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MINISTRY OF TRANSPORT
AND INFRASTRUCTURE

AYGM
Altyapı Yatırımları Genel Müdürlüğü

ÇINAR®
ENGINEERING
CONSULTANCY INC.

FİLYOS AND ÇUKUROVA LAST-MILE RAIL CONNECTIVITY INFRASTRUCTURE PROJECT

INVASIVE ALIEN SPECIES MANAGEMENT PROCEDURE

CNR-ZNG-ADN-IASMP-001

(Final)

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ABBREVIATIONS & DEFINITIONS

CBD	The Convention on Biological Diversity
ÇINAR	Çınar Engineering Consultancy Inc.
DGII	Directorate General of Infrastructure Investments
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EPPO	European and Mediterranean Plant Protection Organization
ESCP	Environmental and Social Commitment Plan
ESF	Environmental and Social Framework
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Standards
GEF	Global Environment Fund
GISD	Global Invasive Species Database
GISP	The Global Invasive Species Programme
GRIIS	Global Register of Introduced and Invasive Species
IAS	Invasive Alien Species
IASMP	Invasive Alien Species Management Procedure
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature and Natural Resources
LMC	Last-Mile Infrastructure Connectivity
MoTI	Ministry of Transport and Infrastructure
PS	Performance Standards on Environmental and Social Sustainability
RAP	Resettlement Action Plan
RLIP	Rail Logistics Improvement Project
SEP	Stakeholder Engagement Plan
WB	World Bank
WBG	World Bank Group

EXECUTIVE SUMMARY

Under the Rail Logistics Improvement Project (RLIP), Filyos and Çukurova Last-Mile Rail Connectivity Infrastructure Project is carried out by the Directorate General of Infrastructure Investments (DGII). In this context, Çınar Engineering Consultancy Inc. (ÇINAR) has been awarded as Consultant for revision of the Environmental and Social Impact Assessments, Resettlement Action Plans, Stakeholder Engagement Plans, and Environmental and Social Management Plans in line with Contract No. AYGM-DAN-2020-WB 10.

This Invasive Alien Species Management Procedure was created in accordance with the ESS6 GN29 requirements. The structure of this report is taken from “The Invasive Alien Species Regulation (Regulation (EU) 1143/2014)”, “European Guidelines on Protected Areas and Invasive Alien Species” prepared by Council of Europe, Strasbourg, Regional Parks Agency, and ESS6 GN29. The Guidelines have been drawn up to follow the legal requirements of the Act.

The Turkish Invasive Alien Species Plant Catalogue was published by the Ministry of Agriculture, Forestry, General Directorate of Agricultural Research and Policies in 2015. Also, the Listed Turkish Invasive Species were published by the Ministry of Agriculture, Forestry, General Directorate of Nature Conservation and National Parks in 2018.

This document provides a management procedure for the invasive alien plants. The first section provides an introduction to the Alien Plant Management. The second section provides a summary of the Acts that apply to management of alien plants on site. The next section provides control guidelines, including specific measures that should be taken during different phases of the project to ensure that alien plants do not become established on site. The next section provides a generic guide to control methods, including mechanical, chemical and biological control, as well as the advantages and disadvantages of each. The next section provides some guidelines for habitat management to ensure that invasive alien plants do not become established on site.

The penultimate section provides detailed steps for the control of alien and invasive species. The last section gives an outline of monitoring requirements for early detection of invasive alien plants on site as well as to evaluate the success of clearing operations. The monitoring covers phases of the project from construction to operation.

1 INTRODUCTION

1.1 Project Description

The Rail Logistics Improvement Project (RLIP), financed by the World Bank and implemented by the Ministry of Transport and Infrastructure (MoTI) through its Directorate General of Infrastructure Investments (DGII), aims to increase rail freight efficiency in Türkiye by improving last-mile infrastructure connectivity (LMC), enhancing the operational efficiency of rail-enabled logistics centers, and strengthening institutional capacity in the rail intermodal and freight logistics sector.

The Project is developed around three main components:

- Component 1 – Construction of railway branch lines and multimodal connections at priority network nodes
- Component 2 – Feasibility studies, detailed engineering designs, environmental and social documentation, and construction supervision for rail last-mile infrastructure connectivity at additional freight nodes
- Component 3 – Phase 2 Covid-19 response support, institutional strengthening, capacity building, and project implementation support

The risk classification of the project is identified as “Substantial” under the World Bank Environmental and Social Framework (ESF). As a result, although the sub-projects have an exemption on Environmental Impact Assessment (EIA) according to the national legislation; Environmental and Social Impact Assessments (ESIAs), Resettlement Action Plans (RAPs), Stakeholder Engagement Plans (SEPs), and Environmental and Social Management Plans (ESMPs) have been prepared in compliance with the World Bank Environmental and Social Framework (ESF), and Environmental and Social Standards (ESSs) for the Project.

The World Bank Group (WBG) General Environmental, Health, and Safety (EHS) Guidelines and Industry Sector EHS Guidelines for Railways, Toll Roads, and Electric Power Transmission and Distribution have been applied for the identification of measures to address the Environmental and Social risks. Furthermore, additional 12 sub-management plans were prepared for RLIP as a part of the ESIA package: Construction Impacts Management Plans, Community Health and Safety Management Plan, Community Relations Management Plan, Employment and Training Plan, Aggregate Management Plan, Traffic (Transportation) Management Plan, Cultural Heritage Management Plan, Pollution Prevention Plan, Waste Management Plan, Emergency Preparedness and Response Plan, Occupational Health and Safety Management Plan, and Critical Habiatat Assessment and Biodiversity Management Plan.

The site studies were completed in February 2020, the ESIA reports were disclosed in May 2020. The mentioned activities are defined as Phase-1 of the Project. During Phase-1 studies; environmental, social, and culturally sensitive areas in the project impact area were specified in the ESIA reports, and mitigation measures were proposed. Within the framework of the Environmental and Social Commitment Plan (ESCP), the whole ESIA package will be revised and updated in line with the World Bank standards, where necessary, and this process is defined as Phase-2 of the Project. Thus, the studies and measurement that could not be performed due to the seasonal restrictions were carried out at Phase-2, and necessary measures were taken for the protected areas.

1.2 Site Characteristics

This Invasive Alien Species Management Procedure (IASMP) applies to the project area[1] and associated infrastructure (See Figure 1). This site-specific management procedure was developed to address the monitoring, control and eradication of all invasive plant species only for the Project and associated infrastructure.

Table 1. Site Characteristics of the Project Area

Key vulnerabilities to invasion on site	▪ Extensive areas of natural vegetation on site, which house important biodiversity within the study area; ▪ Riparian areas, which could act as conduits for alien invasions, as well as being vulnerable to altered ecological conditions under heavy invasion - they are also the areas that most often become heavily invaded in this geographical area; ▪ Neighboring areas that may potentially be vulnerable due to spreading of invasive alien species on site.
Key factors that may promote establishment and spreading of invasive alien species on site	▪ High levels of disturbance anticipated in parts of the site, especially areas of proposed construction, but also various areas that will develop secondary or previously disturbed vegetation following construction. ▪ Transport of propagules of alien invasive species via various vectors, primarily construction vehicles and materials.
Key current advantages	▪ There are no existing stands of alien trees on site or in neighboring areas. ▪ Current management of invasive alien species on site has not been required.
Proposed management objectives	▪ Compliance with relevant legislation; ▪ Protection of existing biodiversity on site; ▪ Eradication and control of unwanted invasive alien species.

[1] This document will be updated once the route of the Filyos sub-project is finalized.

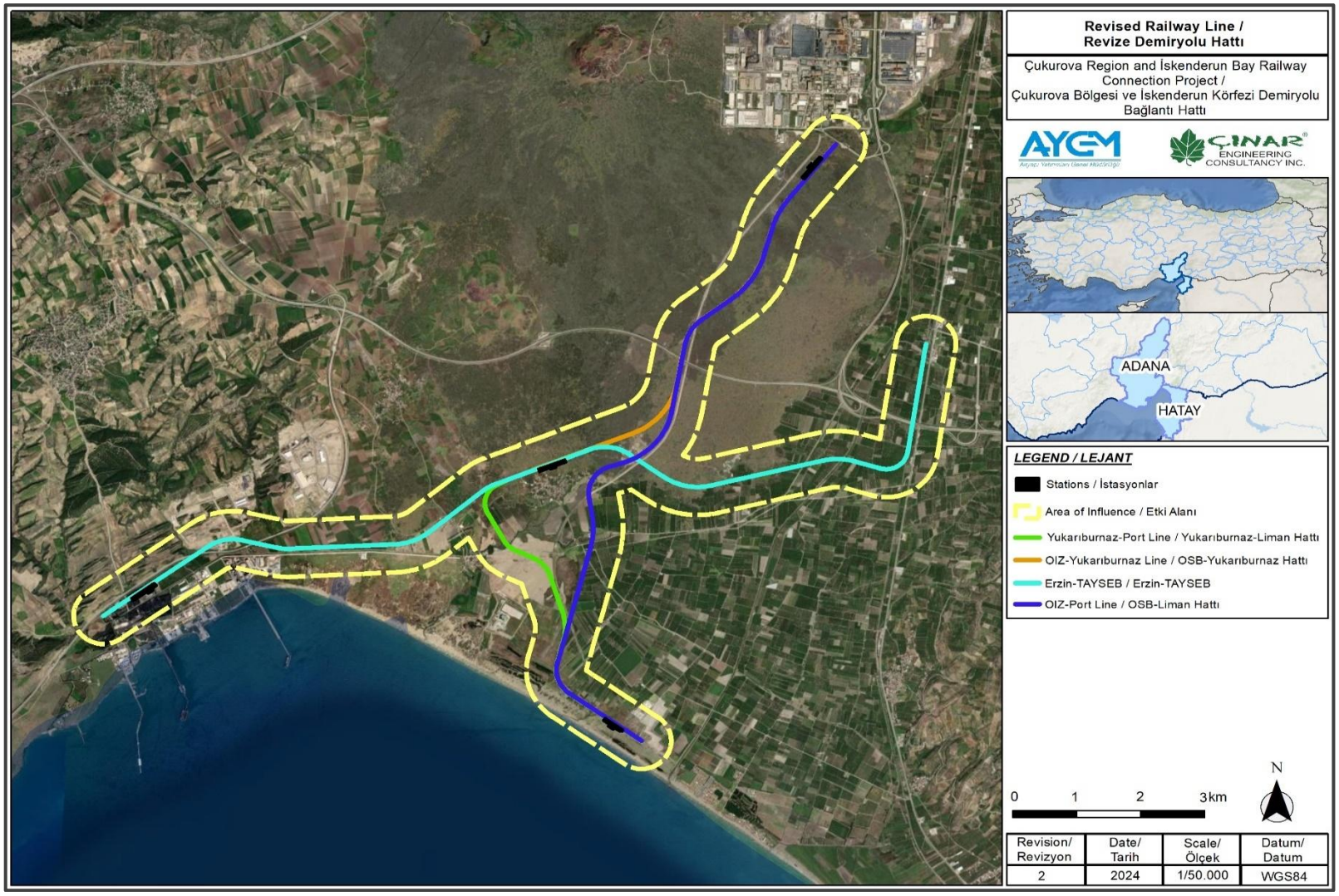

Figure 1. Revised Railway Line – Çukurova Section

2 APPLICABLE LEGISLATION

The Convention on Biological Diversity (CBD) defines invasive alien species (IAS) as species whose introduction and/or spread outside their natural past or present distribution threatens biological diversity. IAS occurs in all taxonomic group of organisms; including animals, plants, fungi and microorganisms, and can affect all types of ecosystems. Invasion by alien species is reported to have caused significant degradation with negative impacts on biological diversity and people's livelihoods according to IUCN, which requires that all projects that may provide a key pathway for invasive species are screened for their potential to accidentally introduce invasive alien species. In line with provisions of ESS6, projects that potentially cause introduction of alien species are subject to a risk assessment. Once established, eradication of IAS requires more effort and resource allocation, prevention is the first step in management.

The Global Invasive Species Programme (GISP) is an international partnership working to address the global threat of IAS, with the main objective of conserving biodiversity and sustain livelihoods by minimizing the spread and impact of invasive alien species with the implementation of Article 8(h) of the CBD. Furthermore, managed by the IUCN's Species Survival Commission, there is a Global Invasive Species Database (GISD), which currently works on establishing a Global Register of Introduced and Invasive Species (GRIIS) to develop country-wise validated, verified and annotated inventories of introduced and invasive species.

Türkiye has a wide marine IAS dataset, while studies on terrestrial ones have been rather limited. With funding from the Global Environment Fund (GEF), a GEF VI project addressing invasive species threats at key marine biodiversity areas is being implemented by the General Directorate of Nature Conservation and National Parks (GEF, 2020). The project started in 2018, was planned to be completed in four years. The objective of the project is to ensure resilience of marine and coastal ecosystems through strengthened capacities and investment in prevention, detection, control and management of IAS. In line with the most recent European Union legislation (1143/2014) on IAS, which requires a mandatory response by all member states to the threats that invasive species pose to biodiversity and ecosystem services, a similar project will be undertaken also for inland water and terrestrial ecosystems.

Studies that have already been conducted reveal an estimated 1.5% of plant species in Türkiye being exotics (Arslan et al. 2015), although a comprehensive list of alien plants is still lacking. Türkiye is a member of EPPO, an intergovernmental organization responsible for cooperation in plant health within the Euro-Mediterranean region, which aims to protect plants by developing international strategies against the introduction and spread of pests and by promoting safe and impactive pest control methods through A1 and A2 lists of pests recommended for regulation. Arslan et. al. (2015) also report that species that have been recorded in the EPPO list of invasive alien plants that are present in Türkiye are; *Acroptilon repens, Ailanthus altissima, Ambrosia artemisiifolia (A. elatior), Carpobrotus edulis, Cortaderia selloana, Cyperus esculentus, Paspalum distichum (P. paspalodes), Oxalis pes-caprae* and *Sicyos angulatus*, while *Azolla filiculoides* and *Rhododendron ponticum* are listed in the EPPO Observation List of Invasive alien plants and Miscanthus sinensis, listed in the EPPO Alert List, are also recorded in the Turkish flora (Arslan et al., 2015).

Project biodiversity studies led by field experts did not yield any data on presence of IAS.

3 CONCEPTUAL GUIDELINES FOR DETERMINING PRIORITY SPECIES AND AREAS FOR CONTROL

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

3.1 Factors That Affect the Risk of a Species Becoming Invasive

There are a number of factors to consider when evaluating the potential risk of invasive species:

- The impact on ecosystem processes and system-wide parameters,
- The impact on community structure,
- The impact on community composition,
- The impact on individual native species,
- The conservation value and/or significance of ecological communities and native species threatened by the invasive species,
- The current range size of the invasive species,
- The proportion of the current range where the invasive species is negatively impacting biodiversity,
- The proportion of a region's biogeographical units that are invaded by the species,
- The diversity of habitats or ecological systems invaded by the invasive species,
- The current trend in total range of the invasive species (expanding, contracting or stable),
- The proportion of the current range currently occupied,
- The long-distance dispersal potential of the invasive species,
- The local range expansion or change in abundance,
- Inherent ability to invade native habitat,
- Similar habitats invaded elsewhere,
- Reproductive characteristics of invasive species,
- General difficulty in managing the species,
- Minimum time commitment for management of the species,
- Impacts of the management program on native species and habitats,
- Accessibility of invaded areas.

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

3.2 Conceptual Phases in the Invasion of a Weed

Population processes, which can occur over long stretches of time and may not always be immediately apparent, determine an invasive species' biological characteristics as well as its propensity to spread. These have to do with a species' capacity to spread out and then become more invasive. Depending on their means of dispersal, life cycle, longevity, size, fecundity, and other factors, plants can exhibit a variety of patterns in time and space. Many adhere to a streamlined "S" pattern, which can be graphically represented as the percentage of all potential habitats occupied by the pest at any given time.

The three key characteristics of a species' spread are a long tail at the start as it overcomes the first set of barriers, a steep rise as it overcomes these barriers and finds suitable habitats, and a flattening off as these habitats become overpopulated. The percentage of the habitat

that is uninfected decreases as the plant spreads at a rate indicated by a "reverse S". Even though spread is a continuous process, there are still points where the rate of change diverges significantly from the previous period, which can usually only be seen in retrospect. The 'S' shape can be idealized as stages for management purposes based on the extent and rate of spread. Any geographic scale, from a field to a continent, can be used to apply this concept.

Migration phase

The species must first travel to the region's edge. Depending on a number of variables, it may or may not enter after arriving. It will be discovered and, it is hoped, eliminated where there are effective quarantine protocols and risk management procedures before it becomes difficult to control.

Escape phase

Once inside the area it may escape only occasionally, or finally become fully naturalized. These naturalization points are most likely to be found along the introduction pathway, such as next to erosion control plantings or in fields of contaminated corn. They have received the moniker "sentinel sites."

Establishment phase

In this stage, the plant can reproduce in the new setting, and population sizes gradually start to increase. Almost all potential habitat is still free of infection.

Expansion phase

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

Entrenchment phase

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

3.3 Implications for Management of Invasive Species

The imperatives of weed-risk assessment are affected by these potential changes in pest spread:

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

3.4 Procedure for Removal of Invasive Species

Table 2. Invasive Alien Species Removal Procedure

Purpose	
This procedure describes the minimum requirements that will be followed to prevent the introduction and spread of invasive alien species (including introduced pests and plant pathogens) as a result of Project activities.	
Context	
Project activities (e.g., importation of equipment and personnel, plantation development) have the potential to introduce invasive alien species including weeds, plant pathogens or pest fauna into the area or facilitate the spread of existing weeds, plant pathogens and pests beyond their initial range.	
Proposed Management and Mitigation Measures	
Training and awareness	Being aware of invasive alien species that are currently in the area, and/or those that could potentially establish in the area, is key to managing this issue. Selected Project personnel will be trained in: ▪ Identifying weed species currently in the area and those that could establish ▪ Identifying plant pathogens and evidence of their presence ▪ Identifying pests known to be in the area and those that could establish ▪ Techniques to prevent and, if necessary, control infestation of invasive alien species
Planning	In planning new activities involving vegetation disturbance, the following will be considered: Identify existing weeds within the vicinity of areas to be cleared ▪ Determine if there is evidence of plant pathogens on the proposed site ▪ Develop control strategies for weed species already established, using a risk-based approach to prioritize implementation, with a focus on noxious weeds ▪ Ensure that chemicals used to control weeds and equipment are on site and in good condition ▪ Should dieback be identified: o Exclude access to these areas OR o Provide boot-washing facilities for staff leaving the area to prevent further spread of the pathogen ▪ Identify existing pests and those that have the potential to establish in the area ▪ Consult with landowners concerning areas known to be infested by invasive alien species
Movement of machinery/ equipment	Use of machinery and equipment from outside the Project area and subsequent movements within the Project area are likely to be the most common causes of invasive alien species being introduced and/or spread. To minimize the likelihood of this occurring, the following practices will be implemented: ▪ Follow quarantine requirements for importation of construction materials, soil or other plant material to the Project area ▪ Check equipment arriving on site to ensure that it is clean. Collect soil or vegetative matter in a plastic bag for subsequent burial in the Project landfill ▪ Minimize movement of equipment and machinery between areas ▪ Before any equipment is moved, remove soil, seeds and vegetation by washing down, paying particular attention to wheels, under-carriage areas and/or tracks
Construction and operations	During construction and operations, the following will be undertaken: ▪ Control the establishment of noxious weeds and pest animals at the edges of cleared or disturbed areas

	▪ Place wastes (food in particular) in a bin (with secure lid) or otherwise in a manner that excludes pest animals such as rodents, and does not allow pest animals to access putrescible waste as a food supply ▪ Do not leave food wastes outside ▪ Initiate weed, pathogen and pest control programs as soon as possible, as required, using species-appropriate methods ▪ Control pest rodents including black rat (*Rattus rattus*) and house mouse (*Mus musculus*) when detected in Project infrastructure areas ▪ Implement riparian buffer zones with no plantations being established within the buffers

Proposed Monitoring and Reporting		
Action	**Frequency**	**Reporting**
Record and report weed, pathogen and pest presence or changes in extent of existing populations within the Project area	Quarterly	Quarterly

Proposed Monitoring and Reporting (cont.)		
Action	**Frequency**	**Reporting**
Record and report pest animal sightings	Event-based	Monthly
Audit truck/machinery washing/cleaning facilities	Quarterly	Quarterly

3.5 General Guidelines

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

1. Controlling alien invasive species, although a legal requirement, is usually a means to achieving a higher goal, such as protecting biodiversity, rehabilitating disturbed areas, restoring ecological functionality, preventing economic loss, protecting of human health, etc. Alien invasive clearing should therefore be aligned with the broader biodiversity targets and strategy for the project.
2. Different species require different control methods.
3. It is essential to break the reproductive cycle of a species.
4. There should always be follow-up of clearing to prevent invasive species from re-establishing in previously cleared areas.
5. The size of the area being cleared should always be manageable.
6. In principle, start in the least-invaded areas and work towards the heavier infestations. This will make it possible to safeguard relatively large areas of natural habitat.
7. Clearing should always start at the highest point in the landscape and work downwards.
8. Cover any exposed soil with plant material but ensure that this is free of seeds of the invasive species or other propagules.
9. If possible, try to clear plants before they produce seeds by cutting them back before they flower.
10. Do not transport seeds, fruits, bulbs, tubers, or stems that root easily from one site to another. It is best to burn material where it is cleared, if possible.
11. Follow-up is essential. This is linked to ongoing monitoring to detect alien seedlings and remove them while they are easy to manage and progressively deplete the soil seed bank.
12. Rehabilitation or restoration of cleared areas is necessary to restore ecological functionality and to create conditions that are less favorable for invasive species.
13. As alien invasive species impact on the condition of habitats and populations of species, their control or eradication, as appropriate, should be undertaken to increase the overall positive biodiversity footprint of the project, in line with an overall biodiversity strategy.

4 MANAGEMENT UNITS

Based on practical considerations, the study area should be divided into separate management units to facilitate more effective control if alien invasive species become established on site and it becomes necessary for management purposes. The most crucial elements are the already present biodiversity patterns that need to be preserved, the identification and invasive potential of any alien species present, and the practical management concerns like connectivity, accessibility, area size, invasion level, and ongoing activities on the property. The locations of the various management units should be plotted on a map. These management units might need to be modified to reflect quantified control and biodiversity restoration targets once the larger biodiversity strategy and targets for the study area are adopted.

The status of the management units must be regularly assessed in order to: (1) track and record the size of any infestations; (2) allow the applicant to report on and monitor the effectiveness of earlier control and eradication efforts; and (3) gauge the development and effectiveness of the control strategy. According to an overall biodiversity strategy, this should support or contribute to quantified biodiversity targets (such as habitat or vegetation condition scores) for each management unit (See Table 3).

Table 3. Assessment Criteria for Alien Species Management Unit

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

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

5 CONTROL METHODS

5.1 Generic Control Methods

This section provides specific generic methods for controlling alien and invasive plants. It is an outline of existing control measures that have been published for the various alien plant species that could potentially occur on site. The section is a summary of control measures – there are more detailed publications for control measures. It includes physical removal methods, use of herbicides and biocontrol methods.

5.1.1 Mechanical Control

Manual removal or use of basic tools can be used to get rid of many invasive plants. This entails physically removing or harming the plant. Various methods, such as uprooting, felling, slashing, mowing, ringbarking, or bark stripping, could be used. Only small-scale or sparse infestations, as well as species that do not coppice after cutting, make this control option really workable. Following mechanical treatment, species that naturally coppice must have the cut stumps or coppice growth treated with herbicides. Mechanical control is labor-intensive, costly, and has the potential to seriously disturb the soil and erode it. There are no existing large stands of invasive foreign plants in the area of the current project.

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

Seedlings

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

Shrubs and small trees

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

Large trees

If the tree is too large for physical removal, consider ring-barking the tree. This technique involves removing a ring of bark at least 25cm wide. Peel the bark down to just below ground level, pulling outwards. Bark peeling is a particularly useful method for destroying invasive Acacia species. Ring-barking interferes with the circulation of the tree and results in it slowly dying. If you wish to hasten the process, fell the tree to a stump that is 30cm above ground

level. Then loosen the bark on the stump by hitting it with a hammer and peel the bark downwards to ground level. Any re-growth that appears must be cut off cleanly at once, to prevent nutrition from new growth reaching the roots.

5.1.2 Chemical Control

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

Herbicides are either classified as selective or non-selective. Selective herbicides are usually specific to a particular group of plants, e.g. those specified for use on broad leaf plants, but should not kill narrow-leaf plants such as grasses. Non-selective herbicides can kill any plant that they come into contact with and are therefore not suitable for use in areas where indigenous vegetation is present. Care should be taken not to impact on threatened or protected species.

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

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

Seedlings and small shrubs

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

Large shrubs and trees

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

Basal stem treatment: Paint a herbicide (mixed with diesel) onto the base of the tree trunk and any exposed roots. Paint the herbicide up to a height of 25cm above ground level. In the case of multi-stemmed trees, each individual stem should be painted. The herbicide will enter the tree's circulation and eventually kill the tree. Foliar spraying: In the case of re-growth from stumps (otherwise known as coppicing), mix a herbicide with water and spray on the re-growth. Allow the re-growth to reach a height of 50cm before treatment. Ensure that a full cover spray is achieved. Trees with bud banks or lignotubers can be destroyed using use a herbicide after sawing off the trunk at ground level.

5.1.3 Biocontrol

Biological weed control consists in the use of natural enemies to reduce the vigour or reproductive potential of an invasive alien plant. Biological control agents include insects, mites, and micro-organisms such as fungi or bacteria. They usually attack specific parts of the plant, either the reproductive organs directly (flower buds, flowers or fruit) or the seeds after they have dropped. The stress caused by the biological control agent may kill a plant outright or it might impact on the plants reproductive capacity. In certain instances, the reproductive capacity is reduced to zero and the population is effectively sterilized. All of these outcomes will help to reduce the spread of the species.

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

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

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

It is recommended that the project develop internal procedures to assist in the effective management of these potential impacts during eradication and removal. All contractors must also be trained in these procedures to ensure the potential impacts are minimized. Eradication

and removal activities must be scheduled in the appropriate dry or wet season to reduce impacts as far as possible.

Specific methods of control for each species that may be found on site must be researched. Where available, this information includes registered herbicide options for each species.

6 RESPONSIBILITIES AND REPORTING REQUIREMENTS

The following are possible reporting requirements:

1. Annual reports by the Contractor's Environmental Officer/Manager to DGII PIU on progress in terms of clearing activities. This is most important during times of active clearing and monitoring in order to document activities.
2. Annual reports by the Contractor's Environmental Officer/Manager reviewing control activities and reporting on monitoring activities. The Invasive Alien Species Management Procedure should be updated annually to take into account new information and revised priorities, including the eventual development and adoption of broader biodiversity targets for the railway and each management unit.
3. Biennial assessments by the Contractor's Environmental Officer/Manager to review progress or once a management unit has been completed and a new unit is targeted (to ensure successful removal was implemented and to ensure targets for removal in the new unit remain as per the original management plan).

In due time, progress monitoring on alien invasive species management should be embedded in the monitoring of the broader set of biodiversity activities for the project.

7 MONITORING AND EVALUATION

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

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

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

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

There are four types of invasive plant monitoring:

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

7.1 Monitoring of Early Detection

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

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

7.2 Monitoring for the Effect of Management Actions on Target Species

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

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

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

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

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

7.4 Monitoring for the Status and Trends of Target Species Populations

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

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

7.5 Monitoring Methods

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

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

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

Specific parameters that can be monitored are as follows:

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

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

7.6 Monitoring Plan

Elements of a monitoring plan include:

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

The objectives of monitoring are to:

- Detect new invasions,
- Detect changes in density, extent, location of invasive species,
- Detect effects of invasive species on habitats,
- Detect effects of management measures on invasive species,
- Detect effects of management measures on habitats, especially their condition or quality, in line with the biological diversity protocol, for biodiversity footprint assessment purposes

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

Table 4. Proposed Monitoring Plan

Monitoring Action	Indicator	Survey Method	Data to be collected	Data Management	Timeframe
Early detection survey	New species appearing on site. This can be reported as a list, latitude-longitude positions of new observations and observations on numbers of individuals and/or estimated density.	Rambling transects (walk-through survey) through target habitats ensuring all habitats are covered in each management unit.	Presence data (identify and control which species are present on site, in the form of a list), estimates of cover / numbers (GPS co-ordinates of individual plants and/or mapped areas of dense invasion with estimates of total numbers within mapped area), photo record (if necessary). The data collected for this Control Plan is an example of an early detection survey.	List, maps and/or data positions curated by environmental manager/officer	During the construction period
Document alien species present on site	Alien species list, which must be amended from time to time. Can include density information, which can be analyzed and presented as bar graphs.	Rambling transects (walk-through survey) through target habitats ensuring all habitats are covered in each management unit.	As for previous point.	List can be saved as document or spreadsheet curated by environmental manager/officer	During the construction period
Map concentrations of invasive species	Extent of invasive species populations	Field mapping using GPS to record perimeter of invasive populations	Mapping data. Where there are stands of invasive species that can be defined as individual landscape units, these should be mapped. Mapping can be repeated after clearing activities and/or after detecting invasive species spreading (if applicable). From this the size and location of areas under cover of different invasive species can be calculated and changes documented over time.	GIS files curated by environmental manager/officer	Whenever changes detected
Document and record alien control measures implemented	Record of clearing activities	Visual observation, report from clearing crew	Descriptive information	Electronic document curated by environmental manager/officer	Can be daily, weekly, monthly and/or annually, depending on reporting requirements
Review alien control success rate	Decline in abundance of alien plant species over time	Plot, transect or targeted surveys	Density, latitude-longitude co-ordinates. Which species have been completely removed or what proportion / numbers were removed.	Electronic document curated by environmental manager/officer	Monthly or annually, depending on reporting requirements

8 CONCLUSION

Project biodiversity studies led by field experts did not yield any data on presence of IAS. This IASMP is an initial assessment and should be modified as control methods are activated, and conditions related to invasion change on site. This requires continuous input and monitoring, including periodic collection of field data in order to analyze the status of the site and the effectiveness of management interventions, notably in terms of improving habitat condition of priority management units. This Management Procedure should feed into / be adapted to a broader biodiversity strategy for the project.

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