Southern African Institute for Environmental Assessment
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Scoping-level Environmental Assessment of Biological Control of Alien Invasive Cactus Plants in Namibia

Final Scoping Report

22 February 2019

Executive Summary

Introduction

Alien invasive cacti are becoming a serious pest in Windhoek. Efforts at controlling them up till now have concentrated on manual clearing, largely driven by a volunteer organisation called Cactus Clean-up. This has made significant strides towards clearing particular areas of the hills in Windhoek, and at the same time raising awareness about the threats posed by cactus plants, but this method is expensive, it disturbs the soil and it can never achieve complete control of the problem because the cacti are very successful at regrowing from small fragments, and certain areas where they occur are inaccessible. Also, the efforts to organise and pay workers depend on the dedication of a few individuals, so this is not a lasting solution. Chemical control methods carry pollution risks and are also very expensive. Biological control has been used elsewhere (e.g. South Africa, Australia) in situations very similar to the one in Namibia – same invasive species, similar environments – with very high rates of success. Importantly, there have been no cases where introduction of the control agents have caused unexpected problems to the indigenous flora or ecosystem. This project intends to use the expertise and facilities available in South Africa and elsewhere, to introduce biological control agents against three species of cacti in Windhoek.

The project is proposed by the Namibian Chamber of Environment (NCE), the Botanical Society of Namibia, and the Centre for Biological Control (CBC) at Rhodes University in South Africa. It is supported by the National Cactus Biocontrol Committee, which includes representatives from government (MET and MAWF), the Windhoek municipality, and the Namibian University of Science and Technology. This Environmental Assessment was commissioned by the NCE to obtain an Environmental Clearance Certificate for the project.

Project description

The three identified cactus species and their biocontrol agents are:

- Imbricated cactus (*Cylindropuntia imbricata*) – controlled by a cochineal *Dactylopius tomentosus*;
- Pest pear cactus (*Opuntia stricta*) – controlled by the cochineal *Dactylopius opuntiae*;
- Midnight lady cactus (*Harrisa pomanensis*) – controlled by a galling mealybug *Hypogeococcus festerianus*.

Other cactus species do occur in Windhoek and are serious pests, but they do not yet have tested and approved control agents.

Research and practical control programmes carried out in South Africa and Australia have demonstrated that these control agents are very host-specific. That is, they feed on only particular cactus species, and do not pose a threat to any other plants. Thorough host-specificity testing methods ensure that all biological control agents for weeds feed only on the plants that they are intended to feed on. Over 400 biological control agents have been released in over 80 countries over the last 100 years and none have had unpredicted non-target effects to other plant species. This track record is strong evidence of the safety of weed biological control. There is zero basis for any concern that the control agents might harm aloes, euphorbias or other indigenous succulents which are superficially similar to cacti. Details in the report describe the host-specificity credentials of the three control agents that are proposed for Windhoek.

Small consignments of the control agents will be imported to Namibia. These will purposely be small so that they can be thoroughly inspected that they do not harbour any other insects or pathogens, and can be readily approved for import by Namibia's phyto-sanitary officials in MAWF. The small populations will be released onto identified infestations of the alien cacti, and allowed to build up so that they become abundant and spread through the infestations. This is expected to take a few years. The control agents have poor powers of dispersal, so they will be physically carried by members of the project team to other infestations once the 'core populations' are large enough to allow this. The control agents are expected to kill and/or sterilise the host cacti, and some physical removal of large dead cactus trees will be required. It is important that the initial populations should not be disturbed or accidentally cleared by manual clearing workers, as this would require the import and population build-up processes to be repeated.

The sites of release of the introduced agents will be monitored and mapped to record the progress and spread of the biological control agents. This work will be undertaken with students from NUST to help develop capacity in biological control in the country.

Relevant legislation

The legislative requirements of the project are described in Section 4. These have to do with:

- Phyto-sanitary controls (Agricultural Pests Act);
- Importation of exotic animals (Customs and Excise Act);

- Controlling the spread of alien invasive species (Forestry Act and the Nature Conservation Ordinance);
- Preventing soil erosion (Soil Conservation Act);
- Preventing pollution (Pollution Control and Waste Management Bill).

The project will fulfil these requirements.

International commitments towards combating desertification and conserving biological diversity are also covered by this project.

Receiving environment

The biophysical and socio-economic environment of Windhoek are briefly described in Section 5. There are important areas (e.g. the Auas Mountains, a biodiversity hotspot in the country) on Windhoek's doorstep which need to be protected against the invasion of invasive cacti. Windhoek's open space policy emphasises the need to maintain the natural vegetation characteristics of Windhoek's hills, and recognises the value of the open spaces for recreation and for maintaining a 'sense of place' in the city.

It is important to emphasise that there are no barriers to invasive alien cacti spreading out beyond the town limits (which they have already done) and colonising farmland in the surrounding areas. This will reduce land productivity and impact on ecosystems and biodiversity, if appropriate action is not taken quickly. The problem has already expanded beyond the ability of manual control to contain it.

Public consultation

This project has invited responses from the public, and contacted the relevant local and national authorities for their inputs and comments. The various media and meetings to achieve this are described in Section 6. Issues and responses for both the first and second round of public consultation are summarised in the report and are fully recorded in Appendix D.

Points raised by interested and affected parties focused on:

- Enquiries about the safety of biological control, its track record pertaining to the species that are going to be introduced here in Namibia, and the possible impacts to indigenous plants and animals;
- Support for effective measures to control cacti so that indigenous vegetation is not lost to these dangerous plants, and done in such a way that pollution risks are avoided;

- Concern for the loss of jobs if manual control methods are stopped. Response: The project has gone to great lengths to explain that manual control of those cactus species that are not targeted for biocontrol, must continue. Manual clearing is an important activity that should continue to be supported, as long as it targets the species for which biocontrol agents are not yet available and not yet proven to be safe.
- Concern that this project will jeopardise the financial support that is given to the Cactus Clean-up campaign. Response: The proponent for this biocontrol project (NCE) issued a statement committing moral support for manual clearing of the appropriate species of cacti, and urging individuals, businesses and other organisation to support Cactus Clean-up. Some grant funding to the campaign has been provided by the NCE.

No critical issues, with the potential to stop the proposed project, were raised during the first round of public consultation. Indeed, there was strong support for this project to go ahead, to address the exploding problem of invasion by alien cactus species in Windhoek and surrounding areas.

No new or significant issues were raised during the second round of public consultation.

Impact assessment

This impact assessment is unusual in that it assesses a project whose main purpose is protection of the natural environment. Obviously it must ensure that any risks in the project are avoided or minimised, but those risks must be viewed in the context of the much greater risk that the invasive alien plants pose to Windhoek and Namibia.

The risk of attack on non-target plants is a key consideration. Evidence from the host-specificity testing done on the control agents in South Africa and elsewhere show that there is no risk of this occurring, even on useful cacti such as Prickly pears (cultivated by some farmers for drought fodder). The cochineal insects that are intended for release, which target *Opuntia* cacti, are unable to survive on or kill any plants other than the species they are targeting.

The mealy-bug that targets Midnight lady cactus sterilises only columnar cacti. There is a small risk to non-target columnar cactus plants, such as those in gardens and nurseries, that the introduced mealy-bug will sterilise and damage them through its galling activities. But it is important to emphasise that those potentially affected plants in gardens and nurseries are themselves the source of potential future invasions. Through the Protected Areas and Wildlife Management Bill, MET is looking at making it illegal for people to have high-risk invasive alien plants on their land, and for nurseries to hold, propagate and sell them. The significance of the impact is rated as Very Low because the extent of dispersal is naturally very small. Furthermore, while this may appear to be a negative impact at present, it will change to be a positive impact when the legislation prohibiting alien invasive plants is passed.

The risk of reduced employment and support to manual clearing projects is noted. Responses from the Proponent, based on experience in South Africa, have given assurances that jobs will not be lost. Most importantly, the Proponent recognises the important role played by Cactus Clean-up in raising awareness of the threats from cacti, and in manually clearing those species that do not yet have tested and assured biocontrol agents. The EMP contains suggestions to local official partners, such as City of Windhoek and MAWF, to continue and expand their financial and logistic support to Cactus Clean-up and other similar initiatives.

Environmental Management Plan

There are a few key activities that will help to make the proposed biocontrol measures more effective:

- The release sites of the three species should be communicated and shown to the Cactus Clean-up team so that they do not mistakenly remove those cacti. This is critically important.
- Teams focussed on manual clearing should confine their work to clearing those species that do not yet have biocontrol agents. For instance, infestations of *Opuntia sulphurae* and *Cylindropuntia pallida* should be targeted.
- Mapping and monitoring of cactus infestations should be carried out throughout Windhoek's open spaces. NUST and the NBRI are already involved as partners in the project, and have pledged this ongoing involvement. Information from the monitoring work should feed into the coordinated control programme between the biocontrol and manual clearing teams.
- Mechanical (manual) control is recognized as an important component of an integrated strategy for the control of invasive alien cactus species, therefore mechanical control should be financially supported.
- The report calls for the City of Windhoek to maintain and increase its support to manual clearing of cacti, and to the Ministry of Agriculture, Water and Forestry (MAWF) to follow the example of the 'Working for Water' campaign in South Africa which receives strong government funding and support.
- Finally, a call is made for urgent proclamation of the Protected Areas and Wildlife Management Act. This will bring legislation into force that will prohibit the import, propagation and sale of cacti, and to make it obligatory for land owners and custodians to remove invasive alien plants from their land.

Conclusion

The report recommends that an Environmental Clearance Certificate should be issued for the proposed project. The report further recommends that, once the Environmental Clearance Certificate has been issued, that:

- The necessary phytosanitary permits and customs approvals be obtained as required.
- Necessary precautions are taken to prevent accidental clearing of the growing population stocks that are released in Windhoek.
- Monitoring the establishment and growth of the populations of biocontrol agents should be carried out, ideally involving local students. This will build experience and capacity in the important field of biological control.

The references and appendices to the report provide the fine details to substantiate the findings made here.

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Abbreviations and Acronyms

CBC	Centre for Biological Control
CV	Curriculum Vitae
DEA	Department of Environmental Affairs
EA	Environmental Assessment
EAP	Environmental Assessment Practitioner
ECC	Environmental Clearance Certificate
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
EMP	Environmental Management Plan
GG	Government Gazette
GN	Government notice
I&AP	Interested and Affected Party
MAWF	Ministry of Agriculture, Water and Forestry
MET	Ministry of Environment and Tourism
NBRI	National Botanical Research Institute
NCRST	National Commission on Research Science and Technology
NUST	Namibia University of Science and Technology
ToR	Terms of Reference

Glossary

Alien plant - Plants that occur in a given area outside of their natural distribution, due to intentional or accidental introduction through humans (also called exotic plants, non-native plants).

Cladode – A branch or portion of a stem that functions as or resembles a leaf, e.g. the pad of a prickly-pear cactus.

Cumulative Impacts - in relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.

Environment - As defined in Environmental Management Act - the complex of natural and anthropogenic factors and elements that are mutually interrelated and affect the ecological equilibrium and the quality of life, including – (a) the natural environment that is land, water and air; all organic and inorganic matter and living organisms and (b) the human environment that is the landscape and natural, cultural, historical, aesthetic, economic and social heritage and values.

Environmental Management Plan – as defined in the EIA Regulations, a plan that describes how activities that may have significant environments effects are to be mitigated, controlled and monitored.

Interested and Affected Party (I&AP) - in relation to the assessment of a listed activity includes - (a) any person, group of persons or organisation interested in or affected by an activity; and (b) any organ of state that may have jurisdiction over any aspect of the activity.

Invasive plants - Alien or native plants which reproduce at high frequency, and can potentially spread over large areas.

Mitigate - practical measures to reduce adverse impacts.

Proponent – as defined in the Environmental Management Act, a person who proposes to undertake a listed activity.

Significant impact - means an impact that by its magnitude, duration, intensity or probability of occurrence may have a notable effect on one or more aspects of the environment.

1 Introduction

1.1 Project Background

The Namibian Chamber of Environment (the Proponent), together with the Botanical Society of Namibia and the Rhodes University Centre for Biological Control (CBC, South Africa), are proposing to introduce insects for the biological control of alien invasive cacti in Windhoek. The release of the biocontrols on invasive cacti – as a pilot test project – would be done for three cactus species that have reached pest proportions in Windhoek.

This document is part of the process for obtaining Environmental Clearance for the proposed introduction, as stipulated in the Environmental Management Act (2007) and the EIA Regulations (2012).

1.2 Project Need and Desirability

1.2.1 Severity of the problem

Some of Southern Africa's most damaging invasive alien species are cacti, and Namibia is one of the countries that is most seriously affected, (Macdonald, 2003) (Kaplan, *et al*., 2017). Invasive alien cacti threaten indigenous biodiversity by outcompeting indigenous plants and harming indigenous animals such as birds and mammals. (Brown *et al*., 1985) (Shackleton *et al*., 2017)

Ecosystems in Namibia are already seriously impacted by alien cacti, but if left unchecked the problem will increase exponentially, and the landscape will be transformed with severe negative consequences for ecosystem functioning. The cacti also have serious negative impacts on agriculture as they reduce productivity and carrying capacity, as well as being physically harmful to livestock and wildlife due to the spines and glochids (small, hair-like spines) (Moran & Zimmermann, 1991) (Klein, 1999) (Hoffmann *et al*., 1999), (Paterson, *et al*., 2011). These impacts have serious economic implications for Namibia at both the local and national levels. It is for these reasons that Namibia's current Biodiversity Strategy and Action Plan states that "by 2018, priority measures are in place to control and manage their (alien and invasive species') impact" (MET 2014).

1.2.2 Possible solutions

The above reasons clearly justify the need to control the spread and proliferation of alien cacti in Namibia, which raises the next question: How? Methods that can be considered are:

- chemical (using herbicide poisons),
- mechanical (using machines or physically clearing them by hand), and
- biological control (using introduced agents that feed on or parasitise the plants).

Biological control is the preferred option for controlling large and well-established populations of alien invasive cacti because it is economical, very effective and long-lasting (Mutota, *et al*. 2018), (Paterson, *et al*., 2011).

Mechanical control methods for large populations are much more expensive and not as effective as biocontrol, and they require ongoing, never-ending efforts to maintain control (Mutota, *et al* ., 2018). They have a role to play in reducing the spread of those species for which biological control agents have not yet been identified and fully screened (Sutton, *et al*., 2018), (Paterson 2018), and for small local outbreaks of plants where the invaded patches are discrete and easily accessible. Chemical control is not advocated because of the harmful impacts of the poisons; it is also very expensive, and not as effective as biocontrol. After years of attempting to control a cactus species in the Kruger Park by means of chemical and manual control, and after spending millions of Rand, the cactus continued to spread. Only when biocontrol was introduced was the situation brought under control and to a level where the cactus plants had virtually disappeared. The same situation occurred in Australia, where some 24 million ha of land under an invasive alien cactus species was lost to farming before biocontrol was introduced.

The record of biological control in South Africa and elsewhere in the world provides clear evidence that this is the most effective management strategy for problematic cactus species based on the long-term efficacy, safety and economic costs, when compared to other control methods such as physical removals or the use of herbicides.

1.2.3 Available expertise that Namibia can use

Most of the cactus species that are invasive in Namibia are the same species as those found in South Africa so management strategies from that country are likely to be applicable here. South Africa has a very active biological control campaign against invasive cacti, run by the South African Department of Environmental Affairs, academic institutions, and national and provincial conservation agencies. Namibia could benefit substantially by taking advantage of the biological control agents that have already been developed in South Africa. The biological control agents in South Africa are freely available, so the costs of implementing biological control in Namibia would be minimal.

1.2.4 Official support for cactus biocontrol in Windhoek

A National Cactus Biocontrol Committee for this project has been established, comprising the following institutions and their representatives:

Institution	Representative
City of Windhoek	Mr Martin Shikongo
Ministry of Environment and Tourism (MET); Division of Scientific Services (Research)	Mr Billy Kazonganga
Botanical Society of Namibia	Ms Diana Thompson
Namibia Botanical Research Institute (NBRI)	Ms Coleen Mannheimer
Namibian University of Science and Technology (NUST)	Ms Shirley Bethune; Dr Rolf Bekker
Namibian Chamber of the Environment (NCE)	Dr Chris Brown

All these organisations fully support the proposed project.

A meeting about the proposed project was held with the Sustainable Development Advisory Council (SDAC), a body established under the Environmental Management Act of 2007 to advise the Minister of MET on matters pertaining to sustainable development and to promote cross-sectoral collaboration in matters of the environment. Invasive alien plants fall into the area requiring cross-sectoral and multi-agency collaboration, as they occur on state, private, and municipal land, on communal and freehold farmlands and in national parks, and impact on agricultural production, indigenous biodiversity and ecosystem functioning.

The SDAC recognises the need for a supportive platform for this initiative, and has also pledged its commitment to controlling invasive alien cacti in Namibia.

1.3 Terms of Reference

The Southern African Institute for Environmental Assessment (SAIEA) has been appointed by the Namibian Chamber for the Environment to undertake a scoping assessment with the purpose of applying for an Environmental Clearance Certificate (ECC) for the project.

The Terms of Reference (ToR) are set out in the Memorandum of Agreement for this project, dated 25 October 2018. This is shown in Appendix B.

Scoping has been conducted with the aim to apply for an ECC only, following the requirements of the Environmental Management Act (No. 7 of 2007) and its Environmental Impact

Assessment (EIA) Regulations (GN. No. 30 of 2012) (see Chapter 4). Any additional permits or licenses and/or approvals that are required (see Chapter 4) for the operation of the project should be applied for by the Proponent.

1.4 Environmental Assessment Process

1.4.1 Registration of Application for Environmental Clearance Certificate

The proposed project includes the activities bulleted below, which are stipulated in the 'List of Activities that may not be undertaken without an Environmental Clearance Certificate' (GN. No. 29 of 2012). Numbering refers to the numbers in the Regulations.

AGRICULTURE AND AQUACULTURE ACTIVITIES

- 7.5 Pest control.
- 7.7 The release of any organism outside its natural area of distribution that is to be used for biological pest control.
- 7.8 The introduction of alien species into local ecosystems.

1.4.2 The Scoping Phase

Depending on the complexity of the project being assessed, an application for an ECC proceeds with the production of a Scoping Report (i.e. this report), which includes all the findings of the scoping phase. This report includes the following:

- A description of the proposed project (including need and desirability of the proposed activity and alternatives) (Chapter 1);
- A description of the existing biophysical and social conditions of the receiving environment (Chapter 3);
- Legislative provisions that have relevance to the proposed project (Chapter 4);
- A description of the public consultation process followed (as described in Regulations 7 and 21 of the EIA Regulations) (Chapter 6);
- A description and significance assessment of all identified potential impacts associated with the proposed project (Chapter 7); and
- Management and mitigation measures required to avoid or minimise the potential negative impacts as outlined in the Environmental Management Plan (EMP) (Chapter 8).

With the submission of the Scoping Report to the office of the Environmental Commissioner, he decides whether the project needs to continue to a full Environmental Impact Assessment. SAIEA is of the opinion that, based on the specialist studies that were conducted prior to this assessment, and a review of the available literature, there is no value in further work being undertaken. SAIEA therefore submits this Scoping Report and an Environmental Management Plan, including explicit conditions for ongoing monitoring of the outcome of the biological control, as fulfilment of the application for an Environmental Clearance Certificate.

2 Project Team

The project team comprises staff from SAIEA. SAIEA's mission is to support sustainable development in southern Africa through promoting the effective and efficient use of environmental assessment as a planning tool. The individuals involved in this EA are John Pallett, Sheldon Husselmann and Dr Peter Tarr, all of whom have significant experience conducting EAs (scoping and assessment level) within the Namibian environmental context.

2.1 John Pallett

John Pallett is a certified Environmental Assessment Practitioner (EAP), with qualifications in geology (BSc) and zoology (BSc Honours). He specialises in providing environmental advice and evaluating environmental issues, particularly through Environmental Impact Assessments (EIAs) and strategic SEAs, for the benefit of managers, decision-makers and the lay public. He has been affiliated to the Southern African Institute for Environmental Assessment (SAIEA) since 2008, and the Desert Research Foundation of Namibia – Environmental Evaluation Associates of Namibia (DRFN-EEAN) for 14 years up to 2008. See CV (Appendix C1).

2.2 Sheldon Husselmann

Sheldon Husselmann is the holder of BSc, BSc (Honours) and MSc in Environmental and Geographical Science (2010, 2011 and 2016 respectively).

During his 7 years as an EAP with Enviro Dynamics cc, GCS Water Environmental Engineering (Pty) Ltd and Urban Green cc, he has gained valuable experience in conducting EAs (including public consultation), both in team set-up as well as individual team leader. Sheldon has also been affiliated with SAIEA since June 2018. Find attached his CV (see Appendix C2).

2.3 Peter Tarr

Peter Tarr is the Executive Director of SAIEA and has a PhD in Environmental Assessment (University of Aberdeen, UK) with more than 25 years of experience in environmental and social impact assessments, strategic environmental assessments (SEAs) and environmental planning, management and monitoring of a very broad range of development programmes. His review and assessment expertise cover agriculture and rural development; water resources management and development; fisheries; natural resources management and conservation; tourism development; power supply and transmission; mining, oil and natural gas exploitation. Find attached his CV (Appendix C3).

3 Project Description

3.1 Description of the problem and a review of possible solutions

Windhoek is experiencing severe alien invasive cactus infestations (Bethune, *et al*., 2004), (EIS, 2018), (Kavirindi, *et al*., 2010), (Mutota, *et al*., 2018). These are areas that are in the public eye (on the hillsides adjacent to roads) and also often areas where public recreation occurs, such as along outdoor walking paths (e.g. various places on 'Windhoek farm' accessed from Avis and Olympia), open areas for outdoor activities (e.g. around Avis Scouts Hall) and in open picnic areas close to Goreangab Dam. And these species have started to spread into the surrounding farmlands in ever greater numbers.

The main cactus species that are pests in Windhoek are the following:

- Imbricated cactus (*Cylindropuntia imbricata*);
- Snake cactus or midnight lady cactus (*Harrisia pomanensis*);
- Pest pear cactus (*Opuntia stricta*);
- (*Opuntia sulphurae*);
- Thistle cactus (*Cylindropuntia pallida).*

These alien plants have become invasive because here they do not have any of their natural enemies, which in their countries of origin prevent them from becoming invasive.

3.2 Alternative methods of controlling cacti

3.2.1 Manual clearing

Manual clearing is the main method which has been used thus far in Windhoek, mainly driven by a volunteer organisation called Cactus Clean-up. Teams of workers are paid a daily fee to physically dig out the cacti and load them into skips. The volunteer effort is driven by one main champion, who funds the work through her own pocket and by gathering funding support from other individuals and organisations. Due to these factors the programme for manual clearing is vulnerable as it is highly dependent on the generosity and dedication of one individual. So far official support for cactus clean-ups from the City of Windhoek and from government authorities i.e. MET and MAWF has been very limited.

Manual clearing is also difficult because inevitably some cladodes are missed, and they quickly re-establish new plants that grow and spread. Furthermore, concerns have been raised about the physical disturbance to the soil on the slopes where the cacti are dug out, leaving the slopes bare of vegetation cover and vulnerable to erosion. Overall, manual clearing involves major expense and human effort, carries negative impacts on the soil, and depends on the

drive of a few individuals. This makes it unsustainable, although it plays an important role in the overall scope of cactus control. Also, once the cacti have escaped from the target areas of the Cactus Clean-up campaign – as they already have into the surrounding countryside – then they are no longer targeted for manual control and they increase and spread in an exponential fashion.

3.2.2 Chemical control

Chemical control with poisons is very expensive and environmentally damaging. The herbicides must be thoroughly applied to each plant which is difficult and, in many cases, impossible where the cacti grow in inaccessible places. The herbicides are not host-specific so that they end up also killing indigenous and desirable vegetation in the areas they are applied and when they are carried downslope and downstream by rainwater. The chemicals are very expensive, and chemical control is not permanent; it requires permanent monitoring and ongoing applications and expense to combat new outbreaks. Chemical control for cactus species has also been found to be ineffective. Many years of chemical control of cactus species in the Kruger Park in South Africa failed to control the problem.

3.2.3 Biological control

Biological control is the most appropriate management intervention for all species of well established invasive cacti that are too widespread and abundant for complete eradication to be feasible (Zachariades, *et al*., 2017). Biological control of Cactaceae in South Africa has been extremely successful, with 80% of the 15 species targeted for biological control being considered under complete or partial control (Klein 2011).

There have been a number of spectacular successes of biocontrol of cacti in South Africa. Two examples: (1) *Cylidropuntia fulgida* var. *mammilata* populations were reduced from large dense stands to just a few small individuals within the space of just two years. (2) Large infestations of *Opuntia stricta* in the Kruger National Park have been permanently reduced to the point where the weed is no longer considered a problem (Paterson, *et al*., 2011). These past successes are clear evidence that biological control is the most effective management strategy for problematic cactus species based on the long-term efficacy, safety and economic cost of biological control when compared to other control methods such as physical removal or the use of herbicides.

Biological control of alien invasive plants (also known as weeds) is a very widespread and well accepted practice. It is utilised by over 40 countries, with well over 400 biological control

agents being released to control over 100 invasive alien species (Winston, *et al*., 2014). Biological control uses host-specific natural enemies collected from the native distribution of the alien plant, which are then released where the weed is a problem in order to regulate the weed population (McFadyen, 1998). When the natural enemy is released onto the invasive plant population it becomes known as a biological control agent. All biological control agents must be host-specific, meaning that they can only feed on the target weed and will therefore not damage or feed on indigenous species or species that are used for agriculture. The majority of plant-feeding insects and pathogens are specific to the level of genus, but there is a continuum of specificity from highly host-specific insects that feed on just one variety of a plant species, to those that are generalists and can eat many plant species (Bernays & Graham, 1988). The majority of the work that biological control researchers do is aimed at determining whether agents are specialists and therefore suitably host-specific for release. This is called host-specificity testing and it is done by testing whether the potential agent can feed and survive on different plant species (see Section 3.4 below).

The strongest evidence for the safety of biological control can be found by examining the track record of biocontrol of weeds. Biological control of weeds has been actively practiced all over the world for over 100 years and of the over 400 agents that have been released none have had a significant unpredicted non-target effect (Suckling & Sforza, 2014). Biological control is therefore an environmentally friendly, sustainable and safe method of controlling invasive alien plants (McFadyen, 1998). The major advantages of biological control are that introduced natural enemies are host-specific and will have no non-target effect on other plant species, and that control is sustainable and does not require continuous and costly follow-up operations (McFadyen, 1998).

Namibia has utilised biological control in the past. The first agent released in Namibia was a water weed agent, the weevil *Cyrtobagous salviniae*, for the control of the South American floating fern *Salvinia molesta* (Schlettwein, 1985). Biological control agents for cacti have also been released but we are not aware of the process that was followed in order to obtain permission to import and release these agents in the country. *Dactylopius opuntiae* (ficus-indica biotype) was released for the control of *Opuntia ficus-indica,* the fruiting prickly-pear, in 1980, resulting in control of this damaging invasive species in the north of the country (Brown, *et al*., 1985).

Biological control is particularly effective against cactus species and the agents that are used are highly host-specific, feeding only on a small number of closely related cacti. There are no indigenous cactus species in Namibia, so no indigenous plants could be threatened by the introduction of cactus biological control agents to the country. There are a number of

biological control agents that are freely available from South Africa which would be very beneficial for controlling damaging invasive alien species in Namibia.

3.3 Project description

This project aims to import biological control agents against the first three of the invasive cacti listed above. These three species have been selected based on their abundance and negative impacts in Windhoek and elsewhere in Namibia, the level of success of the biological control programme against the species in South Africa, and the availability of the agent.

The Cactus Working Group in South Africa, which includes members from various government and non-government alien invasive control organisations in that country, fully supports the use of biocontrol for cactus species and has supported the selection of these three species as the first possible targets for biocontrol in Namibia. The three target species and their biological control agents are:

- *Cylindropuntia imbricata* (Imbricated cactus or Devil's rope cactus) controlled by *Dactylopius tomentosus* (Cylindropuntia cochineal);
- *Opuntia stricta* (Pest pear cactus) controlled by *Dactylopius opuntiae* "stricta biotype" (Stricta cochineal):
- *Harrisia pomanensis* (Midnight lady cactus or snake cactus) controlled by *Hypogeococcus festerianus* (Cactus mealybug).

3.3.1 Imbricated cactus

Cylindropuntia imbricata is one of the most abundant and problematic alien species in Namibia. It is abundant around Windhoek and most of southern Namibia (Zimmermann, 2010) and has been recorded as far north as Maroelaboom in the Grootfontein District in The Namibian Alien Invasive Species Atlas. This species grows into large trees of over 2 m in height and forms dense thickets that are impenetrable to wildlife and livestock (Figure 1). The long spines are also injurious to any animal that comes into contact with the plant and often result in the death of birds, small mammals and reptiles (Paterson, *et al*., 2011). The primary mode of reproduction is through the growth of dislodged joints that are transported when stuck in the fur or hides of animals that have passed through infested areas. This species is already very problematic in Namibia and without intervention the distribution and density of the species is likely to increase.

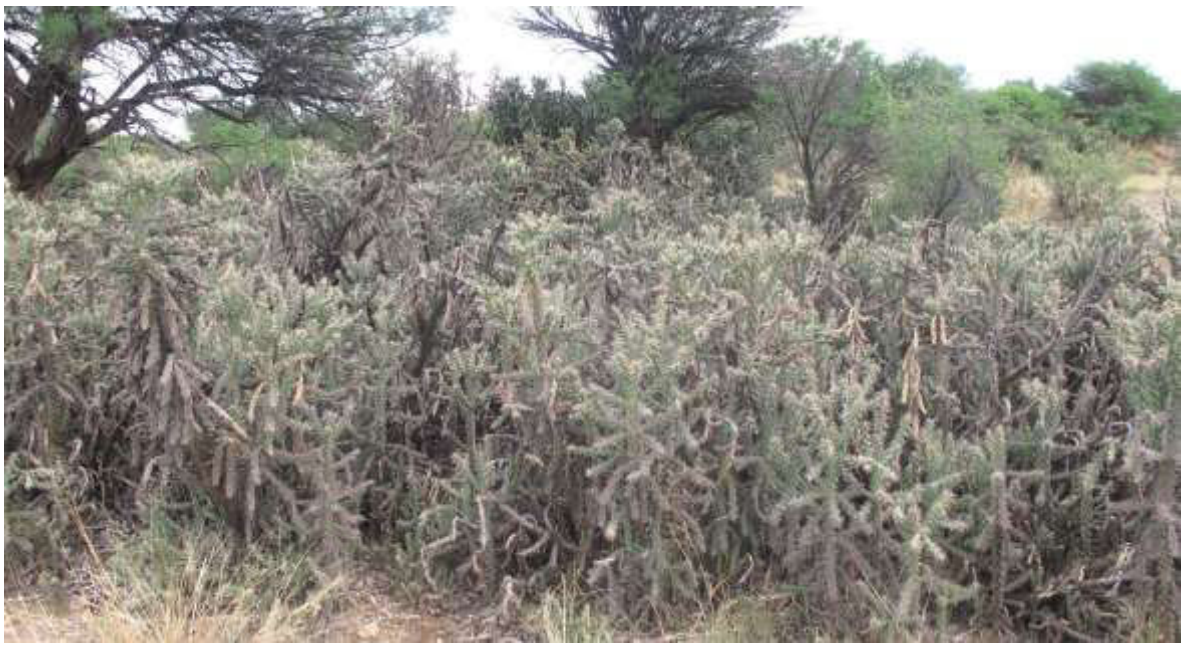

Figure 1: ***Cylindropuntia imbricata*** **(Imbricated cactus). Photo: C. Mannheimer**

Cylindropuntia imbricata is also invasive in Australia and South Africa. The biocontrol agent, a cochineal insect called *Dactylopius tomentosus*, was released in South Africa in the 1970s and has resulted in the effective control of the weed (Klein, 2011).

3.3.2 Pest pear cactus

Opuntia stricta (Figure 2) is abundant throughout Namibia and some large infestations are present, especially in the northern regions of the country (Zimmermann, 2010), (Mutota, 2018), (EIS, 2018). The potential for expansion in range and density of *O. stricta* is large as evident from the 24 million hectares that were infested by this plant in Australia and the fact that it was the most problematic invasive species in the Kruger National Park of South Africa (Zimmermann, 2010), (Paterson, *et al*., 2011). The plant is now under complete biological control in both the Kruger Park and Australia (Zimmermann & Moran, 1991), (Paterson, *et al*., 2011).

Figure 2: ***Opuntia stricta*** **(Pest pear cactus).**

3.3.3 Midnight lady cactus

Harrisia pomanensis (Figure 3) is extremely abundant in the veld surrounding Windhoek. The infestations around Windhoek are dense and make veld inaccessible to wildlife and livestock. The plant prolifically produces fruits that are eaten by baboons and birds which distribute the seeds and start new infestations, resulting in the spread of the plant. Although it is not yet spread throughout Namibia, it is extremely likely to spread and increase in abundance if control measures are not implemented as soon as possible.

The biological control agent for *Harrisia pomanensis* is a galling mealybug called *Hypogeococcus festerianus*. This agent feeds on a wide variety of different columnar cactus species such as *Harrisia, Cereus* and their close relatives. None of these species are indigenous to Namibia, and all are potentially invasive pests.

Figure 3: ***Harrisia pomanensis*** **(Midnight lady cactus).**

3.4 Description and host-specificity of the proposed control agents

3.4.1 Host-specificity testing for weed biological control

A centrifugal phylogenetic method (Wapshere, 1974) has long been used to determine the host-range of potential biological control agents by sequentially testing plant taxa most closely related to the target weed, followed by increasingly distantly related taxa, until the host-range has been circumscribed. This approach is supported by recent advances in molecular techniques: for example, host-shifts in lineages of specialist phytophagous arthropods are strongly linked to the evolution of host-plant lineages, and in particular plant chemistry. Such herbivores show a strong phylogenetic conservatism of host associations (Briese, 1996) (Briese and Walker, 2002). This pattern of strong phylogenetic conservatism in diet suggests the non-target plants of greatest risk are those closely related to known hosts (Futuyama, 2000)Service Bulleting, and this has been validated by recent reviews of non-target attack by biological control agents (Briese and Walker, 2002) (Louda, *et al*., 2003) (Paynter, *et al*., 2004) (Pemberton, 2000) (Barton, 2004). The use of this host-specificity testing method has ensured that all biological control agents for weeds feed only on the plants that they are intended to feed on. Over 400 biological control agents have been released in over 80 countries over the last 100 years and none have had unpredicted non-target effects

to other plant species (Suckling & Sforza, 2014), (Downey & Paterson, 2016). This track record is excellent evidence of the safety of weed biological control.

3.4.2 Host-specificity of *Dactylopius tomentosus*

Dactylopius tomentosus has been utilized as a biological control agent in Australia since 1925 and in South Africa since 1970 (Winston, *et al*., 2014). The agents have been widely successful at controlling the various *Cylindropuntia* species that have been targeted for control (Hosking, *et al*., 1988), (Klein, 2011). All species of cochineal, the insect family Dactylopiidae, are completely restricted in host range to members of the subfamily Opuntioideae in the Cactaceae and in particular, *Dactylopius tomentosus* is restricted to the genus *Cylindropuntia* (Mann, 1969), (De Lotto, 1974), (Zimmermann, 2017). *Dactylopius tomentosus* is completely restricted to feeding on plant species in the genus *Cylindropuntia*, a genus comprising 33 species of cactus all native to Mexico and the U.S.A (Anderson, 2001). It cannot feed on any plant species outside of the genus and can therefore not feed or survive on any indigenous or crop species in Namibia or elsewhere in Africa. Evidence for this comes from the fact that the agent has never been recorded feeding of any plants beside *Cylindropuntia* species in the native distribution or after almost 100 years in Australia and almost 50 years in South Africa. The specificity of the species has also been thoroughly tested using host-specificity testing that has confirmed that only *Cylindropuntia* species are acceptable host plants for feeding and survival (Zimmermann and Granata, 2002), (Mathenge, *et al*., 2009b), (Mathenge, *et al*., 2009a), (Jones, *et al*., 2015), (Jones, *et al*., 2016).

3.4.3 Host-specificity of *Dactylopius opuntiae*

As with all cochineal (Dactylopiidae) species, *Dactylopius opuntiae* can only feed and survive on a restricted number of cactus species, all in the subfamily Opuntioideae and the majority are restricted to the closely related genera *Opuntia* or *Cylindropuntia* (Mann, 1969), (De Lotto, 1974), (Moran, 1980), (Zimmermann, 2017). *Dactylopius opuntiae* has been utilised as a biological control agent in Australia since 1926, South Africa since 1938 and Hawaii U.S.A. since 1949 (Klein *et al*. 2011), (Winston *et al*. 2014). It was also released in Namibia where it has successfully reduced populations of the cactus *Opuntia ficus-indica* since 1975 (Brown, *et al*., 1985). There have been no reports of the cochineal feeding on any species outside of the genus *Opuntia* in the native distribution or in any country where it has been released.

There are two biotypes[1] of *D. opuntiae* used for biological control, each specialised to a different cactus species (Hoffmann, et. al., 2002). Although the two biotypes can survive on either *O. ficus-indica* or *O. stricta,* only the correct cochineal for each species will successfully kill the target weed (Hoffmann, *et al*., 2002). *Dactylopius opuntiae 'ficus-indica'* was released in Namibia in 1975, and although this species will feed on *O. stricta* it will not result in substantial control (Hoffmann, *et al*., 2002). This project intends to release *Dactylopius opuntiae 'stricta'* which is even more restricted in its host range, not feeding on *O. ficus-indica* under field conditions but killing *O. stricta* plants (Githurie, *et al*., 1999). This highly host-specific biotype of *D. opuntiae* can therefore even be released where *O. ficus-indica* is valued, as it is no threat to that species (Githurie, *et al*., 1999). No indigenous plants or crop species are therefore threatened by the release of *D. opuntiae*.

The history of the release of the "ficus-indica" biotype of *Dactylopius opuntiae* in Namibia in the early 1980s (Brown, *et al*., 1985) is relevant to the issue of host-specificity. The "ficus-indica" biotype does feed on *O. stricta* and is present on some infestations of this weed in Namibia, but it does not reduce populations of *O. stricta* to acceptable levels because it is not the correct biocontrol agent for the weed species. The "stricta" biotype effectively kills only *O. stricta* plants, it does not kill *O. ficus-indica*. Therefore the "stricta" biotype is not a threat to farmers or gardeners who cultivate the prickly-pear, *Opuntia ficus-indica.*

D. opuntiae "stricta" has had massive positive impacts in South Africa and Australia, and no non-target or undesirable impacts have been detected in those countries.

3.4.4 Host-specificity of *Hypogeococcus festerianus*

Hypogeococcus festerianus has a host range that is restricted to a tribe of columnar cacti, the Cereanae (McFadyen, 1979). Extensive surveys in the indigenous distribution, as well as extensive host-specificity testing conducted in Australia with 50 different plant species has shown that the agent is completely restricted to this tribe of cactus (McFadyen, 1979), (McFadyen, 2012). It was released in Australia in 1974 and South Africa in 1983 (Winston, *et al*., 2014). There have never been any records of the biological control agent feeding on any non-target species, but the agent has been effective at controlling a variety of cactus species in the tribe Cereanae (McFadyen, 1979), (Klein, 1999), (Paterson, *et al*., 2011), (Klein, 2011), (Sutton, *et al*, 2018). Importantly, *Hypogeococcus festerianus* is incapable of feeding on the

[1] Biotypes – organisms that are genetically identical (i.e. the same species) but which are physiologically distinct from each other.

Opuntia species of cactus, such as *Opuntia ficus-indica*, which are the cacti that are most often utilised for their fruit and as drought fodder for domestic stock in Namibia.

Hypogeococcus festerianus is used for the control of *Cereus jamacaru*, the queen of the night cactus, in South Africa. When used for the control of *C. jamacaru*, the agent kills small plants and sterilises older plants, but large plants are not often killed by the agent. The mortality of seedlings and sterilisation of older plants results in complete control in a period of between 15 to 20 years (Sutton, 2017). *Harrisia pomanensis* is a fairly new target for biological control in South Africa because the weed has a limited distribution in the country. In 2013 the plant was identified as a threat due to its rapid spread, and biological control using *H. festerianus* was implemented. In the past 5 years *H. festerianus* has effectively sterilised the plant and reduced plant health (Figure 4) but no mortality of plants has been recorded yet. Sterilisation of this species has however significantly reduced the invasive potential of this species and it is likely that mortality of plants will be recorded over the next few years.

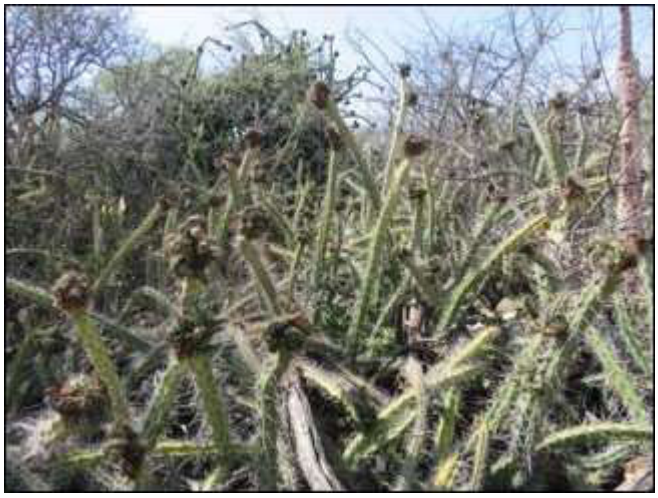

Figure 4: ***Hypogeococcus*** **galls on Lady of the night cactus in South Africa. Photo I. Paterson**

The release of this agent in Namibia is likely to sterilise *H. pomanensis* populations to a point that the spread of the plant is reduced and its invasive potential is dramatically decreased. It is also possible that it will kill older plants after the agent has been present for some time (between 5 and 10 years). The dry conditions in Namibia are ideal for this agent as it is more effective at killing plants in dry conditions.

Hypogeococcus festerianus will only feed on cactus plants in the tribe Cereanae. None of these species are native to Namibia and many of them are either already invasive and problematic or have the potential to become problematic in future.

Some of the cactus species that are grown in gardens in Namibia could be susceptible to this agent. The agent is unlikely to kill large cactus plants, but will form galls which usually results in the sterilisation of the species. It is unlikely that the agent would spread to gardens unless it were released directly into the garden or if it is released on invasive populations of the cactus near the garden. If desired, *Hypoceoccus festerianus* can be controlled using insecticides.

The threat that *H. pomanensis* poses to indigenous biodiversity and agriculture in Namibia is significant, and great enough to outweigh the possibility of some minor impacts on cactus species that are being utilised as garden ornamental plants. In addition to this, the sterilisation of these garden plants would be beneficial in terms of reducing their invasive potential.

3.5 Methods

3.5.1 Import of the control agents from SA

The biological control agents are freely available from the Centre for Biological Control at Rhodes University, where they are mass-reared as part of the Department of Environmental Affair's campaign to increase the utilisation of biological control for invasive cactus species.

Small consignments of the two cochineal agents on loose cladodes of the target species will be imported into Namibia after entomologists at the CBC have cleaned the cultures of any possible contaminants. The consignments will purposefully be small so that they can be thoroughly checked to prevent any unintended insects being brought into Namibia. The Phytosanitary Division of MAWF will also have to verify that the consignments are free of other species and can be safely imported.

The CBC mass-rearing facility produces galls of *H. festerianus* for release in South Africa. Mass-rearing of this species is done using live, potted plants rather than loose cladodes because the insect is a galling agent and therefore requires active growth of the plant to proliferate. Cleaned and uncontaminated galls from the facility will be imported into Namibia.

3.5.2 Release of control agents onto Windhoek cactus infestations

The current management strategy in South Africa is to release the agents and allow for a few years for the agent populations to become abundant and spread throughout the infestations. This process will be followed in Windhoek.

In the case of Imbricated cactus, the imported cochineal insects, existing on a few infested cladodes, will be released into the canopy of each *C. imbricata* tree at pre-identified release

sites. Once large numbers of the agent have grown, infested cladodes will be redistributed from that site to others, so that the cochineals can get to work reducing the infestations at other sites.

The control agents cause defoliation of the cacti, so all the cladodes fall from the trees, leaving just the main branches and trunks of large trees alive (Figure 5). Unlike healthy loose cladodes, cladodes that are infested with cochineal are not viable and will die before they can root and grow into a new plant. Once the plants are defoliated, the trunks of the larger trees will need to be cut down at the base using an axe or machete. This will result in the large trees dying, permanently reducing each infestation to a few small plants.

Figure 5: *C. imbricata* plant infested with cochineal and losing its cladodes, which are unable to regenerate on the ground. Photo I. Paterson

Based on the efficacy of this biocontrol agent in South Africa, it is likely that the agent will take about 3 years to become abundant and widespread in Windhoek if it is actively redistributed to new sites. When high abundance of the agent results in complete defoliation at a site this should be followed by cutting the main trunk of large plants. Small plants will be killed by the agent but large plants with trunks greater than about 15 cm in diameter will persist for many years if the trunk is not cut after defoliation. The timing of cutting the trunks is important because the plant must be weakened by high levels of cochineal in order to be killed completely, and cutting the trunks without releasing the agent will result in an increase in abundance and spread of the plant rather than control of it.

In the case of Pest pear cactus, it took about six years in the Kruger Park before the cochineal populations brought the weed under complete control (Paterson, *et al*., 2011). Although this may seem like a long period of time, it is important to note that control is permanent and there are no other techniques of permanently controlling this plant that have been successful anywhere in the world. The rate of increase of the cochineal, as well as the decline in cactus density, is likely to be greater in Namibia than it was in the Kruger Park because the climate is more suitable for the agent in Windhoek.

In the case of the Midnight lady cactus, imported galls will be released directly onto an isolated experimental infestation site in Windhoek. The release and further distribution of the galling agent is expected to sterilise the cactus populations to a point that the spread of the plant is reduced and its invasive potential is dramatically decreased. It is also possible that it will kill older plants after the agent has been present for some time (between 5 and 10 years). The dry conditions in Namibia are ideal for this agent as it is more effective at killing plants in dry conditions.

3.5.3 Monitoring of extent and condition of cacti in Windhoek

The sites of release of the introduced agents will be monitored and mapped to record the progress of the biological control agents. This work will be undertaken with students from NUST to help develop capacity in biological control in the country.

Already, two students from NUST have worked on invasive alien cactus species during 2018 (Mutota, *et al*., 2018), (Iipinge, 2018). The Dean of the Natural Resources faculty has expressed strong committed to this initiative as part of a long-term research engagement by NUST.

4 Legislation Relevant to the Project

This chapter provides an overview to the legislation that is applicable to the project. It is divided into: (i) national legislative requirements – i.e. the legal framework for environmental management in Namibia and national sectoral legislative requirements (including required approvals/permits) applicable to the activities of the proposed project; and (ii) relevant international legislation.

4.1 National Legislative Requirements

The legal framework for EA in Namibia and national sectoral legislation pertaining to various environmental aspects (including approval and permit requirements) are listed in Table 4-1 below.

Table 4-1: Legislation applicable to the project

Statute	Provisions	Project Implications
Environmental Assessment Legal Framework		
The Namibian Constitution (1990)	Article 95 (1) states that "*the State shall actively promote and maintain the welfare of the people by adopting, inter alia, policies aimed at… maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of natural resources on a sustainable basis"*	The project should support the provisions of the Namibian Constitution. It supports these environmental provisions by controlling the impacts of invasive alien cactus species that impact on ecosystems, ecological processes and indigenous biodiversity.
Environmental Management Act (No 7 of 2007)	Part II, Section 3 of the EMA provides a set of environmental principles that give effect to the provisions of the Namibian Constitution for integrated environmental management. Subsection (2)(g) states that Namibia's cultural and natural heritage, including its biological diversity, must be protected and respected for the benefit of present and future generations; and	The project should adhere to the principles provided in the EMA. An ECC should be obtained for the proposed project, because this directly supports the environmental principles cited, protects indigenous biodiversity, and reduces, limits and controls

Statute	Provisions	Project Implications
	Subsection (2)(l) sates that damage to the environment must be prevented and activities which cause such damage must be reduced, limited or controlled. Section 27(3) stipulates that no party, whether private or governmental, can conduct a listed activity without an ECC obtained from the Environmental Commissioner. Section 40(1) stipulates that an ECC remains valid for a period not exceeding three years, subject to cancellation or suspension.	the negative impacts of invasive alien cactus species.
Environmental Impact Assessment (EIA) Regulations GN 28-30 (GG 4878)	Details requirements for public consultation within a given environmental assessment process (Rs21-24). Details the requirements for what should be included in a Scoping Report (R8) and an Assessment Report (R15).	The EIA Regulations should inform and guide this EA process.
National Sectoral Legislation		
Agricultural Pests Act (No. 3 of 1973)	Deals with, inter alia, the control of insect and plant disease imports. The Act aims to prevent the introduction of organisms that may be detrimental to the agricultural sector, while Sec 12 allows the importation of bio-control agents needed for the control of pests.	This is the legal basis for the Phytosanitary Division of MAWF. Alien organisms introduced to Namibia will need to be positively identified and guaranteed to be uncontaminated.
Customs and Excise Act (No. 20 of 1998)	Customs officials execute the function of controlling the entry of exotic plants and animals. No goods which require a permit, certificate or other authority, may be imported into Namibia unless they are accompanied by a permit issued by the Permanent Secretary.	The Environmental Clearance Certificate issued by the Environmental Commissioner will presumably serve as 'clearance' for the PS to issue the import permit.

Statute	Provisions	Project Implications
Forestry Act (No. 12 of 2001)	Part IV of this Act provides for the general protection of the environment.	Forest management plans, where applicable, should include measures to control the spread of alien invasive species.
Soil Conservation Act No. 76 of 1969	Provides for the prevention and combating of soil erosion; conservation, improvement and manner of use of soil and vegetation, and protection of water sources.	"Improvement of vegetation" gives a clear go-ahead for control of alien invasive plants. At the same time, "combating of soil erosion" and "protection of water sources" can be interpreted as a caution against both manual and chemical control of cacti.
Nature Conservation Ordinance No. 4 of 1975 (as amended)	Makes provision for the protection of indigenous flora and fauna.	Sec 78: The Minister may take measures for the destruction, decrease or elimination of any species which may be harmful or detrimental to the existence of any other species.
Draft Pollution Control and Waste Management Bill (September 2003) (not yet enforced as an Act)	Promotes sustainable development and relates to preventing and regulating the discharge of pollutants to water and land (Part 3).	Pollution to the soil and water should be avoided; this can be interpreted as a caution against chemical control of alien invasive plants.

4.2 International Treaties and Conventions

The international treaties and conventions applicable to the project are listed below in Table 4-2 below.

Table 4-2: International Treaties and Conventions applicable to the Project

STATUTE	PROVISIONS	PROJECT IMPLICATIONS
The United Nations Convention to Combat Desertification (UNCCD)	Addresses land degradation in arid regions with the purpose to contribute to the conservation and sustainable use of biodiversity.	Control of alien invasive plants is a step towards improving land productivity and combating land degradation.
Convention on Biological Diversity 1992	Regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas, with a view to ensuring their conservation and sustainable use. Promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings.	The 1998 review of alien invasive species (Griffin & Simmons, 1998), undertaken as a requirement of the CBD, recognises invasive alien species as the biggest cause of biodiversity loss. Article 8 specifically requires parties to the Convention to control or eradicate their alien species which threaten ecosystems, habitats or species.

5 Description of the Receiving Environment

5.1 Biophysical Environment

5.1.1 Climate

The climate of Windhoek is classified as semi-arid, with annual average rainfall of 300-400 mm. The highest temperatures are measured in December with an average daily maximum of 31 C, the coldest temperatures in July with an average daily minimum of 2-3 C.

5.1.2 Topography, geology and soils

Windhoek is situated within a natural 'basin' containing open plains and undulating hills, and is surrounded by mountains to the south and high ground to the east and west.

The underlying rocks of the majority of the Windhoek area are schists of the Kuiseb Formation, making up part of the southern zone of the Damara Sequence (Africon, 2004). Windhoek generally has poorly developed thin topsoil that is the product of erosion from the schistose rocks comprising mainly fine sands and silts intermixed with residual quartz pebbles. River alluvium in the plains and along the ephemeral river courses and valleys are comprised of sand, gravel and stones, forming the thickest soils (Africon, 2004).

The schists are dissected by a number of drainage lines oriented roughly north-south, comprising the main stems and tributaries of the Klein Windhoek, Arebbusch, Gammams and Aretaregas Rivers (van Mansveld, *et al*., 2008). These valleys and river beds hold unconsolidated surficial deposits (calcrete gravel, sand and finer alluvium) and act as an infiltration medium for surface water during ephemeral flows. Flattish alluvial plains in the Windhoek basin are found in the southern parts of the city.

Immediately south-east of Windhoek is dominated by the Auas Mountains, with the second highest point in the country at Moltkeblick at 2,479 metres, while due south is the Gross Herzog Friedrich Berg at 2,337 m high. The mountains comprise mainly quartzite. The quartzites south of Windhoek are fractured along fault lines that hold groundwater reserves in the Windhoek aquifers, which are an important component of the total water supply to the city (Africon, 2004). No pollution should be allowed along the known fault lines through these quartzites, as it will easily migrate to the subsurface aquifer (Africon, 2004), a further reason why herbicides and poisons are not appropriate to control invasive cacti.

5.1.3 Biodiversity

5.1.3.1 Biomes and Vegetation Types

Windhoek lies in the centre of the Highland savanna vegetation zone in the Acacia tree-and-shrub savanna biome (Giess, 1998), (Mendelsohn, *et al*., 2003). Vegetation in the built-up areas is mostly altered from its natural state, and comprises a mixture of exotic and indigenous plants which is not of concern to this assessment (although exotic garden cacti are often the original source of invasive alien infestations).

The naturally vegetated hills and slopes of Windhoek are dominated by a variety of Acacia trees (*A. mellifera, A. karoo, A. erubescens, A. hereroensis, A. hebeclada*) together with *Combretum apiculatum, Euclea undulata, Dombeya rotundifolia, Tarchonanthus camphoratus, Rhus marlothi* and *R. dinteri, Albizia anthelmintica* and *Ozoroa crassinerva*.

Along the river beds on alluvial banks there are trees of a variety of species including: *A. karoo, A. erioloba, Rhus lancea* and *Ziziphus mucronata*. Exotic *Prosopis* trees are also common in the river beds. Grass cover is sparse on the slopes but more prominent in the valley floors.

The Auas mountains are recognised as an Important Plant Area (Hofmeyr, 2004), based on the presence of some threatened species, that there are some relics of Mesembs and some believed to be of Karoo/grassland origin, and that high altitude habitats are typically important in Namibia. In addition, mountainous terrain tends to have higher biodiversity potential than its lower surroundings, based on the fact that higher altitude areas will experience relatively more rainfall and lower temperatures, and could therefore host distinct vegetation and animals. On this basis, (Irish, 2002) identified Auas as Namibia's second-most important mountain in terms of biodiversity.

This emphasises the importance of preventing the spread of invasive cacti into the Important Plant Area, where they could potentially take over the habitat of the high-priority plants and animals. Biological control would be the preferred option to implement this control, considering the difficulties of access on the steep, rugged mountain to do manual or chemical control, and the likely disturbance and erosion that would result from these activities.

The invasive cacti are common on rocky slopes and hillsides and on lower ground, in many places forming dense patches and even extensive mats that are impenetrable and inaccessible. The Windhoek Environmental Structure Plan (Africon, 2004) recognises *Opuntia* infestations as a problem on the hills and open areas of Windhoek, and notes that the source of these are often garden landfill sites and open spaces where people illegally dump garden refuse. Discarded cuttings and broken-off cladodes spread from these sources, either vegetatively or through dispersal by baboons, for example.

It is important to emphasise that many of the cactus species that originated as garden ornamental plants in Windhoek (and they should never have been allowed to enter Namibia in the first place), have spread to the townland limits and are now spreading well beyond and onto the adjacent farmlands. As the diameter of the outward colonising circle increases, so do they increase exponentially in number and area, as does their impact on the environment. Their spread is already well beyond the threshold for mechanical and chemical control. The situation is already cause for deep concern, and the introduction of biocontrol is overdue.

5.1.3.2 Fauna

A few species of common small mammals, such as types of mongooses, rodents and bats, exist in the municipal areas of Windhoek, and larger species such as kudu, baboon and black-backed jackal are occasional visitors or resident in the open areas around the edges of suburbia. The townlands extend far beyond the built-up areas and it is in these quieter areas with less human disturbance where there is greater diversity and abundance of animals. Priority mammal conservation species that have been recorded in the wider area include leopard (classified as Vulnerable) and brown hyaena (Near-Threatened) (EIS, 2018). Such species are most likely to exist in relatively quieter, secluded areas where they come into minimal contact with humans. Invasion of habitat by spiny cacti would reduce potential movements and available habitat for most mammals.

Reptiles such as leopard tortoise, snakes, flap-necked chameleon and rock agama occur in the municipal areas, within gardens and open spaces with natural vegetation. Since people traditionally react negatively to most reptile species, the populations of these animals are low in those open spaces where recreational activities such as dog-walking take place. Priority reptile species that exist in the Windhoek area include dwarf python, veld leguaan and leopard tortoise (all classified as Vulnerable) (Griffin, 2005).

Windhoek and immediately surrounding areas have an impressive bird list of more than 250 species. From within the city itself, more than 150 bird species have been recorded.

Mountainous terrain tends to have higher biodiversity potential than its lower surroundings, based on the fact that higher altitude areas will experience relatively more rainfall and lower temperatures, and could therefore host distinct vegetation. On this basis, (Irish, 2002) identified Auas as Namibia's second-most important mountain in terms of biodiversity.

5.2 Socio-economic environment: Windhoek municipal area and land use

The population of Windhoek currently stands at approximately 400,000 (CoW 2016), settled in an area of about 10,000 ha. The total extent of the townlands is a much larger area, recently (2015) expanded to cover a total area of 513,300 ha. Open spaces therefore make up more than 90% of the total land area of the City.

Windhoek has an impressive network of natural areas and open spaces, with the built-up urban and suburban areas concentrated in the lower-lying ground and many of the hills and interlinking river corridors in a relatively natural state (van Mansveld, *et al*., 2008). The topography, together with a mixture of modern and traditional German architecture and bountiful open spaces, enhances Windhoek's appeal as a scenically beautiful city.

5.2.1 Status of open spaces

The Windhoek Environmental Structure Plan (Africon, 2004), and the Strategic Environmental Assessment of Windhoek and the Windhoek Townlands (CoW, 2016) both recognise the importance of the city's open spaces and their contribution to the quality of life of Windhoek inhabitants. The Environmental Structure Plan explicitly includes the following criteria for identifying various 'control zones' where developments may or may not be permitted:

- The relative importance of the 'sense of place' or the specific character of Windhoek determined through resident participation, which includes topography and landscape quality as well as cultural / historical resources.
- The need to protect open space in Windhoek, which includes the river and aquatic systems, as well as the ridgelines, hills and mountains, and natural areas surrounding the city.
- The need to protect, manage and conserve sensitive natural vegetation cover.

This emphasises the need to maintain the natural vegetation characteristics of Windhoek's open spaces, which is the underlying motivation for the biological control of cacti proposed in this project.

It is important to emphasise that there are no barriers to invasive alien cacti spreading out beyond the town limits (which they have already done) and colonising farmland in the surrounding areas. This will reduce land productivity and impact on ecosystems and biodiversity, if appropriate action is not taken quickly. The problem has already expanded beyond the ability of manual control to contain it.

5.2.2 Cultural heritage sites

The Windhoek Environmental Structure Plan (Africon, 2004) lists 63 sites of historical and cultural importance in the Windhoek municipal area. These are all buildings or structures of historic interest; there are no sites of open ground or natural habitat where cacti are likely to occur or where there might be limitations on what activities could be conducted to control them.

6 Public Consultation

Public consultation is an important aspect of an Environmental Assessment (EA) process. During public consultation, potential impacts that the proposed project may have on the receiving environment, were identified. Consultation with Interested and Affected Parties (I&APs) (state and non-state) enables transparent decision-making.

This chapter provides details of the public consultation process that was followed and the I&APs that were notified of the EA. It also includes the main issues and concerns raised during the public consultation process and comments received on the Background Information Document (BID) distributed during the first round of public consultation.

Public consultation was carried out as prescribed by Regulations 21 to 24 of the Environmental Impact Assessment Regulations (GN. 30 of 2012).

6.1 First Round of Public Consultation

Engagement with I&APs commenced on 5 November 2018 and concluded on 26 November 2018. During the first round of consultation, I&APs (including authorities) were given an opportunity to register and submit comments on the proposed project.

6.1.1 Public Consultation Activities

Activities undertaken to date to ensure effective and adequate I&AP involvement, are as follows:

- A register of I&APs was compiled and maintained (Appendix D1). A total of 44 I&APs was included in the database.
- A notification email (Appendix D2) with BID (Appendix D3) was distributed to all registered I&APs on 7 November 2018.
- Notification letters were hand delivered on 20 November 2018 to the City of Windhoek (local authority) and the relevant national ministries situated in Windhoek (Appendix D4). The national ministries include the Ministry of Environment and Tourism (MET) (for input regarding environmental management concerns) and the Ministry of Agriculture Water and Forestry (MAWF) (for input regarding potential impacts on local flora).
- Public notices announcing the commencement of the EA and an invitation to register as an I&AP were placed in “Algemeine Zeitung” and “The Namibian” on 5 and 12 November 2018 (Appendix D5).
- A notice board (with the dimensions 60cm x 42cm) was placed at three appropriate public spaces – Namib Trees Nursery, Camelthorn Garden Centre and Ferreira’s Garden Centre (Appendix D6).

- A public meeting was held on 12 November 2018, at 19:30 at the Namibian Scientific Society, c/o Robert Mugabe Ave and John Meinert St, Windhoek (see Appendix D7 for meeting minutes).

6.1.2 Comments Received and Responses Provided

All comments and feedback regarding potential issues received from I&APs are summarised in Table 6-1 below. In some instances, responses were provided via email by the EAP (SAIEA) (see Appendix D8) and subsequently by the Proponents (Rhodes University Centre for Biological Control (CBC) or NCE). Some of the responses provided subsequently by the CBC/NCE were not directly sent to the relevant I&AP, but are included in the section below to elaborate on the initial response provided by the EAP.

A copy of all the original email correspondence (including feedback that does not specifically raise any issues) is attached as Appendix D8.

Table 6-1: Comments received and responses provided during the first round of public consultation.

No.	Name	Comment / Issue	Response
1.	Abraham Kanime Email 9/11/2018	Please register me as a "Concerned Namibian Environmentalist", I do not live in Windhoek anymore, so I would not qualify to be concerned Windhoek resident. My interests as an environmentalist are: Are three proposed insect species (to be released) local or alien?	SAIEA: Alien. They are selected from the natural enemies that these plants have in their natural home – North America CBC: The origin of these three species is where the alien invasive cacti are native (the Americas). All of these species have been widely utilised in South Africa and Australia for many years. They are host-specific natural enemies (called biological control agents) that can only survive on a limited number of cactus species. No cactus species are native to Namibia, and most of them are problematic invasive species.
2.	Abraham Kanime Email 9/11/2018 (contd.)	How were they chosen?	SAIEA: These insects tend to be very host-specific so once the entomologist has identified which species attacks the particular pest plant, then tests are made under controlled conditions to find out whether the species also attacks other closely related plants. The tests are run in a widening radius of genetic relatedness to the particular pest plant, to ensure that other plants (eg aloes, hoodias, euphorbias) are not susceptible. CBC: The three agents were chosen based on their host-specificity, efficacy, availability and the need for control in Namibia. These are safe agents (suitably host-specific), that are very damaging and effective in Australia and South Africa, and will control problematic invasive species in Namibia.
3.	Abraham Kanime Email 9/11/2018	Is this is new experiment or tested somewhere already?	SAIEA: Extensive experimental work has been carried out in SA and Australia. The SA situation is closest to ours and there have been no records of these insect agents attacking indigenous plants in that country. It can be safely assumed that the situation will be the same in Namibia.

No.	Name	Comment / Issue	Response
	(contd.)		CBC: These agents have been used successfully in Australia for about 80 years and in South Africa for about 30 years. They have successfully controlled the invasive alien cactus species and have had no detrimental environmental consequences. They have therefore been of great benefit to the natural environment of both countries.
4.	Abraham Kanime Email 9/11/2018 (contd.)	What are the likely impact that proposed insect species will have on other local animal species?	SAIEA: None. The insects can only eat cacti. I will ask Prof Paterson on Monday whether there are any other effects on other local insects such as competition or parasitisation.. CBC: These agents will hopefully become part of the ecosystem, reducing the density of the cactus pests and providing permanent control. Neither the cactus nor the agent will ever completely disappear. There will always be some cacti, but they will also have populations of the agent on them. The aim of biological control is to reduce the cactus population density to below a damage threshold so that it is no longer a pest. There may be some beetles and spiders that feed on these agents in the field, but the amount of predation and parasitism will be minimal because these agents are protected by a waxy covering and (for cochineal) carminic acid. They are therefore generally unpalatable and only specialist predators and parasitoids (none of which are present in Namibia) feed on them. The minimal possible negative implications to the food web are greatly outweighed by the positive implications to the food wed of controlling the invasive alien species.
5.	Abraham Kanime Email 9/11/2018	What mode of operation will the insects will use to curb spread of targeted cacti?	SAIEA: They halt production of new flowers and buds, and eventually kill the host plants. In the case of mealybug, they make galls on the plants which sterilises the plants.

No.	Name	Comment / Issue	Response
	(contd.)		CBC: Cochineal insects (two of the agents) suck the plants juices of the cladodes. This reduces fruiting and eventually kills the plant. Dislodged cladodes (pads or joints of cactus) with cochineal are not viable and generally die. *Hypogeococcus*, the galling mealybug, galls the columnar cacti. Once a plant is galled it will not produce fruit. They sometimes still flower, but can't develop fruits, which for most columnar cacti are the primary means of spread. This will halt the spread of the invasion. After a few years (5 years) plants will start to die from the galls and there will be no regeneration of the population as small plants are killed quickly by the agent and no seeds are added to the system.
6.	Abraham Kanime Email 9/11/2018 (contd.)	How can one arrive at assurance that the released species will target only cacti and not untargeted species?	Over 100 years of similar work in SA and Australia have recorded no impacts on untargeted species. Monitoring by NUST students will be included in the project, as a safeguard for early detection of potential problems. CBC: These agents have been utilised for many years as biological control agents and have never had any non-target effects. Host-specificity testing was conducted for these species that proved that they can only survive on a small group of closely related cactus species. There is a very close relationship between the insects and the host plant due to co-evolution. This is widely recognised in biological control. There are over 400 weed biocontrol agents that have been released in over 80 countries worldwide and none have had significant negative impacts to any plants that they were not known to feed on before release over the last 120 years. This is due to scientist confirming that the agents are host-specific and will only feed on the target weed.

No.	Name	Comment / Issue	Response
7.	G. Voigts Email 21/11/2018	As representative of the CACTUS CLEAN UP initiative I am an interested and affected party in connection of cacti infestation and want to state: Several alien invasive plants are exponentially fast taking over the habitat of our own vegetation in our City and spreading into our country. The worst of them are several cactus species. Throughout our community a gross underestimation of the extent of that development and its pace of expanding can be realized. 90% of the affected areas in Windhoek are City of Windhoek open spaces. But neither on City of Windhoek area nor on private property the problem is addressed so far by City of Windhoek authorities. It has now reached its tipping point. Where ever there are tested and safe natural enemies available they should urgently and very fast be released into our environment to help to bring down the speed of vegetation conversion. We very urgently need the implementation of such agents.	SAIEA: The reduction of alien invasive cacti using biological control is the aim of this project. The control agents are the natural enemies of these cacti in their 'home' environment. They have been thoroughly tested for host-specificity in South Africa and elsewhere in the world, and are proven to be completely safe. CBC: Biological control has successfully been used in South Africa to reduce alien invasive cactus problems. We agree that the release of the agents should be treated as urgent. The sooner the agents are released the better.
8.	G. Voigts	But still even when a cactus plant is already dying it is likely to activate a lot of generative and vegetative propagation beforehand. And this will not jet be the end:	SAIEA: The proponent fully recognises the importance of physically clearing the dead cacti, and recognises the role that volunteer cactus clean-up teams can play in this.

No.	Name	Comment / Issue	Response
	Email 21/11/2018 (contd.)	Even if a cactus is dead, it still has to be removed physically.	CBC: Mechanical clearing is also an important strategy to control invasive alien cacti and should be continued. Communication between biocontrol practitioners and mechanical clearance teams is important because mechanically clearing of areas where biological control is established should not take place. It will disrupt the control process. There are many species that are not targeted for biological control and those should be the cacti targeted for mechanical control.
9.	G. Voigts Email 21/11/2018 (contd.)	We should not rely on one single method only but activate all means together simultaneously as fast as possible.	CBC: We agree with this statement but must stress that activities should be directed and should not counteract each other. If biocontrol release sites are manually removed it will stop biological control from ever being effective.
10.	G. Voigts Email 21/11/2018 (contd.)	With N$ 140- for a day of cactus work offered to unemployed workers at the street side, they are not overpaid. The increase of vegetation loss every season where the problem is not addressed makes it increasingly expensive.	SAIEA agrees completely.
11.	G. Voigts Email 21/11/2018 (contd.)	As Windhoek is situated right on top of its own palatable water resources, application of chemicals should not be an option because they would seep away without having gone through reclamation works.	SAIEA agrees completely. In addition, chemical control is not effective or efficient for cactus control and also damages local indigenous plants. We do not support chemical control and this proposal does not advocate chemical control. CBC: The Centre for Biological Control staff are experts in biological control and cannot comment on whether chemicals are likely to seep into water resources in Windhoek. We do know that chemical control of these species in South Africa and

No.	Name	Comment / Issue	Response
			Australia has been almost completely abandoned because biological control is more effective, safer for the environment, economically viable and sustainable.
12.	G. Voigts Email 21/11/2018 (contd.)	Where cacti and the respective Bio control both come from you do not find a balanced vegetation but cactus deserts with beautiful cactus flowers and snakes. That is what we definitely do not want in place of our own vegetation.	CBC: Biological control of these cactus species has been extremely successful in South Africa and Australia. There is very good scientific evidence that biological control of these species works. In the indigenous distribution, the three biological control agents are heavily predated and parasitized by a large suite of natural enemies that keep the populations of the agents in check. These natural enemies are not present in South Africa, Australia or Namibia. The reason why the agents reduce the target plant populations so drastically outside of the native distribution is due to this escape from their natural enemies. So after effective biocontrol there will be less cactus than in the native distribution, as has occurred in South Africa and Australia in the past. Biological control aims to reduce cactus populations, not eradicate them. There will always be some cacti left, even after successful biological control. Eradication of well-established invasive alien species (such as all the targets for biocontrol in Namibia) has been shown time and time again to be impossible using mechanical control or herbicide control. So cactus weeds will always be present in Namibia, but with biocontrol they could be permanently kept at low levels so that they are no longer problematic.
13.	Freya Lund, Committee Member, Windhoek	Hallo, wir werden NCE noch wissen lassen dass du und Friedhelm unsere Vertreter seid. Unsere Punkte:	CBC: We agree with this statement. But biocontrol is not a way of taking people's jobs away. In South Africa, a large number of people are employed to disperse and rear biological control agents. There is also a disabled persons programme where people with physical disabilities work to rear and release agents.

No.	Name	Comment / Issue	Response
	Residents & Ratepayers Association (WRPA) Email received from G.Voigts, 21/11/2018	1. manually is labor intensive, thus creating jobs for the ones that really need it.	
14.	Freya Lund, Committee Member (WRPA) (contd.)	2. chemical eradication is doubtful because of the unknown effect on environment	CBC: Chemical control is extremely expensive and requires advanced training. If implemented incorrectly chemical control can have serious negative consequences to the environment.
15.	Freya Lund, Committee Member (WRPA) (contd.)	3. manually is the least environment disturbing because very selective eradication	SAIEA: Two points to raise – biological control is actually far less environmentally damaging than manual clearing, and the situation has got so far out of control – with many cactus species have already spread beyond the townlands onto adjacent farms – that that manual control can simply not contain the situation. CBC: Manual removals are often very damaging to the environment, disrupting soil structure and trampling native vegetation. Biological control is the most selective and least environmentally damaging method available for the control of the three cactus species that are targeted in this proposal. Manual clearing should be focused on cactus species that do not have a suitable biological control agent. There are many species of cactus that have no biological control option.

No.	Name	Comment / Issue	Response
16.	Freya Lund, Committee Member (WRPA) (contd.)	4.biological eradication also doubtful because of unknown side effects on environment, e.g. hares in Australia, Prosopis in Namibia	CBC: The agents that are proposed to release are highly host-specific and will not have any side effects besides a slow and sustained reduction in cactus densities. Eradication is not the goal of biological control. The goal is a significant reduction below a threshold density where the alien invasive cacti are no longer problematic. Eradication of any of the three targets is impossible with any method. Hares are an invasive alien species in Australia. They were not introduced as biological control agents. They are in fact controlled very well by a biological control agents (virus) introduced by the Australian government. This has been a very successful biological control programme. Prosopis is a serious invasive alien species in Namibia and is not an example of how biological control has side effects because it was never a biological control agent. Prosopis is a target for biological control.
17.	Freya Lund, Committee Member (WRPA) (contd.)	5. it just seems to be very expensive, but the side effects of job creation with the spin off effect has to be taken into account; 1 job but 5-6 dependents Thanks for your commitment Windhoek Residents and Ratepayers Association	Employing people to control alien invasive species is extremely beneficial. There is more than enough work for manual clearing teams to do on species that are no targeted for biological control. By focusing on species without suitable biological control agents mechanical control will not clash with biological control efforts and overall cactus control in Windhoek will improve.
18.	Manda Steynberg Email 25/11/2018	Hi John and Sheldon A friend and I bumped into Coleen Mannheimer this morning on Farm Windhoek. We got talking about the cacti taking over and rapidly spreading everywhere on Farm Windhoek, Avis dam area and many other places that we as walkers regularly walk. We walked every	SAIEA: noted. Your observations reflect the concerns of the City of Windhoek, the Botanical Society of Namibia, the National Botanical Research Institute, the Namibia University of Science & Technology, the Ministry of Environment & Tourism and the Namibian Chamber of Environment. That is why these organisations are working

No.	Name	Comment / Issue	Response
		weekend for the past about 15 years around Windhoek. We walk for about 10 km a day in the veld on game and cattle tracks and some cycling tracks and some bundu bashing. We see the cacti taking over and worry about it. Coleen recommended that we comment to you. I am not sure what to say and will just note down a few comments: * Two or three years ago there were a few places where one saw a few cacti. Now they have rapidly spread to most places where we walk and the amount of cacti and variety of species have increased exponentially. * On the side of some of the Avis dam riverbeds (higher up than Avis dam area - on private farms / municipal grounds) the cacti form a dense "forest" totally covering the side of the riverbed. When the river flows, leaves and fruit flow down with the river and into Avis dam and beyond. * At the river near Waldorf school and on the hill above, there is lots of cacti. * Actually, there is cacti nearly everywhere - sure you know …. * Many of the cacti in certain places have cochineal, but many is not the correct type of cochineal. At other places there do not seem to be any cochineal. * We believe it to be important to take urgent action as soon as possible. Each cacti makes thousands of seeds every year which gets spread by birds, baboons, etc. The sooner action is taken, the less we will have to do (and the less money it will cost!) to control the cacti.	together to address the problem by means of the only practical and safe method – biocontrol. It is also important to record that, at the end of the public meeting, once all questions had been answered, the facilitator asked the participants if anyone had any concerns or reservations about the cactus biocontrol project going ahead. There were no concerns. It was noted that, unlike most EA processes, which look at impacts from developments and how to mitigate these, this project looks at how to address a problem and make the environment better. There was unanimous support for this project to move forward swiftly, because of the clear need and obvious environmental benefits.

No.	Name	Comment / Issue	Response
		* We are losing browsing areas (money lost), we are losing our beautiful views (now with horrible cacti), we are losing indigenous plants which gets overgrown by the cacti, animals and people get thorns which get infected, etc etc Please let me know if there is any specific information or comments that will be helpful. All the best with this project! Manda Steynberg Cell 081 611 2254	
19.	Olga Jones Email 25/11/2018 'Plea for the urgency of importing cochineal'	Hi John, Herewith my request to appeal to the Namibian Government to urgently approve the importation of cochineal to help control the spread of cacti all over Namibia. As a regular visitor of Farm Windhoek and Avis dam in particular, we have noticed an increased spread of cacti particularly around the Waldorf entrance area. This is despite efforts to manually eradicate these invasive species. Regards, Olga Jones	SAIEA: Hi Olga, thanks for your supportive email. We'll register you as an Interested and Affected Party for the project, and keep you updated with progress. Best regards John

No.	Name	Comment / Issue	Response
20.	Hilda-Marie Burger Email 25/11/2018 'Cacti'	I fully support the mass control of invader cacti and that is only possible by chemical control. Here in Windhoek poor animals are caught in the cacti and on farms the cacti invade the lands and rob farmers of agriculture land. I have noticed on farms that the cacti are being spread by water running in small rivers which means that no human will ever be able to manually destroy all the cacti. Hilda-Marié Burger PO Box 9853, Eros, Windhoek, Namibia Tel +264 61 259337 Cell + 264 81 1285199	SAIEA: Noted
21.	Herta Kolberg Email 26/11/18 'Cacti'	Hi Sheldon/John, Would a (small) negative impact not be the loss of income for the guys that presently control cacti mechanically? I know it's not sustainable and permanent/full-time employment, but they would loose their jobs. Could they not be used elsewhere in this project?	SAIEA: Hi Herta, thanks for your comment in the cactus discussion. The possible loss of jobs to the cactus clean-up workers has been raised as a possible negative impact of this project, and we recognise that this would be a considerable impact to those directly benefitting from Gunhild's efforts. However they will not be negatively impacted by the release of biocontrol agents. There will be an ongoing role for manual clearing work in the overall programme of cactus control, and at the moment their work will be no different because other species that are problematic in Windhoek – Opuntia sulphurae, Cylindropuntia pallida, and others – do not yet have confirmed and tested control agents. These species will therefore not be targeted in the present project, and the next best option is therefore to continue manual clearing of them. The cactus clean-up volunteers and workers will have no shortage of work concentrating on those species. I do not have figures readily available, but the CBC co-proponent, Dr Iain Paterson, has assured me that in South Africa the cactus teams have been re-deployed in

No.	Name	Comment / Issue	Response
			distributing control agents and clearing areas where cacti had died but the trunks of large cactus trees needed to be cut down. There was no reduction in the number of workers involved after they switched from manual to biological control of certain species, and there are always other species on the rise, for which the testing of control agents is not yet complete, that can be manually cleared. It is important to recognise that manual clearing will always have a role in the control of invasive cacti, alongside the main role of biological control agents. If invasive cacti ever become fully controlled, then the volunteers could equally be directed towards other alien invasive plants such as rubber vine, agaves, and others. This response is copied to Gunhild Voigts and the proponents in case they would like to add anything further. This issue and response will be included in the Scoping Report which is being compiled now.
22.	Herta Kolberg Email 28/11/18	John, Just thought of something else: will your EIA include an economic comparison between manual and biological methods? Maybe along the lines of the studies done for "Work for Water" in SA? If we can provide work for some of our multitude of jobless people, maybe the N$/c cost should not be the only criterion when choosing between these two methods. I agree that both methods should complement each other. We maybe just need to think about where to apply either of these methods e.g in towns where there are many workers available use	CBC: Thanks very much for your thoughts on this. As you said, it is very important to think about where to use the different methods. As you will see below, I think it should be divided based on species with the three targets for biocontrol being excluded from manual clearing and ones we don't have agents for being targeted for manual clearing, but the most important thing is that the biocontrol release sites and the immediate area around the release sites are left as biocontrol reserves. Then if people want to use the agents at other sites in future it can be redistributed from there and we don't have to go through the whole process of reimporting the agent. To my mind there are two important points here.

No.	Name	Comment / Issue	Response
		manual method, while in parks or on farms e.g. one could use biological method?	1. We are targeting three cactus species for biological control. There are many others that we are not targeting, and those species alone will be enough for manual clearing teams to work on for the next few decades. The manual clearing teams could even be increased in number to employ more people. Controlling cactus weeds is a huge job and there is no competition for work. Manual clearing and biological control must just speak to each other so that biocontrol sites are not destroyed soon after release. 2. The organization I work for employs 21 people from previously disadvantaged backgrounds, nine of who are physically disabled, to rear and redistribute biological control agents. So there is also significant job creation opportunities in biological control. In the Kruger Park, the teams that were used to mechanically and chemically clear Opuntia stricta now mass-rear and redistribute the agent. There is good evidence from the WfW programme that, without biological control, the manual clearing of invasive alien plants will never result in control on a large scale. Biological control is therefore not only the best option because of the cost, it is the best option because it is the only effective option in the long term. See: (Van Wilgen, *et al*., 2012) SAIEA: Hi Herta The EIA will consider alternatives to biocontrol and briefly address the economics of the methods since that is an important factor.
23.	Gunhild Voigts	Protest to the opinion that bio control will solve all vegetation problems alone!	CBC (Dr Iain Paterson): Dear Gunhild

No.	Name	Comment / Issue	Response
	Email 28/11/2018 'Breakdown of Namibian vegetation'	Several alien invasive plants are exponentially fast taking over the habitat of our own vegetation in our City and spreading into our country. The worst of them are several cactus species. Throughout our community a gross underestimation of the extent of that development and its pace of expanding can be realized. 90% of the affected areas in Windhoek are City of Windhoek open spaces. But neither on City of Windhoek areal nor on private property the problem is addressed so far by City of Windhoek authorities. It has now reached its tipping point. Where ever there are tested and safe natural enemies available they should urgently and very fast be released into our environment to help to bring down the speed of vegetation conversion. We very urgently need the implementation of such agents. But still even when a cactus plant is already dying it is likely to activate a lot of generative and vegetative propagation beforehand. And this will not jet be the end: Even if a cactus is dead, it still has to be removed physically. We should not rely on one single method only but activate all means together simultaneously as fast as possible. With N$ 140,- for a day of cactus work offered to unemployed workers at the street side, they are not overpaid. The increase of vegetation loss every season where the problem is not addressed makes it increasingly expensive. With no funding from the City of Windhoek side	I don't think that anybody has suggested that biocontrol will solve all vegetation problems alone. We have repeatedly said that there is a need for manual clearing and biological control. So we are in agreement on this matter and there is no need for a protest. Kind regards Iain NCE (Dr Chris Brown): Dear Gunhild, I am not sure that I fully follow all your e-mail. But for the sake of clarity I want to make a few points. 1. You and your team have done a fantastic job. You have achieved two very important outcomes: (i) you have cleared large areas of heavily infested townlands of invasive alien cactus species and made space for indigenous vegetation, and (ii) you have raised public awareness around the issue of invasive alien plants, especially cactus species. 2. The work that you and your team are doing must continue. There are many invasive alien cactus species that, at this stage, can only be cleared using manual means and by employing people. 3. For those three species of cactus that do have biological control agents, they are best and most cost-effectively controlled by means of those biocontrol methods. Some of these species have already escaped beyond the boundaries of the City of Windhoek, and are starting to spread across the farmlands. They are already beyond our manual ability to control them. 4. Biocontrol and manual control must work hand-in-hand and in a mutually supportive and complimentary fashion.

No.	Name	Comment / Issue	Response
		we have to ask tourists to clear City of Windhoek areas themselves or to pay the work from their and our own pockets. As Windhoek is situated right on top of its own palatable water resources, application of chemicals should not be an option because they would seep away without having gone through reclamation works. Because ´´Environmentalists´´ spread the ´´message from the experts´´ that manual eradication of invaders is an ineffective and too expensive method, donors who have contributed to the payment of cactus fighting learn that they have spent their money ineffectively. So far nothing is undertaken to correct this view in public. As a result Cactus Clean Up is left with N$ 1100,- for 45 units of workdays and we our self are expected not only to ´´bridge´´ until there might be fresh funds but we have to pay everything from our own pocket if we want to clear starting positions of cactus growth. What is left unattended or planted purposely, will just multiply. Where cacti and the respective Bio- control both come from, you do not find a balanced vegetation but cactus deserts, that is not what we want to replace our aloes. If this collapse of our own vegetation is not addressed very fast and vigorously and with all acceptable available methods together, 2018 will be remembered as the year when Namibia finally lost its own vegetation. Kind Regards, Gunhild Voigts	5. No “environmentalist” or “expert” is saying that manual control is wrong and should not be supported or funded. Quite the opposite. We need more investment into manual control for those species that currently do not have a biocontrol agent. 6. The only situation where manual control is not recommended is for the three cactus species for which there is a biocontrol. The biocontrol will hopefully address the problem for these three species – but only for these three species. All the other cactus species need manual eradication. I hope that this clarifies the situation. Kind regards, Chris

No.	Name	Comment / Issue	Response
24.	Gunhild Voigts Email 29/11/2018 'Break down of Namibian vegetation'	Good morning, Thank you for your reply to my e-mail. Unfortunately that does not address the problem. I do not need a clap on my shoulder and an e-mail of understanding from two individuals. The BID document reads: ...Clearing cacti can be done manually, but it is expensive and time consuming and can never get ahead of new infestations that appear in new locations.....Biological control is the only viable option for controlling large and well established populations because mechanical and chemical control for large and well established populations of alien invasive cacti is ineffective and extremely expensive.... Who ever has payed from his or her pocket workers to clear other places than his private garden is interested and can read in this document that what he had payed for is ineffective and a too expensive way to do it. Along with chemical solutions it should not be recommended. If someone asks me now to proceed with what I am doing, it means he wants me to proceed with no sponsors or support at all and to pay everything entirely from my own pocket. We may let the expansion of invaders and the loss of vegetation proceed with no hurry because as soon as it is well established, there will be a very cheep bio control balance with no petrol cost, no salaries, no costs what so ever involved. I can not find any attempt from your side to address this misunderstanding in public. City of Windhoek	CBC (Dr Iain Paterson): Dear Gunhild, Can we address this issue by clearly stating that mechanical control is also an important component of an integrated strategy for the control of invasive alien cactus species. And that mechanical control should be financially supported. Kind regards, Iain NCE (Dr Chris Brown): Dear Gunhild, The problem of invasive alien cacti in Namibia is far larger than can be managed by manual clearing alone. In relatively small areas (e.g. in Windhoek and immediate surroundings) manual clearing may be a good option. As soon as these invasive cactus species move out into the countryside, manual clearing and follow-up is no longer possible. With the introduction of biological control, we are taking a national perspective, because the problem is national. However, the introduction of biocontrol was never intended to replace the ongoing work of manual clearing. We are proposing the introduction of biocontrol agents for only three cactus species. All the other invasive cactus species need to be controlled manually. Manual clearing and biocontrol need to work together – they are both important mechanisms to control invasive alien species. Also, it was never our intention to give the impression that biocontrol would take over from manual clearing (except for the three intended target species), and we were at pains to state in the public meetings that manual clearing needs to continue. To help reverse any misunderstanding amongst your current and potential future sponsors, I attach an information pamphlet that explains this. In the pamphlet I say

No.	Name	Comment / Issue	Response
		officials do not even know what cacti are, Information on this topic is blocked away from Hon. Pohamba Shifeta, the PS and other officials. Please make sure the information on the situation of our environment is going out in a very understandable manor and is informing in a way you can take responsibility for. Kind regards, Gunhild	that the NCE will continue to fund manual clearing. To this end, we will be making a donation of N$5,000 to your ongoing work. Please send me your bank details. Kind regards, Chris

6.1.3 Outcome of First Round of Public Consultation

No critical issues, with the potential to stop the proposed project, were raised during the first round of public consultation. Indeed, there was strong and wide support for this project to go ahead, to address the exploding problem of invasion by alien cactus species in Windhoek and surrounding areas.

The most important issues raised by the I&APs in the public meeting and in correspondence are bulleted below:

- Risks of spread of the biocontrol agents to other plants, specifically to other cacti grown as part of farming operations, and other cacti grown for ornamental + gardening purposes.
    - Response: In more than 100 years of using biocontrol against alien invasive cacti in South Africa and Australia, there has been no spread of control agents onto non-target plants. The recognised risk of spread onto ornamental cacti (which strictly speaking are target plants), is very small, and is addressed in Sec 7.2.1 below.
- Economic impact of this biocontrol project on existing manual cactus clearing operations: concern that the manual work will no longer be necessary (i.e. jobs will be lost), and that support to manual control projects will diminish.
    - This is addressed in numerous responses from CBC and NCE above, and in Sec 7.2.2 below.
- The suggestion for an economic comparison of biological versus manual control (point 22 in the table above) is deemed not necessary, since both are required and need to be applied in a coordinated fashion, based on the availability of tested and assured biocontrol agents against the relevant problem species.
- There is a need for wider involvement of other authorities and institutions in controlling cacti, to carry out activities such as
    - Education on the threats posed by alien invasive cacti;
    - Involvement of farmers to identify and clear patches of cacti on their land;
    - Enforcement of legislation that prohibits the importation of alien plants;
    - Greater involvement of nurseries in not selling cacti, and in promoting indigenous succulents instead;

  These activities are beyond the scope of this EIA, but they are included as part of the wider context of cactus control.

6.2 Second Round of Public Consultation

Engagement with I&APs as part of the second round of public consultation commenced on the 24th of January 2019 and concluded on the 18th of February 2019. During the second round of consultation, I&APs (including affected authorities) were given an opportunity to review the draft scoping report and submit comments.

6.2.1 Public Consultation Activities

Activities undertaken to date to ensure effective and adequate I&AP involvement, are as follows:

- A notification email (Appendix D9) was distributed to all registered I&APs on 24 January 2019 informing them of the availability of the draft scoping report (via a link to a digital copy) for review.
- The aforementioned notification email was sent on 24 January 2019 to several representatives of the City of Windhoek (including the Chief Executive Officer) (see Appendix D1). Subsequent to this email, reminder email was sent on the 2nd of February 2019 and then a notification letter was hand-delivered (see Appendix D10) along with a hard copy of the draft scoping report on 14 February 2019 to the City of Windhoek for review and comment. No comments on the content of the draft scoping report have been received by the City of Windhoek to date.

6.2.2 Comments Received and Responses Provided

All comments and feedback regarding the content of the draft scoping report received from I&APs are summarised in Table 6-2 below.

A copy of all the original email correspondence (including feedback that does not specifically raise any issues) is attached as Appendix D11.

Table 6-2: Comments received and responses provided during the second round of public consultation.

No.	Name	Comment / Issue	Response
1.	Frances Chase Email 25/01/2019	Dear John and Sheldon, I hope you are both well. Thank you for sending a copy of the cactus scoping reports. If I could raise two concerns. Firstly, under point 2.2 Location of Activity, in the application for environmental clearance it states that the biological control will be '**reared in specialised facilities at the National Botanical Research Institute (NBRI)**'. No one at the NBRI is aware of this, it may be a good idea to contact Esmerialda Strauss <Esmerialda.strauss@mawf.gov.na>, as permission from the PS may be needed. I would also suggest that the project has a NBRI representative or liaison. Coleen is associated with the NBRI but is not a staff member. Secondly, in the background information document the comment 'clearing cacti can be done manually, but it is expensive and time consuming, and can never get ahead of new infestations that appear in new locations' I agree it is expensive and time consuming, however I do feel areas that have been cleared by the cactus cleanup team show that it is an effective way of removing cacti over time (areas do need to be revisited). One should	SAIEA (via telephone): The points raised here refer to activities that were proposed in the preliminary stages of the project, and which were revised during the EIA. The corrected activities are reported in the main report. To clarify: 1. There will be no rearing of the control agents in specialised facilities at the NBRI. 2. The main report makes it explicitly clear that there is a need for manual clearing of cacti, and that this must focus on those species that do not yet have safe and assured biocontrol agents.

No.	Name	Comment / Issue	Response
		clarify in the report that manual removal should be continued for species of cacti that have no biological control like Opuntia sulphurea which is hugely problematic around Windhoek. I worry the report/background information as it stands may be damaging to the work of the cactus clear up team - removing cacti manually is a horrible job but it creates employment, has willing workers and assists with the eradication of an invasive species when biological control is not an option. I am aware the cactus clear up team needs to be come more sustainable in its use of funds to continue in being effective. I hope you will take my comments into consideration. Kind regards, Frances	
2.	Abraham Kanime Email 05/02/2019 (contd.)	Hi John, I have received the report. thank you very much. Just quick further clarity for interest sake (not sure if completely addressed in the report), I assume these plants were introduced in Namibia some years ago. Now my interest is to know the following: 1. Are there some animals species that might have adapted in an ecosystem where cactus had grown,	SAIEA: 1. It is possible that some animals will use the resources that cacti offer, such as protection and food. But it is certain that they will not adapt so fast that they can use ONLY those resources. When cacti are removed or killed, the natural vegetation regrows and the animals that were using cacti for whatever purpose can go back to what they were using before cacti invaded. It is definitely not the case that the removal of cacti will leave some animals worse off, because those animals are better suited to surviving in their natural habitat, which originally did not include cacti.

No.	Name	Comment / Issue	Response
		whether is for the purpose of protection (hiding from predators); feeding on fruits and other juicy parts of the plant (e.g., bees, birds) or simply for shelter? If so what will happen to this adaptation? 2. The proposed research is based on outcome of similar projects implemented in some parts of Africa, are we really clear that Namibian environment is exactly similar to the study areas of previous research? 3. What is the outcome of assessment on proposed biocontrol versus manual/mechanical control as alternative? 4. If the proposed alien insect species is indeed a "natural killer" for cactus in the country of origin, does this means there are no more cactus in that part of the world? or on what basis that this insect species can help to eradicate cactus in Namibia? My final comment is that the idea is good to control this invasive species of cactus, but just not sure why we have to introduce another alien species in Namibia. Introduction of alien species comes with unforeseen risks that the current assessment may never be able to identify in advance. Hence we need to be much more careful.	2. The report states: "Over 400 biological control agents have been released in over 80 countries (including arid environments in South Africa, and in Namibia itself) over the last 100 years and none have had unpredicted non-target effects to other plant species." (my addition in parentheses). The biologists who do this research are equally concerned as you and I that the control agents should not have unwanted, negative consequences on non-target plants. Yet such effects have not been recorded. There is no reason to expect that the present Namibian situation should be different from the scientific evidence seen elsewhere. 3. The report states: "The suggestion for an economic comparison of biological versus manual control is deemed not necessary, since both are required and need to be applied in a coordinated fashion, based on the availability of tested and assured biocontrol agents against the relevant problem species." In addition, we know that manual control is not a long-lasting, sustainable solution. This is the strongest point in favour of biocontrol as the first priority. Manual control is needed for those species for which biocontrol agents are not yet available. 4. No. There are other natural predators and ecological factors which keep the populations of insects in balance where they occur naturally. So the cacti are not totally destroyed by the insects. The biocontrol agents will not actually eradicate the cacti in Namibia. They will bring the cactus populations down to a point where they will be kept at a low population, and the insect population will also survive at a low level. 5. (Final comment) You are correct: introduction of an alien species into any country needs to be done very carefully. The decades of research work that has been carried out on biocontrol of cacti serves as proof that this method is 1) effective and 2) safe.

No.	Name	Comment / Issue	Response
		I also advise the EIA team to liaise with the National Commission on Research, Science and Technology (NCRST) because this might be regarded as a research project not just a project, hence may need a research permit. Regards, Abraham	It is also important to recognise that Windhoek urgently needs a solution to the cacti pests: if something is not done to control them, they will inflict severe damage to our open spaces and surrounding rangelands. This is a matter of weighing up the risks: there is a very large risk of damage by uncontrolled cacti, and an extremely small risk (scientific evidence actually shows there will be zero risk) that biocontrol will cause unwanted problems. This justifies the need to introduce these alien species. This project is led by NCE which has acquired the necessary permit for research as stipulated by the NCRST.

6.2.3 Outcome of Second Round of Public Consultation

No new issues, with the potential to stop the proposed project, were raised during the second round of public consultation.

The most important issues raised by the I&APs in writing are bulleted below:

- Risks of spread of the biocontrol agents to other plants.
- Economic impact of this biocontrol project on existing manual cactus clearing operations: concern that the manual work will no longer be necessary (i.e. jobs will be lost), and that support to manual control projects will diminish.
    - This is addressed in numerous responses from CBC and NCE above, and in Section 7.2.2 below.

7 Impact Assessment

This impact assessment is unusual in that it is assessing a project whose main purpose is protection of the natural environment through combating the spread of an alien invasive pest. It is unlike other EIAs which normally have to address negative impacts arising from establishment of infrastructure, noise, pollution and other harmful activities. The intention of this project is to prevent and minimise a looming biodiversity threat i.e. its overall aim is helpful to the natural environment. The focus of the assessment is, like other EIAs, to ensure that any risks in the project are avoided or minimised. But any risks that are identified must be viewed in the context of the much greater risk that the invasive alien plants pose to Windhoek and Namibia.

The purpose of this chapter is to identify potential negative impacts that the project may have on the receiving environment and determine their significance. Each point provides a description and assessment of the potential impact, following a standardised method described in Section 7.1 below.

Mitigation measures are suggested, which are aimed at avoiding, minimising or mitigating negative impacts or enhancing potential benefits. The significance of potential impacts with mitigation is then provided.

7.1 Assessment Method

The identified impacts are assessed according to a synthesis of criteria required by the integrated environmental management procedure. This entails consideration of the expected impact's extent (spatial scale), duration (time scale), magnitude (intensity), probability, and degree of confidence, in combination providing the expected significance (see Table 7-1). Significance of the impact is assessed first without any mitigations, and then with the effect of the mitigations in place.

Table 7-1: Criteria applied to each potential impact

Criteria	Category
Impact	This is a description of the expected impact.
Status Describes the type of impact.	*Positive:* The activity will have an environmental (social or biophysical) benefit. *Neutral:* The activity will have no effect.

Criteria	Category
	Negative: The activity will have an environmentally (social or biophysical) harmful effect.
Extent The area affected by the impact.	*Site Specific:* Expanding only as far as the activity itself *(on-site)* *Small:* Restricted to the site's immediate environment within 1 km of the site *(limited)* *Medium:* Within 5 km of the site *Large:* Beyond 5 km of the site *(regional)*
Duration Predicts the lifetime of the impact.	*Temporary:* < 1 year *Short-term:* 1 – 5 years *Medium term:* 5 – 15 years *Long-term:* >15 years (impact will stop after the operational or running life of the activity, either due to natural causes or by human interference) *Permanent:* Impact will be where mitigation or moderation by natural causes or by human interference will not occur in a particular means or in a particular time period that the impact can be considered temporary.
Magnitude Describes the scale or intensity of the impact.	*Very low:* Affects the environment in such a way that natural and/or social functions/processes are not affected. *Low:* Natural and/or social functions/processes are slightly altered. *Medium:* Natural and/or social functions/processes are notably altered in a modified way. *High:* Natural and/or social functions/processes are severely altered and may temporarily or permanently cease.
Probability of Occurrence Describes the probability of the impact actually occurring.	*Improbable:* Not at all likely. *Probable:* Distinct possibility. *Highly probable:* Most likely to happen. *Definite:* Impact will occur regardless of any prevention measures.
Degree of Confidence in Predictions	*Unsure/Low:* Little confidence regarding information available. *Probable/Med:* Moderate confidence regarding information available.

Criteria	Category
Describes the degree of confidence in the predictions, based on availability of information and specialist knowledge.	*Definite/High:* High confidence regarding information available.
Significance The impact is determined by a combination of the above criteria.	*No change:* A potential concern which was found to have no impact when evaluated. *Very low:* Impacts will be site-specific and temporary with no mitigation necessary. *Low:* The impacts will have a minor influence on the project and/or environment. These impacts require some thought to adjustment of the project design where achievable, or alternative mitigation measures. *Moderate:* Impacts will be experienced in the local and surrounding areas for the life span of the development and may result in long term changes. The impact can be lessened or improved by an amendment in the project design or implementation of effective mitigation measures. *High:* Impacts have a high magnitude and will be experienced regionally for at least the life span of the development, or will be irreversible. The impacts could have the no-go proposition on portions of the development in spite of any mitigation measures that could be implemented.

7.2 Key Impacts

7.2.1 Risks to non-target plants

The risks of attack on non-target plants must be considered for the two different types of control agents: (i) the cochineals that target *Opuntia* cacti; and (ii) the mealy-bug that targets columnar cacti.

(i) *Opuntia* cacti

There is a perception that releasing cochineal insects into Namibia will put at risk plantations of Prickly pear cactus, *Opuntia ficus-indica*, which are grown for their fruits and as a cattle feed during dry conditions.

The perception is false. The 'stricta biotype' of cochineal that will be released is virulent against *Opuntia stricta*, but does not feed on or kill *Opuntia ficus-indica.* This is explained in Section 3.4.3: the different biotypes have been specifically cultivated in South Africa for their specific ability to feed on either *Opuntia stricta* or *Opuntia ficus-indica*. This project will release the stricta biotype that targets *Opuntia stricta* only.

(ii) Columnar cacti

There is a small risk to non-target columnar cactus plants, such as those in gardens and nurseries, that the introduced mealy-bug will sterilise and damage them through its galling activities (see Section 3.4.4). But it is important to emphasise that it is only alien columnar cactus species that can be affected – not any indigenous species – and these potentially affected plants in gardens and nurseries are themselves the source of potential future invasions. Through the Protected Areas and Wildlife Management Bill, MET is looking at making it illegal for people to have high-risk invasive alien plants on their land, and for nurseries to hold, propagate and sell them.

Table 7-2: Assessment of impact associated with risks to non-target columnar cacti.

Criteria	Description
Potential impact	Non-target cactus plants will be sterilised and/or killed by the introduced mealy-bug *Hypogeococcus festerianus.*
Status (+ or -)	**Negative** (Once Parks & Wildlife Bill is passed, this would change to **Positive)**
Extent	The introduced insect is a very poor disperser so the risk is only in those areas very close (less than ~500 m) to infestations of Imbricated cactus where the insect will occur. This is a very small, localised impact.
Duration	The risk will be greatest while the populations of Imbricated cactus are high. Once the mealy-bug has brought the target cactus population down, expected to occur after about 10 years, the mealy-bug population will also decrease considerably, making the likelihood of attack onto non-target species similarly small.

Criteria	Description
Magnitude	The combination of a very localised impact and relatively short duration of any risk, makes the magnitude of the impact low.
Probability	The chances of the insects attacking non-target plants is small, considering the extent and duration criteria above.
Significance (no mitigation)	The impact of attack onto non-target plants will be to sterilise plants that are kept only for ornamental purposes. In this sense, the impact is trivial compared to the much greater benefit of controlling the spread of a pest that can cause substantial loss of land productivity and local biodiversity. The significance of the negative impact is very low.
Mitigation	If desired, the mealy-bug can be killed with insecticide. It is therefore possible for people who keep cacti to protect their plants against attack by spraying them, if they consider their plants to be vulnerable.
Confidence level	High. The biology of this biocontrol agent has been well studied, and there is robust scientific evidence for the very low risk that is posed to non-target species.
Significance (with mitigation)	Very low to insignificant.

7.2.2 Risk of loss of jobs and support to manual clearing projects

Biocontrol of alien invasive cacti, as set out in the proposed project, is expected to be very effective and economically much less expensive than manual clearing. This raised a concern by Cactus Clean-up proponents and others supporting manual methods that there would be loss of jobs, and less support for this important component of cactus control.

Responses from the Proponent, based on experience in South Africa, have given assurances that jobs will not be lost. Most importantly, the Proponent recognises the important role played by Cactus Clean-up in raising awareness of the threats from cacti, and in manually clearing those species that do not yet have tested and assured biocontrol agents. The EMP contains suggestions to local official partners, such as City of Windhoek and MAWF, to continue and expand their financial and logistic support to Cactus Clean-up and other similar initiatives.

8 Environmental management plan

8.1 Suggestions to the Proponent and the National Cactus Biocontrol Committee

There are a few key activities that will help to make the proposed biocontrol measures more effective:

1. The release sites of the three species should be communicated and shown to the Cactus Clean-up team so that they do not mistakenly remove those cacti. This is critically important.
2. There should be close coordination between the teams focussed on biocontrol and those focussed on manual clearing (i.e. Cactus Clean-up). It is important that Cactus Clean-up should confine its work to clearing those species that do not yet have biocontrol agents. There is plenty of work for them to do just concentrating on e.g. *Opuntia sulphurae* and *Cylindopuntia pallida* alone.
3. Mapping and monitoring of cactus infestations should be carried out throughout Windhoek's open spaces, involving students and volunteers where necessary, to identify areas that should be targeted for cactus control operations. This will require long-term commitment to supporting such studies and monitoring, by established institutions such as local universities (i.e. NUST and/or Unam) and the Namibian Botanical Research Institute (NBRI). These institutions are already involved as partners in the project, and have pledged this ongoing involvement.
4. Information from the monitoring work should feed into the coordinated control programme between Cactus Clean-up and the biocontrol team, so that the manual clearing work can focus on complementing the biocontrol programme.
5. Mechanical (manual) control is recognized as an important component of an integrated strategy for the control of invasive alien cactus species. The only situation where manual control is not recommended is for the three cactus species for which there is a biocontrol. All the other cactus species need manual eradication, therefore mechanical control should be financially supported (see below).

8.2 Suggestions to CoW, MAWF and MET

In the interest of controlling the main invading species of cacti in Windhoek, the City of Windhoek is encouraged to continue and expand its support to the Cactus Clean-up programme. Most importantly, financial support is needed to keep this programme going, so that time and effort is not taken up for raising funds. Other support can be provided through active cooperation with delivering empty skips to collect the cleared cacti, and regularly removing them and disposing of the contents safely. This is carried out at present, and should be continued.

South Africa organises work teams to combat invasive cacti through its 'Working for Water' campaign, which carries full government support and actively employs and pays groups of workers to clear alien invasive plants. Such government support for the campaign is commendable, and should also be provided by the Namibian Government with collaboration of relevant Local Authorities. The Cactus Clean-up team is an obvious beneficiary for such financial support, since the main champion of this volunteer work (who asks for no payment for herself) is highly committed, but often unable to pay her team due to insufficient funds.

The draft Protected Areas and Wildlife Management Bill needs to be passed as soon as possible, and Regulations prepared for the prevention of import, propagation and sale of invasive species, including all cacti, and to make it obligatory for land owners and custodians to remove invasive alien plants from their land. In some cases, they will need assistance for this, and this work on biocontrol will be an important contributor to getting invasive alien plants under control in Namibia.

9 Conclusions and Recommendations

This chapter presents the conclusions of the scoping phase and the recommendations for consideration by the proponent and relevant authorities. The conclusions and recommendations presented are based on the impact assessment presented in Chapter 7 above.

9.1 Conclusion

The importation and release of three biocontrol agents into pilot sites in Windhoek will be an important first step in controlling the large suite of invasive alien cactus species in Namibia. Controlling these cacti will result in the protection of indigenous biodiversity, wildlife, livestock and ecosystem services and will thus benefit the country as a whole.

The initial work to develop new biological control agents is expensive and the success rate of new agents is generally rather low, but these agents have already been developed and tested in Australia and South Africa and have proven to be safe and effective in those countries as well as in others (Winston, *et al*., 2014). Namibia can therefore take advantage of this freely available, inexpensive and effective method of controlling invasive alien cactus species in an affordable, sustainable and environmentally friendly manner.

Based on the information regarding host-specificity of the proposed biocontrol agents, and the findings of the public consultation process that was undertaken during this environmental assessment, it can be concluded that no further detailed assessments are required, and that there is no reason to withhold an Environmental Clearance Certificate for this project.

9.2 Recommendations

It is recommended that an Environmental Clearance Certificate be issued for the proposed project. It is further recommended that, once the Environmental Clearance Certificate has been issued, that:

- The necessary phytosanitary permits and approvals be obtained as required.
- Necessary precautions are taken to prevent accidental clearing of the growing population stocks that are released in Windhoek.
- Monitoring the establishment and growth of the populations of biocontrol agents should be carried out, ideally involving local students. This will build experience and capacity in the important field of biological control.

10 References

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