



Manildra Solar Farm Groundcover Management Plan



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ACRONYMS AND ABBREVIATIONS

BA	Biodiversity Assessment
CEMP	Construction Environmental Management Plan
DoPE	(NSW) Department of Planning and Environment
FFMP	Flora and Fauna Management Plan
EEC	Endangered Ecological Community
LLS	Local Land Services
NSW	New South Wales
OEH	(NSW) Office of Environment and Heritage, formerly Department of Environment, Climate Change and Water
PV	Photovoltaic
SoC	Statement of Commitment
sp/spp	Species/multiple species

1 INTRODUCTION

1.1 THE PROJECT

The approved Manildra Solar Farm will be constructed in the central western area of NSW, on farmland adjacent to an existing substation, approximately 2 kilometres north-east of Manildra and 30 kilometres east of Parkes. The project encompasses the construction and operation of approximately 50MW of photovoltaic (PV) arrays over an area of approximately 180 hectares. It includes associated electrical infrastructure, maintenance facilities, access tracks and minor upgrades to adjacent roads.

1.2 RELATIONSHIP TO PROJECT APPROVAL, OTHER ASSESSMENTS AND PLANS

The Manildra Solar Farm project was approved by the NSW Department of Planning in March 2011, under Part 3A (Major Projects) of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). In October 2014, a modification application was submitted to the NSW Department of Planning and Environment under Section 75W of the EP&A Act. The Modification 1 application sought to include the use of tracking panels that would have a 5 metre maximum height. This Modification was approved on 25 March 2015 by the delegate of the Minister for Planning, subject to conditions.

In July 2015, a second Modification application was submitted to the NSW Department of Planning and Environment under Section 75W of the EP&A Act. The modification 2 application sought to modify the Project's Approval, including: extending the lapse date of the approval by 3 years (i.e. to March 2019); allowing string inverters to be installed at the project; changing the noise monitoring requirements; and, updating the schedule of land for the project. The Modification 2 application was approved on 28 August 2015 by the Minister for Planning, subject to conditions.

Specific mitigation measures to minimise impacts to groundcover form part of the project's consent conditions, including the commitment to prepare a management plan to monitor and respond to adverse groundcover impacts, as required.

This Groundcover Management Plan forms a sub-plan of the Construction Environmental Management Plan (CEMP) for the project and is linked to the Flora and Fauna Management Sub-Plan (FFMP). The plan also addresses rehabilitation of disturbed areas and weed control and has operational management aspects, as per condition of consent requirements.

A Biodiversity Assessment (BA) was completed in November 2010 as part of an environmental assessment for the project (NGH Environmental 2010a). The BA discussed the potential impacts to groundcover within areas that would be covered by the solar arrays, due to altered microclimate. The degree of impact to vegetation composition and cover from factors such as reduced light, altered moisture distribution and near ground wind levels following the installation of the PV arrays cannot be predicted with certainty.

1.3 OBJECTIVES OF THIS PLAN AND APPROACH

This management plan has been prepared to address relevant statements of commitment made by the proponent and the conditions of approval for the project. This plan is structured as follows:

- Background information
 - Vegetation types and their condition onsite
 - Disturbance and weeds onsite
- Potential impacts of the project and management strategies
- Management protocols specific to:
 - Minimising disturbance to groundcover
 - Weed control
 - Rehabilitation of areas disturbed by the project
 - Grazing management, if desirable
 - Reporting and responding to the results of monitoring
- Groundcover monitoring requirements and protocol

While the monitoring program is specific to detecting changes in groundcover vegetation within the array area, management protocols for minimising disturbance, weed control and rehabilitation, apply to the entire project site.

1.4 APPROVAL CONDITIONS CROSS REFERENCE TABLE

Table 1-1 below identifies the statements of commitment and conditions of consent relevant to groundcover management and how they have been addressed in this plan.

Table 1-1 Details of how each relevant statement of commitment and consent condition has been addressed by this management plan.

ID	Commitment/condition	Comment	Section Reference
Revised Statements of commitment, Submissions report 2010			
14	Where practicable, grass surfaces and shrubs will be retained or restored on infrequently used vehicle routes.	The rehabilitation protocol provided in this document satisfies this condition.	Section 4.1
15	Site stabilisation, rehabilitation and revegetation of all disturbed areas would be undertaken without delay.	The rehabilitation protocol provided in this document satisfies this condition.	Section 4.3
17	Works will be avoided during and immediately following heavy rainfall events to protect soils and vegetation at the site.	The minimal disturbance protocol provided in this document satisfies this condition.	Section 4.1
18	<p>Weed/pathogen controls will be implemented, including:</p> <ul style="list-style-type: none"> • Machinery and vehicles used in construction works will be washed before and after site access to reduce the introduction and spread of weeds and pathogens. • Laydown sites for excavated spoil, equipment and construction materials will be weed-free or treated for weeds wherever practicable. • Weed monitoring will be carried out at all sites after the completion of construction works and ongoing weed control will occur where noxious or invasive species are recorded. In particular, monitoring will be undertaken during the following late spring/early summer, and remedial action taken as required. • Sediment control materials should be weed free (straw bales, geotextiles). 	The weed control protocol provided in this document satisfies this commitment.	Section 4.2

ID	Commitment/condition	Comment	Section Reference
	<ul style="list-style-type: none"> Imported materials such as sand and gravel will be sourced from sites which do not show evidence of noxious weeds or Phytophthora infection. 		
24	<p>A groundcover management plan would be developed that would include regular monitoring of vegetation cover and composition and allow for adaptive management. This would include:</p> <ul style="list-style-type: none"> Establishment of a shade tolerant perennial groundcover across the cropping and exotic dominated grazing paddocks prior to the installation of the PV arrays Advice from an agronomist in relation to preferred species/varieties, establishment methods of alternative pastures and best practice management Where information is lacking, trials may be required onsite 	<p>This monitoring protocol in section 5 has been developed with reference to several botanical investigations of the site over several years. Currently the site to be developed has had several species of shade tolerant perennial groundcover established. These include exotic species such as Lucerne, Phalaris and Sub Clover Species.</p>	Section 5
26	<p>The space between the PV array rows should be maintained and kept clear to enable access by vehicles for ongoing weed control, and pasture renovation if required.</p>	<p>Addressed in Design phase but noted in the weed control protocol.</p>	Sections 4.2
27	<p>Efforts should be made to minimise disturbance to existing groundcover during construction. Construction and maintenance vehicles should not access the site when soils are very wet to minimise soil compaction and disturbance.</p>	<p>The minimal disturbance protocol provided in this document satisfies this condition.</p>	Section 4.1
62	<p>Thick and continuous pasture cover should be established prior to the installation of the array, and maintained at all times, including during winter and drought periods if possible.</p>	<p>The minimal disturbance protocol provided in this document satisfies this condition.</p>	Section 4.1
NSW Department of Planning and Environment Conditions of Consent			
C14 b)	<p>A Ground Cover Management Plan, developed in consultation with OEH, to outline measures to ensure adequate vegetation cover and composition beneath the solar PV array. The Plan shall include, but not necessarily be limited to:</p>	<p>This management plan satisfies this commitment. The input of an agronomist was not considered necessary in developing the protocols contained herein. Consultation with an agronomist is included within this plan's protocols, where rehabilitation targets are not being met. NSW OEH</p>	Entire document

ID	Commitment/condition	Comment	Section Reference
		were provided with a draft plan for comment. This document now includes their comments regarding temporary impacts.	
	i) procedures to minimise disturbance to ground cover not impacted by the project particularly in the area of the native pasture in good condition;		Section 4.1
	ii) procedures for the stabilisation, rehabilitation and revegetation of disturbed ground cover including reference to field trials where required;		Section 4.3 and 5
	iii) weed management measures to control and prevent the spread of noxious weeds;		Section 4.2
	iv) monitoring methods to assess the impact of the project on the ground cover vegetation; and		Section 5
	v) a procedure to review management methods where they are found to be ineffective.		Section 5
F6	The proponent shall implement a revegetation and rehabilitation program for all areas of the development footprint which are disturbed during the construction of the project but, which are not required for the ongoing operation of the project including temporary construction facility sites and sections of construction access roads, The Proponent shall ensure that all revegetation measures are implemented progressively where possible and in all cases within six months of the cessation of construction activities at the relevant area. Unless otherwise agreed to by the Secretary, the Proponent shall monitor and maintain the health of all revegetated areas until such time that the plantings have been verified by an independent and suitably qualified expert (whose appointment has been agreed to by the Secretary) as being established, in good health and self sustaining.	The rehabilitation protocol provided in this document satisfies this condition.	Section 4.3
Text from Environmental Assessment (page numbers provided as ID)			
P37	Once the construction phase has finished, any tracks not used for	The rehabilitation protocol provided in this	Section 4.3

ID	Commitment/condition	Comment	Section Reference
	normal farming practice or PV array maintenance would be rehabilitated. Internal access tracks would be maintained to allow maintenance and repairs to the PV array.	document satisfies this commitment	
P43	Weed control would be undertaken as required using a spray unit mounted on a quad bike. Groundcover vegetation around the panel rows would be either slashed or grazed by sheep to maintain a safe height below the panels.	The weed control and grazing management protocols provided in this document satisfies this commitment.	Section 4.2

2 BACKGROUND INFORMATION

2.1 GROUNDCOVER VEGETATION AND ITS CONDITION

The majority of the proposal site (excluding the far western paddock) was under cropping at the time of the Biodiversity Assessment (2010a), or was dominated by exotic grass species. These areas where no overstorey is present do not constitute native vegetation. However, scattered paddock trees were present in cropped and exotic pasture areas and, in comparison with more intact native vegetation within and adjoining the proposal site, it was possible to ascertain the vegetation community that these trees were derived from.

Remnant native vegetation within and adjoining the proposal site is representative of Box-Gum Woodland communities including species such as White Box (*Eucalyptus albens*), Yellow Box (*E. melliodora*) and Blakely's Red Gum (*E. blakelyi*). Native grassland occurs in the far west of the site and is likely to be derived from these communities.

Other vegetation present within the proposal site was restricted to isolated paddock trees comprising Kurrajong (*Brachychiton populneus*) and the introduced Pepper Tree (**Schinus areira*).

In summary, three vegetation types were identified:

- Derived native grassland
- Box-Gum Woodland (native)
- Exotic (crop or pasture)

As part of this investigation, extensive surveying of vegetation condition was undertaken, demonstrating while some small areas were in good condition, the majority of the native vegetation was found to be in relatively poor condition as a result of extensive grazing. The distribution of the vegetation types within the project area at the time of the Biodiversity Assessment is shown in Figure 2-1.

2.2 DISTURBANCE AND WEEDS

Forests and woodlands have been cleared and thinned at the site to provide pasture. Clearing and agriculture has produced a range of direct and indirect impacts to flora habitats, including altered microclimate, loss of fauna responsible for pollination and dispersal, sheet erosion of soils, watercourse bed incision and damming, localised sedimentation and elevated soil nutrients. Minor gully erosion was evident in the drainage line in the south west of the western section of the site.

Agricultural activities have also resulted in the majority of the site being planted with introduced crop species such as Wheat and Canola. The disturbance has led to the colonisation of a range of other introduced plant species. In areas not utilised for cropping, grazing is likely to have reduced or eliminated selectively grazed or grazing sensitive species, such as Kangaroo Grass (*Themeda australis*), terrestrial orchids, forbs, wattles and pea shrubs.

Minor pasture weed species were common across the majority of the study area. Three noxious weeds declared for the Cabonne Shire Council Area under the *Noxious Weeds Act 1993* were recorded at the subject site. The status and distribution of these weeds at the site are summarised in Table 2-1.

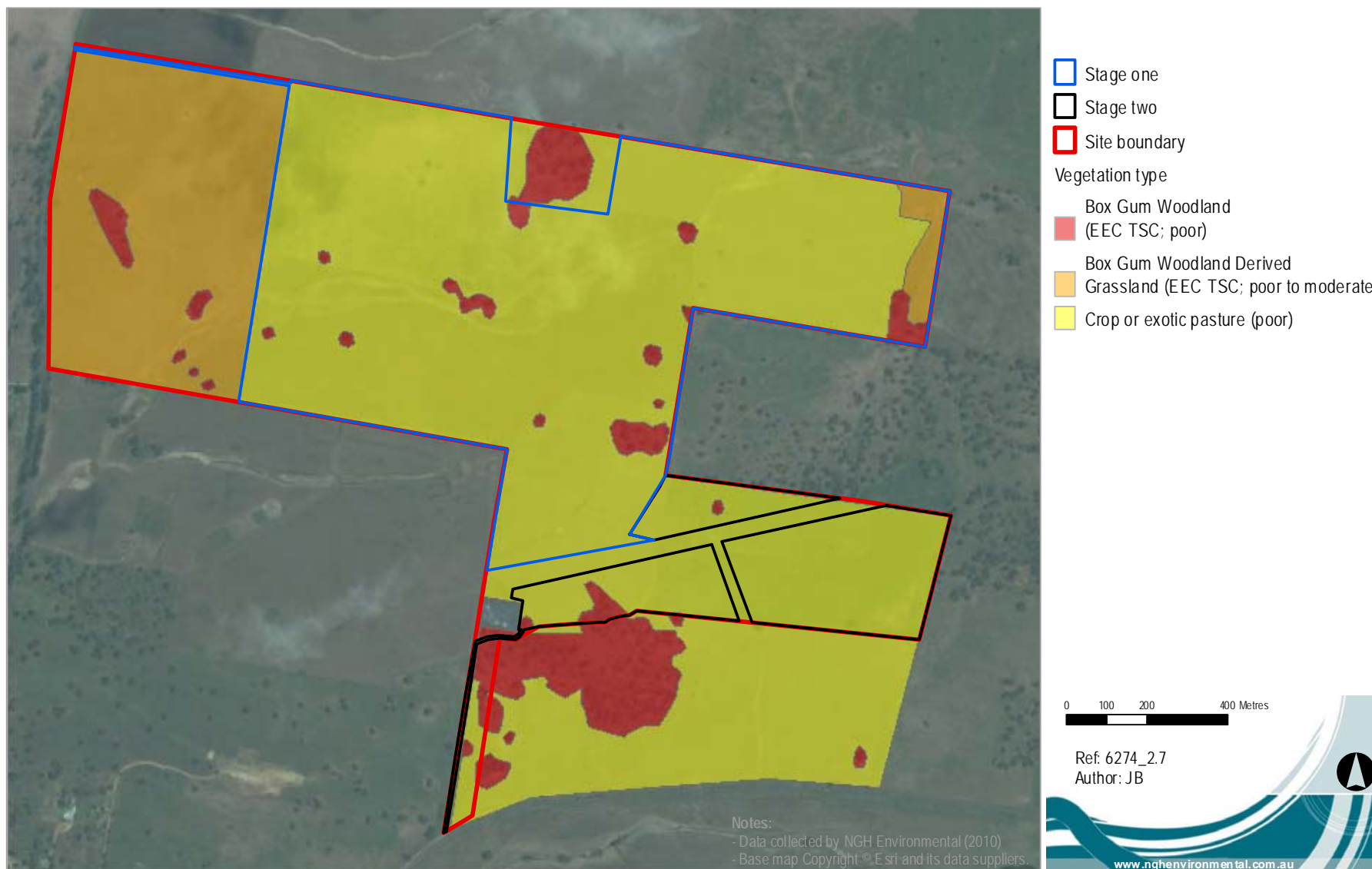


Figure 2-1 Distribution of vegetation types within the project area (Biodiversity Addendum; 2010d)

All of the recorded noxious weeds are listed as Class 4 weeds, meaning that the growth and spread of the plant must be controlled according to the measures specified in a management plan published by the local control authority.

Table 2-1 Noxious weeds at the subject site and their distribution

Weed species	Status	Abundance and distribution
African Boxthorn * <i>Lycium ferocissimum</i>	Class 4	Uncommon in pasture across the site
Bathurst Burr * <i>Xanthium spinosum</i>	Class 4	Occasionally in pasture across the site
Scotch Thistle * <i>Onopordum acanthium</i>	Class 4	Uncommon in pasture across the site



Figure 2-2 African Boxthorn



Figure 2-3 Bathurst Burr



Figure 2-4 Scotch Thistle

The site carries noxious weeds which would require control before and after the proposed works. With the application of weed controls during and following construction, weed impacts within and off the proposal site are not expected to be significant. The spacing between the PV array rows would be adequate to allow an all-terrain vehicle to access the site for ongoing weed control and pasture renovation, as required.

3 POTENTIAL IMPACTS OF THE PROJECT

3.1 CONSTRUCTION IMPACTS

3.1.1 Impact areas

Based on an 'upper limit' of impact (largest layout being considered), around 137 ha of ground cover would be affected by the development. This is the total area within the development envelope and the vast majority of this vegetation is exotic (non-native); 129.50ha. The native vegetation to be affected is in poor condition although is listed as an Endangered Ecological Community (Box Gum Woodland and derived grasslands) at the State level. The loss of this vegetation is not considered to be significant and would be subject to an offset plan.

The major impacts to groundcover during construction would be:

- Through minor stripping and grading of the array area. To prepare site for installation of solar arrays, some areas under the arrays may need to be stripped and graded. If required, this activity will temporarily remove ground cover from the affected areas and compact the soil. Ground cover will be restored post-construction. Stripping and grading would be limited as much as practical.
- Through shading and trampling caused by vehicle movements and stockpiling of materials.

The development envelope and affected vegetation is mapped in Figure 2.1.

Table 3-1 Estimated impact areas of final layout (provided September 2015).

Total area of impact	Stage one (ha)	Stage two (ha)	Total (ha)
Native vegetation	6.34	0.92	7.26
<i>Box Gum Woodland Derived Grassland (EEC, TSC)</i>	2.92	0.00	2.92
<i>Box-Gum Woodland (EEC, TSC)</i>	3.42	0.92	4.34
Crop or exotic pasture	105.97	23.53	129.50
Total:	112.31	24.44	136.76

3.1.2 Management and monitoring strategies

The rehabilitation of areas disturbed temporarily during construction is addressed in Section 4.3: Rehabilitation protocol.

Short term monitoring (during the construction phase) of the ground cover at the Manildra Solar Farm will be undertaken with reference to photographic records of the ground cover. Photos will be taken

before impacts and regularly taken during the construction phase to allow for comparison monitoring of vegetation to be made and remedial actions taken where necessary.

3.2 OPERATIONAL IMPACTS

3.2.1 Impacts - known and unknown

Once construction has been completed, the solar farm will affect grassland at the site in two ways

- Through microclimatic changes, particularly in terms of rainfall distribution, shading from ground covering by the solar array
- Through trampling of vegetation caused by vehicle movements within the array area required for maintenance activities. The predicted impacts are discussed further below.

Rainfall distribution

There will be a concentration of rainfall runoff in a strip below the lower edge of the solar panel rows. This will increase rain splash intensity and soil erosion potential in this area during heavy rainfall events however, this will be partially offset by the operation of the tracker as the drip line will move change the position of the array throughout the day. A rain shadow below the solar panel rows will also be created. Soil in this area may be drier than surrounding soil, but this will be offset by reduced evapo-transpiration losses due to shading and reduced air movement, variations in the angle of rainfall and lateral movement of water from adjacent rain-exposed areas.

Note that no water will be introduced to wash the modules. If module washing is required, a dry brush will be used.

Shading

The total area of permanent shading has been modelled to be up to 30% of the area under the array (Biodiversity Assessment for the project; NGH Environmental 2010) affecting 36 ha of exotic dominated groundcover. 70% (84 ha) will be partially shaded depending on the season and time of day and operation of the tracker.

The shading effect is likely to lead to reduced insolation and daytime temperatures and result in lower rates of plant growth and biological productivity under the array. Growth may be offset by increased soil moisture in some seasons but the shading is likely to result in some shift in species composition (favouring more shade tolerant species).

Vehicle movements within the array

Periodically, vehicles will be required to move between the rows of solar panels for access and maintenance. This activity may result in compaction of the soil which may impede vegetation growth. The risk of compaction is particularly high during periods where the soils are wet.

Vehicle, equipment and the movement of personnel also provides a vector for the introduction and spread of weeds at the site.

3.2.2 Management and monitoring strategies

The project life will be approximately 50 years. Changes to micro-climatic conditions and shading under the arrays will have an unknown effect. Consistent with the findings of the environmental assessment for

the project, the best means of managing any future impact is considered to be through monitoring and adaptive management during the life of the project.

The management measures and groundcover monitoring protocol in Section 4 and 5 will allow for adaptive management to avoid and minimise these operational impacts.

4 GROUNDCOVER MANAGEMENT PROTOCOLS

Four protocols have been developed to manage impacts to ground cover as a result of the construction and operational phase of the Manildra Solar Farm:

1. Minimal disturbance: most relevant to construction impacts
2. Weed controls: required throughout construction and operation
3. Rehabilitation: required during construction and at the end of construction
4. Grazing management: most relevant to operation

4.1 MINIMAL DISTURBANCE DURING CONSTRUCTION PROTOCOL

OBJECTIVE: Minimise disturbance to ground cover

The following protocol outlines procedures to minimise disturbance to existing and established groundcover during construction, including areas that are subject to monitoring. This protocol applies during construction.

ID	ACTIVITY	PROTOCOL	RESPONSIBILITY
1	Minimise disturbance to groundcover: under the array	<ul style="list-style-type: none"> • Prior to the installation of the PV array, thick and continuous pasture cover must be established at the site. The pasture must be maintained at all times during construction, including during winter and drought periods if possible. The exception to this will be where stripping and grading is required. <p>It is noted that currently the site to be developed has had several species of shade tolerant perennial groundcover established. These include exotic species such as Lucerne, Phalaris and Sub Clover Species. This ground cover will only be removed if stripping and grading is required for construction of solar arrays.</p>	EPC Construction Manager
2	Minimise disturbance to groundcover: other areas within the development envelope	<ul style="list-style-type: none"> • Temporary impacts include construction traffic and all equipment laydown areas and stockpiles required during construction. Temporary impacts would be confined to crop / exotic pasture areas as mapped on Figure 2.1. The rehabilitation protocol would be applied to restore all areas disturbed by temporary impacts 	EPC Construction Manager

ID	ACTIVITY	PROTOCOL	RESPONSIBILITY
		<p>progressively during construction, in accordance with Section 4.3.</p> <ul style="list-style-type: none"> Where practicable, grass surfaces will be retained on infrequently used vehicle routes. Heavy vehicles, equipment and machinery will not be parked in areas outside of disturbed areas or formalised tracks for periods in excess of 24 hours. Access and parking for other vehicles will be rationalised to minimise impacts, in a Traffic Management Plan. Works will be avoided during and immediately following heavy rainfall events where there is pooling of water or flooding, to protect soils and vegetation at the site. 	
3	Communicate about minimising disturbance:	<ul style="list-style-type: none"> Toolbox / site inductions to discuss the importance of groundcover and minimising disturbance to ensure ongoing perennial groundcover across site. Topics to include soil disturbance, compaction, bare earth and erosion problems. Specific management required near areas in good condition will be discussed in environmental inductions. E.g. Western Offset Paddock – no vehicles to enter this area; area fenced off. 	EPC Construction Manager

4.2 WEED CONTROL PROTOCOL

OBJECTIVE: Treat existing weeds / minimise new infestations

The protocol below ensures that all relevant weed control mitigation measures are followed during construction works. This protocol applies to the entire development site. Ongoing operational weed monitoring will be undertaken as part of the ground cover monitoring, outlined in Section 5.

ID	ACTIVITY	PROTOCOL	RESPONSIBILITY
4	Treat existing infestations:	<ul style="list-style-type: none"> Treat existing weed infestations in accordance with the noxious weed management methods outlined below this table. Herbicides will be selected to minimise impacts on non-target species. Cabonne Shire Council or a qualified person (ecologist or agronomist) will be consulted to determine suitable herbicides based on the weeds present at the site prior to treatment. 	EPC Construction Manager

ID	ACTIVITY	PROTOCOL	RESPONSIBILITY
		<ul style="list-style-type: none"> Laydown sites for excavated spoil, equipment and construction materials will be weed-free or treated for weeds prior to use, so weeds are not spread. 	
5	Manage noxious weeds	<ul style="list-style-type: none"> The works areas contain a number of Class 4 noxious weeds as outlined in Section 2.2. <ul style="list-style-type: none"> African Boxthorn, Bathurst Burr and Scotch Thistle Class 4 weeds must be controlled according to the measures specified in a management plan published by the local control authority; Cabonne Council have produced a Noxious Weeds Policy which includes a management plan for Class 4 noxious weeds. The most up to date policy and other relevant noxious weed information from Cabonne Council can be found on their website at http://www.cabonne.nsw.gov.au/sites/cabonne/files/public/images/documents/cabonne/mig/2757-weedsplan_20060621094609.pdf. A copy of this is provided in Appendix B. 	EPC Construction Manager
6	Minimise new infestations:	<ul style="list-style-type: none"> Minimise the area of disturbance by implementing the Vegetation Clearing Protocol within the Flora and Fauna Management Plan. Imported fill and sediment control materials (e.g. straw bales, geotextiles), if required, will be weed free (confirmed by supplier). Imported materials such as sand and gravel will be sourced from sites which do not show evidence of noxious weeds or Phytophthora infection. Vehicle and machinery movements and temporary storage of equipment/materials will be confined to disturbed areas and defined tracks where possible. Vehicles and machinery will be cleaned (tyres brushed or washed down) prior to accessing and leaving areas where noxious weeds have been identified. Post works, promptly rehabilitate all disturbed areas according to the Rehabilitation Protocol in Section 4.3. 	EPC Construction Manager
7	Reuse of weedy material:	<ul style="list-style-type: none"> Mulched vegetation, if non-weedy, can be used in rehabilitation works however, weedy vegetation cannot be reused. The status of the material will be confirmed by the environmental site officer or ecologist. Weedy vegetation will be treated onsite in preference to carting it away for disposal (mulching 	EPC Construction Manager

ID	ACTIVITY	PROTOCOL	RESPONSIBILITY
		preferred over burning). Cartage of weedy material carries risk of spreading infestations.	
6	Maintain records:	<ul style="list-style-type: none"> A map(s) will be prepared identifying the locations of existing noxious weed infestations. Methods used for weed control and the timing of weed control activities will be documented. 	MSFPL Site Manager
8	Ongoing weed monitoring and control	<ul style="list-style-type: none"> Weed monitoring will be carried out at all sites after the completion of construction works. Ongoing weed control will occur where noxious or invasive species are recorded. In particular, monitoring will be undertaken during late spring/ early summer and remedial action taken as required. The space between the PV array rows should be maintained and kept clear to enable access by vehicles for ongoing weed control, and pasture renovation if required. 	MSFPL Site Manager

4.3 REHABILITATION PROTOCOL

OBJECTIVE: Successfully rehabilitate all areas disturbed by construction

The following protocol will be implemented to maximise the success of rehabilitation in areas that are temporarily disturbed such as the laydown area and temporary access routes. The objective of this protocol is to rapidly re-establish stable surfaces resistant to erosion and weed ingress and to ultimately return disturbed areas to their undisturbed state.

ID	ACTIVITY	PROTOCOL	RESPONSIBILITY
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ID	ACTIVITY	PROTOCOL	RESPONSIBILITY
9	During construction works:	<ul style="list-style-type: none"> • Photographic records should be used as tool to monitor progress. Photos will be taken before impacts and regularly taken during the construction phase to allow for comparison monitoring of vegetation to be made and remedial actions taken where necessary. • Top soils from excavation that do not contain invasive or noxious weeds will be stored separately and respread prior to rehabilitation. Trenches will be filled such that top soil is placed above subsoil in the trench. • Where practicable, whole sods will be removed with an excavator where these areas are well-vegetated with dense root systems. Sods will be stored in moist, shaded conditions and replaced following the works. Sod storage time will be minimised and sods will be replaced in a manner that maximises the chances of re-establishment. • Rehabilitation and revegetation measures must be implemented at disturbed areas progressively throughout the construction phase where possible, and in all cases, within six months of the cessation of works at the relevant area. • The protocols will be adapted as required to ensure the objective is achieved. Indicators to be monitored will include: <ul style="list-style-type: none"> ○ Percentage grass cover – 70% is the minimum required (excluding areas required for internal access ways, roads and O&M facilities) ○ Weed ingress – bare ground is susceptible to weed infestation ○ Active soil erosion - bare ground is susceptible to soil erosion, further reducing the ability to re-establish ground cover 	Ecologist to identify weedy areas where top soil is not to be reused.

ID	ACTIVITY	PROTOCOL	RESPONSIBILITY
10	After construction works:	<ul style="list-style-type: none"> • After construction is complete, any tracks not required for normal farming practice or PV array maintenance will be rehabilitated. Where practicable, grass surfaces will be restored on infrequently used vehicle routes. • In areas with limited topsoil, hydromulch or imported non-weedy topsoil will be used during rehabilitation and revegetation. • If rainfall is insufficient to establish the growth of vegetation, reseeded areas will be watered weekly until plants are established and self-sufficient (evidenced by germination and active growth of seeded species based on weekly monitoring). If germination is not occurring within two (2) weeks of reseeded, follow-up works would be considered as outlined below. • In rehabilitation areas that are actively grazed, stock will be restricted until a stable surface (70% grass cover) is achieved. • The success of the rehabilitation works will be monitored on a monthly basis post works to ensure stable surfaces (70% grass cover) are achieved within three (3) months of the commencement of rehabilitation. Follow-up works would be conducted if this is not achieved. • Follow-up works may include, surface ripping or scarification, using additives during watering to assist in water penetration, weed control and reseeded, as required by monitoring. • Within the exotic dominated pasture area which will be disturbed by the installation of the solar array, a mix of summer and winter tolerant perennials are recommended for re-seeding and may include but not be limited to species such as Winter Fescue, Cocksfoot, Perennial Rye Grass, and existing pasture species at the site such as Phalaris, Lucerne and Sub Clover. Further advice on an appropriate groundcover mix suitable for local conditions would be sort from a qualified local agronomist as required. <p><i>Notes:</i></p> <p><i>Additional strategies may be required to achieve 70% cover, dependent on season, amount of top soil and species selected. Strategies will involve an ecologist or agronomist where 70% cover has not been achieved within three months of the commencement of rehabilitation activities.</i></p> <p><i>Rehabilitation techniques can range from replacement of top soil, allowing the natural seed bank to germinate, through to importation of topsoil and planting of tube stock. Maintenance (watering and follow-up seeding or planting) will similarly depend on the seasonal and other environmental conditions at the time of the works. The key to effective rehabilitation will be using strategies appropriate to the location and condition. These decisions will be made with input from an ecologist or agronomist as required.</i></p> <p><i>If native tube stock is used, several months lead time will be required from local nurseries.</i></p> <p><i>Erosion control devices work hand in hand with restoring ground cover – refer to Soil and Water Management Sub-plan.</i></p>	<p>Site Construction Manager to ensure rehabilitation is undertaken as soon as possible as works progress.</p> <p>Site Construction Manager to ensure grass cover achieves 70% before ceasing maintenance and monitoring of these areas.</p>

4.4 GROUNDCOVER MANAGEMENT

OBJECTIVE: Successfully maintain appropriate groundcover while reducing weeds and enhancing native species diversity

Grazing by sheep may be utilised within the array area to control biomass. A number of strategic grazing strategies can be implemented, for example; optimised, short-term or long-term deferred grazing or timed grazing. The strategy to be implemented will depend on the condition and composition of the grassland at the time and should be informed by a professional agronomist. It is noted that grazing may not be used and that slashing or isolated spraying (limited targeted applications where soil protection would not be reduced) may alternatively be implemented.

If grazing is to be utilised, the following protocol would be implemented.

ID	ACTIVITY	PROTOCOL	RESPONSIBILITY
11	Determine and implement suitable grazing, slashing or spraying strategies	<ul style="list-style-type: none"> Prior to operation, consult with an agronomist and the land owner to determine the most suitable grazing strategies for the array area. Different strategies may be required for the western and eastern paddocks considering their past management and current composition. Document the recommended strategy and append to this GCMP. Strategy must include suitable frequency of monitoring to gauge the impact of the grazing (i.e. in addition to annual groundcover monitoring) and each monitoring event must include agronomist advice regarding continuation of grazing or any changes to grazing management to ensure no adverse impacts are occurring. If stock are brought into the area, they would come off pastures that are free of noxious weeds or subject to regular weed control. 	MSFPL Site Manager
12	Adapt grazing strategies to changing grassland condition and composition	<ul style="list-style-type: none"> Following each grazing monitoring event (i.e. in addition to the annual groundcover monitoring), consult with an agronomist to discuss the suitability of existing grazing regimes and adapt if recommended. Document any alterations to the strategy. Implement changes proposed by agronomist to improve the on-ground results of the strategy. 	MSFPL Site Manager

5 GROUNDCOVER MONITORING REQUIREMENTS

Groundcover monitoring would commence the first winter after the PV panels have been installed and continue annually. Monitoring requirements are as follows:

Objectives	<ul style="list-style-type: none"> • The primary objective of this monitoring is to determine the effects of the panel shading on groundcover. • Secondly, the monitoring will trigger management, where required, to maintain stable ground cover, suitable to resist erosion and weed infestation. • Given the highly modified nature of the groundcover at the development site and the dominance of exotic species, monitoring would focus on the degree of general vegetative cover and biomass present. The relative abundance of all native and exotic species and species diversity is not considered an important factor however gaining an idea of what species are being successful (or not) is crucial to ongoing adaptive management.
Personnel	<ul style="list-style-type: none"> • The surveys require an individual competent in the identification of common pasture species. They would optimally be undertaken by the same person, to reduce variations due to subjective assessments (for example in estimating percentage ground cover) but this is not essential.
Timing and duration	<ul style="list-style-type: none"> • Monitoring would be undertaken annually during early winter (June). This timing is considered most suitable as pasture growth is generally lower but remnant reproductive material may still be present which would enable identification of species or at least genera. Assessing the groundcover during this time provides for a better indication of the health of the groundcover as growth rates are down and climatic stresses are generally higher. Shading from the solar arrays would also likely have their greatest impact during this time as there is reduced insolation in general. • For at least the first three years, data will be collected annually and reported to the OEH. After three years, the need for monitoring and reporting would be reviewed in consultation with OEH.
Survey protocol	<ol style="list-style-type: none"> 1. Permanent 5m x 1m monitoring plots would be established throughout the array area. At each monitoring location there would be two plots with one each placed in the following areas 2. In permanent shade, directly beneath panels 3. Between panels that will receive the most sun 4. Each plot would consist of a series of three 1m x 1m quadrats each spaced one metre apart. The top left hand corner and the top right hand corner of the plot under the arrays would be permanently marked with a steel stake or similar. These would serve as reference points for placing the quadrats. From these points, tape measures could be used to place each quadrat. It is not recommended that the plot in the inter-row spaces be permanently marked as it is likely to be subject to occasional vehicular traffic. The distance from the plot under the array to that in the inter-row space will be dependent on the final constructed layout and will be recorded during the monitoring. The arrangement at each monitoring location is illustrated below.

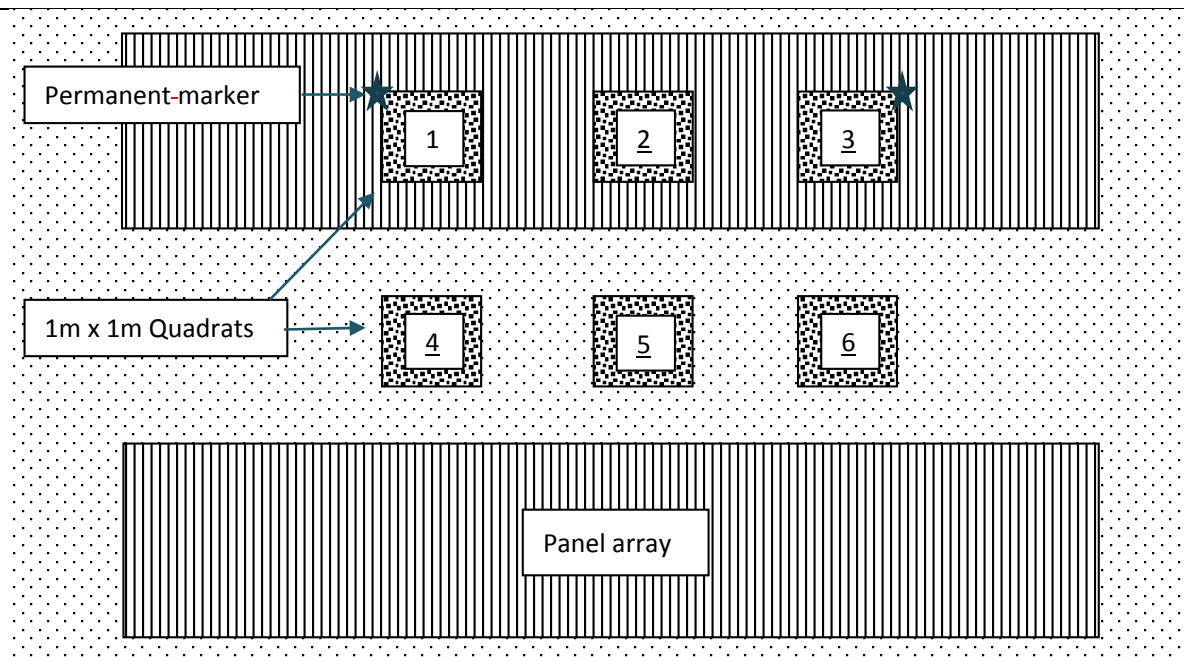


Figure 5-1 Monitoring plot arrangement

- It is suggested that monitoring plots be established at minimum of six locations across the array area (12 5m x 1m plots) capturing variations in aspect and topography. For each quadrat at a monitoring location the following will be recorded. Example data sheets as provided in Appendix A.
 - Total alive and dead/leaf litter vegetative cover using percentage cover estimates in 5% intervals
 - Total cover of bare ground using percentage cover estimates in 5% intervals
 - Dominant five species in each quadrat (or less if less species are present) and their percentage contribution to the living plant cover in each quadrat.
 - Total biomass using the rising plate method. Measurements will be taken at the centre of each quadrat.
 - A digital photographic image
 - Data recorded from each of the three quadrats would be averaged to provide a single value for each plot. Only one physical quadrat should be required which can be moved to the correct location in each plot using the reference points and a tape measure. The actual distance from the reference points back to the inter-row plot will also be recorded on the datasheets to allow for accurate replication.

	<ul style="list-style-type: none"> ○ In addition to the plot data recorded above, incidental records of any noxious weeds will also be recorded across the broader site.
Analysis and interpretation of data	<ul style="list-style-type: none"> ● The data can be simply analysed by plotting the variables recorded over time to identify trends in declining or increasing cover and biomass. The relative abundance of certain species could also be plotted over time to gain an understanding of species that are being successful or declining. The data would be used to inform the requirement for management actions such as weed control, alterations to grazing regimes or seeding/planting as outlined in the response to monitoring protocol.
Benchmarks and indicators	<ul style="list-style-type: none"> ● Indicators to be monitored will include: <ul style="list-style-type: none"> ○ Percentage grass cover – 70% is the minimum required ○ Weed ingress – bare ground is susceptible to weed infestation ○ Active soil erosion - bare ground is susceptible to soil erosion, further reducing the ability to re-establish ground cover ● A data sheet including these indicators is provided in Appendix A.
Reporting requirements	<ul style="list-style-type: none"> ● Within 3 months of annual monitoring events, the results will be written up in a report and submitted to the OEH. The report will contain as a minimum: <ul style="list-style-type: none"> ○ The noxious weed map(s) will be updated to reflect the current distribution of noxious weeds on the site ○ The results of monitoring ○ Details of management activities carried out such as weed control and rehabilitation ○ A discussion of the current groundcover condition relative to the results of monitoring from previous years monitoring ○ Recommendations for adaptive management
Response to results	<ul style="list-style-type: none"> ● Management protocols will be adapted and implemented as required, as set out in Section 5. Particularly: <ul style="list-style-type: none"> ○ Weed control activities will be undertaken as per the Weed Control Protocol. ○ The OEH and an agronomist will be consulted to determine an effective approach to maintaining groundcover greater than 70% if this target is not being met. ○ Trials may be considered where information gaps are identified.

6 CONCLUSION

This Groundcover Management Plan has identified the potential impacts to groundcover at the Manildra Solar Farm site. A monitoring framework has been developed to monitor these impacts and series of protocols have been developed to adaptively manage impacts, primarily during construction but also into operations. With the implementation of this Groundcover Management Plan, new information will be provided on the impacts of PV solar arrays and impacts to the groundcover vegetation at the site are expected to be minimised.

7 REFERENCES

NGH Environmental (2010a) Biodiversity Assessment - Manildra Solar Farm, October 2010

NGH Environmental (2010b) Submissions Report – Manildra Solar Farm, December 2010

APPENDIX A MONITORING DATA SHEET

Manildra Solar Farm ground cover monitoring program

General details

Recorder:	Date:	Plot identifier
Plot location (include distance from reference points if an inter-row plot):		

Quadrat observations

Quadrat 1		Quadrat 2		Quadrat 3	
Percent total living cover:		Percent living cover:		Percent living cover:	
Percent total litter/dead cover:		Percent total litter/dead cover:		Percent total litter/dead cover:	
Percent bare ground:		Percent bare ground:		Percent bare ground:	
Dominant species	% cover	Dominant species	% cover	Dominant species	% cover
1.		1.		1.	
2.		2.		2.	
3.		3.		3.	
4.		4.		4.	
5.		5.		5.	
Rising plate reading:		Rising plate reading:		Rising plate reading:	
Image reference:		Image reference:		Image reference:	
General notes, noxious weeds etc:					

APPENDIX B CABONNE SHIRE COUNCIL LOCAL NOXIOUS WEEDS MANAGEMENT RESOURCES

The following information was sourced from the Cabonne Shire Council Website http://www.cabonne.nsw.gov.au/sites/cabonne/files/public/images/documents/cabonne/mig/2757-weedsplan_20060621094609.pdf on the 3rd July 2015. It is recommended that the accuracy of this information be checked with Cabonne Shire Council on a bi-annual basis which is the review period of the plan.

Additionally, an A3 map is provided that can be used to plot infestations during weed monitoring.

Local Noxious Weeds Management Plan

The purpose of the Local Noxious Weeds Management Plan is to specify the control measures required for the various Class 4 noxious weeds listed in the table below.

Purpose

To specify the control measures required for the various class 4 noxious weeds listed in table below.

Control class

According to the Weed Control Order 19 under the Noxious Weeds Act 1993 (dated 23 December 2005), issued by the Minister for Primary Industries. The noxious weeds listed in table below are classified as class 4 weeds (A locally controlled weed).

Class 4 weeds are plants that pose a threat to primary production, the environment or human health, are widely distributed in an area to which the order applies and are likely to spread in the area or to another area.

Control Objective

The control objective for this class of weed is to minimise the negative impact of those plants on the economy, community and environment of New South Wales.

Control Measures

As listed in table below.

Management Plan

An owner/occupier (other than a public authority) of land in Cabonne Shire Council area must control class 4 noxious weeds according to the control measure specified in the table below. The management plan will be reviewed every two years.

Common Name	Botanical Name	Specified Control Measure	Weed Class
African boxthorn	<i>Lycium ferocissimum</i>	The plant must be fully and continuously suppressed and destroyed.	4
African lovegrass	<i>Eragrostis curvula</i>	The plant must be prevented from spreading and its numbers and distribution reduced.	4
Bathurst/Noogoora/Californian/cockle burrs	<i>Xanthium</i> species	The plant must be fully and continuously suppressed and destroyed.	4
Blackberry	<i>Rubus fruticosus</i> aggregate species	The plant must be fully and continuously suppressed and destroyed and plant may not be sold, propagated or knowingly distributed	4
Biddy Bush	<i>Cassinia arcuate</i>	The plant must be fully and continuously suppressed and destroyed.	4
Blue Heliotrope	<i>Heliotropium amplexicaule</i>	The plant must be prevented from spreading and its numbers and distribution reduced. Or biological control agents introduced, maintained and monitored	4
Buffalo Burr	<i>Solanum rostratum</i> <i>Dunal</i>	The plant must be fully and continuously suppressed and destroyed.	4
Chilean needle grass	<i>Nassella neesiana</i>	The plant must not be sold, propagated or knowingly distributed.	4
Devil's Claw	<i>Proboscidea louisiancu</i> / <i>Isicella lutea</i>	The plant must be prevented from spreading and its numbers and distribution reduced. Or biological control agents introduced, maintained and monitored	4
Green Cestrum	<i>Cestrum parqui</i>	The plant must be fully and continuously suppressed and destroyed. Or biological control agents introduced, maintained and monitored	4
Harrisia cactus	<i>Harrisia</i> species	The plant must be fully and continuously suppressed and destroyed. Or biological control agents introduced, maintained and monitored	4
Hemlock	<i>Conium maculatum</i>	The plant must be fully and continuously suppressed and destroyed.	4

Common Name	Botanical Name	Specified Control Measure	Weed Class
Nodding thistle	<i>Carduus nutans</i>	The plant must be prevented from spreading and its numbers and distribution reduced. Or biological control agents introduced, maintained and monitored	4
Pampas grass	<i>Cortaderia</i> species	The plant must be fully and continuously suppressed and destroyed.	4
Rhus tree	<i>Toxicodendron succedanea</i>	The plant must be fully and continuously suppressed and destroyed.	4
Scotch broom/English broom	<i>Cytisus scoparius</i>	The plant must be fully and continuously suppressed and destroyed.	4
Scotch thistle, Stemless thistle, Illyrian thistle, Taurian thistle	<i>Onopordum</i> species	The plant must be prevented from spreading and its numbers and distribution reduced. Or biological control agents introduced, maintained and monitored.	4
Serrated tussock	<i>Nassella trichotoma</i>	The plant must be fully and continuously suppressed and destroyed.	4
Silverleaf Nightshade	<i>Solanum elaeagnifolium</i>	The plant must be prevented from spreading and its numbers and distribution reduced.	4
Spiny Burr-Grass	<i>Cenchrus incertus/Cenchrus longispinus</i>	The plant must be prevented from spreading and its numbers and distribution reduced. Or biological control agents introduced, maintained and monitored	4
St John's Wort	<i>Hypericum perforatum</i>	The plant must be prevented from spreading and its numbers and distribution reduced. Or biological control agents introduced, maintained and monitored	4
Sweet briar	<i>Rosa rubiginosa</i>	The plant must be prevented from spreading and its numbers and distribution reduced.	4
Tree of Heaven	<i>Ailanthus altissima</i>	The plant must be prevented from spreading and its numbers and distribution reduced. Or biological control agents introduced, maintained and monitored.	4
Wild Radish	<i>Raphanus raphanistrum</i>	The plant must be prevented from spreading and its numbers and distribution reduced. Or biological control agents introduced, maintained and monitored.	4

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Weed management map. Use this map to record infestations prior to control actions. This will keep track of progress and note any new areas requiring treatment.



