks of native plants in dense stands over time
Scientific: *Eucalyptus grandis* **Common**: Saligna gum **Family**: Myrtaceae	CARA Cat 2	A tall, evergreen tree with a shaft-like trunk 25-55m high with smooth bark except for the part of the trunk up to 4m from the ground. The bark peels in long, thin strips to expose a powdery, white, grey-white or blue-grey surface. Dark green leaves which are glossy above and paler below. Cream flowers appear from April to August. Brown fruit capsules with a bluish-grey powdery surface. This tree invades forest clearings, plantations, watercourses and roadsides.	• Reduces stream flow • Affects soil erosion to a variable degree • Competes with and replaces indigenous species
Scientific: *Paraserianthus lophantha* **Common**: Stink Bean **Family**: Fabaceae	CARA Cat 1 NEMBA Cat 1b	A fine bi-pinnate leaved evergreen shrub or tree growing 4-6m high, somewhat resembles the large-leafed black wattle (*Acacia mearnsii).* The dark green leaves are paler below, up to 300 mm or longer and golden-hairy. Cream-coloured flowers appear in dense, bottlebrush-like heads from June-August followed by brown compressed seedpods with raised edges. The seeds emit a nauseating odour when crushed and this tree is poisonous. It invades forest margins, riverbanks, moist slopes in fynbos and wooded kloofs.	• Competes with and replaces indigenous species • Reduce stream flow
Scientific: *Pinus pinea* **Common**: Umbrella Pine, Stone Pine **Family**: Pinaceae	NEMBA Cat 3	A coniferous tree 12-30m high, forming an umbrella-shaped crown with dense foliage at maturity. The trunk is straight, often forking with reddish-brown bark and deeply cracked into plates. Light green leaf needles in bundles of two. Nut-brown, woody cones 10-15cm long. It invades grasslands and mountain fynbos.	• Out-competes native trees • Dense stands limit options for fire management • Decreases stream flow
Scientific: *Pinus pinaster* **Common**: Cluster Pine **Family**: Pinaceae	CARA Cat 2 NEMBA Cat 2	A coniferous tree 8-15m high, conical when young, becoming cylindrical with a tall, bare trunk when older. Reddish-brown bark, which is deeply cracked into plates. Dull grey-green leaf needles in bundles of two. Cones initially purple, turning light brown 9-18cm long. This pine invades mountains and lowland fynbos.	• Out-competes and replaces indigenous trees • Dense stands limit options for fire management

Species Name	Category	Description	Environmental Impact
			• Decreases stream flow • Reduces grazing
Scientific: *Pittosprum undulatum* **Common**: Australian chessewood **Family**: Pittosporaceae	CARA Cat 1 NEMBA Cat 1b	Evergreen shrub or broadly conical tree up to 12m high. Dark green, shiny leavers tapering at both ends and usually wavy margins at the end of the branches. Fragrant white flowers in terminal clusters from August to September. Showy, orange turning brown capsules.	• Competes with and replaces indigenous species • Indigenous birds might neglect the dispersal of indigenous plants due to their preference for the fruits of this alien species.
Scientific: *Populus canescens* **Common**: Gray Poplar **Family**: Salicaceae	CARA Cat 2 NEMBA Cat 2	It is a medium-sized deciduous tree, growing to heights of up to 16-27 m (rarely more), with a trunk up to 2 m diameter and a broad rounded crown. The bark is smooth and greenish-white to greyish-white. The leaves are 4-15 cm long, five-lobed, with a thick covering of white scurfy down on both sides but thicker underneath. The flowers are catkins up to 8 cm long, produced in early spring. The female catkins lengthen to 8–10 cm after pollination, with several green seed capsules, maturing in late spring to early summer. It also propagates by means of root suckers growing from the lateral roots, often as far as 20-30 m from the trunk, to form extensive clonal colonies	• Form dense and uniform stands along riverbanks and in vleis. • Can spread into surrounding veld
Scientific: *Robinia pseudoacacia* **Common**: Black Locust **Family**: Fabaceae	CARA Cat 2 NEMBA Cat 1b	A deciduous tree up to 12m high, exceptionally 25m, with an oval or rounded crown and bark that is dark brown and deeply furrowed. It suckers freely and often forms thickets. Young stems and branchlets have short spines. Small, bright green leaves above and paler beneath which become yellow in autumn. White, fragrant flowers in drooping spray from September to November. Reddish-brown pods. The seeds, leaves and inner bark are poisonous seeds.	• Competes with and replaces indigenous species • Dense stands can cover vast areas • Can reduces and restrict water access to animals • Poisonous to human and domestic livestock

Species Name	Category	Description	Environmental Impact
Scientific: *Rubus fruticosus* **Common**: European Blackberry **Family**: Rosaceae	CARA Cat 2 NEMBA Cat 2	Thorny shrub to 2m high with strongly arching stems that root at the growing point of the shoot. Green leaves, sometimes grey-downy beneath. White or pink flowers with petals that is much longer than the sepals, appearing from September to January. The flowerheads are prickly. The edible fruits are red turning black.	• Hybridizes with native *Rubus* species • Competes with and replaces indigenous woody and grassland species • Dense stands are impenetrable and restrict access to forestry plantations • Restrict access to grazing and water by domestic and wild animals

Table 4: Summary of the invasive alien plant species within the relevant sites of Stellenbosch Municipality

Species	Louwsbos Plantation	Stellenbosch-berg	Jonkershoek Picnic Site	Papegaaiberg NR	Jan Marais * NR	Botmaskop	Ida's Valley Dam Area	Mont Rochelle NR	Culcattabos	Wemmersh.	Purgatory
Acacia implexa		X		X		X	X				
Acacia mearnsii		X	X			X	X	X	X		X
Acacia melanoxylon		X				X	X	X			
Acacia pygnantha		X				X	X				
Acacia saligna	X		X	X			X		X		X
Eucalyptus globulus		X		X		X	X	X			
Paraserianthus lophantha			X								
Pinus pinea	X	X	X	X		X	X	X		X	

Pittosprum undulatum			X								
Populus canescens			X								X
Robinia pseudoacacia			X								
Rubus fruticosus			X								

* There are no invasive alien plants within Jan Marais Nature Reserve, with exception of several old Eucalyptus and *Pinus pinaster* trees.

9. MANAGING ALIEN INVASIVE PLANT SPECIES IN STELLENBOSCH MUNICIPALITIE

There have been many attempts to control the spread of invasive alien plant species since the 1940's, though success has been diminutive due to the easily spreading nature of these species. More recently studies have been researching the spread and effects of invasive species, though up until 1985 little has been written on the controlling aspects[10]. During more recent years many studies have been focused on prioritizing invasive species for their control and management[11].

Many management plans are at fault due to their focus on reducing the density of invasive species rather than the causing disturbance that leads to their establishment[12]. By only focussing on reducing the density of invasion species, and not the underlying causing disturbance, many of these plans lead to the control and management of one species, only to have another establish in the disturbed area[13]. Managing invasive species should thus firstly focus on managing for the ecosystem and the disturbance that caused their establishment in order to prevent further establishment of invasive species. Managing for the disturbance to ensure an increased ecologically and environmentally aware management plan should include ecosystem management, integrated environmental management and watershed management[14]. Though the general aim for invasive alien plant management is to clear and manage area by area, certain factors (such as the species present, terrain, availability of resources) may cause controlling efforts to be limiting and thus lead to an attempt for species controlling instead. An integrated controlling strategy is therefor required. An integrated controlling strategy involves the integration of control for management area ("block") in which more than one alien species may be encountered and the integration of mechanical, chemical and biological control of a given species.

10 Macdonals *et al*. 1985
11 Van Wilgen *et al*. 2007; van Wilgen *et al*. 2012
12 Edwards, 1998
13 Edward 1998; Allen and Starr, 1982; Allen and Hoekastra, 1992; Denny, 1992.
14 Edward 1998; Margerum and Born, 1995

9.1 ALIEN INVASIVE PLANTS IN STELLENBOSCH MUNICIPALITY

The following sections were taken directly from the Management Plan for Alien Invasive Plants on Municipal Land in Stellenbosch Municipality[15]. This work is regarded as still being relevant at the time of the compilation of this plan. Actual implementation, however, will require verification and the degree of representation thereof as part of the planning of operations as described in Section 5-5.1 above.

In the Management Plan for Alien Invasive Plants on Municipal Land in Stellenbosch Municipality[16] a general ecological description along with the current alien infestation was compiled for each site listed in Section 7.2 above. This was done to determine the best control strategy for the removal of invasive alien plants within each site.

The methodology for estimating the density of invasive alien plant infestation within each site included informal interviews with individuals from the municipal staff, a review of all invasions alien plant related municipal documents and site visits. Informal interviews, as well as all documents relating to alien invasive plants generated by the Municipality, was gathered to determine the current extent of the knowledge on the current invasive alien infestation within the sites, including what measures has been taken to address the infestation. Site visits were further conducted to estimate the current invasive alien infestation within the sites using the standard manual for determining invasive alien plant densities generated by David Le Maitre and Dirk Versfeld[17] (1994). Within each site the densities of each invasive alien plant species was determined (see Table 5)[18] and recorded onto a generated map of each site. The table below has been simplified and the densities rounded off to facilitate mapping and classification. The table can also be used to convert between the different density measures e.g. from plants per ha and canopy diameter to density per ha.

Table 5: Guideline density conservation table for use in mapping aliens by species and size class.

	Size class	**Tall shrubs**	**Medium trees**	**Tall trees**
Rare				
Individuals are known o occur in the area, but are few and far between				
Occasional (>10 canopy diameters apart; <2% cover)				
Density (plant/ha)	Seedlings	<1100	<400	<400
	Young	<100	<40	<25
	adult	<40	<25	<10
Very scattered (6-10 canopy diameters apart; 2-3% cover)				
Density (plant/ha)	Seedlings	<3000	<1000	<1000
	Young	<250	<120	<75
	adult	<120	<75	<30
Scattered (3-6 canopy diameters apart; 3-5% cover)				
Density	Seedlings	<10000	<3600	<3600

[15] Lizelle Koen, 2013
[16] Lizelle Koen, 2013
[17] Le Maitre and Versfeld, 1994
[18] Le Maitre and Versfeld, 1994

(plant/ha)	Young	<900	<400	<220
	adult	<250	<150	<100
Medium (1-3 canopy diameters apart; 5-25% cover)				
Density (plant/ha)	Seedlings	1000-55000	3600-20000	3600-20000
	Young	900-5000	400-2100	220-1200
	adult	250-2200	150-1200	100-500
Dense (0.1-1 canopy diameters apart; 25-27%)				
Density (plant/ha)	Seedlings	55-350000	20-120000	20-120000
	Young	5000-30000	2200-14000	1200-7600
	adult	2200-14000	1200-7600	500-2000
Closed (<0.2 diameters apart; 75% cover)				
Density (plant/ha)	Seedlings	>3500000	>120000	>120000
	Young	>30000	>14000	>7600
	adult	>14000	>7600	>2000

For riparian strips: 10m wide = 0.1 ha per 100 m, 20 m wide = 0.1 ha per 50 m

9.2 PRIORITIZING SITES FOR CLEARING STRATEGIES

The limitations of financial and labour resources prevent the simultaneous implementation of integrated controlling strategies within all invaded areas. Prioritizing of areas and invasive alien species is an important process when planning controlling strategies[19]. The following factors should be recognized when prioritizing areas and invasive alien species for the implementation of integrated controlling strategies:

- units should be assigned to priorities per management unit;
- sometimes it is advisable to await the development of biological control techniques;
- it is necessary to assess the potential for maintain control of priority areas;
- the constraints implicit n habitat conservation imperatives conservation should be considered;
- the relative cost effectiveness of embarking on a control programme should be considered;
- the role of visitor perception of the alien problem should be considered;
- the effect of alien plant species on water yield should be given primary consideration;
- identification of the source of invasion is of primary importance, as any control programme which is initiated should attack the source of invasion. Both internal and external sources and patterns of invasion should be identified.

Le Maitre *et al*. (2002) also added that areas with high recreation value, indigenous biodiversity, low-density invasion (cover of less than 25%) and recent fire occurrence should have a high priority allocation. He also suggested that the identification of invasive alien species present is not as important as environmental characteristics of the area in which the site occurs. Another factor, which is important to consider, is that of potential water release from removing invasive alien species. This is especially important within areas such as Stellenbosch where water availability becomes scarce during dryer seasons.

[19] Macdonald *et al*. 1985

According to the above factors, the relevant municipal properties are prioritized as follows (Culcattabos, Wemmershoek Wetland and Purgatory were added to the following prioritization done by Koen, 2013):

1. Papegaaiberg: Papegaaiberg Nature Reserve contains a highly endangered vegetation type namely Renosterveld. Removing invasive alien plants will decrease its threat of biodiversity loss.
2. Brandwacht: Brandwacht is one of the few sites still having high indigenous biodiversity and protective measures to prevent any threat of loss, such as invasive alien plants, should be reduced.
3. Stellenboschberg: Though this site is transformed, resent clearing efforts has led to disturbed areas which need to be continuously monitored and cleared to prevent the establishment of new populations which may be more difficult to clear in the future. Recreation value of the site is high due to its close proximity to residential areas.
4. Paradyskloof: Paradyskloof has high indigenous biodiversity that is currently under threat by invasive alien plants. The clearing of invasive alien plants may aid in the prevention of biodiversity loss. The area is also in close proximity to a residential area and have a high recreational value.
5. Ida's Valley Dam: The Ida's Valley Dam Area has a high water supply value and the removal of the invasive alien plants may aid in the increase of water availability during drier periods.
6. Botmaskop: Botmaskop is divided into two sites. One has high recreational value, although it has been transformed for plantation purposes and the second high biodiversity potential.
7. Louwsbos Plantation: Louwsbos Plantation is relatively small in comparison with the other properties. The property's vegetation has been completely transformed and rehabilitation of the site will be necessary to re-establish indigenous biodiversity.
8. Jonkershoek Picnic Site: This site is a relatively small area along the upper reach of the Eerste River. The large invasive trees provide aesthetic value to visitors. Selective clearing along the whole of the Eerste River may increase water supply.
9. Culcattabos: Culcattabos, on the R304 to the north of Stellenbosch town is heavily invaded with Eucalyptus grobulus.

Both Jan Marais Nature Reserve and Mont Rochelle Nature Reserve, as well as the Wemmershoek Wetland Area and Purgatory Outspan, were regarded as cleared of alien invasive species and were not included within the prioritizing list.

10. MANAGING ALIEN INVASIVE PLANT SPECIES ON A SITE SPECIFIC SCALE

10.1 PAPEGAAIBERG NATURE RESERVE

10.1.1 Location

Papegaaiberg is located within the town of Stellenbosch (refer to Figure 5). Papegaaiberg Nature Reserve is bordered in the west by the Onder-Papegaaiberg residential area and the farm Middelvlei. Kayamandi forms the northern boundary while the industrial areas of Plankenbrug and Papegaaiberg, Distell cellars, the Bergkelder, Bosman's Crossing and Oudemolen collectively form the eastern boundary of the nature reserve. The Stellenbosch cemetery and Oude Libertas form the southern boundary.

Papegaaiberg is approximately 140ha in size and rises gradually from all sides towards its highest point of approximately 159m relatively the centre of Papegaaiberg. The area has recently been declared a nature reserve in terms of Section 23 of the National Environmental Management: Protected Areas Act, 57 of 2003.

10.1.2 Soil

The soil of Papegaaiberg is well-drained dark alluvial to clay soils with a low to medium base status.

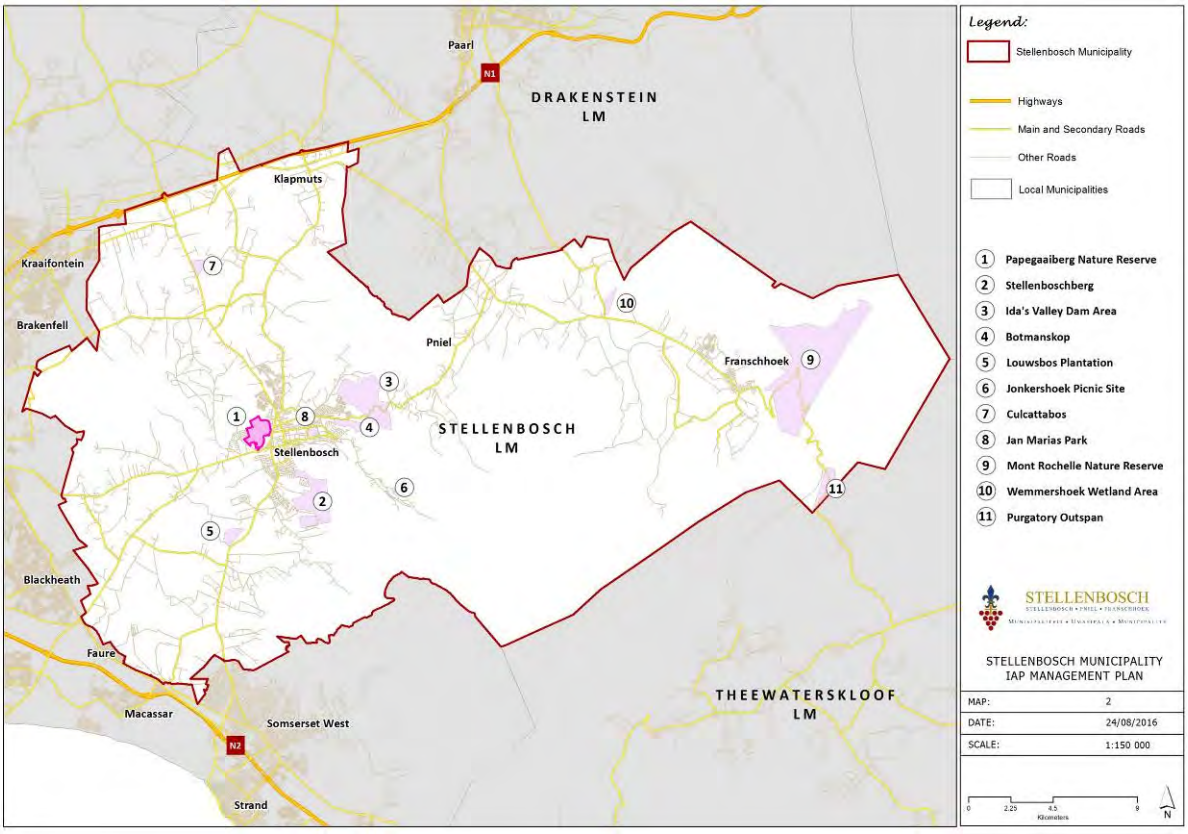

Figure 5: Papegaaiberg Nature Reserve.

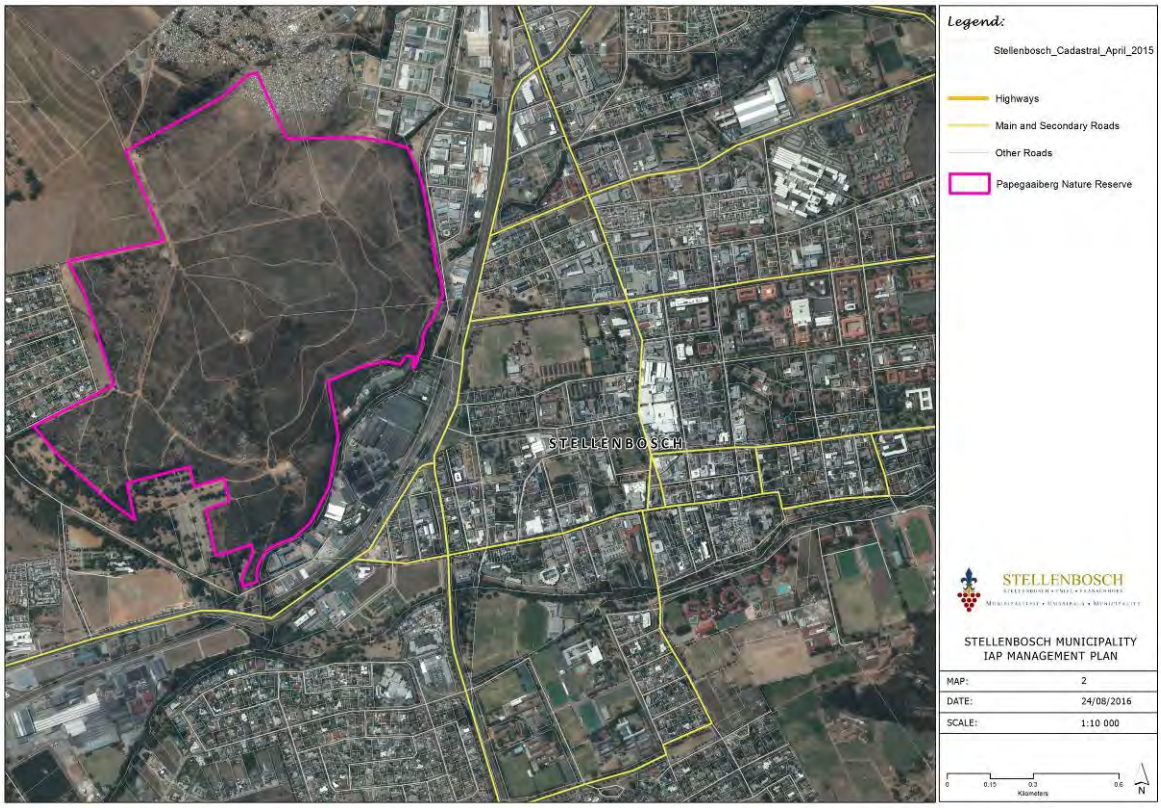

Figure 6: Local context of Papegaaiberg Nature Reserve.

10.1.3 Hydrology

Papegaaiberg forms part of quarternary catchment[20] No. G22G and G22H. There are two rivers that flow adjacent to the foot of Papegaaiberg, namely Krom River and Plankenbrug River. The Plankenbrug River joins the Eerste River south of Papegaaiberg.

10.1.4 Vegetation

Remnants of almost extinct Renosterveld vegetation types, Swartland Shale Renosterveld and Swartland Granite Renosterveld, are found on Papegaaiberg, making it significantly important in terms of its conservation status. Both Swartland Shale Renosterveld and Swartland Granite Renosterveld are critically endangered vegetation types[21]. It has been estimated that as little as 10% of the area in which Swartland Renosterveld occurs is left undisturbed or intact. This is mainly due to its high fertility quality that it has been transformed for agricultural reasons. The remaining remnants are found in isolated areas such as Papegaaiberg, which is usually on steeper or elevated areas. Only approximately 20% of the areas where Swartland Granite Renosterveld occurs remain left. These areas were transformed mostly for agricultural reasons and urbanization.

20 Catchment (or catchment area) is defined as the entire land area from which water flows into a river; catchments can be divided into smaller 'sub-catchments' which are usually the area which drains a tributary to the main river or a part of the main river.

21 Dennis Moss Partners, 2011

10.1.5 Current Alien Invasive Plant Infestation

The major invasive alien plants located on Papegaaiberg include *Acacia saligna, Acacia mearnsii*, *Pinus pinea* and *Eucalyptus grobulus*. Of these *Acacia saligna* and *Acacia mearnsii* has the highest densities (Figure 7). Though invasion density on Papegaaiberg is less than 50%, there is a high invasion density at the foot of the mountain.

The western slope of Papegaaiberg is highly infested by both *Acacia saligna* and *Acacia mearsnii* (Figure 8 and 9). This may be due to the occerance of fire several years prior to the survey. The lack of follow-up removal strategies has led to the establishment of both species within the disturbed area, which are able to out-competing native species for the natural and spatial resources. Though infestation increases up the slope of Papegaaiberg *A. saligna* densities are still relatively high in comparison with the other invasive species. *A. mearnsii* and *Eucalyptus grobulus* (Figure 10) densities decrease up the slope of the mountain.

Eucalyptus grobulus is mostly contained along the southern slope, though several individuals are found on the northern slope. *E. grobulus* also occurs on the recently burnt western slope, though the higher growth rate of *Acacia saligna* and *Acacia mearnsii* most likely enabled these species to outcompete both *E. grobulus* and *Pinus pinea* (Figure 11) for nutrient and spatial resources. *P. pinea* densities are relatively low, with exception to several large pine trees located along the foot of Papegaaiberg.

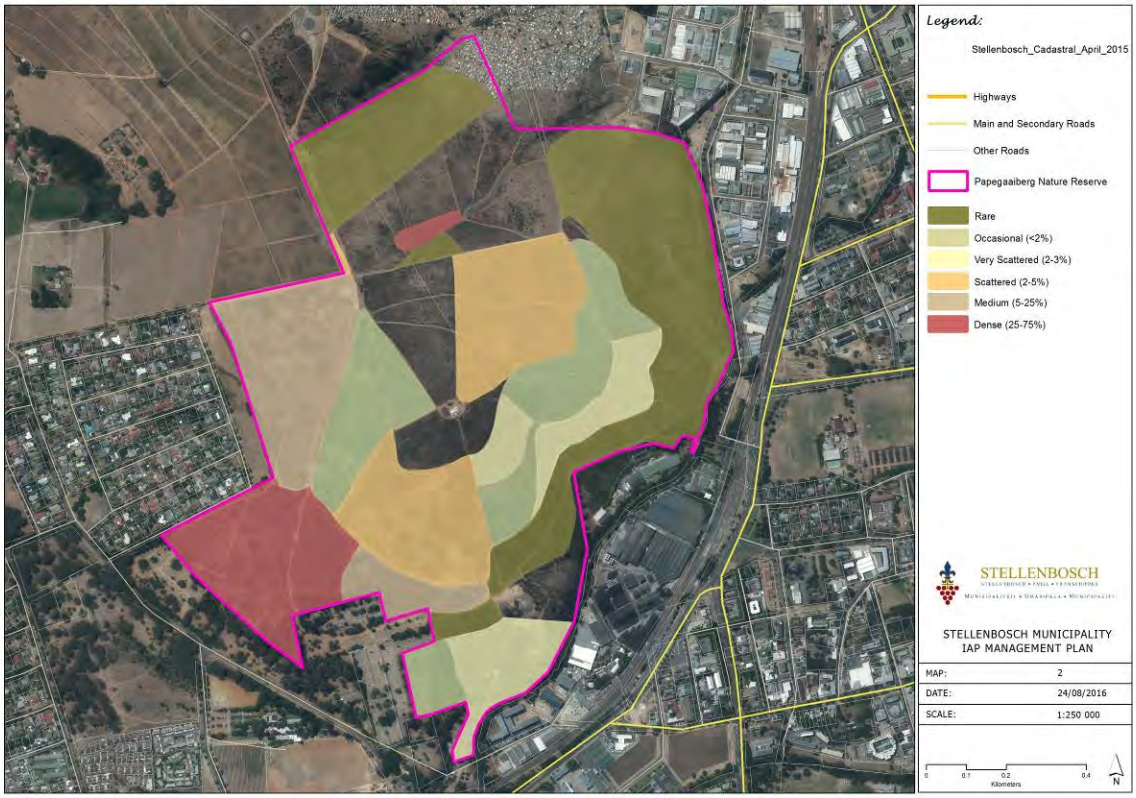

Figure 7: Alien invasive plant density (%) on Papegaaiberg Nature Reserve.

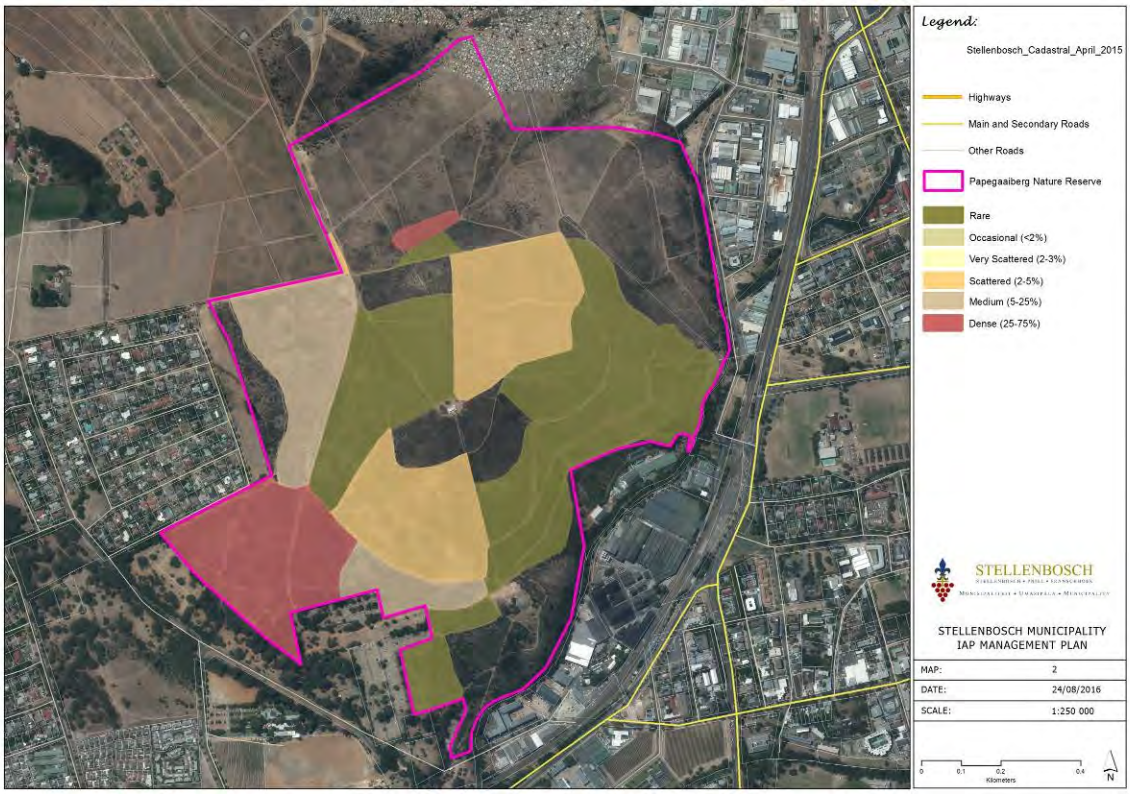

Figure 8: Acacia saligna density (%) on Papegaaiberg Nature Reserve.

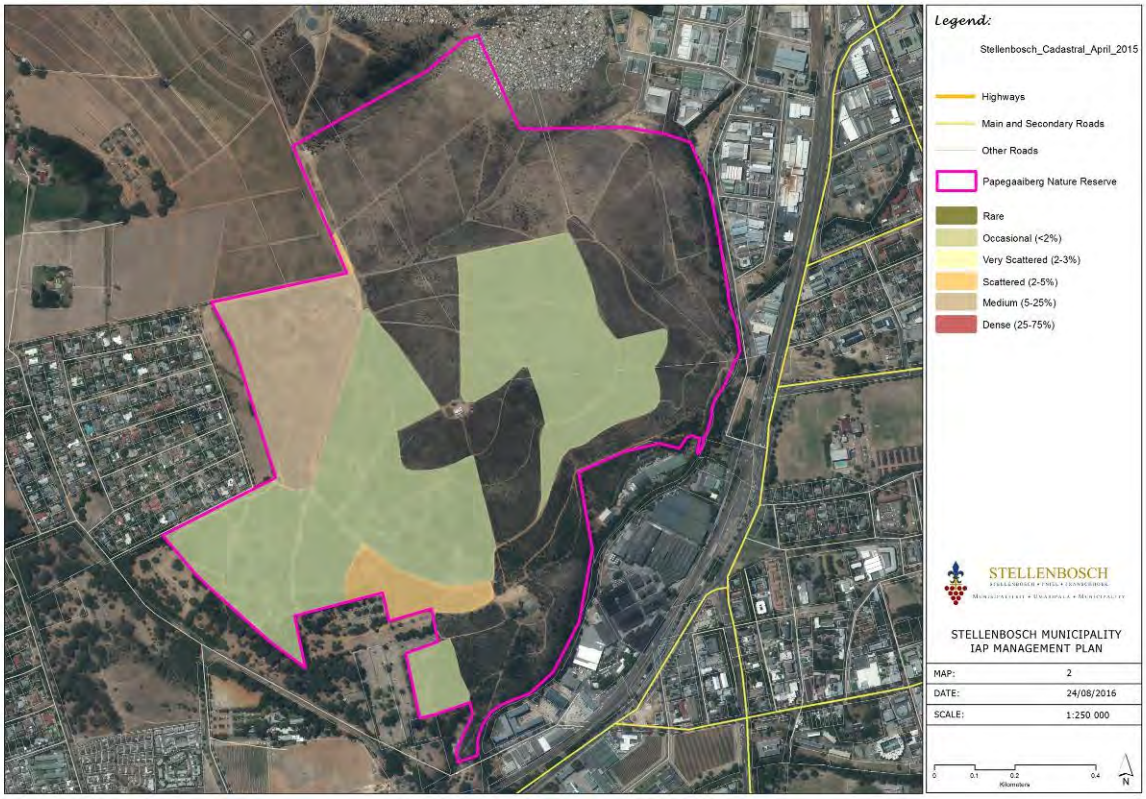

Figure 9: Acacia mearnii density (%) on Papegaaiberg Nature Reserve.

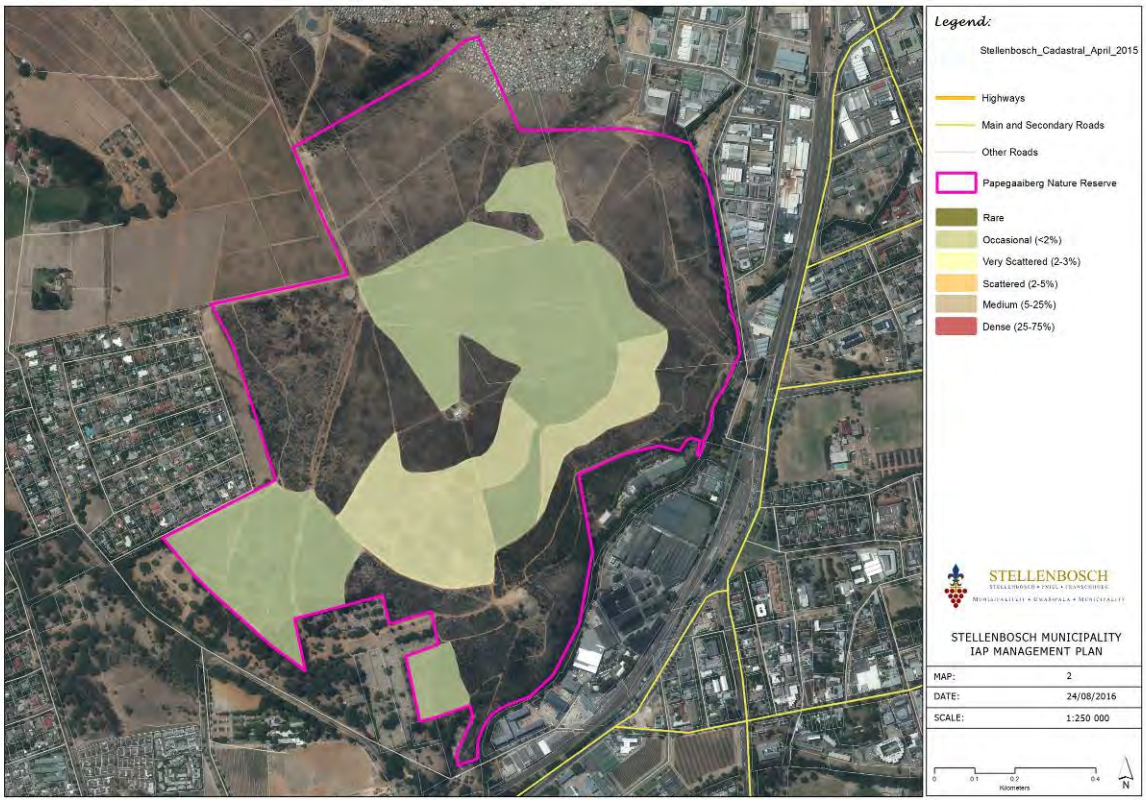

Figure 10: Eucalyptus grobulus density (%) on Papegaaiberg Nature Reserve.

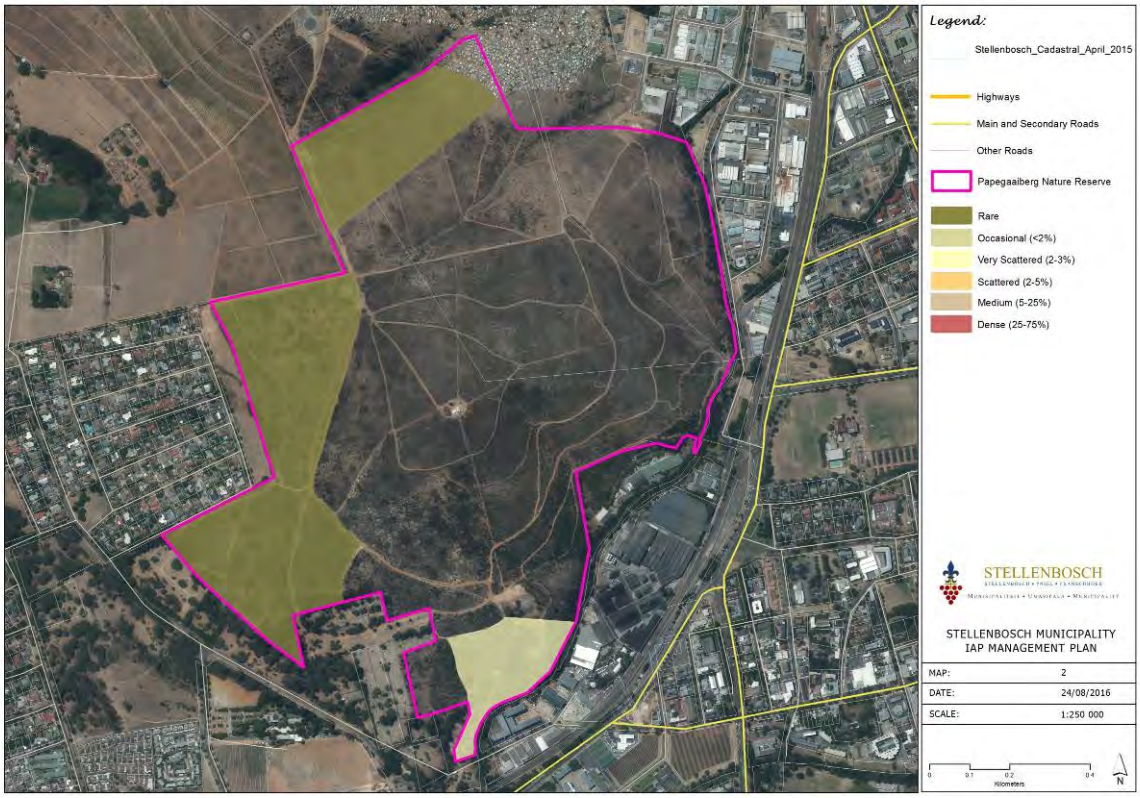

Figure 11: Pinus pinea density (%) on Papegaaiberg Nature Reserve.

10.1.6 Clearing Methods

The high conservation significance of the Renosterveld on Papegaaiberg makes the removal of invasive alien plant species a high priority. A comprehensive management strategy needs to be followed to ensure successful clearing of invasive alien species. Such a management strategy includes initial clearing methods with several follow-up and monitoring efforts to ensure successful clearing of invasive alien plants. When clearing an area that occurs on a slope, clearing strategies should initiate at the top of the slope and continue downwards. This strategy will reduce erosion effect as well as minimize the re-establishment process of invasive alien plants within the cleared areas from overhead populations. Large tree trunks should be strategically placed to reduce soil erosion on slopes after invasive alien clearing.

Strategies for clearing alien invasive species should be a combination of mechanical and chemical methods (Table 7, Section 11). All species should be removed mechanically by uprooting young plants and tree felling of larger trees (via axe or chainsaw), followed by the application of chemical herbicides to the cut surface to prevent resprouting. Each species has its own corresponding herbicide requirements to prevent resprouting activities and should be applied soon after tree felling (see Table 7, Section 11). The use of herbicides may have negative effects on the health of soil composition and the natural ecosystem and should thus be used with caution and in reasonable amounts. Continuous follow-up and removal of new seedlings after the initial clearing efforts are essential in order to clear the property of invasive alien plants. Follow ups and monitoring should occur annually and remaining or re-established invasive species should be removed when located.

10.1.7 Zonation as an aid to the management of invasive alien plant species

A zonation map (Figure 12) was constructed as an aid for clearing alien invasive plants on Papegaaiberg. Roads on the property were used for zone boundaries. The property is divided into 5 large zones (A-E) and divided into smaller zones to assit clearing strategies.

To prevent spread of alien invasive plants down the slope into cleared areas during clearing, clearing should start at the summit of Papegaaiberg, which is also the centre of the site, marked as A1-A5. When zones A1-A5 are cleared, continue downward to zones B1-B5, followed by zones C1-C5. Zones E1-E3 should be cleared last.

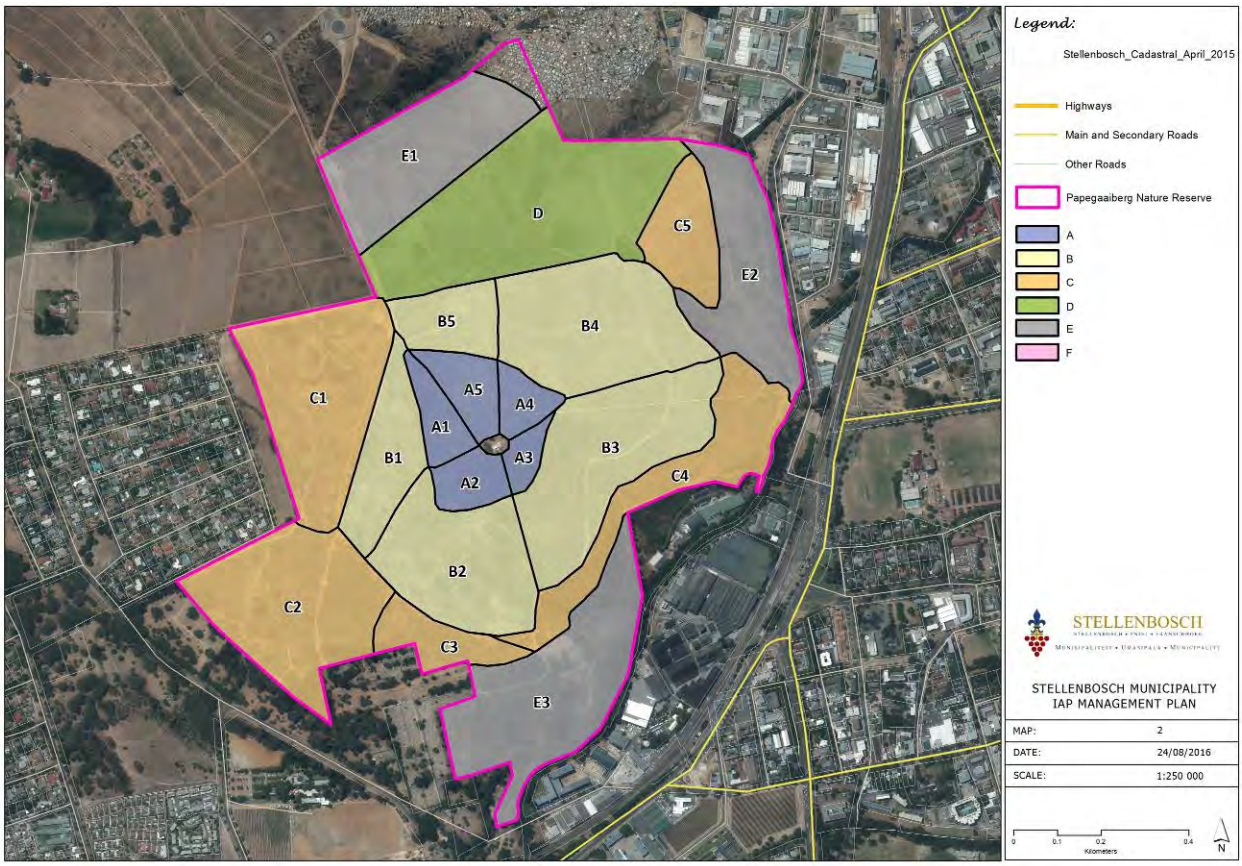

Figure 12: Zonation of Papegaaiberg as an aid for alien invasive plant clearing

10.2 STELLENBOSCHBERG (including the areas of Paradyskloof and Brandwacht)

10.2.1 Location

The area is located in the town of Stellenbosch, along the western slope of the Stellenbosch Mountain range (Figure 13 & 14). Brandwacht is bordered on its northern boundary by farms, while the western boundary is bordered by the Krigevile and Brandwacht residential areas. The southern boundary of Brandwacht is adjacent to the Stellenboschberg site, which is bordered by farmland and the Paradyskloof residential area on the western boundary. The southern boundary of Stellenbosch site is adjacent with the Paradyskloof site, which is bordered by farmland on the western and southern borders.

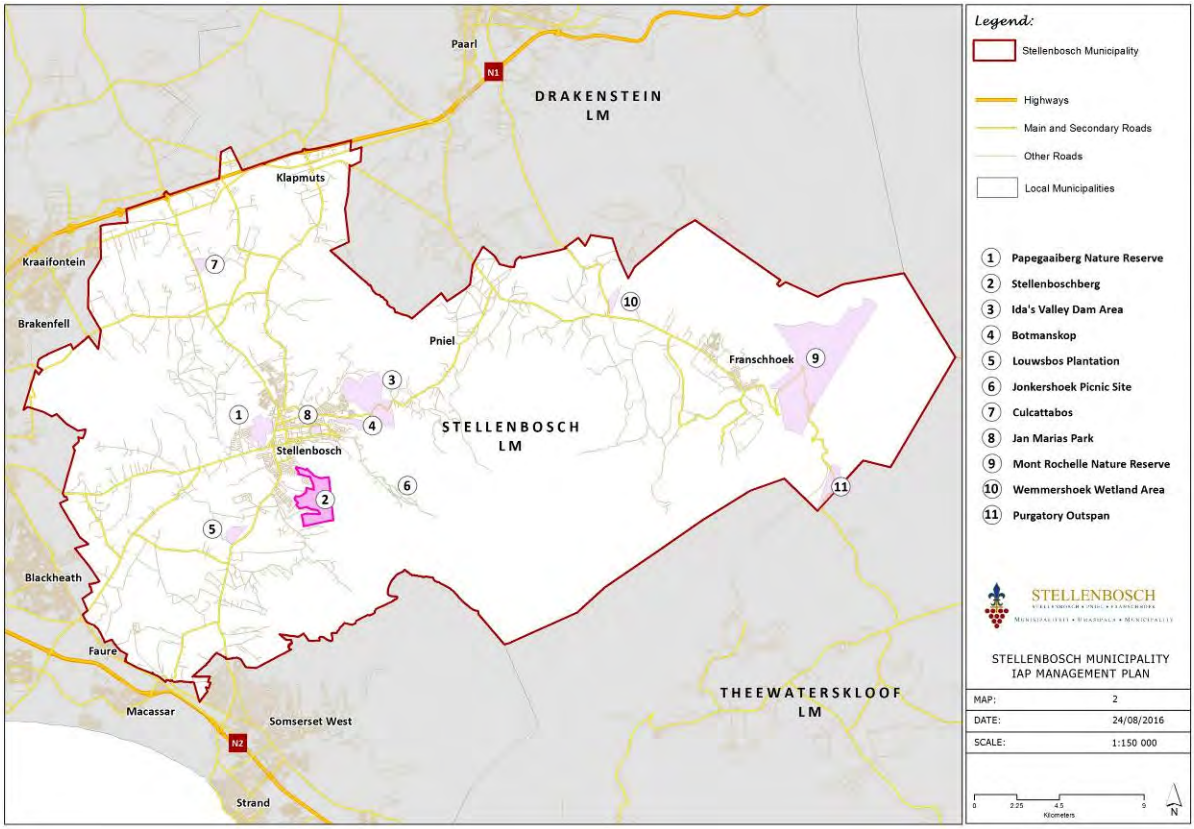

Figure 13: Stellenboschberg.

10.2.2 Soil

The soil of the property is red and a yellow soil which is freely drained, structure-less and has a low to medium base status.

10.2.3 Hydrology

The sites borders the Hottentots-Holland mountain catchment area, which is a quaternary catchment and play an important role in the water resources of the broader area.

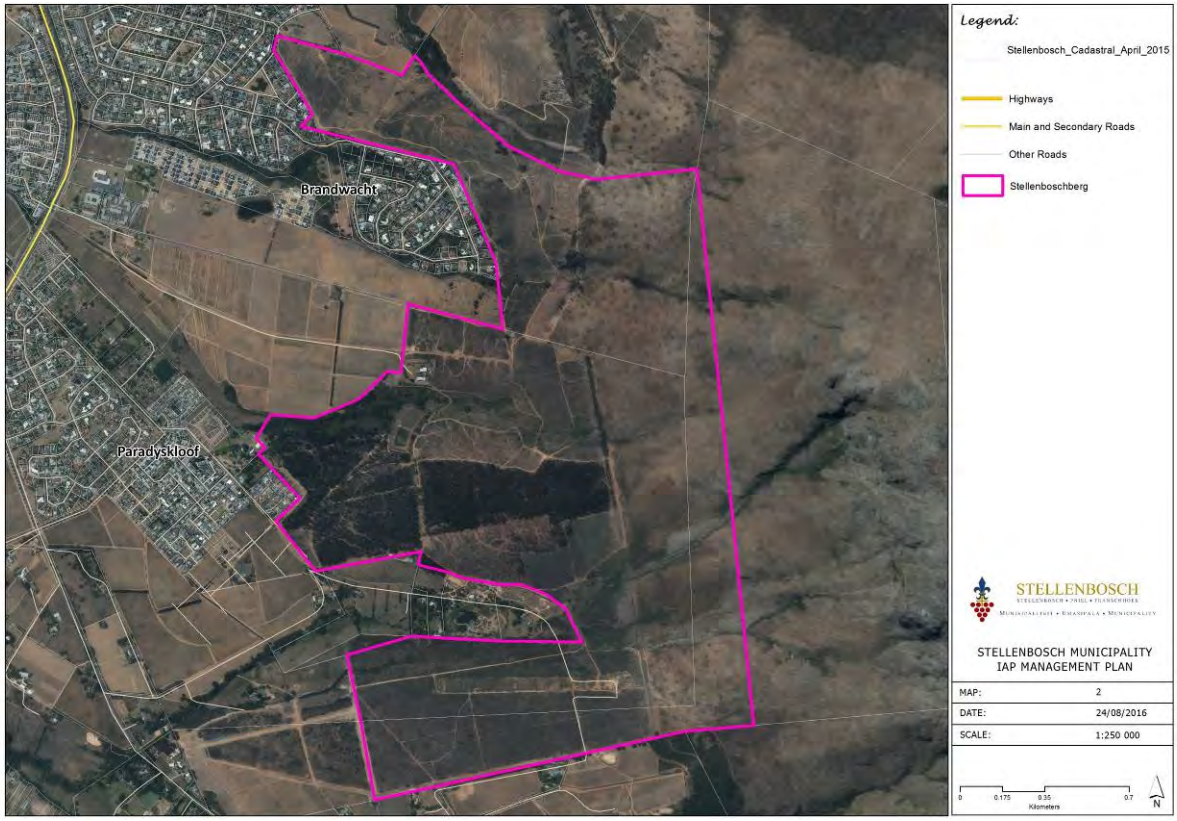

Figure 14: Local context of Stellenboschberg.

10.2.4 Vegetation

The vegetation type of Paradyskloof is Cape Wineland Shale fynbos and is a vulnerable terrestrial ecosystem. Cape Wineland Shale Fynbos soil is naturally poor in nutrients, moist and is slightly acidic. Mostly found in lower mountain slopes and high, rolling plains in the Western Cape, the biodiversity of the Cape Wineland Shale Fynbos is, however, incredibly high. The Cape Wineland Shale Fynbos comprises of a diversity of protea, erica, geophyte and daisy species as well as some endemic species. The vegetation type is of conservation significance because of its high vulnerability state due to its location on lower slopes, which are mostly used for agricultural and urban development. Of the 54% remaining natural areas only 25% are formally protected.

10.2.5 Current Alien Invasive Plant Infestation

The site is heavily invaded (Figure 15). Brandwacht has the least infestations with only a third of the site being heavily infested, mainly by *Acacia saligna*, *Acacia mearnsii* and *Eucalypus grobulus*. The infestation of *Acacia saligna* within Brandwacht (Figure 16) is less severe than that of *Acacia mearnsii* (Figure 17) and *Eucalypus grobulus* (Figure 18), covering only about 2% of the infested land surface. *Acacia mearnsii* is more abundant, infesting about 5% of the infested land surface, while a medium density boundary of *Eucalypus grobulus* stands occurs at the top of Brandwacht. These large stands of trees change the soil composition and thus affect soil erosion to a variable degree.

Within the Stellenboshberg site, most of the natural vegetation originally has been transformed into pine plantations. The pine species *Pinus pinea* is the main invading species and occupies more than 75% of Stellenboschberg's land surface (Figure 19). This can mainly be attributed to the plantation history of the area, consequently filling the seed bank with pine seeds over the plantation period. New seedlings sprout from the seed bank when vacant space becomes available after harvesting or clearing activities. There is a high occurrence of seedlings within the site, which is contributed to the disturbance caused by clearing efforts that occurred several months earlier. Within the disturbed area opportunistic recruitment of other invasive species, such as *Acacia saligna* and *Acacia mearnsii* was able to establish (Figure 16 and 17). Though their infestation is less severe than that of *Pinus pinea*, it is important to take into account the fast spreading nature of the species (via wind or human dispersal from already established populations) may lead to high infestation in the area if left unmanaged.

Paradyskloof is infested with *Pinus pinea*, *Eucalyptus grobulus*, *Acacia implexa, Acacia melanoxolyn, Acacia mearnsii, Acacia saligna* and *Acacia pygnantha,* of which *Acace saligna* and *Acacia mearnsii* infestation is the most severe, collectively covering up to 25% of the site. A boundary of large *Eucalyptus grobulus* trees occur between the sites and the upper mountain slope, though these were most likely introduced purposefully as a buffer zone between the sites and the upper mountain slope.

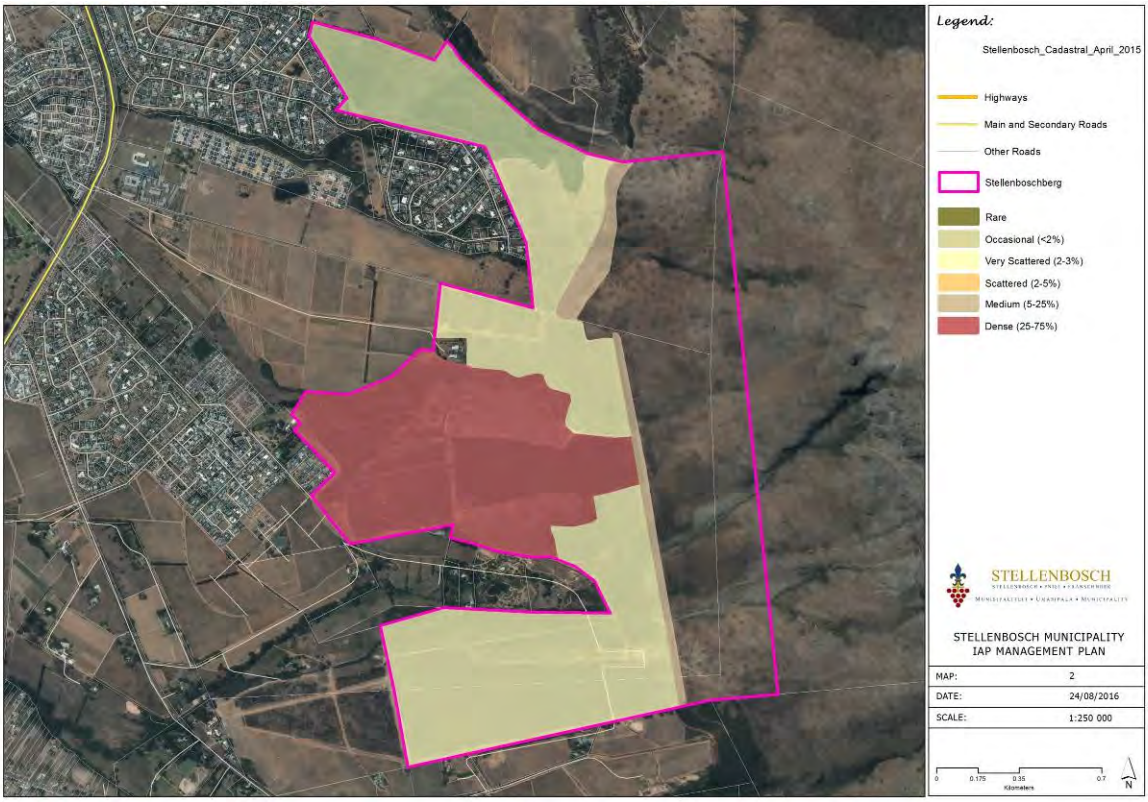

Figure 15: Alien invasive plant density (%) on Stellenboschberg.

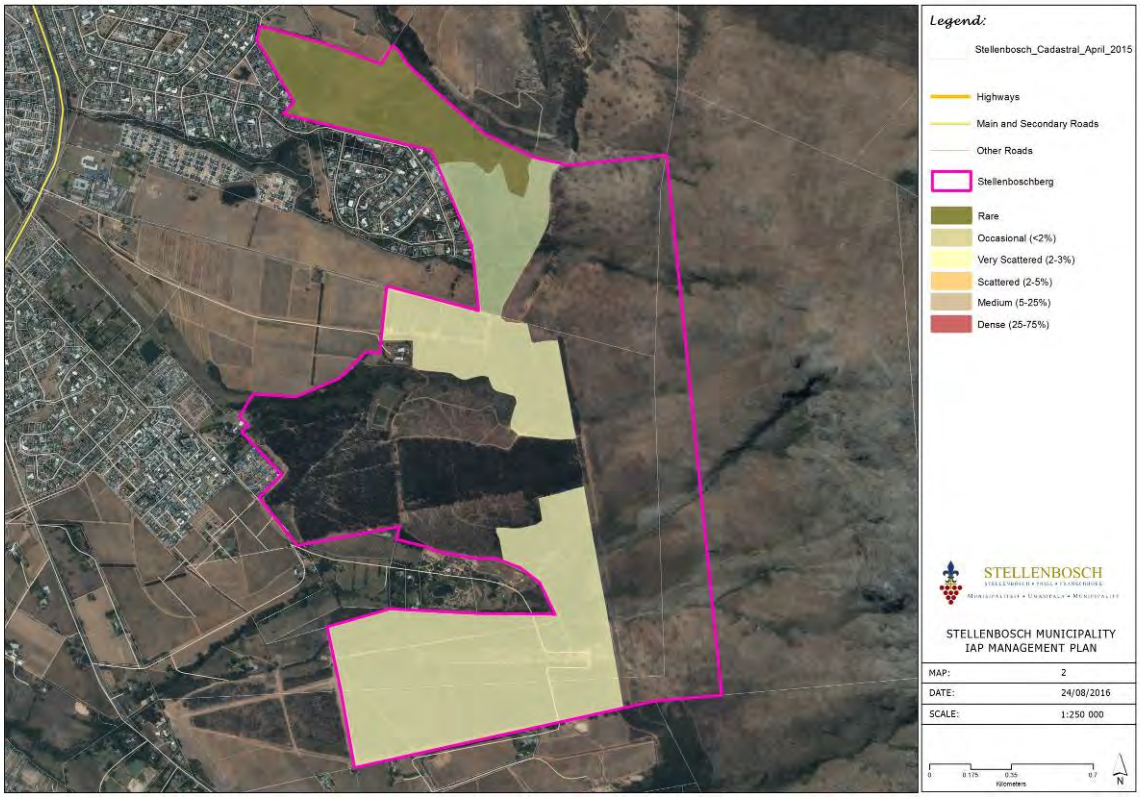

Figure 16: Acicia saligna density (%) on Stellenboschberg.

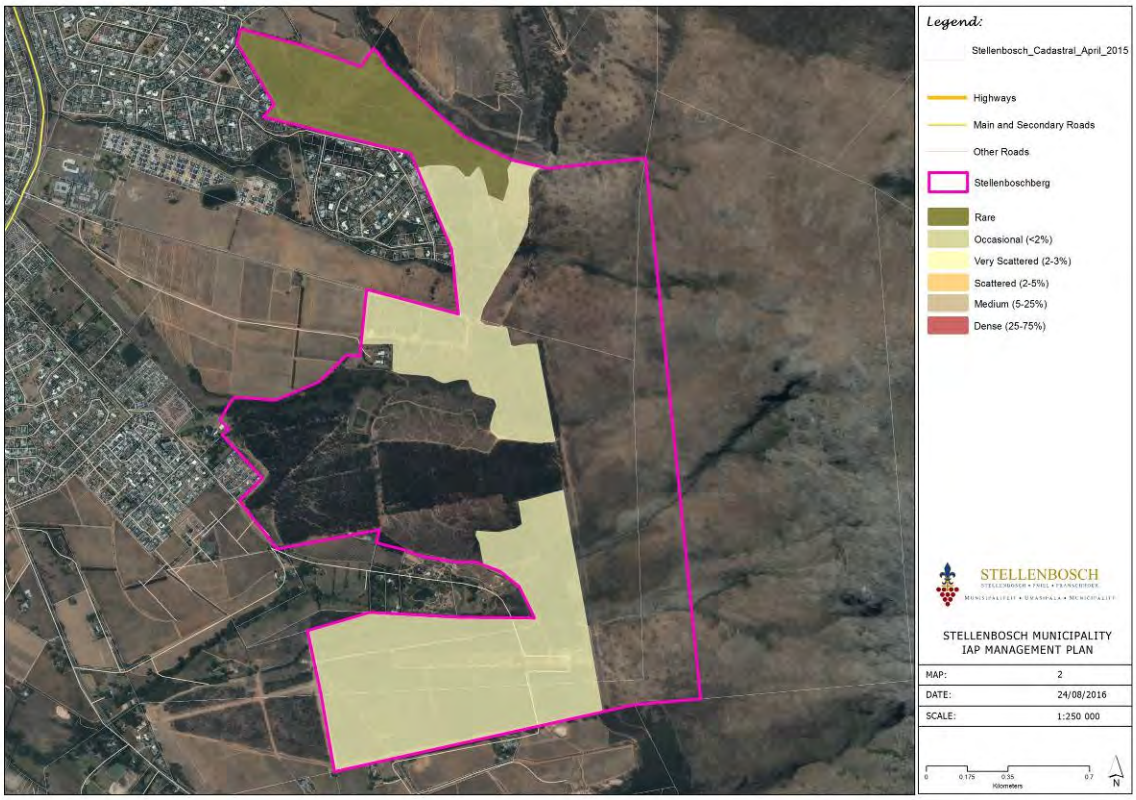

Figure 17: Acacia mearnii density (%) on Stellenboschberg.

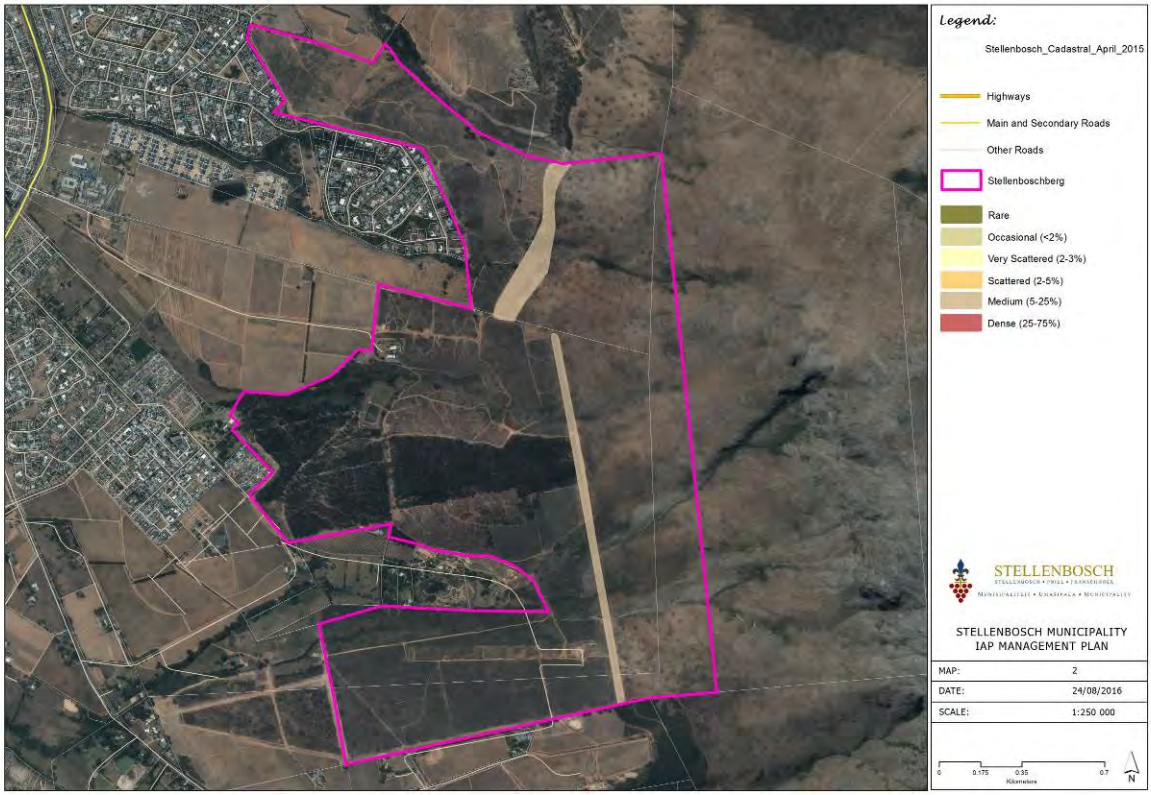

Figure 18: Eucalyptus grobulus density (%) on Stellenboschberg.

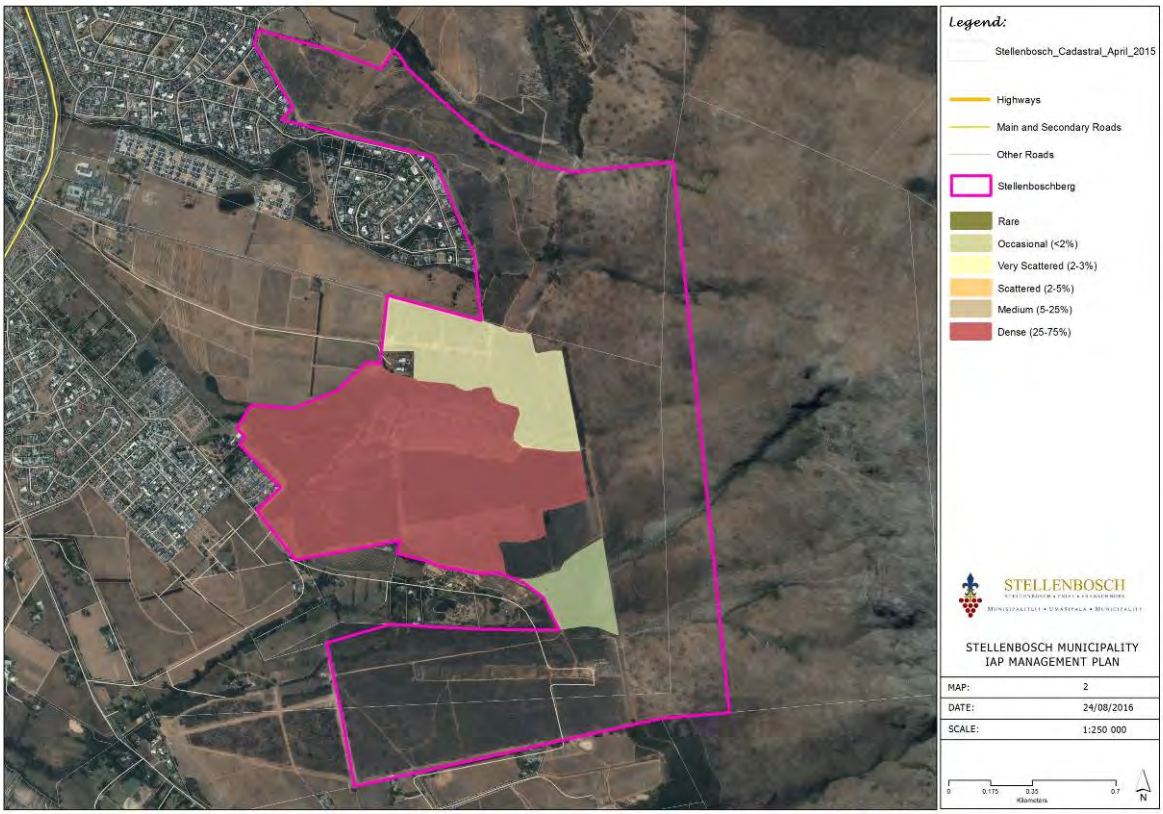

Figure 19: Pinus pinea density (%) on Stellenboschberg.

10.2.6 Clearing Methods

Past clearing efforts have taken place on Stellenboschberg, though the lack of follow up strategies has enabled the establishment of seedlings within the cleared areas. A comprehensive management strategy needs to be followed to ensure successful clearing of invasive alien species. Such a management strategy includes initial clearing methods with several follow-up and monitoring efforts to ensure successful clearing of invasive alien plants. When clearing an area that occurs on a slope, clearing strategies should initiate at the top of the slope and continue downwards. This strategy will reduce erosion effect as well as minimize the re-establishment process of invasive alien plants within the cleared areas from overhead populations. Strategic placement of large tree trunks should reduce soil erosion on slopes after invasive alien clearing.

The Brandwacht site is still rich in native biodiversity. To reduce the threat of biodiversity loss within the site, invasive alien plants should be removed as soon as possible. Clearing strategies should thus start on the upper slope in the Brandwacht site and continue downwards.

Removal strategies for clearing invasive alien species on Stellenboschberg should be a combination of mechanical and chemical methods (Table 7, Section 11). All species should be removed mechanically by uprooting young plants and tree felling of larger trees (via axe or chainsaw), followed by the application of chemical herbicides to the cut surface to prevent resprouting. Each species has its own corresponding herbicide requirements to prevent resprouting activities and should be applied soon after tree felling (see Table 7, Section 11). The use of herbicides may have negative effects on the health of soil composition and the natural ecosystem and should thus be used with caution and in reasonable amounts.

Continuous follow-up and removal of new seedlings after the initial clearing efforts are essential in order to clear the property of invasive alien plants. Follow ups and monitoring should occur annually and remaining or re-established invasive species should be removed when located.

10.2.7 Zonation as an aid to the management of invasive alien plant species

A zonation map (Figure 20) was constructed as an aid for clearing alien invasive plants in Brandwacht, Stellenboschberg and Paradyskloof. The property boundaries and road was used for zone boundaries. The property is divided into 4 large zones (A-D). Clearing operations should start from the highest points within zones A, B and D and proceed downhill.

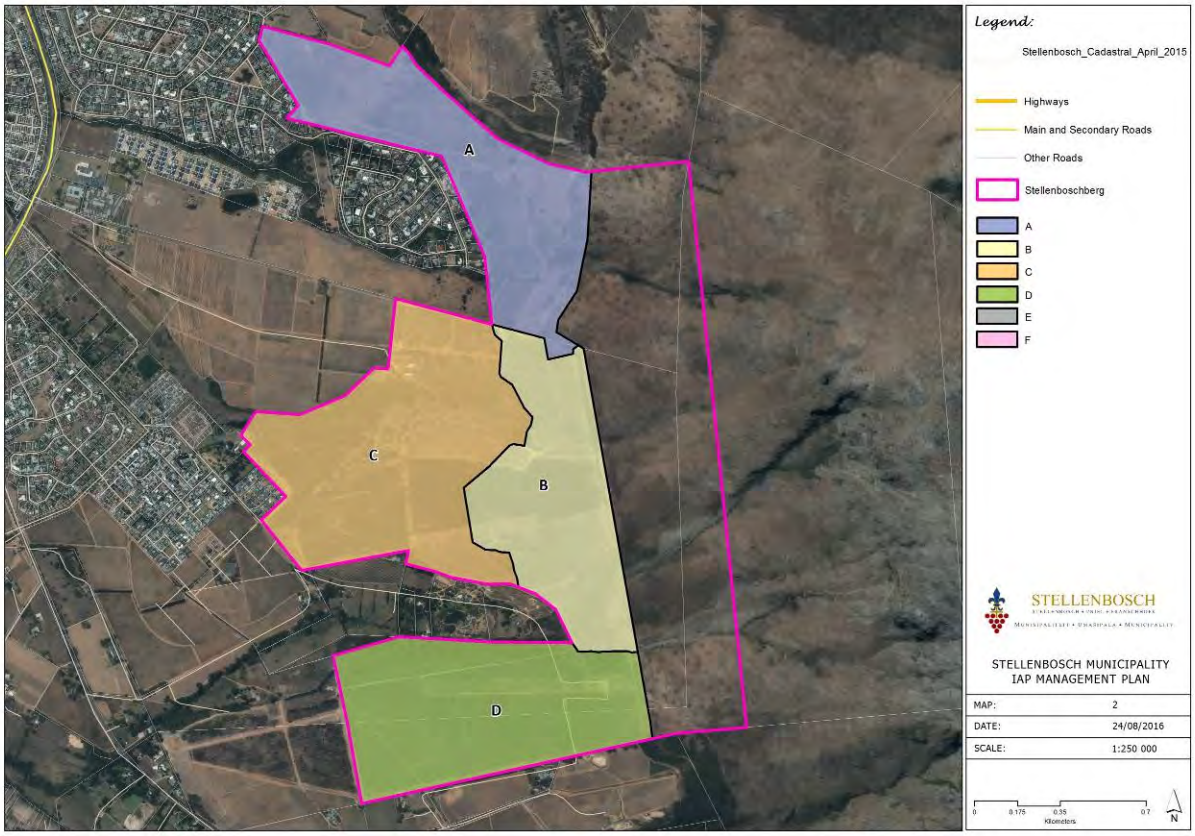

Figure 20: Zonation of Stellenboschberg as an aid for alien invasive plant clearing

10.3 IDA'S VALLEY DAM AREA

10.3.1 Location

Ida's Valley is situated on the edge of the town of Stellenbosch, above the Helshoogte pass across from Botmaskop. Ida's Valley residential area borders the area on its southern boundary, while the western boundary is bordered by privately owned land. The northern boundary as well as the eastern boundary is bordered by private farmlands which are mostly vineyards. The eastern boundary is adjacent the Tokara farmland. The area is more or less 250ha in size and is the main water supply for Stellenbosch.

10.3.2 Soil

The soil of the Ida's Valley Dam Area is red and yellow soils with low-medium status that is freely drained and structure-less.

10.3.3 Hydrology

The Ida's Valley Dam Area is located in a quarternary catchment draining from Simonsberg and the Hottentots Holland Mountain Catchment Area. Botmaskop forms part of quarternary catchment No. G22G with a small portion falling within quarternary catchment No. G22F. Although the catchment

functions of the planning area may seem insignificant, it is important to note that the latter forms part of an integrated group of ecosystems that collectively determine the health of the total catchment[22].

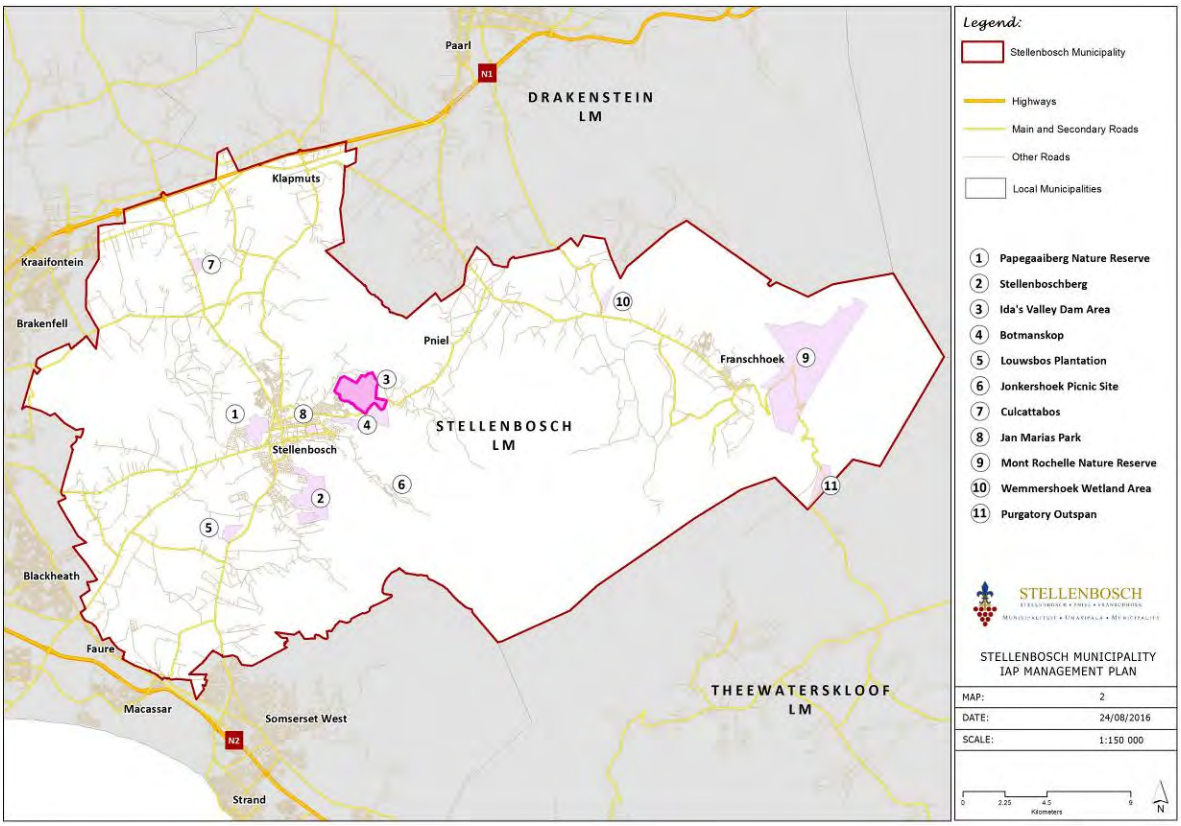

Figure 21: Ida's Valley Dam Area.

The primary threat to environmental health is fragmentation of the community-supporting ecosystems. Fragmentation generally leads to a cycle of environmental degradation, which consequently influences the well-being of the dependent communities. Ecosystems and/or catchments are mutually dependent on every natural component for their existence. The loss, or degradation, of one component thus affects all others, possibly leading to the collapse of the total system on which communities may depend for their livelihood. Hence the importance of conserving every natural part, or life form, of a system that forms part of the natural water cycle.

The Krom River arises in the Simonsberg Mountains approximately 9 km north east of Stellenbosch. The river feeds the Ida's Valley Dam. The river flows through forestry and agricultural areas before entering Ida's Valley. The quality of the Krom River is average to poor and is influenced by urban and agricultural run-off. The value of the river as a habitat for indigenous flora and fauna has been substantially altered and compromised due to the growth of alien invasive plants.

[22] Catchment (or catchment area) is defined as the entire land area from which water flows into a river; catchments can be divided into smaller 'sub-catchments' which are usually the area which drains a tributary to the main river or a part of the main river.

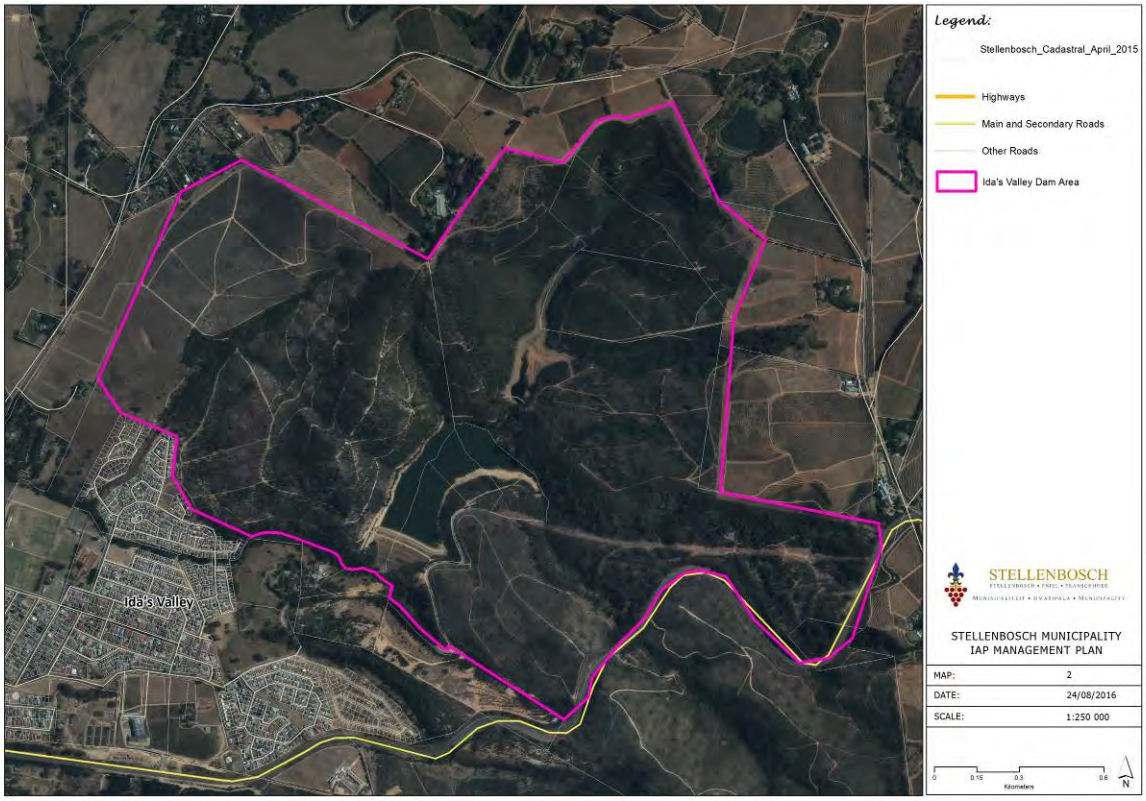

Figure 22: Local context of Ida's Valley Dam Area.

10.3.4 Vegetation

Botmaskop consists of two vegetation types, namely Boland Granite Fynbos and Cape Wineland Shale Fynbos. Both are vulnerable vegetation types within the Western Cape. Boland granite fynbos has 56 Red Data plant species and 23 endemic plant species. There are approximately 62% remaining natural areas, of which 14% is protected in the Hawequas, Hottentots Holland and Paarl Mountain Nature Reserve.

The Cape Wineland Shale Fynbos comprises of a diversity of Protea, Erica, geophyte and daisy species as well as some endemic species. The vegetation type is of conservation significance because of its high vulnerability state due to it location on lower slopes, which are mostly used for agricultural and urban development. Of the 54% remaining natural areas, only 25% are actively protected (SANBI 2009).

10.3.5 Current Alien Invasive Plant Infestation

Over 80% Ida's Valleys land surface is infested with and transformed by invasive alien plants, making the Ida's Valley Dam Area the most invaded site in the survey (Figure 23). The major invasive alien plants of Ida's Valley Dam Area are *Pinus pinea* and *Eucalytpus globulus* (Figures 25 and 26).

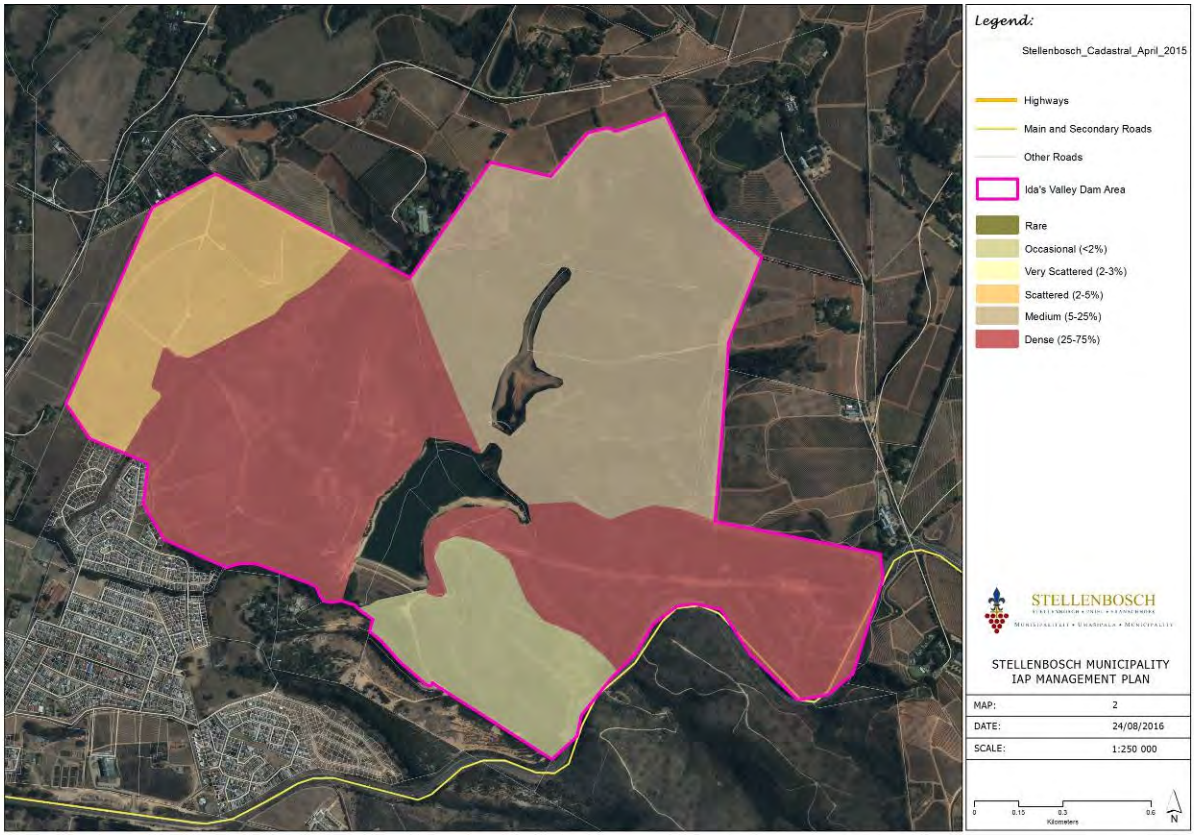

Figure 23: Alien invasive plant density (%) on Ida's Valley Dam Area.

Both *P. pinea* and *E. globulus* occur in large, dense stands, which cover over 55% of the sites land surface. Though clearing efforst have taken place along the northern boundary of Ida's Valley, the disturbance and lack of follow-up efforts has led to re-establishment of both *P. pinea* and *E. globulus* as well as the new establishment of *Acacia saligna* and *Acacia mearnsii* (Figure 24).

Other invasive alien plant species such as *Acacia implexa, Acacia melanoxylon* and *Acacia pygnantha* also occur in the Ida's Valley Dam Area, though their infestation is of a lesser extent.

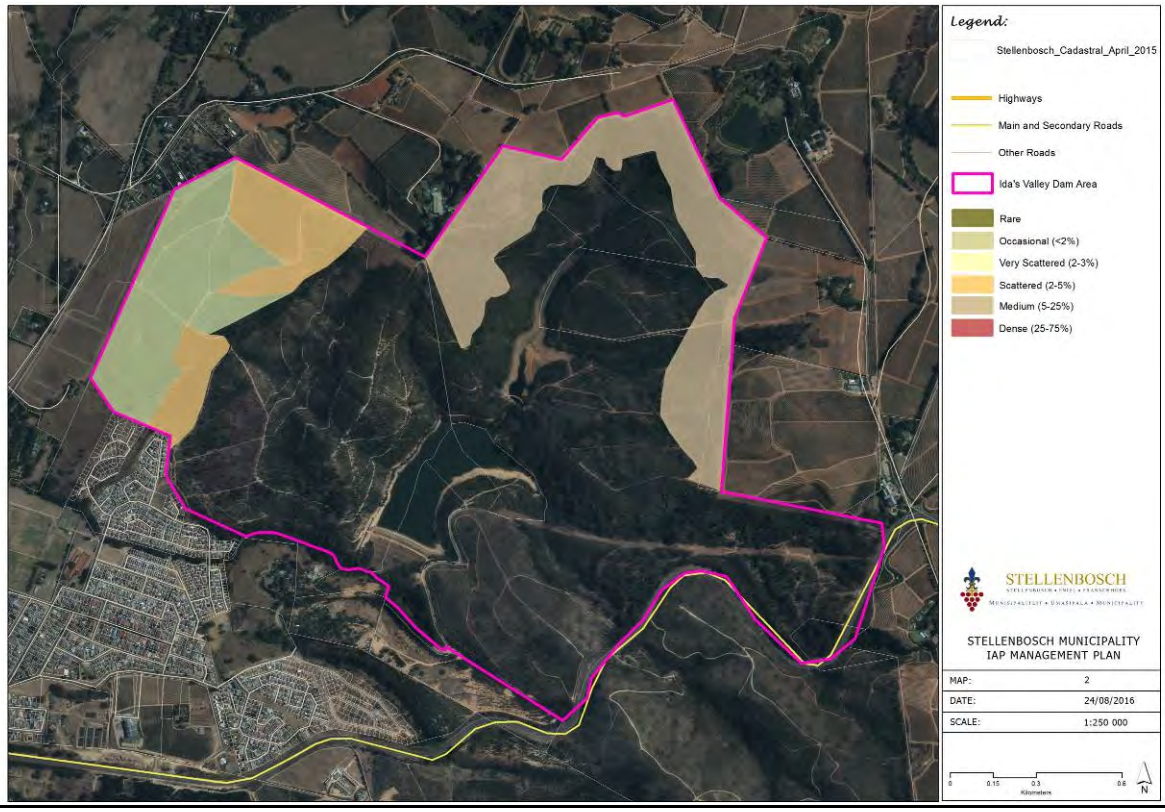

Figure 24: Acacia saligna and Acacia mearnii density (%) on Ida's Valley Dam Area.

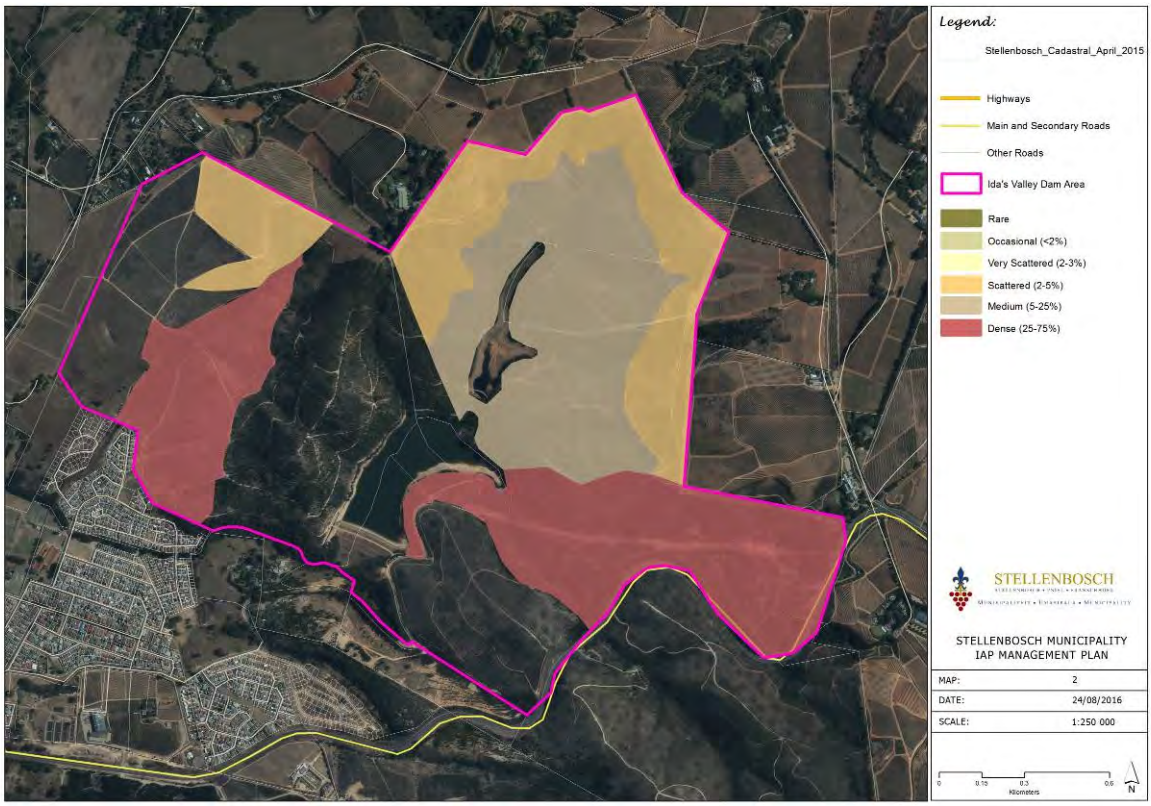

Figure 25: Eucalyptus grobulus density (%) on Ida's Valley Dam Area.

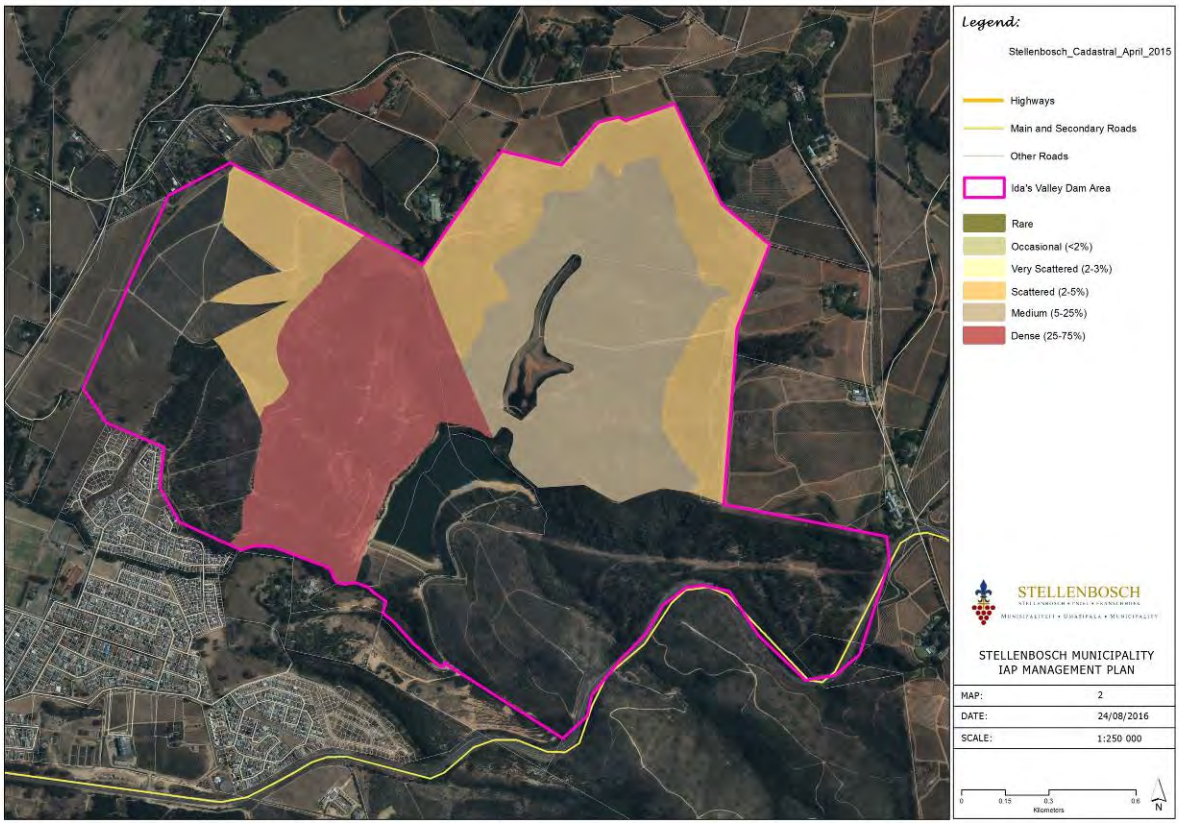

Figure 26: Pinus pinea density (%) on Ida's Valley Dam Area.

10.3.6 Clearing Methods

Past clearing efforts have taken place along the northern boundary of Ida's Valley Dam Area, though the lack of follow up strategies has led re-establishment of invasive alien plants in these areas. A comprehensive management strategy needs to be followed to ensure successful clearing of invasive alien species. Such a management strategy includes initial clearing methods with several follow-up and monitoring efforts to ensure successful clearing of invasive alien plants. When clearing an area that occurs on a slope, clearing strategies should initiate at the top of the slope and continue downwards. This strategy will reduce erosion effect as well as minimize the re-establishment process of invasive alien plants within the cleared areas from overhead populations. Strategic placement of large tree trunks should reduce soil erosion on slopes after invasive alien clearing.

Removal strategies for clearing invasive alien species in Ida's Valley Dam Area should be a combination of mechanical and chemical methods (Table 7, Section 11). Invasive alien plants should be removed mechanically by uprooting young plants and tree felling of larger trees (via axe or chainsaw). All the invasive alien species that occur within Botmaskop have resprouting characteristics and herbicides should be applied to the cut surface. Each species has its own corresponding herbicide requirements to prevent resprouting and should be applied soon after tree felling (see Appendix Table 7, Section 11). The use of herbicides may have negative effects on the health of soil composition and the natural ecosystem and should thus be used with caution and in reasonable

amounts. Continuous follow-up and removal of new seedlings after the initial clearing efforts are essential in order to clear the property of invasive alien plants. Follow-ups and monitoring should occur annually and remaining or re-established invasive species should be removed when located. Biomass should be disposed of at a distance from the property. Wood from large trees can be retailed as timber products.

10.3.7 Zonation as an aid to the management of invasive alien plant species

A zonation map (Figure 27) was constructed as an aid for clearing alien invasive plants on Ida's Valley. Roads on the property were used for zone boundaries. The property is divided into 6 large zones (A-F) and each larger zone is further divided into smaller zones.

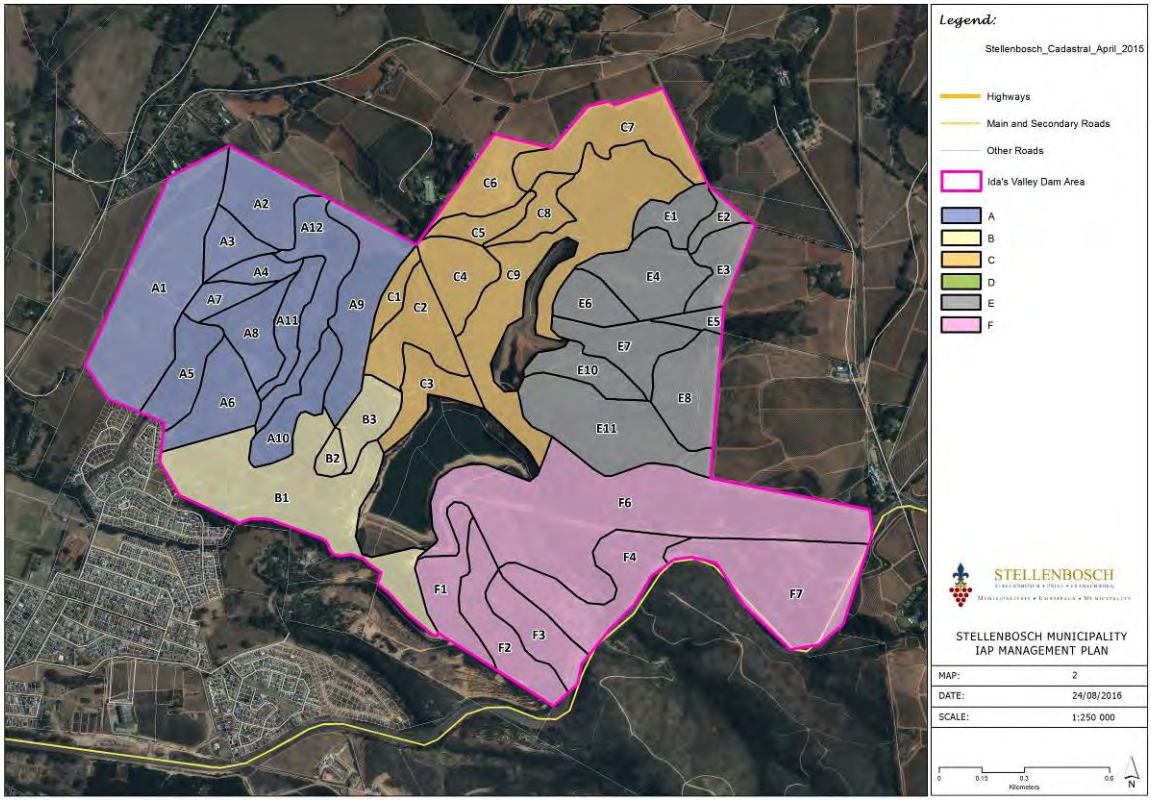

Figure 27: Zonation of Ida's Valley Dam Area as an aid for alien invasive plant clearing

Clearing should start within zones C and E (these zones are at the highest point within the Ida's Valley Dam Area) should start at the highest points and continue in all four directions towards the boundaries of the zones. When zones C and E are cleared, clearing within zone D should start at the highest point and continue in all four directions towards the boundary of the adjacent zones. Once zone D is cleared, clearing should start at the highest points within B and continue to the boundary of the zone after which clearing will continue into zone a and move towards the north and western boundaries. Once clearing in these zones are done, clearing should continue from the highest point within zone F, which is on the boundary of zones F and E, and continue downward towards the southern boundary. Once clearing of both sites has been concluded, follow-up and monitoring strategies should occur annually following the same strategy.

10.4 BOTMASKOP

10.4.1 Location

Botmaskop, situated in the town of Stellenbosch, is divided into two sites, east and west (see Figure 28) south of the Helshoogte pas. The eastern site is bordered by the Rozendal residential area on the western boundary, while the Plumbago Cottage property borders the site on the southern boundary. The northern and eastern boundaries are adjacent to private farmlands. The western site is bordered by private farmlands on the southern and eastern boundaries, while the north and western boundaries are bordered adjacent the Helshoogte pas, across from the Ida's Valley Dam Area.

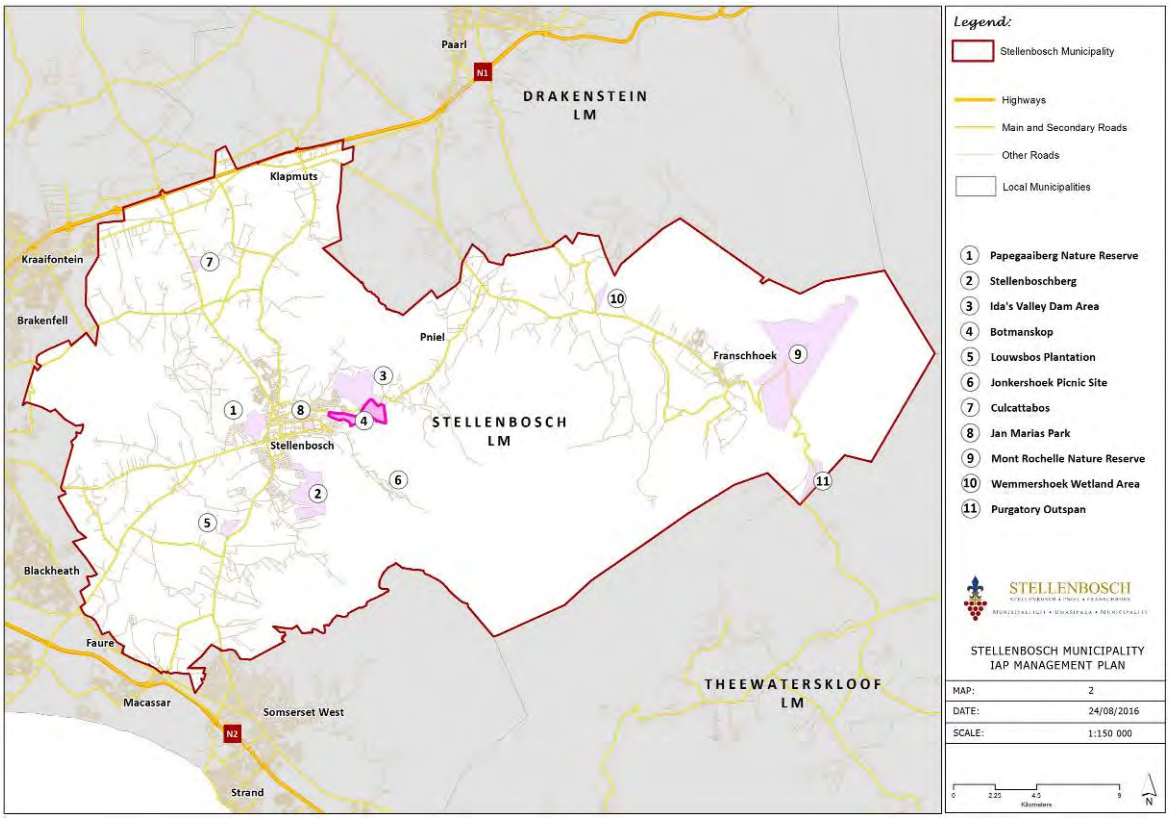

Figure 28: Botmaskop.

Botmaskop is classified as a hill with a height less than 300m. The area was previously used as pine and eucalyptus plantation with a size of approximately 46ha. The site is located at the base of the Jonkershoek mountain range and gradually rises from the southern boundary to the northern boundary.

10.4.2 Soil

The soil of Botmaskop is red and yellow with low-medium base status and rock with limited soils that is freely drained, structure-less soils and has a non-soil land classes.

10.4.3 Hydrology

Botmaskop is situated on the edge of the catchment described in the Ida's Valley Dam Area section above.

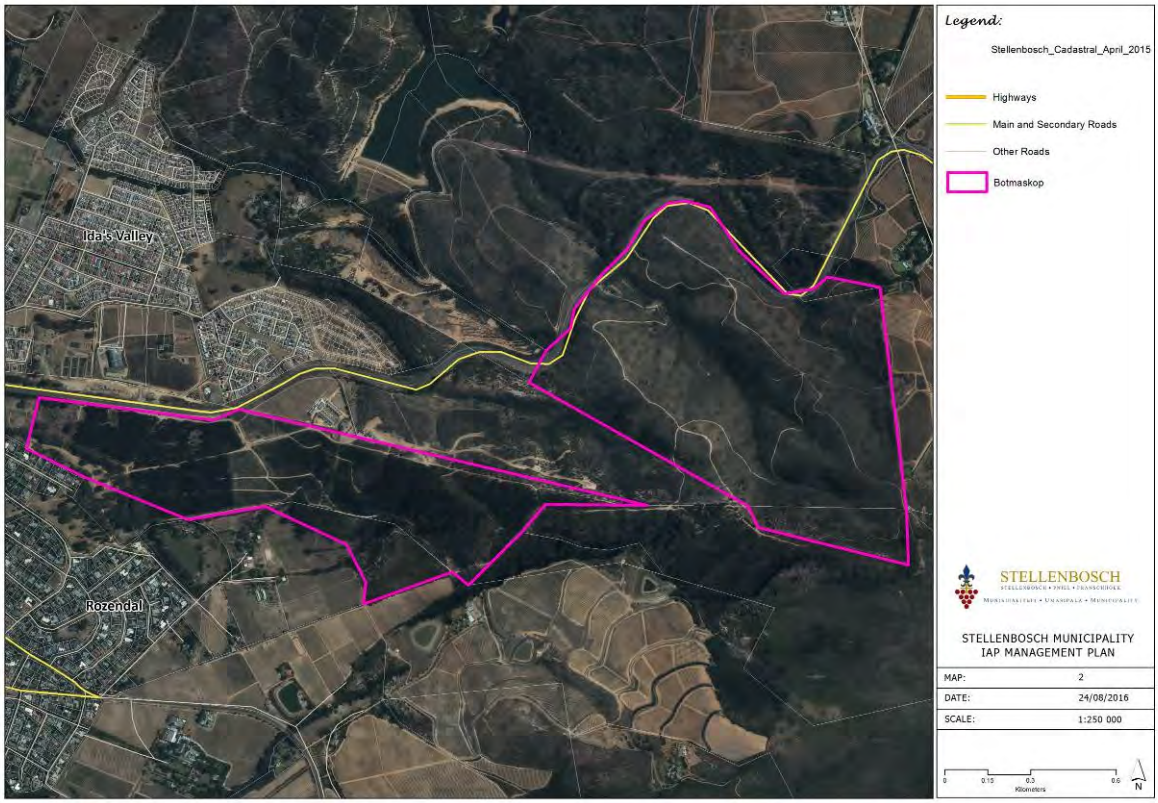

Figure 29: Local context of Botmaskop.

10.4.4 Vegetation

Botmaskop consists of two vegetation types, namely Boland Granite Fynbos and Cape Wineland Shale Fynbos. Both are vulnerable vegetation types within the Western Cape.

10.4.5 Current Alien Invasive Plant Infestation

The original vegetation of Botmaskop has been completely transformed for *Pinus pinea* and *Eucalyptus grobulus* plantation purposes (Figure 30). The transformation and introduction of pine trees into the site, for extensive pine production intended for industrial use, has led to the complete infestation by these invasive alien plants. Though past removal efforts have taken place, the disturbance and lack of follow-up efforts has led to re-establishment of *P. pinea* and *E. grobulus* recruitments within the cleared areas. Other invasive alien species such as *Acacia implexa, Acacia melanoxylon, Acacia mearnsii* and *Acacia pygnantha* is also located within the sites, though not to such an extent as *P. pinea* and *E. grobulus.*

The original vegetation of Botmaskop in site 2 is not as severely infested as that of site 1 and the invasive alien plants (mainly *Pinus pinea* and *Eucalyptus grobulus*) mostly occurs on the south-western slopes of the site (Figure 31 and 32). *Acacia implexa, Acacia melanoxylon, Acacia mearnsii* and *Acacia pygnantha* is also located within the sites, though also to a lesser extent as that of *P. pinea* and *E. grobulus*. Invasion densities within the site increase within valleys and near water resources where conditions are more favourable. The less invaded areas, on the lower plains of the site, are natural fynbos vegetation, though infestation within these areas may increase if left unmanaged.

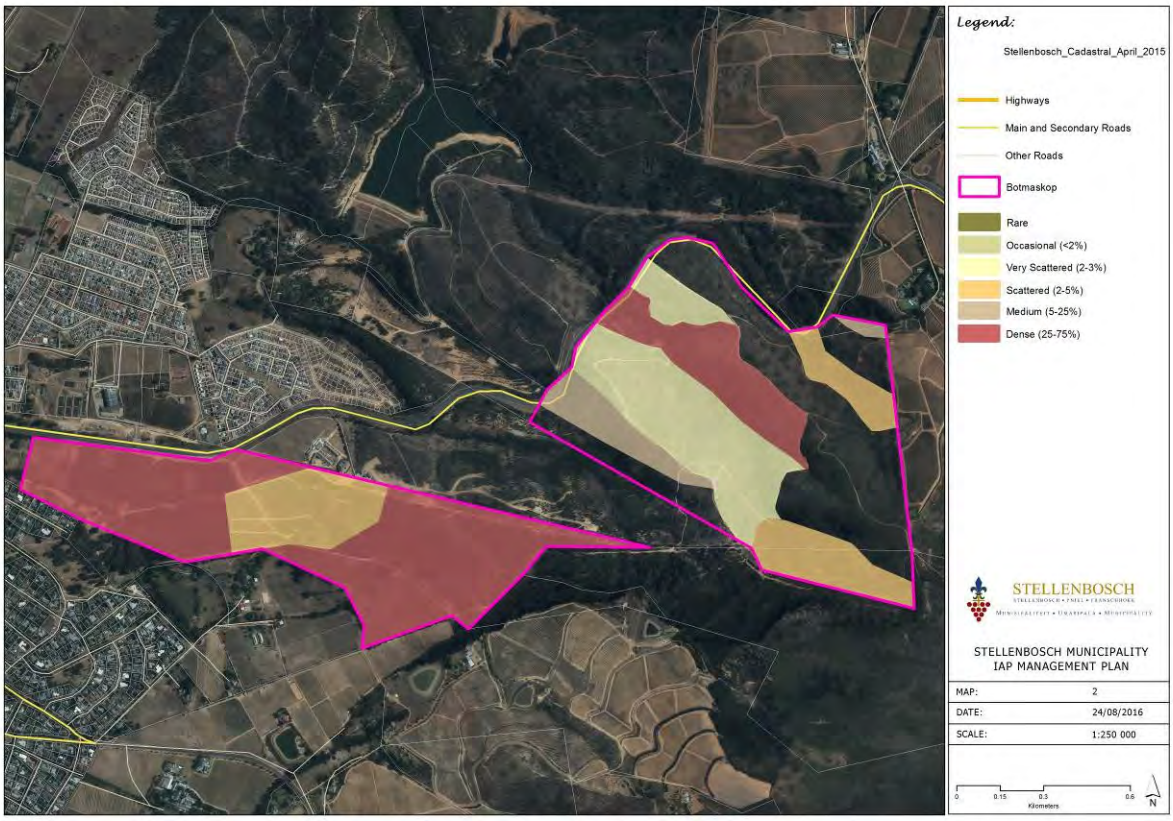

Figure 30: Alien invasive plant density (%) on Botmaskop.

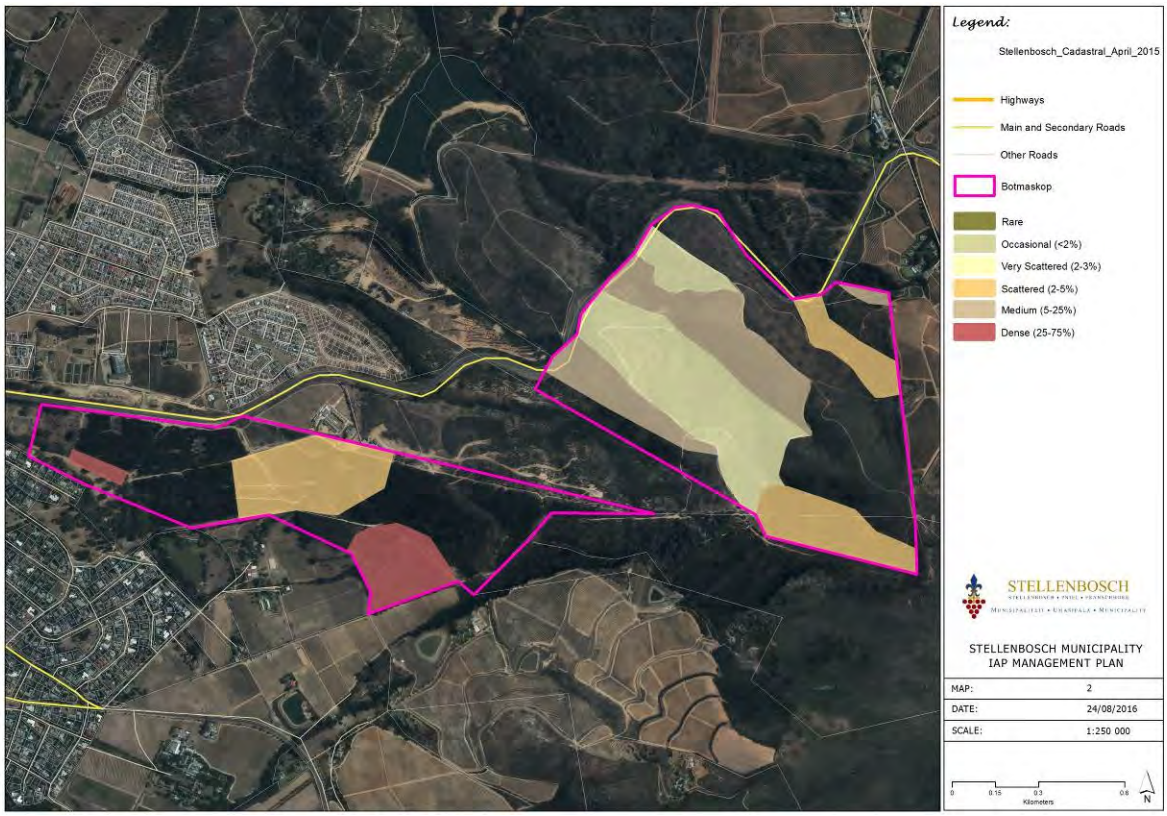

Figure 31: Eucalyptus grobolus density (%) on Botmaskop.

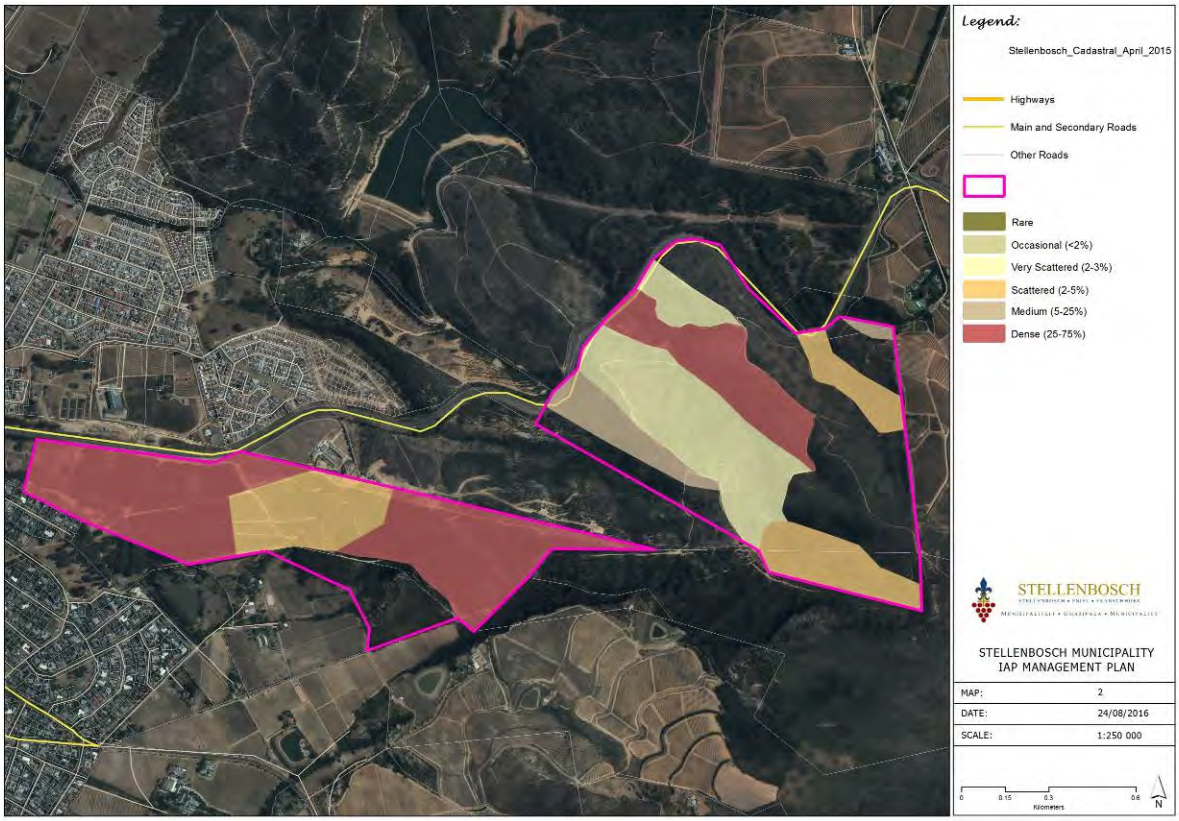

Figure 32: Pinus pinea density (%) on Botmaskop.

10.4.6 Clearing Methods

Past clearing efforts have taken place within Botmaskop, though the lack of follow up strategies has led these clearing efforts to be unsuccessful. Thus, a comprehensive management strategy needs to be followed to ensure successful clearing of invasive alien species. Such a management strategy includes initial clearing methods with several follow-up and monitoring efforts to ensure successful clearing of invasive alien plants. When clearing an area that occurs on a slope, clearing strategies should initiate at the top of the slope and continue downwards. This strategy will reduce erosion effect as well as minimize the re-establishment process of invasive alien plants within the cleared areas from overhead populations. Strategic placement of large tree trunks is a further way to reduce soil erosion on slopes after invasive alien clearing.

Removal strategies for clearing invasive alien species on Botmaskop should be a combination of mechanical and chemical methods (Table 7, Section 11). Invasive alien plants should be removed mechanically by uprooting young plants and tree felling of larger trees (via axe or chainsaw). All the invasive alien species that occur within Botmaskop have resprouting characteristics and herbicides should be applied to the cut surface. Each species has its own corresponding herbicide requirements to prevent resprouting and should be applied soon after tree felling (see Table 7, Section 11). The use of herbicides may have negative effects on the health of soil composition and the natural ecosystem and should thus be used with caution and in reasonable amounts.

In Botmaskop, eastern site, zones A and B (Figure 33) have the potential to be transformed into a picnic site for local residents. Within these two zones removal of invasive alien species should be selective as to create an ambiance and aesthetic valued environment for visitors. This will also include possible rehabilitation of the areas and re-establishment of natural vegetation to increase these values within the zones. Rehabilitation and re-establishment of natural vegetation will also be necessary to re-establish the original vegetation within the site.

Continuous follow-up and removal of new seedlings after the initial clearing efforts are essential in order to clear the property of invasive alien plants. Follow-ups and monitoring should occur annually for a minimal of 5 years and remaining or re-established invasive species should be removed when located. Biomass should be disposed of at a distance from the property. Wood from large trees can be retailed as timber products.

10.4.7 Zonation as an aid to the management of invasive alien plant species

A zonation map (Figure 33) was constructed as an aid for clearing alien invasive plants on Botmaskop. Roads on the property were used for zone boundaries. The eastern site is divided 5 large zones (A-E) and the western site into 6 large zones (A-F) and each larger zone further divided into smaller zones.

Clearing strategies within site the eastern should start on the northern boundary of sites A, C and E proceed southwards to sides B and D.

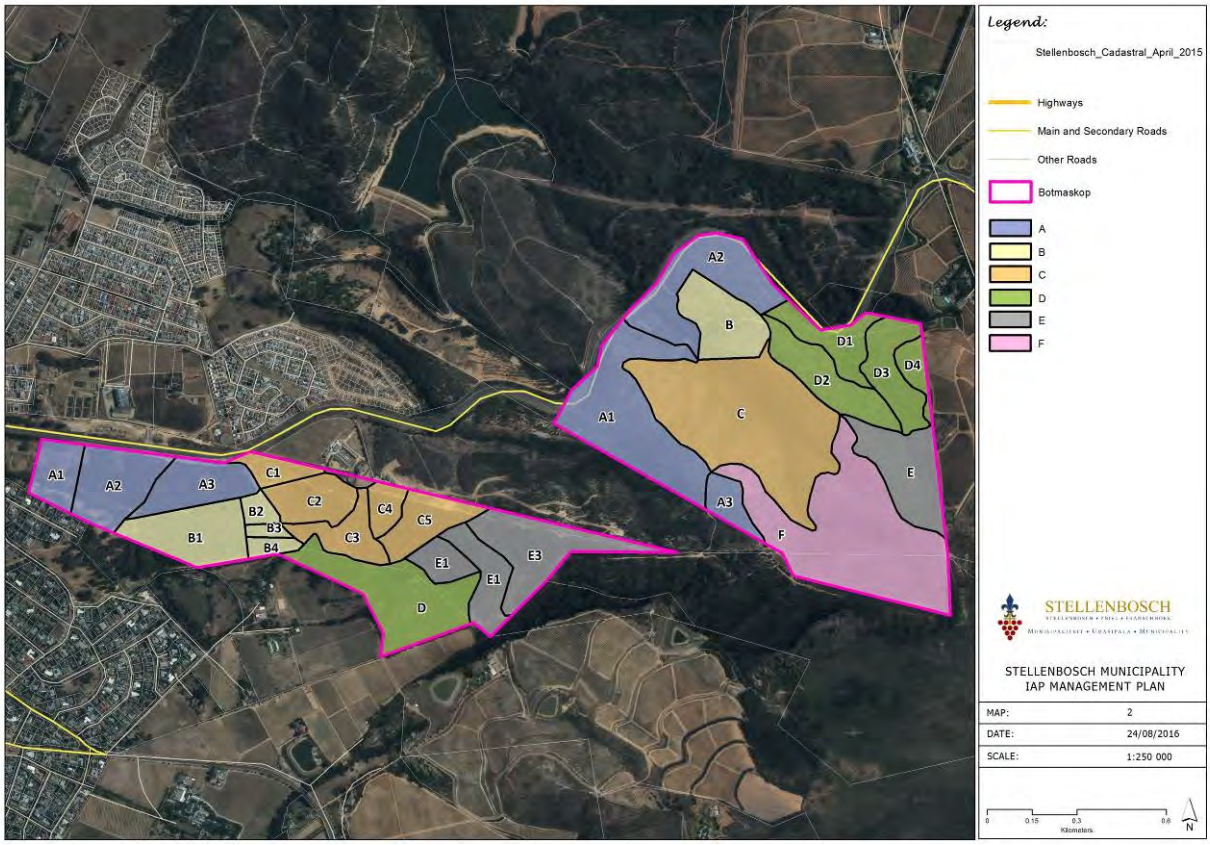

Figure 33: Zonation of Botmaskop as an aid for alien invasive plant clearing

For the western site clearing should start at on the highest point within zones C and E and continue downward in both northern and southern directions to the adjacent zones. Clearing should then start at the highest point of these zones and continue downward towards the next adjacent zones boundary. Once clearing of both sites has been concluded, follow-up and monitoring strategies should occur annually following the same strategy.

10.5 LOUWSBOS PLANTATION

10.5.1 Location

Louwsbos plantation is located along the R44 road between Stellenbosch and Somerset. The western boundary is border by several farms, including Kleinbosch lodge, Zimzala and Bellevue Manor Bed and Breakfast. On the southern boundary the property is bordered by a water storage dam and greenhouse agricultural property, while the western boundary is bordered by the Stellenbosch Flying club. De Zalze Golf Club borders the property on the northern boundary. Louwsbos Plantation is a recently acquired stone pine plantation and is approximately 47ha in size. The property is relatively flat terrain. There is a horse training farm and school located within the borders of the property and their training equipment is spread across the property.

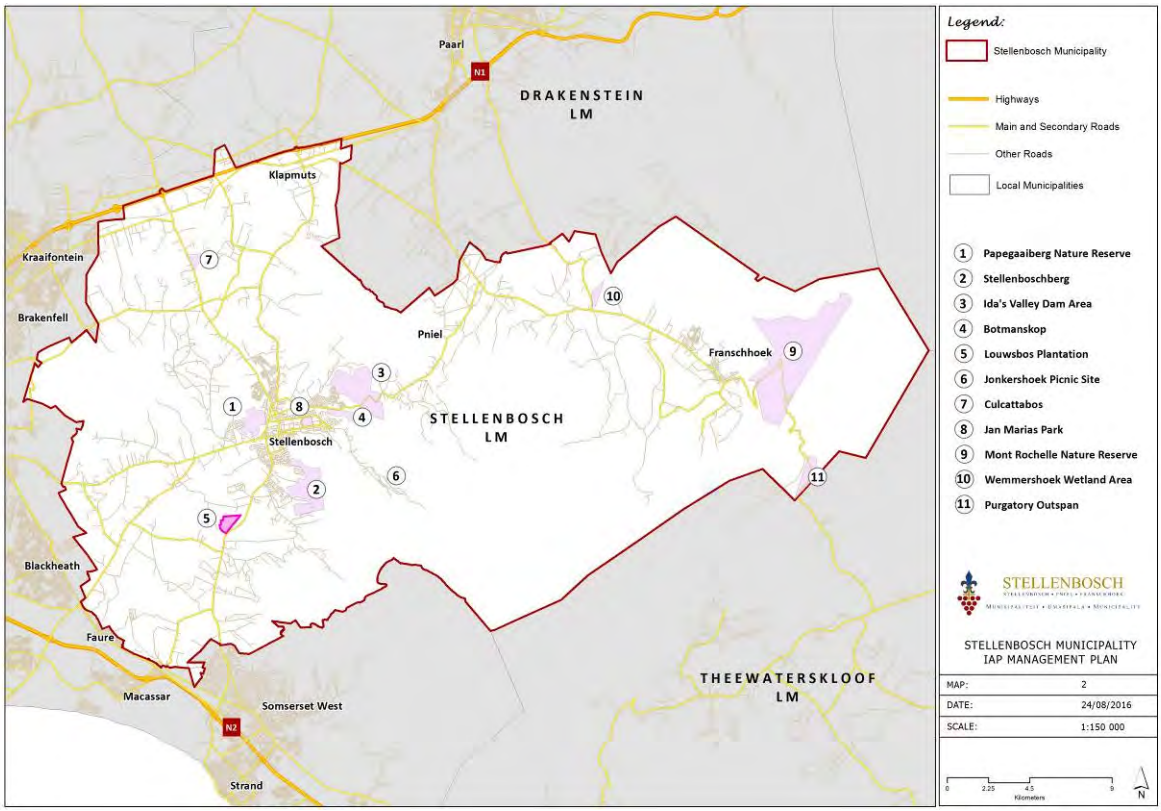

Figure 34: Louwsbos Plantation.

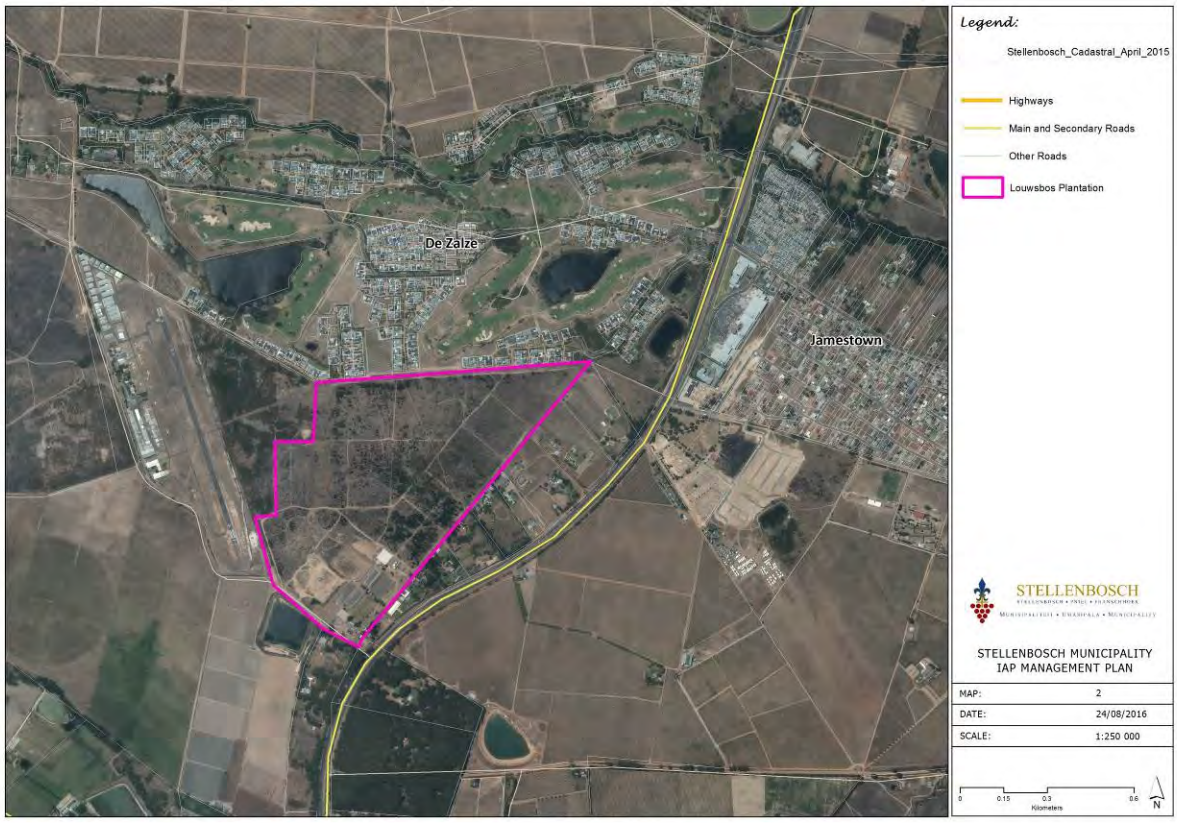

Figure 35: Local context of Louwsbos Plantation.

10.5.2 Soil

The soil is imperfectly drained soil which is shallow with a plinthic horizon. It is a marked clay accumulation which is strongly structured and is a non-reddish colour.

10.5.3 Hydrology

Though there are no rivers flowing through the property nor are there any wetlands within the property boundaries.

10.5.4 Vegetation

The Swartland Granite Renosterveld vegetation type of Louwbos plantation is an almost extinct vegetation type. Approximately 85% of all Swartland Granite Renosterbos has been transformed to agricultural and urbanization activities. Of the 15% remaining natural area, less that 1% is actively protected. The vegetation type contains about 127 Red Data plant species and 27 endemic plant species. The near extinct status of this vegetation type makes the conservation and rehabilitation efforts of its remaining remnants of high conservation importance (SANBI 2009).

10.5.5 Current Alien Invasive Plant Infestation

The natural vegetation originally occurring in Louwbos plantation has been completely transformed for pine plantation purposes. The transformation and introduction of pine trees into the site, for extensive pine production intended for industrial use, has led to the complete infestation by invasive alien plants. Though past removal efforts have taken place, the disturbance and lack of follow-up efforts has led to re-establishment of Pine tree recruitments as well as the establishment of new invasive species, such as *Acacia saligna*, into the site (Figure 36).

The Pinus species *Pinus pinea* is the main invading species in Louwbos plantation and occupies more than 75% of the sites land surface (Figure 37). This can mainly be attributable to the plantation history of the area, consequently filling the seed bank with pine seeds over the plantation period. New seedlings sprout from the seed bank when vacant space becomes available after harvesting or clearing activities.

The infestation of *Acacia saligna* is less severe and covers only approximately 8.3% of the property (Figure 38), though the fast spreading nature of the species (via wind or human dispersal from already established populations) may lead to high infestation in the area if left unmanaged.

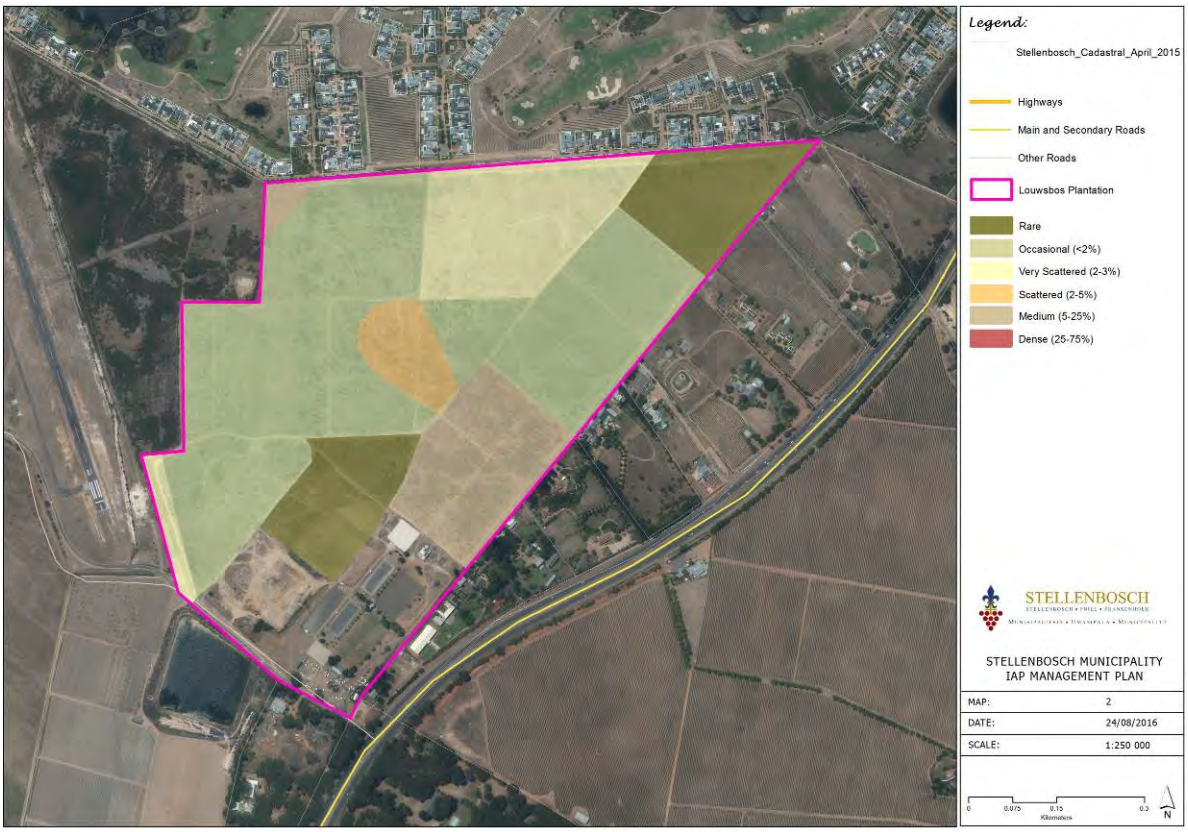

Figure 36: Alien invasive plant density (%) of Louwsbos Plantation.

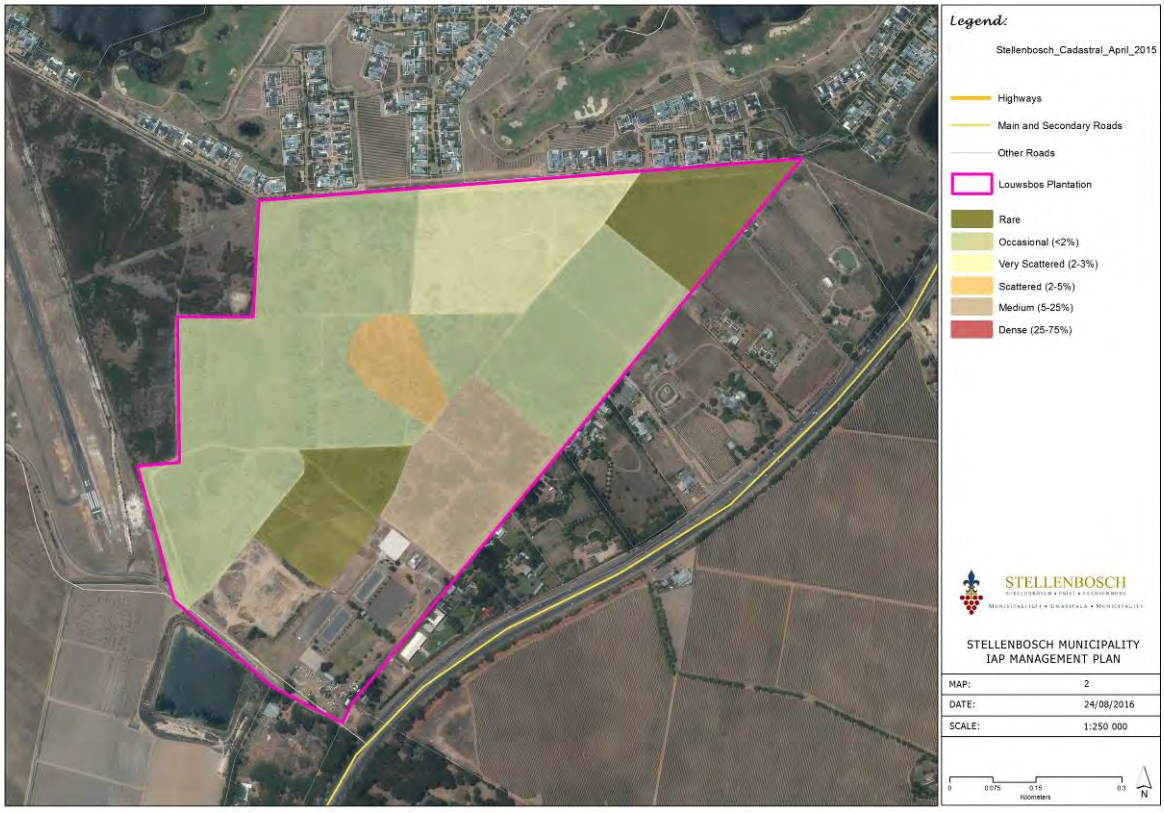

Figure 37: Pinus pinea density (%) of Louwsbos Plantation.

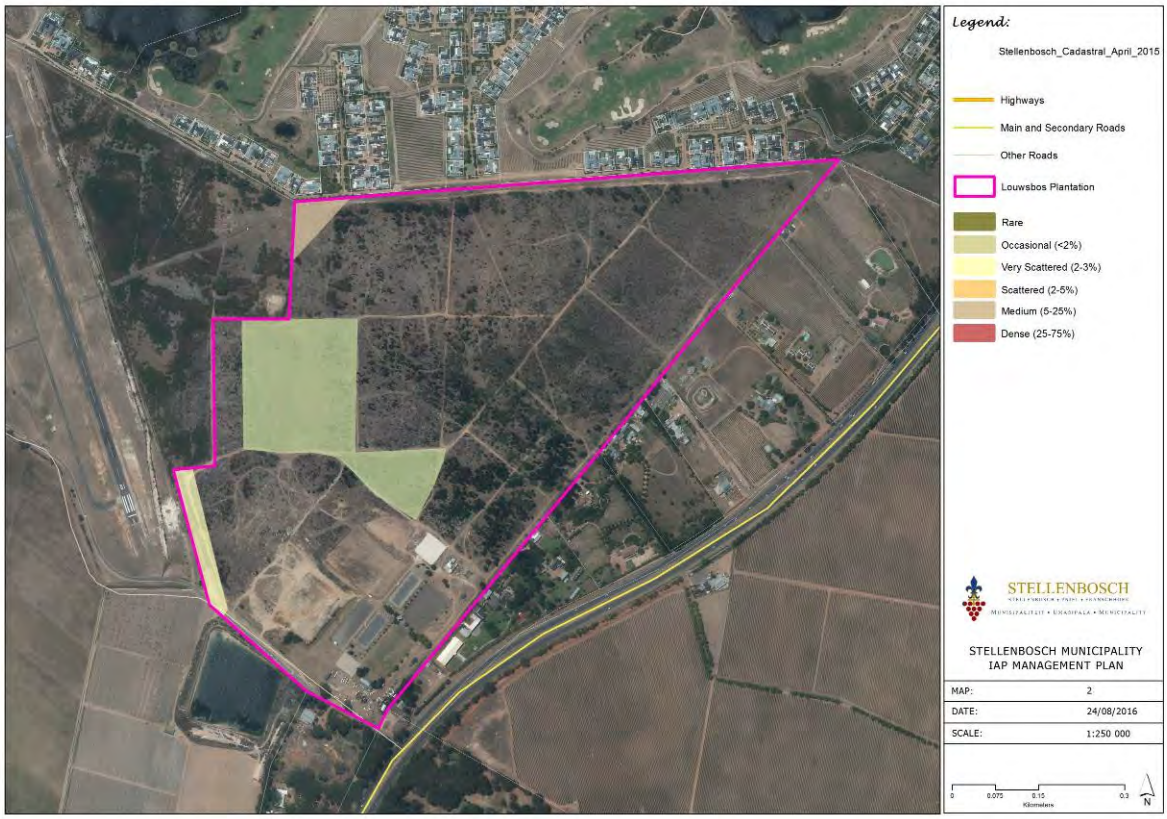

Figure 38: Acacia saligna density (%) of Louwsbos Plantation.

10.5.6 Clearing Methods

Past clearing efforts have taken place within Louwsbos plantation, though the lack of follow up strategies has led these clearing efforts to be unsuccessful. Thus, a comprehensive management strategy needs to be followed to ensure successful clearing of invasive alien species. Such a management strategy includes initial clearing methods with several follow-up and monitoring efforts to ensure successful clearing of invasive alien plants.

Removal strategies for clearing invasive alien species in Louwsbos plantation should be a combination of mechanical and chemical methods (Table 7, Section 11). Both *Pinus pinea* and *Acacia saligna* should be removed mechanically by uprooting young plants and tree felling of larger trees (via axe or chainsaw). Both P. *pinea* and *A. saligna* have resprouting characteristic and herbicides should be applied to the cut surface. Each species has its own corresponding herbicide requirements to prevent resprouting activities and should be applied soon after tree felling (see Table 7, Section 11). The use of herbicides may have negative effects on the health of soil composition and the natural ecosystem and should thus be used with caution and in reasonable amounts. Continuous follow-up and removal of new seedlings after the initial clearing efforts are essential in order to clear the property of invasive alien plants. Follow ups and monitoring should occur annually and remaining or re-established invasive species should be removed when located. Biomass should be disposed of at a distance from the property. Wood from large trees can be retailed as timber products.

10.5.7 Zonation as an aid to the management of invasive alien plant species

A zonation map (Figure 39) was constructed as an aid for clearing alien invasive plants on the Louwbos Plantation siet. Roads on the property were used as zone boundaries. The property is divided into 6 large zones (A-F) and each larger zone is further divided into smaller zones. Clearing of alien invasive plants in Louwsbos Plantation should start at the western boundary of zone A1 and move in a north eastern direction towards A2. Continue to clear zones A2 to A4. When Zone A is cleared, continue onto zones B1 and C1, then D1 and finally E1 and F1 and finish clearing in zone F3. Repeat this working cycle when conducting monitoring and removal of re-establish alien species.

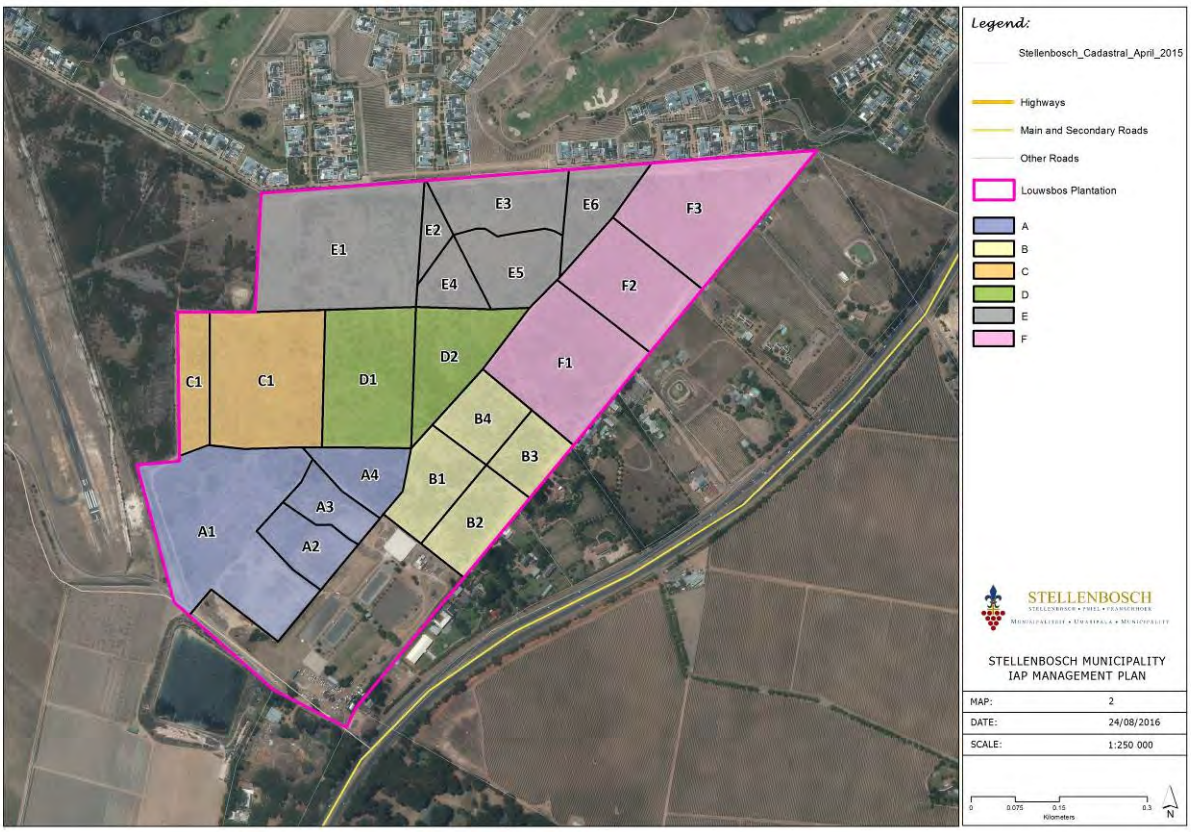

Figure 39: Zonation of Louwsbos Plantation as an aid for alien invasive plant clearing

10.6 JONKERSHOEK PICNIC SITE

10.6.1 Location

Jonkershoek Picnic Site is located within the valley between the Stellenbbosch and Jonkershoek Mountain ranges and is accessible along the Jonkershoek road. The entrance to the picnic area is 1800m before the entrance of the Jonkershoek Nature Reserve, on the western side of the road. The property is bordered by the Eerste River to the south and by the Jonkershoek Road to the north. The eastern boundary is bordered by the Oki Jooste Camp Site.

The property is approximately 8ha in size and is relatively flat. The site is open to the public and there are braai and lavatory structures within the site.

10.6.2 Soil

The soil of Jonkershoek Picnic site consists of Lithosols, rocky with limited soil.

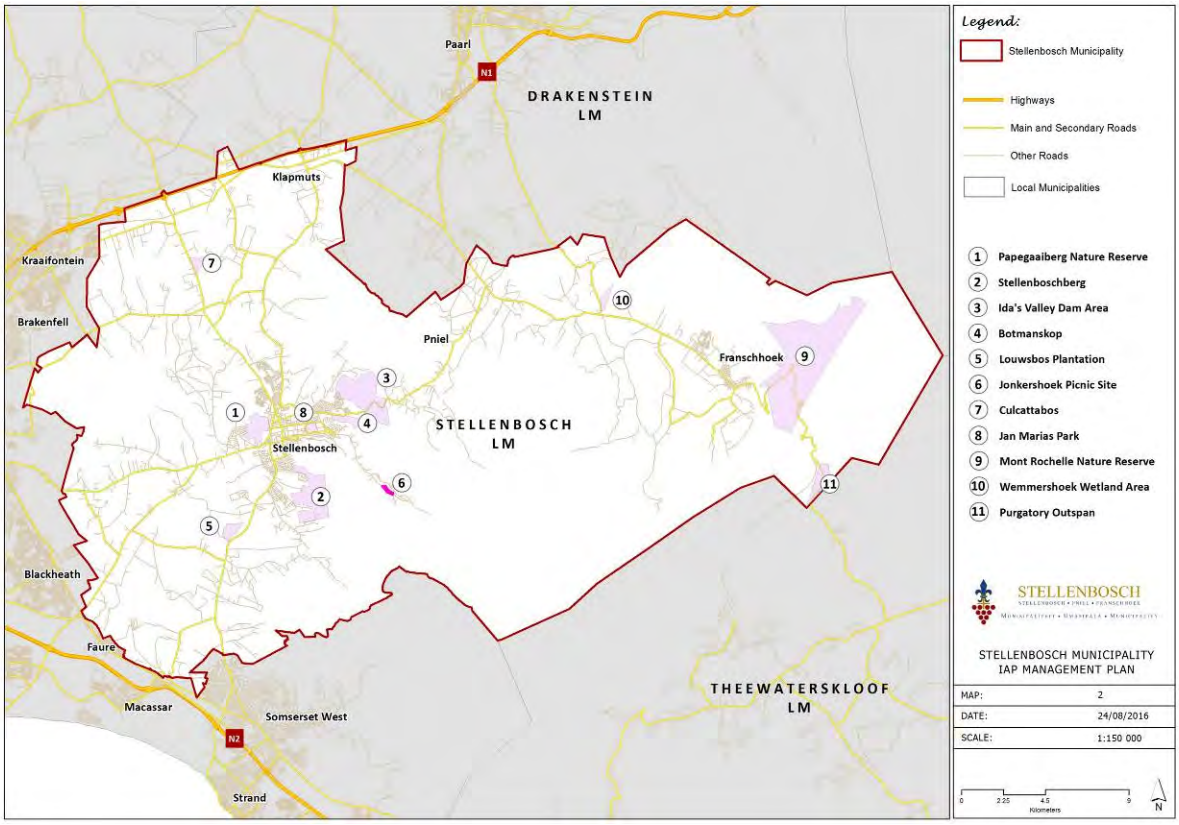

Figure 40: Jonkershoek Picnic Site.

10.6.3 Hydrology

Jonkershoek Picnic Site is bordered by the Eerste River, which originates within the Jonkershoek mountain range. Three rivers, also originating within the mountain range, enter the Eerste River above the Jonershoek Picnic site. These rivers are, in order of entering with the Eerste River, the Lambrechtsbos River, the Adolskloof River and Bosboukloof River.

10.6.4 Vegetation

Jonckershoek Picnic site is located within the Boland granite fynbos vegetation type. Boland granite fynbos has 56 Red Data plant species and 23 endemic plant species. There are approximately 62% remaining natural areas, of which 14% is protected in the Hawequas, Hottentots Holland and Paarl Mountain Nature Reserve. The 38% area lost has been transformed into vine orchids (SANBI 2009).

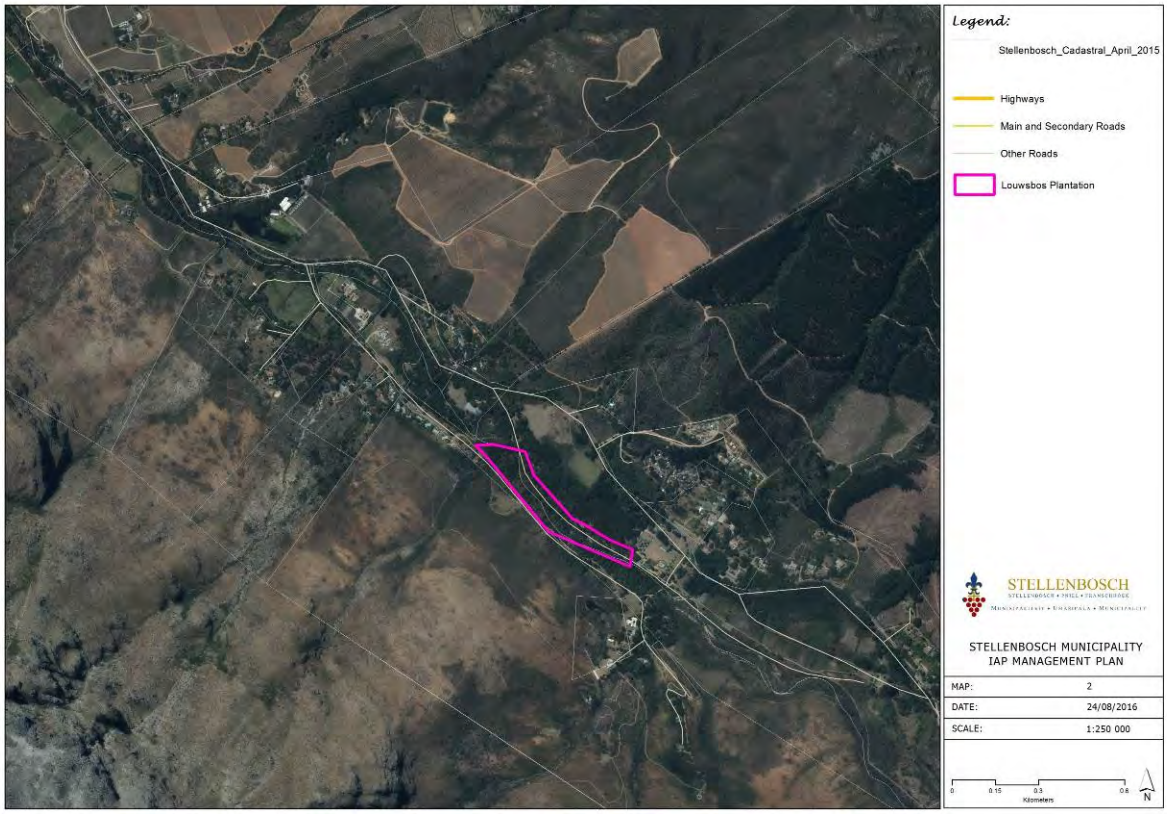

Figure 41: Local context of Jonkershoek Picnic Site.

10.6.5 Current Alien Invasive Plant Infestation

The natural vegetation originally occurring at Jonkershoek Picnic Site has been completely transformed by the large invasive trees that occur there (Figure 42). These invasive plants include *Acacia mearnsii, Acacia saligna, Rubus fruticosus, Robinia pseudoacacia, Populus canescens, Pinus pinea, Paraserianthus lophantha* and *Pittosporum undulatum.* The density of invasion is higher on the banks of the Eerste River.

10.6.6 Clearing Methods

The ambiance and aesthetic value provided by the tall trees makes Jonkershoek Picnic Site a popular picnic area for visitors. The complete removal of these trees will thus be regarded as undesirable. Selective clearing of invasive alien species will be the best removal strategy in order to decrease invasive species impact on the natural environment as well as keeping the ambiance and aesthetic value of the site. Invasive species with the highest negative environmental impact potential should be selected for removal. These species are *Acacia saligna*, *Acacia mearnsii*, *Acacia pygnantha, Acacia melanoxylon, Paraserianthus lophantha*, *Rubus fruicosus* and *Robinia pseudoacacia.* Clearing strategies should start at the area within the site from which the river enters the property and move downstream. This will minimize the re-establishment process of invasive alien plants within the cleared areas from overhead populations.

Figure 42: Alien invasive plant density (%) of Jonkershoek Picnic Site.

Removal strategies for clearing invasive alien species in Jonkershoek Picnic Site should be a combination of mechanical and chemical methods (Table 7, Section 11). Young trees should be removed mechanically by uprooting and large trees should be removed mechanically by tree felling of larger trees (via axe or chainsaw). The following species has resprouting characteristics and herbicides should be applied to the cut surface:

- *Acacia saligna;*
- *Acacia mearnsii;*
- *Acacia pygnantha;*
- *Acacia melanoxylon;*
- *Rubus fruicosus;*
- *Robinia pseudoacacia.*

Paraserianthus lophantha does not resprout and chemical methods are thus not necessary. The use of herbicides may have negative effects on the health of soil composition and the natural ecosystem and should thus be used with caution and in reasonable amounts. Continuous follow-up and removal of new seedlings after the initial clearing efforts are essential in order to clear the property of invasive alien plants. Follow-ups and monitoring should occur annually for a minimal of 5 years and remaining or re-established invasive species should be removed when located. The remaining invasive alien plants (such as *Populus canescens* and *Pinus pinea*), should be continuously monitored to ensure their negative environmental impacts do not increase. If these environmental impacts do increase, these species should also be removed.

Further recommendations for clearing strategies along the Eerste River includes collaborating with farmers and landowners downstream from Jonkershoek Picnic Site to clear invasive alien species along the river as an attempt to increase stream flow and thus water availability within the Jonkershoek area.

10.6.7 Zonation as an aid to the management of invasive alien plant species

A zonation map (Figure 43) was constructed as an aid for clearing alien invasive plants on Jonkershoek Picnic Site. The property boundaries and road was used for zone boundaries. The property is divided into 4 large zones (A-D).

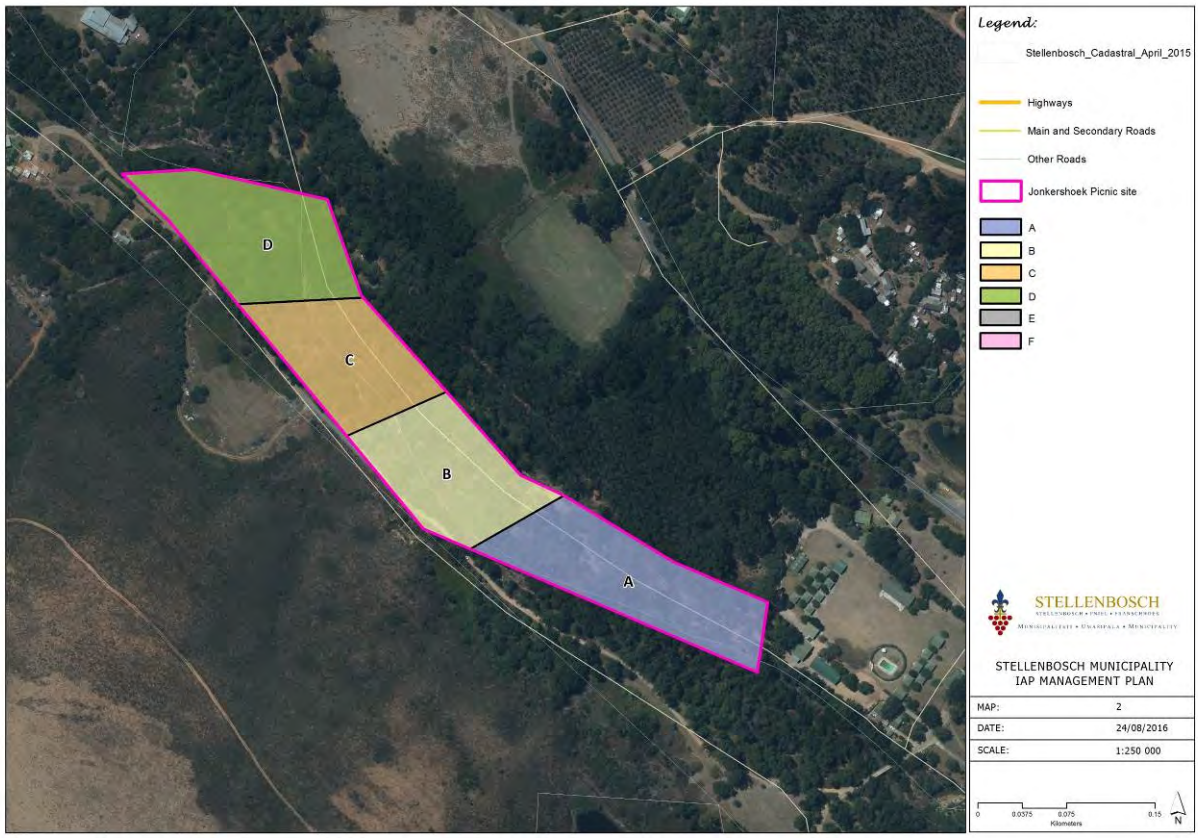

Figure 43: Zonation of Jonkershoek Picnic Site as an aid for alien invasive plant clearing.

Clearing of alien invasive plants on Jonkershoek Picnic Site should start at the north-western boundary of zone A and move in a south-eastern western direction towards zone B. Continue to clear zones B, C to D. Repeat this working cycle when conducting monitoring and removal of re-establish alien species.

10.7 CULCATTABOS

10.7.1 Location

Culcattabos borders the R304 to the north of Koelenhof and covers an area of approximately 40ha. Culcattabos is surrounded by privately owned agricultural land that is actively farmed. Because of this the area is highly transformed.

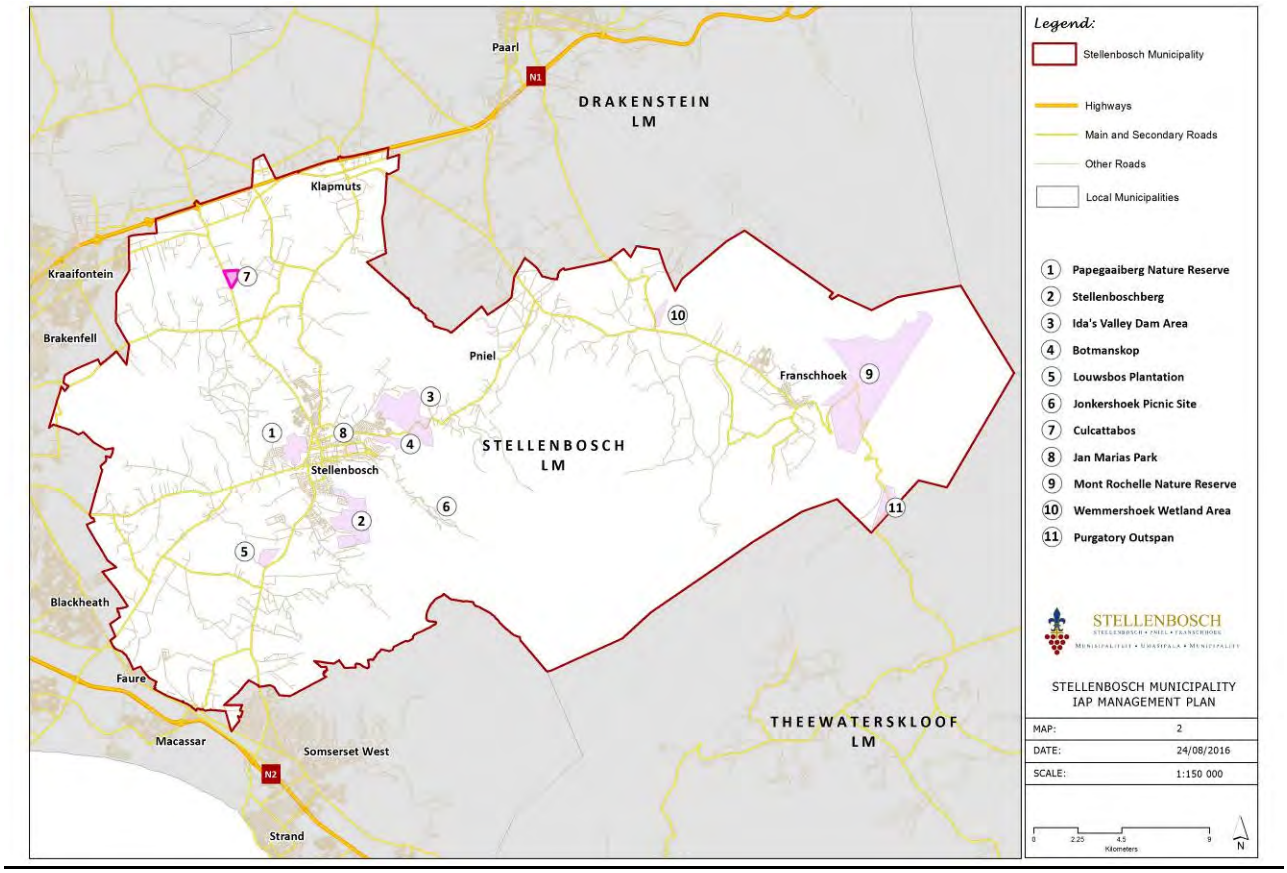

Figure 44: Culcattabos.

A stream that joins the Plankenbrug towards Stellenbosch town flows past the eastern portion of the site.

10.7.2 Current Alien Invasive Plant Infestation

Culcattabos is heavily with *Eucalyptus grobulus* across the whole of the property.

10.7.3 Clearing Methods

A comprehensive management strategy needs to be followed to ensure successful clearing of invasive alien species on Calcattabos, especially due to the degree of infestation in the area and the

maturity thereof. Such a management strategy includes initial clearing methods with several follow-up and monitoring efforts to ensure successful clearing of invasive alien plants.

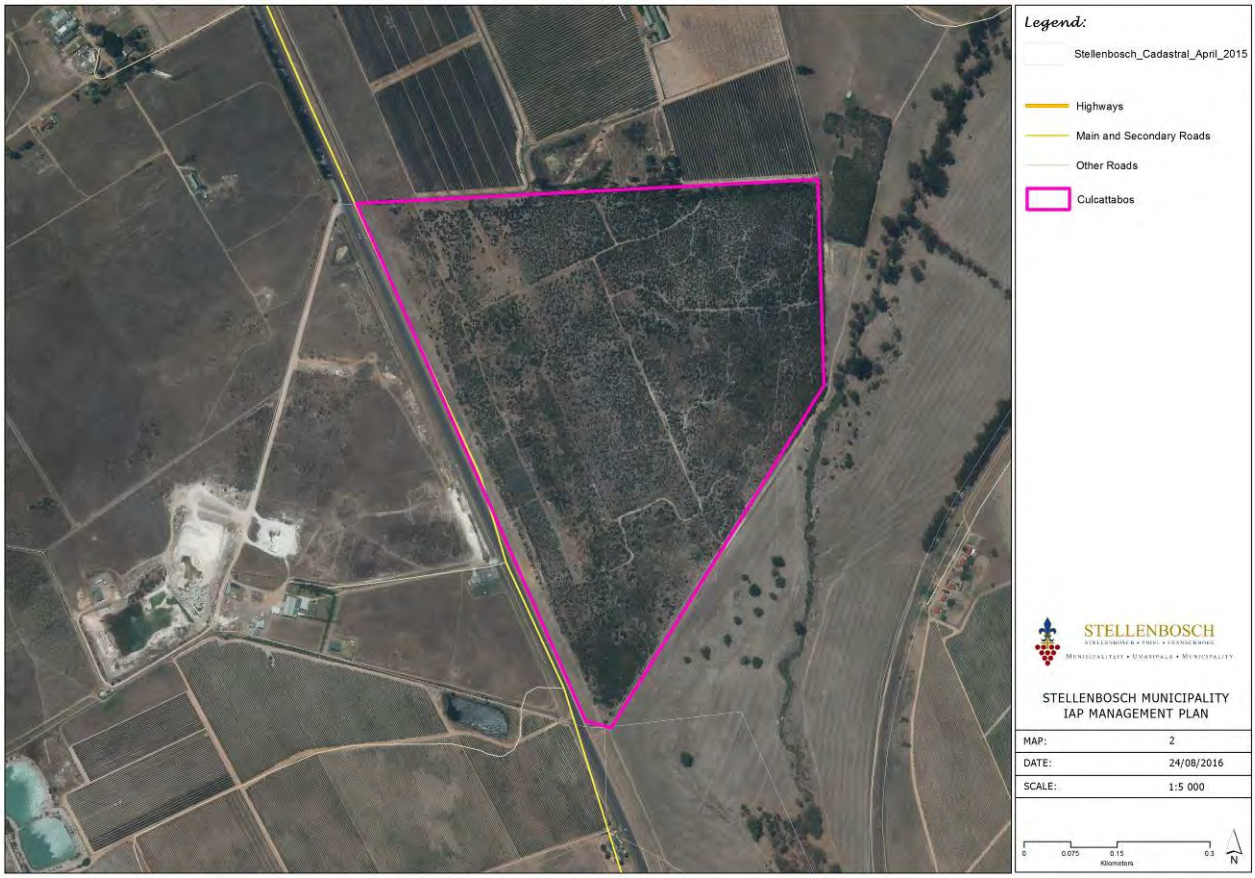

Figure 45: Culcattabos.

Removal strategies for clearing invasive alien species on Culcattabos should be a combination of mechanical and chemical methods (Table 7, Section 11). Trees should be removed mechanically by uprooting young plants and tree felling of larger trees (via axe or chainsaw). Herbicides should be applied to the cut surface soon after tree felling (see Table 7, Section 11). The use of herbicides may have negative effects on the health of soil composition and the natural ecosystem and should thus be used with caution and in reasonable amounts. Continuous follow-up and removal of new seedlings after the initial clearing efforts are essential in order to clear the property of invasive alien plants. Follow ups and monitoring should occur annually and remaining or re-established invasive species should be removed when located. Biomass should be disposed of at a distance from the property. Wood from large trees can be retailed as timber products.

10.7.4 Zonation as an aid to the management of invasive alien plant species

A zonation map (Figure 46) was constructed as an aid for clearing alien invasive plants on the Culcattabos site. The property boundaries and road was used for zone boundaries. The property is divided into 3 large zones (A-C).

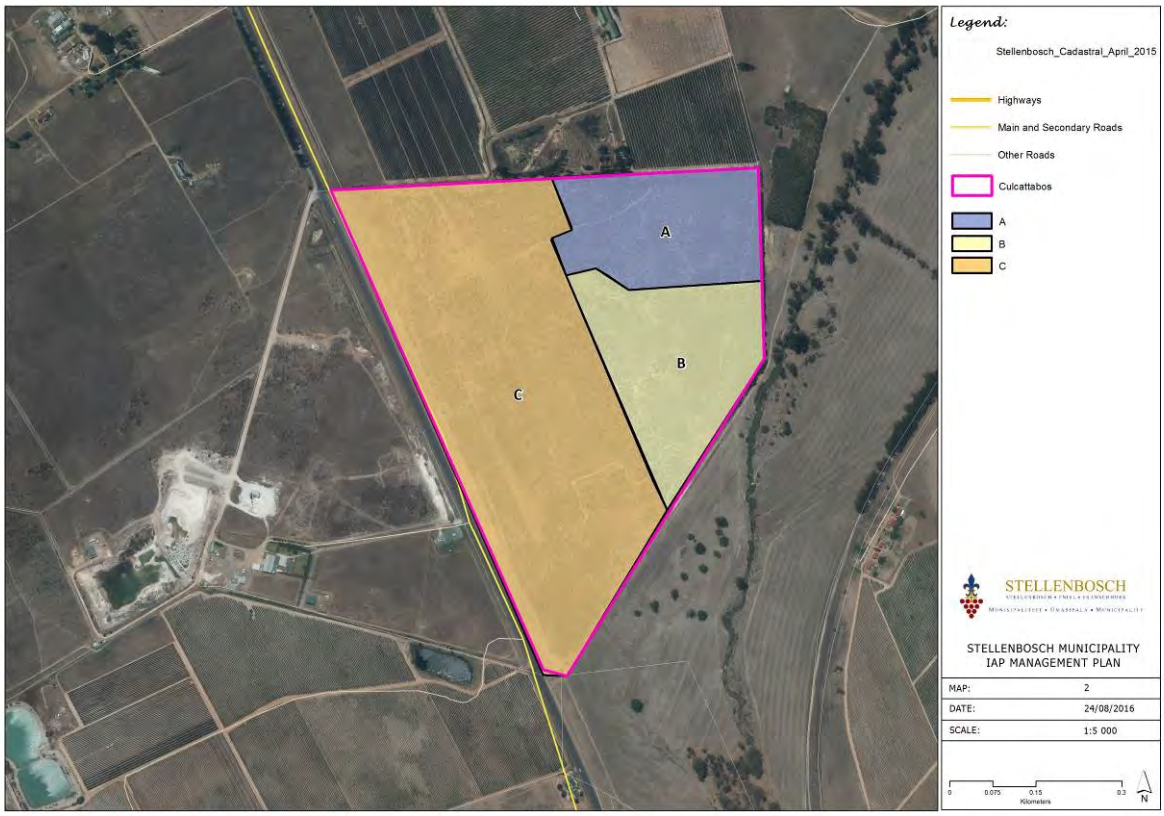

Figure 46: Zonation of Culcattabos as an aid for alien invasive plant clearing.

Clearing of alien invasive plants at Culcattabos should start at the north-eastern corner of zone A and move in a south- western direction towards C. Repeat this working cycle when conducting monitoring and removal of re-establish alien species.

10.8 JAN MARAIS NATURE RESERVE

10.8.1 Location

Jan Marais Nature Reserve is situated within the town of Stellenbosch and covers an area of about 23ha. There are private residential properties adjacent the reserves north, east and south boundaries, though a road separates the reserve with the north and east residential properties. Along the western border, separated by a road, is the Stellenbosch High School. The terrain is relatively flat and open to the public during the day.

10.8.2 Soil

The soil is imperfectly drained sandy soil and is mostly comprised of rock with limited soil.

10.8.3 Hydrology

There are no rivers that flow through the reserve, though there is a wetland found within the boundaries of the reserve. This wetland is an important habitat for many species such as dragon and damselflies.

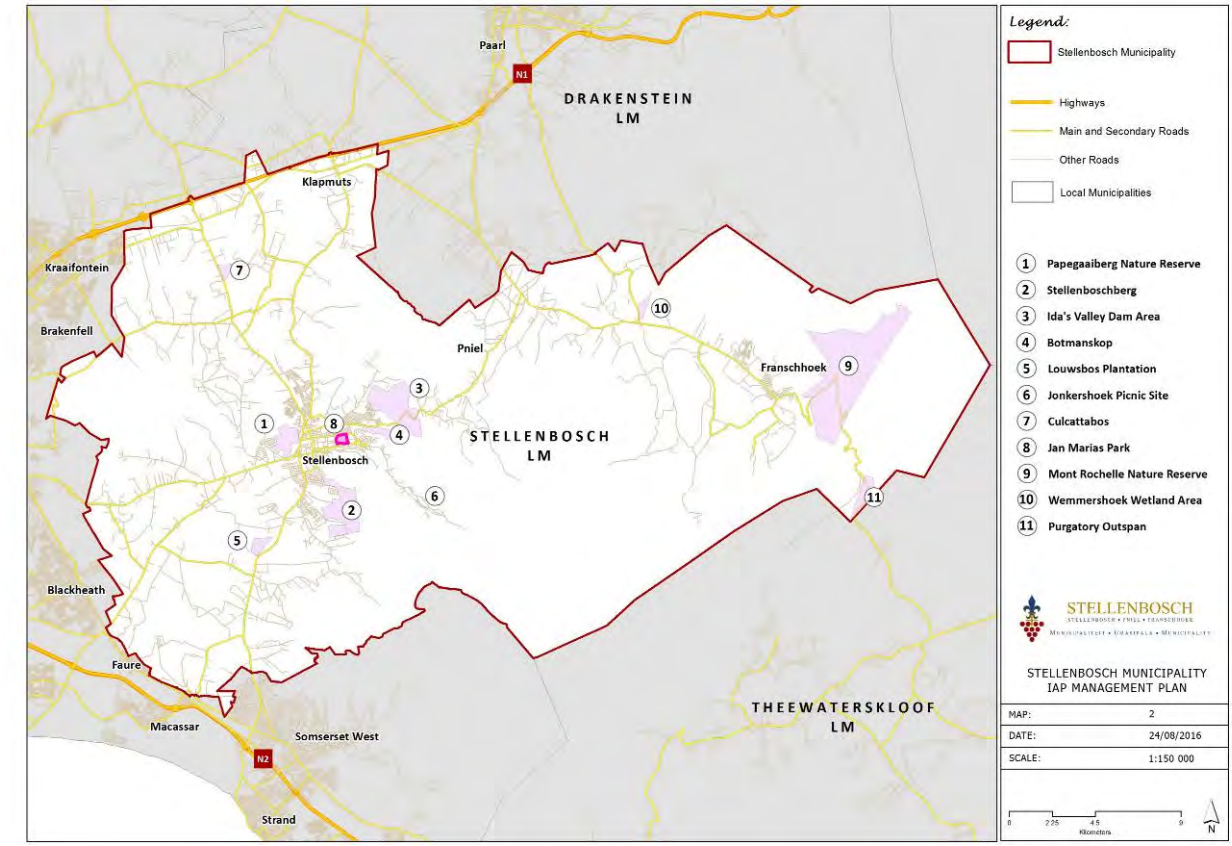

Figure 47: Jan Marais Nature Reserve.

10.8.4 Vegetation

The reserve is a formal land based protected area with Boland Granite Fynbos vegetation type, which is highly threatened due to extensive farming activities and thus falls within the vulnerable terrestrial ecosystem. Boland granite fynbos has 56 Red Data plant species and 23 endemic plant species. There are approximately 62% remaining natural areas, of which 14% is protected in the Hawequas, Hottentots Holland and Paarl Mountain Nature Reserve.

10.8.5 Current Alien Invasive Plant Infestation

There are no major infestations of alien invasive plants within Jan Marais Nature Reserve with the exception of several large *Eucalyptus grobulus* and large *Pinus pinea* trees along the northern border of the reserve. Continuous monitoring regularly occurs to ensure no regrowth of any invasive species.

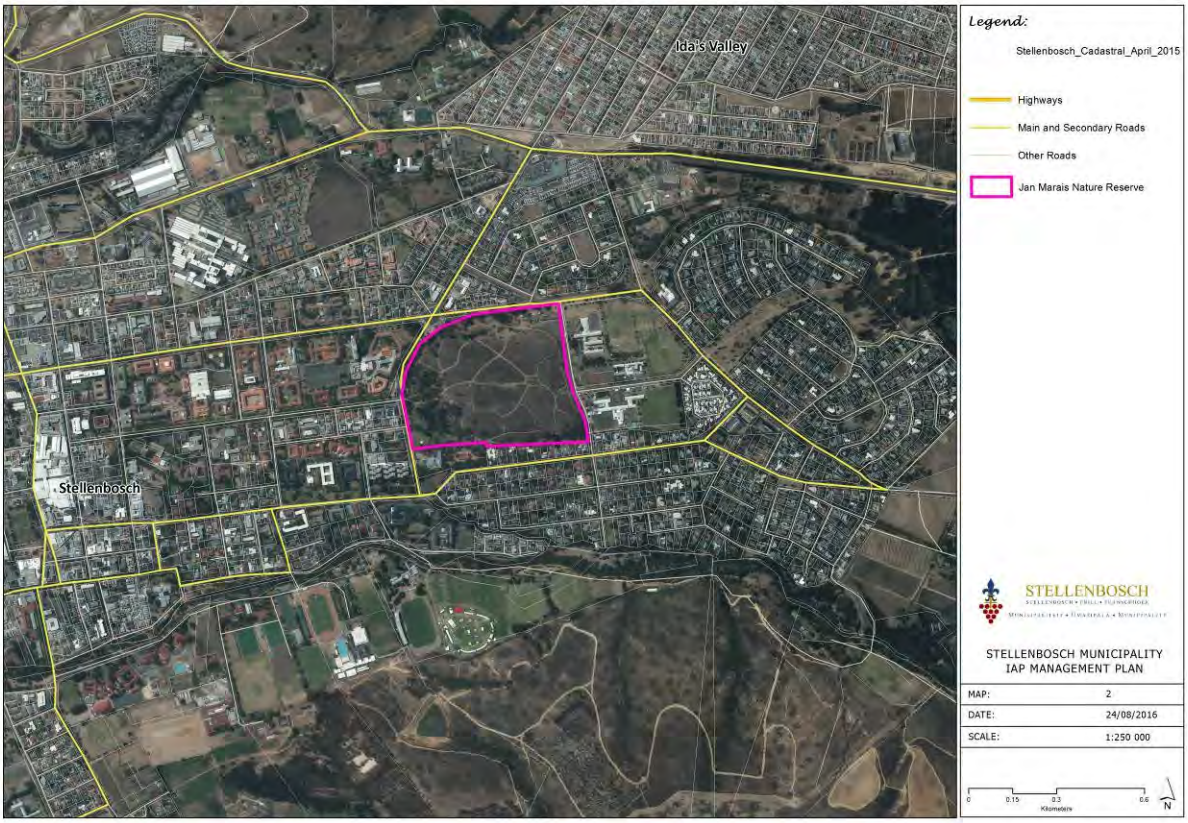

Figure 48: Jan Marais Nature Reserve.

10.8.6 Clearing Methods

Jan Marais Nature Reserve is by al standards cleared of alien invasive species, though continuous monitoring for possible establishment of invasive species should occur regularly. If an alien invasive plant is found within the reserve it should be removed (by uprooting it) and disposed of away from the reserve.

10.9 MONT ROCHELLE NATURE RESERVE

10.9.1 Location

Mont Rochelle Nature Reserve occurs on the edge of the town Franschoek, on the slope of the Franschoek Mountain Range. The northern boundary of the reserve is virtually at the uppermost height of the mountain range, while the eastern boundary, which runs along the Lambrechts road. The southern boundary borders a plantation while a private residential area to the south and a pine plantation to the north border the western boundary.

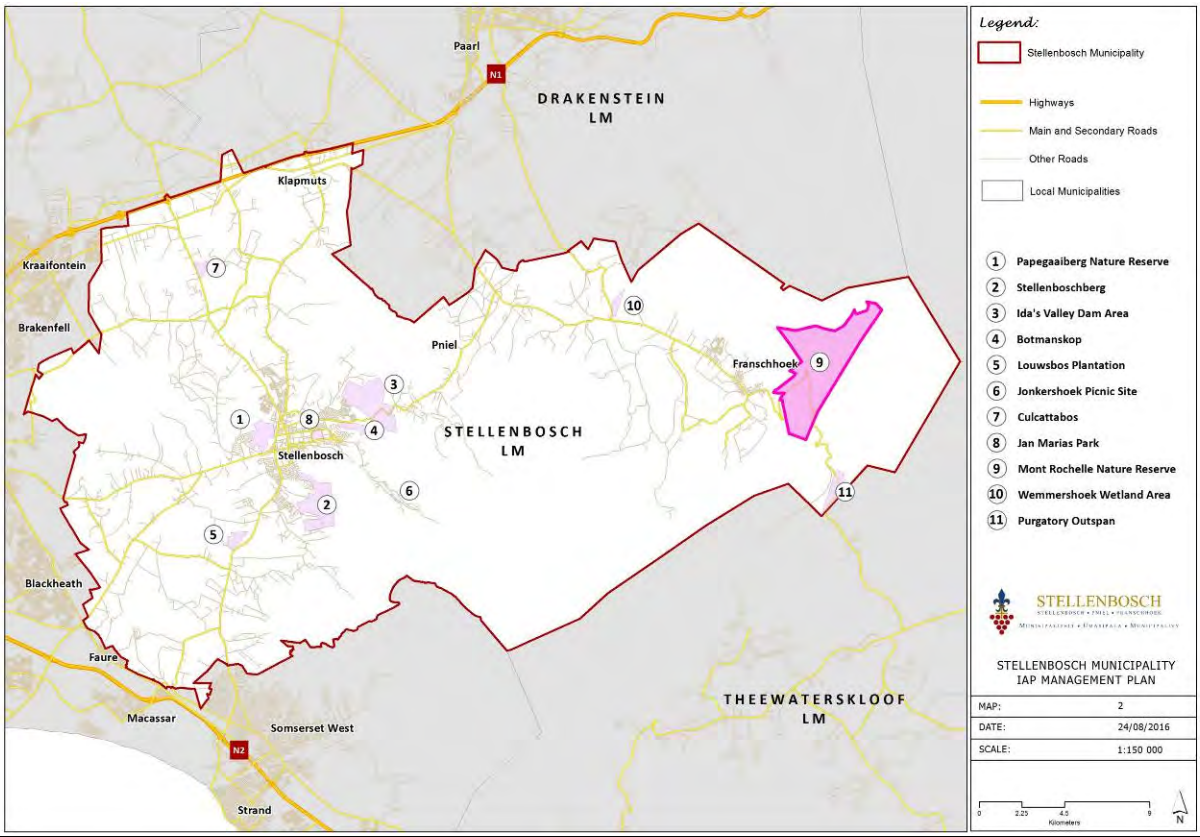

Figure 49: Mont Rochelle Nature Reserve.

Mont Rochelle Nature Reserve is approximately 95ha in size. The reserve gradually increases in height up the slope of the Franschhoek Mountain.

10.9.2 Soil

The soil type is rock with minimum development soils that is usually shallow on hard, weathered rock and is with/without intermediate diverse soils. It has a non-soil land class with structure less and poorly drained soils. Lime is rare or absent in the landscape.

10.9.3 Hydrology

Two rivers are located in close proximity of the Reserve. De Toits River flows adjacent the eastern boundary (which is up slope from the reserve) and the Franshoek River.

10.9.4 Vegetation

The Boland granite fynbos and Kogelberg sandstone fynbos vegetation types found in Mont Rochelle Nature Reserve are of significant conservation importance. Boland granite fynbos has 56 Red Data plant species and 23 endemic plant species. There are approximately 62% remaining natural areas, of which 14% is protected in the Hawequas, Hottentots Holland and Paarl Mountain Nature Reserve. The 38% area lost has been transformed into vine orchids.

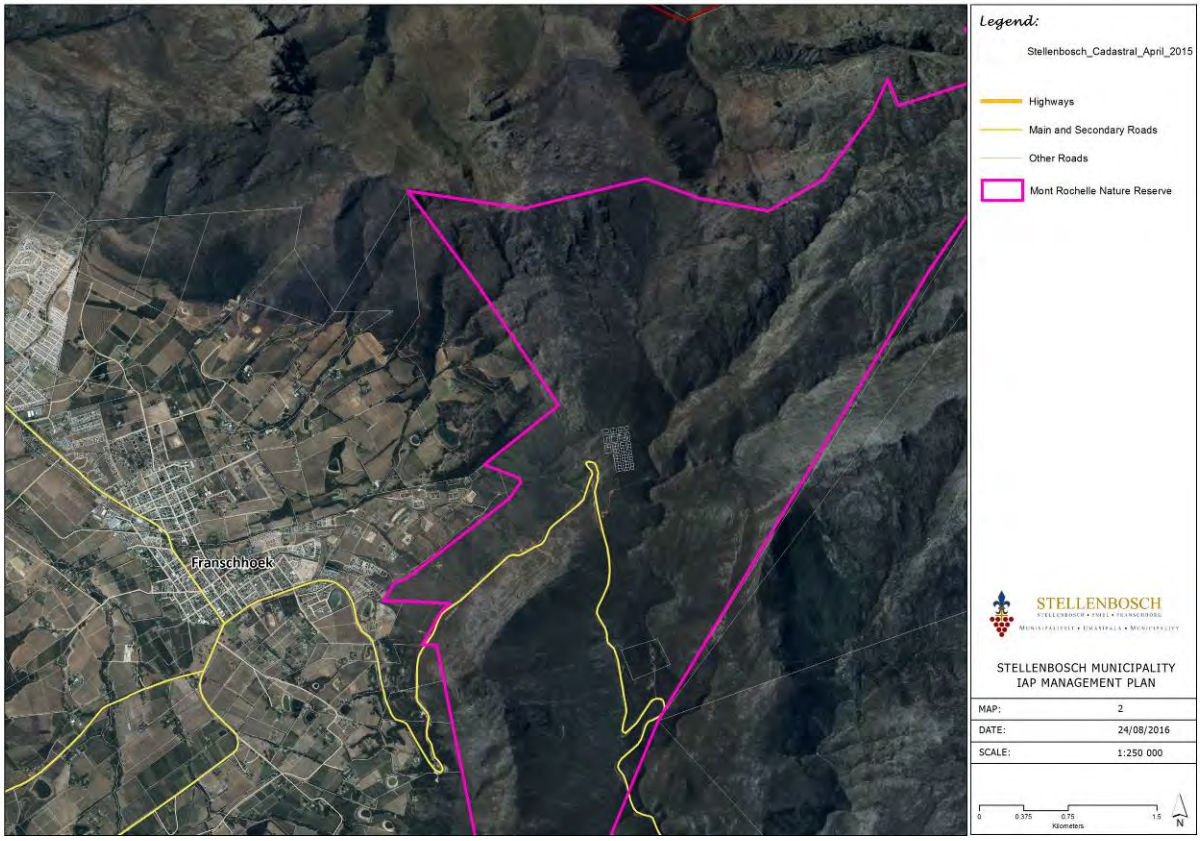

Figure 50: Local context of Mont Rochelle Nature Reserve.

Kogelberg sandtone vegetation is well protected with a remaining 88% of which approximately 58% is actively protected in the Hottentots Holland and Groenlandberg nature Reserve as well as the Kogelberg Biosphere Reserve. There are 99 Red Data plant species located within the Kogelberg sandstone fynbos, and has 176 endemic plant species (SANBI 2009).

10.9.5 Current Alien Invasive Plant Infestation

There are no major infestations of alien invasive plants within Mont Rochelle Nature Reserve. The presence of *Pinus* species, *Eucalyptus* species, *Acacia Mearnsii* and *Acacia melanoxylon* is classified as exceedingly rare and was thus not recorded. Continuous monitoring, however, should transpire regularly to ensure no regrowth of any invasive species occurs. If a species sprouts it is removed almost immediately and destroyed.

10.9.6 Clearing Methods

Mont Rochelle Nature Reserve is by all standards cleared of alien invasive species. The Pine plantation, located on the northern side of the southern western boundary, and the Eucalyptus plantation, located on the southern boundary, has potential to spread into the reserve, and continuous monitoring for possible establishment of invasive species should occur regularly. If an

alien invasive plant is found within the reserve it should be removed (by pulling the plant out) and disposed of away from the reserve.

10.10 WEMMERSHOEK WETLAND AREA

10.10.1 Location

Wemmershoek wetland area is located at the intersection of the R45 and the R301 at Wemmershoek on the way to Franschhoek town. The whole of the property is approximately 40ha in size sloping towards the Franschhoek River with a wetland at the lowest point.

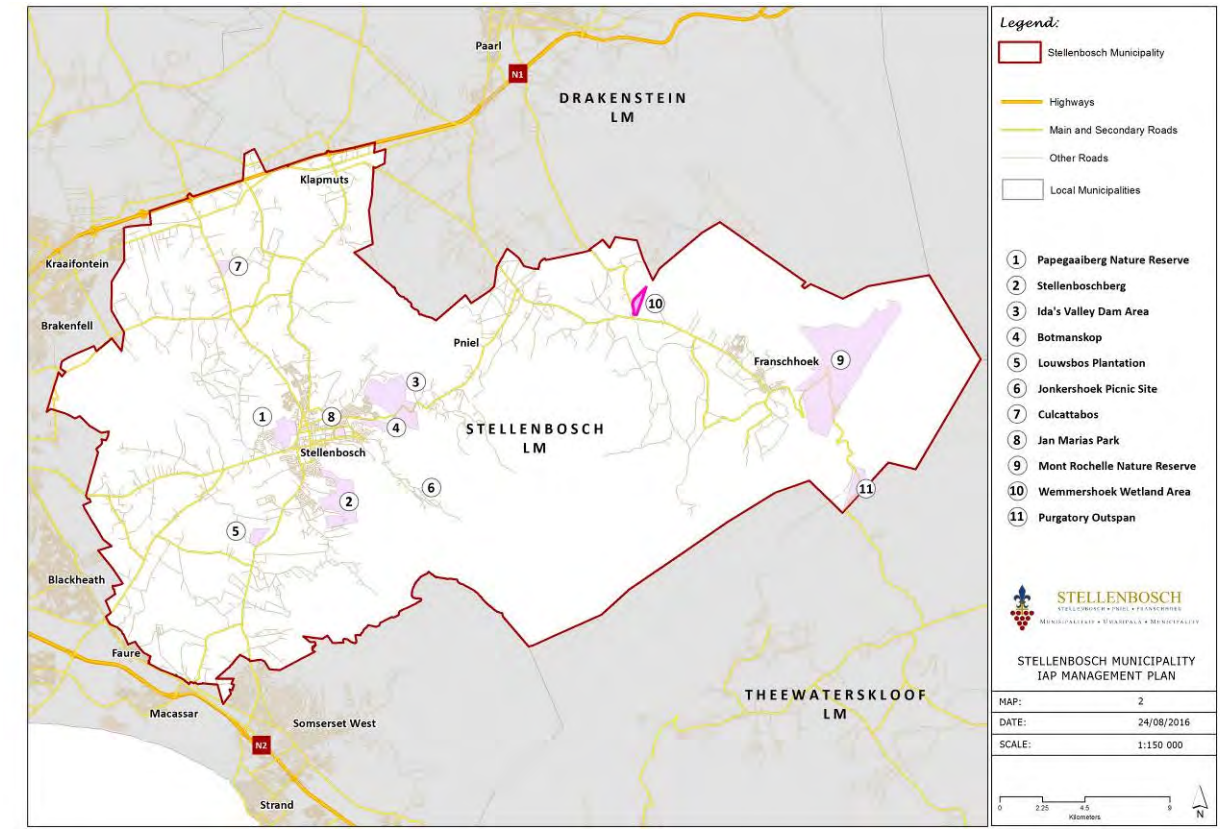

Figure 51: Wemmershoek Wetland Area.

10.10.2 Vegetation

Although the property has no formal protection status, a recent survey listed various Red Data plant species, especially in the vicinity of the wetland.

10.10.3 Current Alien Invasive Plant Infestation

There are no major infestations of alien invasive plants within the Wemmershoek wetland area.

Continuous monitoring, however, should transpire regularly to ensure no regrowth of any invasive species occurs. If a species sprouts it should be removed immediately and destroyed.

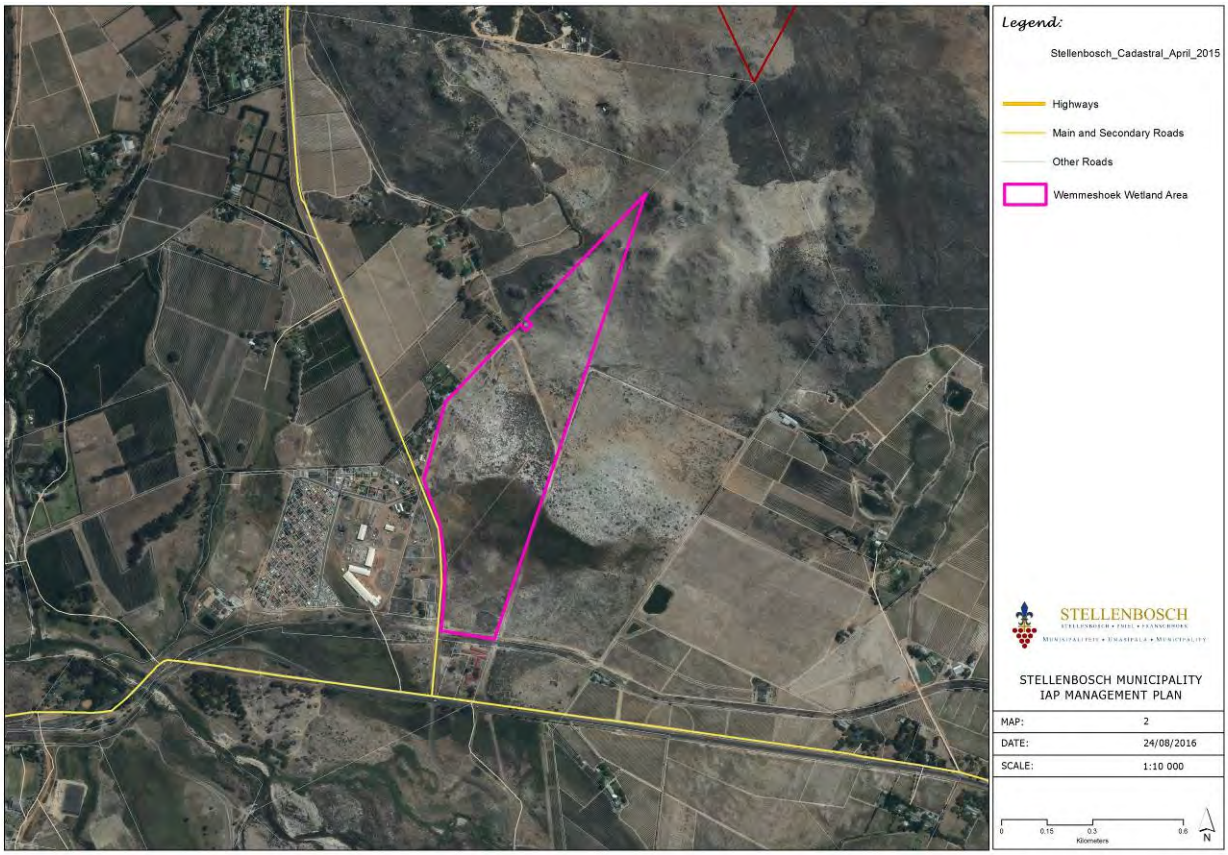

Figure 52: Wemmershoek Wetland Area.

10.10.6 Clearing Methods

Wemmershoek wetland area is by all standards cleared of alien invasive species. Continuous monitoring for possible establishment of invasive species should occur regularly. If an alien invasive plant is found within the area it should be removed (by pulling the plant out) and disposed of away from the property.

10.11 PURGATORY OUTSPAN

10.11.1 Location

Purgatory Outspan is located on the Theewaterskloof Dam's side of the Franschhoek Pass (see Figure 53 below). It is located at the foot of the pass on the municipal boundary and consists of an area of approximately 120ha.

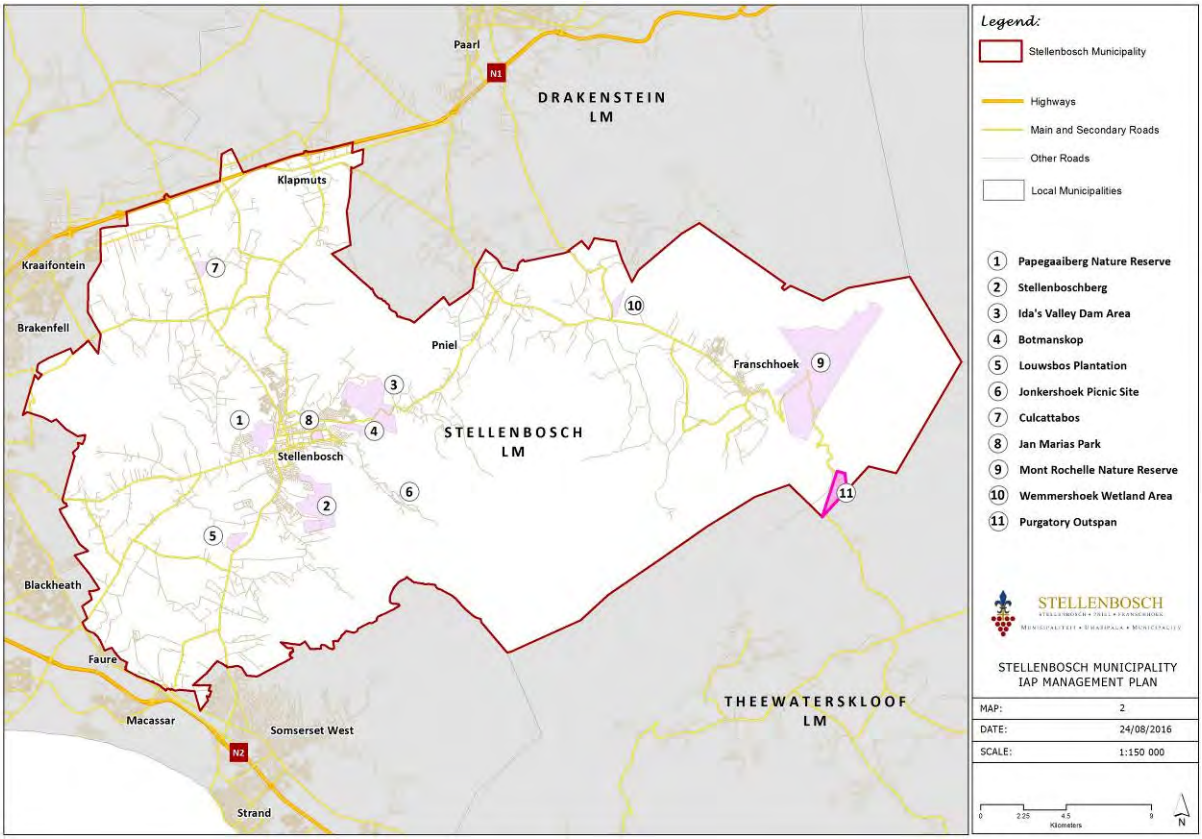

Figure 53: Purgatory Outspan.

10.11.2 Hydrology

Purgatory Outspan is located in a drainage area feeding the Theewaterskloof Dam.

10.11.4 Vegetation

The Boland granite fynbos and Kogelberg sandstone fynbos vegetation types found in the Pargatory Outspan area are of significant conservation importance. Boland granite fynbos has 56 Red Data plant species and 23 endemic plant species. There are approximately 62% remaining natural areas, of which 14% is protected in the Hawequas, Hottentots Holland and Paarl Mountain Nature Reserve. The 38% area lost has been transformed into vine orchids.

Kogelberg sandtone vegetation is well protected with a remaining 88% of which approximately 58% is actively protected in the Hottentots Holland and Groenlandberg nature Reserve as well as the Kogelberg Biosphere Reserve. There are 99 Red Data plant species located within the Kogelberg sandstone fynbos, and has 176 endemic plant species (SANBI 2009).

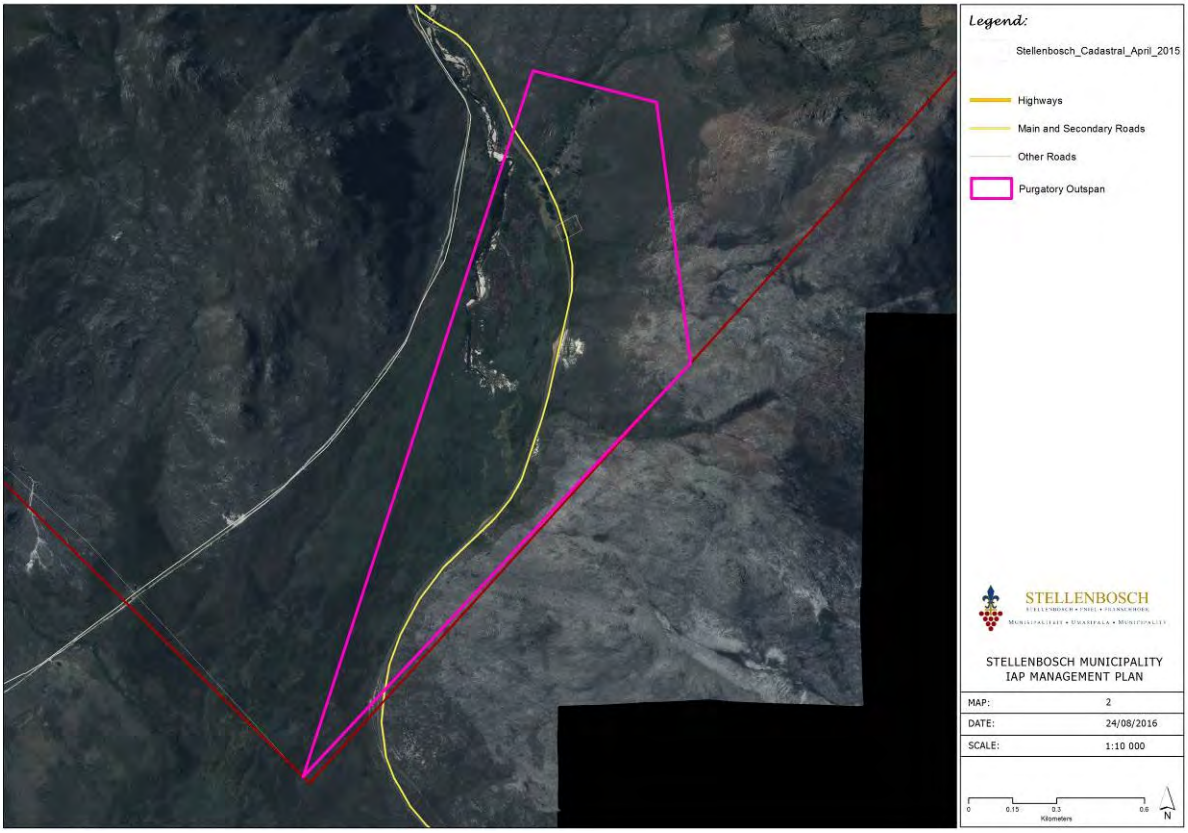

Figure 54: Local context of Purgatory Outspan.

10.11.5 Current Alien Invasive Plant Infestation

There are no major infestations of alien invasive plants within the Pargatory Outspan area. Continuous monitoring, however, should transpire regularly to ensure no regrowth of any invasive species occurs. If a species sprouts it is removed almost immediately and destroyed.

10.11.6 Clearing Methods

The Pargatory Outspan area is by all standards cleared of alien invasive species. Monitoring for possible establishment of invasive species should occur regularly. If an alien invasive plant is found on the property it should be removed (by pulling the plant out) and disposed of away from the site.

11. STRATEGIES FOR CLEARING

Table 7: Control methods of alien invasive plant species occurring in the Stellenbosch Municipal Area[23].

Species	Plant Invasion Impact	Control methods	Control Caution
Acacia implexa (Screw-pod wattle)	Screw-pod wattle is a fast growing tree and invades agricultural lands, planted forest and disturbed areas. It can become highly invasive if not controlled.	**Mechanical:** Uproot young plants. Uproot and sever below junction of roots. Tree felling. **Chemical:** There is no registered herbicide for this species.	There is no registered chemical for this species, thus mechanical removal of this species should be executed with caution.
Acacia mearnsii (Black Wattle)	Black wattle forms dense impenetrable 'jungle thickets' that supresses indigenous vegetation. When occurring along watercourses may reduce water flow.	**Mechanical:** Uproot and sever below junction of roots. Tree felling. **Chemical:** Trees severed above ground should be treated with herbicides, such as 2,4,5-T in diesel oil. Glyphosphate can be used to control seedlings and saplings. • CHOPPER (L3444), HATCHET (L7409). Use 1 l/10 l water. Apply to freshly cut stumps. Apply at least 10 ml per 100 mm of stump diameter. • ACCESS 240 LS (L4920), BROWSER (L7357). Use 150 ml + 50 ml Actipron Super or BP Crop Oil/10 ml water. Apply to the cut surface of low cut stumps within 3 hours of felling. • LUMBERJACK 360 SL (L7295), TIMBREL 360 SL (L4917). Use 300 ml + 50 ml Acrtipron Super or BP Crop Oil/10l water. Apply to the cut surface of low cut stumps within 3 hours of felling.	Do not fell, bulldoze or burn without immediate follow up with herbicides due to rapid resprouting.
Acacia melanoxylon (Blackwood)	Grows best in moist and cool situations and is most common in forests, on forest margins and along streams.	**Mechanical:** Uproot young plants. Uproot and sever below junction of roots. Tree felling. **Chemical:** Trees severed above ground should be treated with	The wood and ornamental products of this species is highly used. This may cause it to be continuously planted for harvesting reasons. Thus, management

[23] Bromiow 2010; Striton 1978; Anon 2005

Species	Plant Invasion Impact	Control methods	Control Caution
	It is a strong competitor with indigenous forest and riverine woodland trees and in shaded areas its seedlings are able o flourish. This species also spreads vegetatively by suckers from its long surface roots.	herbicides. • CONFRONT 360 SL (L7314). Use 400 ml + 50 ml Actipron Super/10 l water. Apply to cut surface of low cut stumps within 3 hours of felling. • TIMBREL 360 SL (4917). Use 600 ml + 50 ml Acrtipron Super/10l water. Apply to the cut surface of low cut stumps within 3 hours of felling. **Biological:** Use as a long-term programme. Release of seed feeding weevil (*Melanterius maculatus*): attacks seeds of Black Wattle and reduces seed bank.	of plantation of the species in highly important to prevent possible escape and establishment outside plantation borders.
Acacia saligna (Port Jackson)	Confined to coastal plains with mean annual rainfall of >250 mm. It is able to establish in dry areas as well as in the wetter areas, and the spread is affected by soil moisture, altitude and seed dispersal agents (mainly man and water).	**Mechanical:** Uproot young plants. Uproot and sever below junction of roots. Tree felling. **Chemical:** Trees severed above ground should be treated with herbicides. • CONFRONT 360 SL (L7314). Use 250 ml + 50 ml Actipron Super/10 l water. Apply to cut surface of low cut stumps within 3 hours of felling. • LUMBERJACK 360 SL (L7295), TIMBREL 360 SL (L4917). Use 300 ml + 50 ml Acrtipron Super or BP Crop Oil/10l water. Apply to the cut surface of low cut stumps within 3 hours of felling.	Port Jacksons reproduce rapidly after fire occurrences. Apply herbicides almost immediately after severing due to rapid resprouting. Port Jackson will rapidly spread to disturbed areas, thus continuous monitoring of disturbed areas are important.
Acacia pygnantha (Golden Wattle)	Less widely distributed and invasive as other wattles. Introduced as stabilizing agent. Replaces indigenous vegetation.	**Mechanical:** Uproot young plants. Uproot and sever below junction of roots. Tree felling. **Chemical:** Trees severed above ground should be treated with herbicides. • MOLOPO 500 SC (L5854) (Soil treatment). Use 1,5 l/2,25l water. Apply on the soil at the base of the target plant before or during rainy season. For seedlings use 2 ml /plant; for trees up to 1 m use 2 x 2 ml /tree; for trees 1-2 m use 3-4 x	This species requires a combination of mechanical, chemical and cultural techniques when removed.

Species	Plant Invasion Impact	Control methods	Control Caution
		2 ml /tree; for each additional metre above 2 m use 2 x 2 ml (maximum of 16 ml) • MOLOPO 800 SC (L7043) (Soil treatment). Use 937 g/3,752 l water. Apply on the soil at the base of the target plant. For seedlings use 2 ml /plant; for trees up to 1 m use 2 x 2 ml /tree; for trees 1-2 m use 3-4 x 2 ml /tree; for each additional metre above 2 m use 2 x 2 ml (maximum of 8 doses)	
Eucalyptus grandis (Saligna gum)	Eucalyptus species use a large amount of water, thus reducing stream flow and lowering water supply. Eucalyptus species are highly competitors and are able to outcompete indigenous species, thereby threatening local biodiversity.	**Mechanical:** Uproot young plants. Uproot and sever below junction of roots. Tree felling. Seedlings can be removed by hand and are also susceptible to fire. **Chemical:** Trees severed above ground should be treated with herbicides. • ROUNDUP MAX (L6790). Use 265 g/10 l water. Apply to cut surface of low cut stumps within 3 hours of felling. • LUMBERJACK 360 SL (L7295), TIMBREL 360 SL (L4917). Use 300 ml + 50 ml Acrtipron Super or BP Crop Oil/10l water. Apply to the cut surface of low cut stumps within 3 hours of felling.	Apply herbicides almost immediately after severing due to rapid resprouting.
Paraserianthus lophantha	This species forms monospecific stands and has altered the landscape in many areas where it occurs.	**Mechanical:** Uproot young plants. Uproot and sever below junction of roots. Tree felling. **Chemical:** This species does not resprout from burnt or cut stems and does not require herbiced application.	Seedfeeding bio-control agents have not been affective and long-term follow-ups are needed to remove this species.
Pinus pinea (Stone Pine)	This species easily establishes in cool moist areas where they transform the landscape and reduce the carrying capacity of the area as well as increase fire risk.	**Mechanical:** Uprooting young plants (especially in moist soil). Uproot and sever below junction of roots. Tree felling. **Chemical:** Trees severed above ground should be treated with herbicides. • ROUNDUP MAX (L6790). Use	Accumulation of fuel load increases the danger of fire.

Species	Plant Invasion Impact	Control methods	Control Caution
		265g/10 l water. Apply to cut surface of low cut stumps within 3 hours of felling. For seedlings use 2 ml /plant; for trees up to 1 m use 2 x 2 ml /tree; for trees 1-2 m use 3-4 x 2 ml /tree; for each additional metre above 2 m use 2 x 2 ml (maximum of 16 ml) • MOLOPO 800 SC (L7043) (Soil treatment). Use 937g/3,752 l water. Apply on the soil at the base of the target plant. For seedlings use 2 ml /plant; for trees up to 1 m use 2 x 2 ml /tree; for trees 1-2 m use 3-4 x 2 ml /tree; for each additional metre above 2 m use 2 x 2 ml (maximum of 8 doses)	
Pinus pinaster (Cluster Pine)	Seedlings germinate easily and establish in cool, moist soil. Pine trees reduce carrying capacity of invaded areas such as mountain and lowland fynbos, and thus threaten native biodiversity.	**Mechanical:** Uproot young plants. Uproot and sever below junction of roots. Tree felling. Burn approximately 12 to 24 months after clearing to eliminate seedlings. **Chemical:** Trees severed above ground should be treated with herbicides. • ROUNDUP MAX (L6790). Use 265g/10 l water. Apply to cut surface of low cut stumps within 3 hours of felling. For seedlings use 2 ml /plant; for trees up to 1 m use 2 x 2 ml /tree; for trees 1-2 m use 3-4 x 2 ml /tree; for each additional metre above 2 m use 2 x 2 ml (maximum of 16 ml) • MOLOPO 800 SC (L7043) (Soil treatment). Use 937g/3,752 l water. Apply on the soil at the base of the target plant. For seedlings use 2 ml /plant; for trees up to 1 m use 2 x 2 ml /tree; for trees 1-2 m use 3-4 x 2 ml /tree; for each additional metre above 2 m use 2 x 2 ml (maximum of 8 doses)	Accumulation of fuel load increases the danger of fire.
Pittosprum undulatum	This species has a fast growth rate and	**Mechanical:** Uproot young plants. Uproot and sever below junction of	There is no registered chemical for this species,

Species	Plant Invasion Impact	Control methods	Control Caution
	shades out many other plants. Its ability to adapt to higher nutrient soils enables it to out-compete indigenous species. Its seeds are highly favourable by birds, and they may neglect the seed of indigenous species, causing a reduction in their seed dispersal.	roots. Tree felling. **Chemical:** There is no registered herbicide for this species.	thus mechanical removal of this species should be executed with caution.
Populus canescens	These trees are found throughout the country on riverbanks and in vleis, where they form dense and uniform stands. They can spread into surrounding veld.	**Mechanical:** Uproot young plants. Uproot and sever below junction of roots. Tree felling. **Chemical:** Trees severed above ground should be treated with herbicides. • CHOPPER (L3444), HATCHET (L7409). Use 500 ml/10 l water. Apply to the cut surface of low cut stumps. Apply at least 10 ml per 100 mm of stump diameter. • ACCESS 240 SL (L4920), BROWSER (L7357). Use 200 ml + Actipron Super or BP Crop Oil//10 l water. Apply to the cut surface of low cut stumps within 3 hours of felling. • LUMBERJACK 360 SL (L7295), TIMBREL 360 SL (L4917). Use 600 ml + 50 ml Acrtipron Super or BP Crop Oil/10l water. Apply to the cut surface of low cut stumps within 3 hours of felling.	This species is difficult to control mechanically as they are able to coppice when cut and regenerates vigorously from root suckers. Herbicides should thus be used when controlling this species.
Robinia pseudoacacia (Black locust)	This species is found on riverbacks and alongside roads. The seeds, inner bark and shoots are poisonous. The flowers compete with native species for pollinators. Dense clonal clusters replace other	**Mechanical:** any attempts to cut down this tree will stimulate sucker production from roots and stumps. Mechanical control is thus non-optional. **Chemical:** This trees species does not respond well to herbicides, though systematic application products are available. • CONFRONT 360 SL (L7314). Use	This species is able to resprout even several years after it appears to be killed. Thus, annual monitoring and follow up treatments are important.

Species	Plant Invasion Impact	Control methods	Control Caution
	indigenous vegetation.	200ml + 50ml Actipron Super/10l water. Apply as full cover spray to actively growing plants. Plants too high should be slashed and regrowth sprayed. • PLENUM 160 ME (L7702). Use 150ml + 50ml Actipron Super/10l water. Apply as full cover spray to actively growing plants.	
Rubus fruticosus (European Blackberry)	This species is recently described as a problem species, though it has little impact in southern parts of South Africa. In Natal, it forms dense stands and the thorny bushes are impenetrable, which restrict the movement of humans and animals.	**Mechanical:** cultivation/removal of the rhizome. **Chemical:** Specialized herbicides are used due to underground runners and are mostly affective in autumn because the sap transports the chemical to the roots. • ROUNDUP MAX (L6790). Use 80g/10l water with knapsack sprayed over 100g/10l water with mist-blower. Apply as full cover. • ROUNDUP TURBO (L7166). Use 240ml/10l water with knapsack sprayed and 320 ml /10l water with mist-blower. • MAMBA MAX 480 SL (L7714). Use 220ml/10l water with knapsack sprayed and 300 ml /10l water with mist-blower. KILO WSG (L7431). Use 300ml/10l water with knapsack sprayed or 400 ml /10l water with mist-blower. Apply as full cover spray to actively growing plants. Slash growth in winter and apply when new growth is more than 0,5 m high.	Underground runners make this species difficult to eradicate, and specialised herbicides should be used when controlling the species. Herbicides should be applied during autumn when downward sap movement can transport the herbicide to the roots.

12. PREVIOUS CONTROL AND ERADICATION MEASRURES

There are several programmes established in South Africa that focus on the removal and control of alien invasive plants as well as management of water and natural ecosystems. These include Working for Water, Working for Wetlands, Working on Fire and the Expanded Public Works Programme. Most of these have been utilized within Stellenbosch Municipality. Whilst Stellenbosch Municipality clears

some areas with workers appointed through the Expanded Public Works Programme, most of the clearing is done by appointed contractors.

The Working for Water programme and the Expanded Public Works Programme rely on governmental funding, which vary annually. The financial budget should therefore be revised annually.

All of the sites in this plan have had some form of control and eradication work done, however, as mentioned above, generally the lack of a strategic approach to such work as well as follow-up removal strategies has led to the re-establishment of targeted species which have been able to out-competing native species for the natural and spatial resources.

13. AUDITING

Control and eradication work performed in terms of this plan must be audited annually. The environment audit to be undertaken is a methodical examination of each site's status in terms of its IAP infestation and to determine the success or impact of the control and eradication measures undertaken.

The environmental audit consists of three stages, namely *pre-audit*, *on-site audit* and *post-audit*. Pre-audit includes the administrative issues associated with planning the audit, selecting the institution to conduct the audit, and preparing the audit protocol. The main purpose of the pre-audit stage will be to develop an audit plan, based on the most recent information and the results of the previous year's audit. The audit plan must also address where the audit is to be conducted, what the scope and objectives of the audit are, how the audit will be conducted (keeping in mind that the results of the audit must be comparable to previous year's audit results), and when the audit is to be conducted.

The on-site audit involves the recording of required information. The audit team gathers information by observation, conducting photographic studies, taking measurements, and conducting tests as was determined during the pre-audit stage. During the on-site audit stage the strength and weaknesses of the methods of information gathering must be evaluated in order to determine whether the process of auditing is effective in achieving its goal. In keeping with the adaptive management approach, the auditing process must also be looking for continual improvement. All the information obtained is recorded and a comprehensive record of the audit and the state of affairs produced.

The audit report is completed during the post-audit stage. Such report will reflect previous, current results, and recommended improvement goals. The audit report will also indicate failures or deficiencies and recommendations for corrective actions.

Table 6: Environmental Indicators for auditing purposes[24].

BIODIVERSITY & NATURAL HERITAGE	
Species Diversity	BD01 – Threatened and extinct species per taxonomic group BD02 – Endemic species per taxonomic group BD03 – Alien (non-indigenous) species per taxonomic group

[24] Environmental Indicators for National State of the Environment Reporting, DEAT, 2002

	BD04 – Population trends of selected species BD05 – Distribution and abundance of selected alien species
Habitat Change	BD06 – Extent of conserved area BD08 – Disturbance regimes: fire frequency BD09 – Disturbance regimes: flood and drought
Resource Value	BD11 – Contribution to job creation: eradication of alien species
Natural Heritage Resources	NH01 – Status of natural heritage resources NH02 – Investment into natural heritage resources NH03 – Visitors to natural heritage resources
LAND USE	
Land Use	LU01 – Land cover LU02 – Land productivity vs potential
Land Condition	LU03 – Soil loss LU04 – Land degradation

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