

# **Priorities for Pest Plant Control, Pest Animal Control, and Fencing at Geothermal Sites in the Waikato Region - 2011 Update**

Prepared by:  
Wildland Consultants Ltd

For:  
Waikato Regional Council  
Private Bag 3038  
Waikato Mail Centre  
HAMILTON 3240

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Ed Brown

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PRIORITIES FOR PEST PLANT  
CONTROL, PEST ANIMAL CONTROL,  
AND FENCING AT GEOTHERMAL SITES  
IN THE WAIKATO REGION  
- 2011 UPDATE





# Priorities for Pest Plant Control, Pest Animal Control, and Fencing at Geothermal Sites in the Waikato Region in 2011

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## Project Team:

Chris Bycroft  
Sarah Beadel  
Lisette Collins  
Willie Shaw

## Prepared for:

Waikato Regional Council  
Private Bag 3038  
Waikato Mail Centre  
Hamilton 3240

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# CONTENTS

1.	INTRODUCTION	1
2.	OBJECTIVES	1
3.	METHODS	1
3.1	Ranking of priorities of pest plant control, pest animal control and fencing	4
4.	FINDINGS	4
4.1	Pest plants	4
4.2	Pest animals	7
4.3	Exclusion of domestic stock	8
4.4	Other threats to geothermal areas	8
5.	SUMMARY	9
	ACKNOWLEDGMENTS	9
	REFERENCES	10
	APPENDICES	
1.	Threats to geothermal sites in Waikato Region - pest plants, pest animals, and grazing (stock)	12
2.	List of site where no field work was undertaken since 2007	27

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## 1. INTRODUCTION

In 2006, Wildland Consultants undertook an assessment (Wildland Consultants 2006b) for the Waikato Regional Council of 40 geothermal sites in the Waikato Region for pest plant control, pest animal control, and fencing requirements that had been assessed in Wildland Consultants (2004). Wildland Consultants (2004) was an inventory of the distribution, extent, and ecological values of geothermal vegetation at 40 sites in the Waikato Region based on an assessment of 2003 aerial photographs and field survey for 39 sites between 2003 and 2004. Information on ecological threats and management requirements to the geothermal vegetation and features at these sites was collected as part of this study. The 2004 report has recently been updated (Wildland Consultants 2011) based on a combination of field assessments at selected sites and a desktop assessment of 2007 aerial photographs. This updated inventory now includes 64 geothermal sites.

This report updates Wildland Consultants (2006b) based on the latest information collected during the fieldwork and desktop assessments undertaken for Waikato Regional Council between 2010 and 2011 and includes assessments of pest plant control, pest animal control, and fencing requirements for all 64 sites assessed in Wildland Consultants (2011).

## 2. OBJECTIVES

The objective of this project is to update the 2006 report (Wildland Consultants 2006b) identifying priorities for pest plant control, pest animal control, and fencing requirements of geothermal sites in the Waikato Region. Each site is to be ranked in order of priority for pest plant control, fencing requirements (i.e. exclusion of domestic stock), and pest animal control (if deemed relevant).

## 3. METHODS

Information collected while collating information for Wildland Consultants (2011) by both field work and a desktop exercise was used as basis to assess and rank sites for management of pest plant, pest animal, and domestic stock threats (i.e. fencing requirements). This report includes data from earlier published and unpublished assessments and reports, aerial photographs, and local knowledge of the sites. Sites that have not been visited in the field since 2007 (14 sites) are listed in Appendix 2. A description of each of the fields and relevant methods used to populate each field presented in Appendix 1 are presented below.

- **Site Number:** The number given to each geothermal site in Wildland Consultants 2011.
- **Site Name:** The name given to each geothermal site in Wildland Consultants 2011.

- **Tenure:** Tenure is shown as either protected or non-covenanted private land, or both if applicable. If an area is protected, the type of protection (e.g. reserve, covenant) is shown.
- **Size:** Extent of geothermal vegetation at each site is given in hectares.
- **Significance level:** The significance level assigned to each site in Wildland Consultants (2011) based on the evaluation criteria defined in the Waikato Regional Policy Statement.
- **Key values of the site:** An indication of why the site is significant including the presence of ‘Threatened’ and ‘At Risk’ species (as per de Lange *et al.* 2008) that have been recorded from the site in Wildland Consultants 2011 and other surveys.
- **Threats:** The threats to the ecological values of each geothermal site and geothermal features are listed under three headings: pest plants (weeds), pest animals, and domestic stock.
- **Vulnerability:** The vulnerability of each site to each of the threat mechanisms is evaluated as follows:
  - *High:* The indigenous plant community or geothermal feature is likely to undergo a significant decline in quality within the next five years if no measures are undertaken to control the threat.
  - *Medium:* The indigenous plant community or geothermal feature is likely to undergo a significant decline in quality in the next five to ten years if no measures are undertaken to control the threat.
  - *Lower:* The indigenous plant community is likely to undergo minor degradation due to the threat in the next ten years or so, or significant decline in quality over a longer period.
- **Description of threats:** A brief description of what impact each threat may have to the site if the threat is not effectively managed.
- **Action required:** A brief description on what measures may be undertaken to reduce or remove the presence of a threat to the ecological feature or geothermal features at the site, if any.

For each site, the management actions required to address the threats are described and the level of ecological benefit and the priority (urgency) of the actions are evaluated.

- **Ecological Benefit:** The ecological benefit of controlling the threat(s) at each site is assessed as follows:
  - *High:* The site has a high conservation value (Regional Significance Level or greater) and management of the threat is likely to significantly improve the

viability of the indigenous geothermal vegetation and geothermal features at the site within the next five years.

- *Medium:*
    - The site has a high conservation value and management of the threat is likely to significantly improve the viability of the site in the next five to ten years, or
    - The site has a moderate or lower conservation value and management of the threat is likely to significantly improve the viability and quality of the site within the next five years.
  - *Lower:* Management of the threat in any site category is likely to improve or maintain the viability of the site over a timeframe beyond the next ten years.
  - *Not applicable:* There is no perceived threat and/or no management action is required or recommended.
- **Priority:** The priority for managing each threat at each site is assessed as follows:
    - *Immediate:* The highest priority sites for active management. These are generally of international or national significance, or large regionally significant sites. Includes sites where a relatively small investment in the short term may deal cost-effectively with a management problem or threat and avoid potentially more significant problems.
    - *High:* Generally sites of high ecological value (e.g. large regionally significant sites, nationally significant sites or better) where threats do not immediately threaten the site, but management will significantly improve the viability of key ecological features.
    - *Medium:* Sites of regional significance or better where management will significantly improve the long-term viability of ecological features at the site, or sites of local significance where the management action has the potential to improve the site so that it may, in future, meet the criteria for regional significance.
    - *Lower:* Either sites of local significance where management will improve the viability of ecological values or geothermal features, or sites ranked higher where management will improve ecological viability but will require the allocation of significant resources.
    - *Not applicable:* No obvious threats or no action required.
  - **Ecological Change and Management Since Previous Assessment (Wildland Consultants 2006b):** Any change that has been known to occur to ecological features of the site since the previous assessment is whether taking into consideration whether changes to site descriptions are real or based on better information for the site (e.g. better quality aerial photographs and identification of areas of geothermal vegetation that, whilst present in 2004, were not mapped

then). In addition, any management of ecological threats that has been undertaken since the previous surveys is noted.

- **Comments:** Any further comments.

### 3.1 Ranking of priorities of pest plant control, pest animal control and fencing

Ranking of sites as priority for pest plant control, pest animal control and considered the following factors:

- The overall value of the site (significance ranking).
- Specific ecological values (e.g. threatened and at risk species) threatened because of pest plants, domestic stock, or animal pests.
- Land tenure and ongoing restoration management activities.
- Potential effectiveness/cost effectiveness of the management effort.

## 4. FINDINGS

Information for 64 sites is summarised in Appendix 1, including key pest plant, pest animal, and domestic stock threats at each site. The vulnerability of each site to those threats, the actions required to address them, and the benefits and priority of ecological management are then presented. In the following sections, sites that are of a high, medium, or lower priority for pest plant control, pest animal management, and/or exclusion of domestic stock are identified.

### 4.1 Pest plants

Six geothermal sites require immediate weed control, and these are listed in Table 1.

- Ongoing control of wilding pines (*Radiata* sp.) and pampas (*Cortaderia selloana*) at Ohaaki Steamfield West (OHV01) and Orakeikorako (OKV03) should be controlled.
- Wilding pines also require control at Waiotapu North (WTV03) and Waiotapu South (WTV05).
- Ornamental trees and plantings at Tokaanu Thermal Park (TOV08) should be removed, whilst at Hipaua (TOV02), surveillance for pest plants (e.g. pampas) is the priority.
- At Waikite Valley (WAV01) *Cyperus involucratus*, ivy (*Hedera helix*), and Mexican daisy (*Erigeron karvinskianus*) is expanding its range alongside geothermal stream margins, and has a potential threaten other parts of this site if allowed to spread.

Wilding pines, particularly maritime pine (*Pinus pinaster*) and radiata pine (*Pinus radiata*), and also lodgepole pine (*Pinus contorta*), black pine (*Pinus nigra*), bishop pine (*Pinus muricata*), ponderosa pine (*Pinus ponderosa*), strobilus pine (*Pinus strobus*), Douglas fir (*Pseudotsuga menziesii*), and European larch (*Larix decidua*), are a threat to many sites. Other pest trees present in the geothermal vegetation in the Waikato Region include flowering cherry (*Prunus* sp.), Chinese privet (*Ligustrum sinense*), cotoneaster (*Cotoneaster simonsii*, *Cotoneaster glaucophyllus*), false acacia (*Robinia pseudoacacia*), eucalyptus (*Eucalyptus* sp.), Tasmanian blackwood (*Acacia melanoxylon*), silver birch (*Betula pendula*), crack willow (*Salix fragilis*), grey willow (*Salix cinerea*), and tree lucerne (*Chamaecytisus palmensis*).

Where herbicides are to be used for control of pest plant trees, care needs to be taken to avoid accidentally killing indigenous plants and vegetation cover. Herbicide should only be applied to deciduous trees when the trees are in leaf (e.g. the best time of the year to control willow is January/February). This applies not only to foliar application but also to drilling and poisoning. When trees are felled, they should be felled away from geothermal vegetation, where possible.

Pampas (*Cortaderia selloana*) is scattered through many geothermal sites and is a high priority for control. Undertaking control when pampas is flowering makes identification easier for weed control operators. One species, *Cyperus involucratus*, was only recorded at one site (Waikite) from where it should be eradicated. This species has the potential to spread further along stream banks at this site, threatening *Christella* aff. *dentata* “thermal” populations. Ivy and Mexican daisy are also invading stream banks threatening *Nephrolepis flexuosa* populations, and should be controlled at the same time.

Blackberry (*Rubus fruticosus* agg.), broom (*Cytisus scoparius*), buddleia (*Buddleja davidii*), Himalayan honeysuckle (*Leycesteria formosa*), broom (*Cytisus scoparius*), gorse (*Ulex europaeus*), Spanish heath (*Erica lusitanica*), and exotic grasses are common on cooler geothermal soils and on the margins of sites, but are difficult to manage in most situations. Where they are present in low abundance (e.g. buffalo grass (*Stenotaphrum secundatum*) at Craters of the Moon) they should be controlled to prevent them from spreading or, if possible, to eradicate them.

When controlling pest plants it is important to avoid damaging indigenous geothermal vegetation. It is advisable that an ecologist who is familiar with geothermal flora and vegetation be involved with planning weed control operations and, in some cases, be on site to advise contractors so that adverse effects on biodiversity values can be avoided or minimised. This is particularly important where there are ‘Threatened’ or ‘At Risk’ flora species growing in close proximity to infestations of pest plants. For example, control of pest plants may make populations of ferns typical of geothermal habitat more susceptible to foliage damage during frosts if the surrounding canopy is removed. Pest plant control can also threaten populations of ‘At Risk’ ferns alongside stream margins by making stream banks more vulnerable to erosion.

Table 1: Geothermal sites in the Waikato Region where pest plant control is of 'immediate', 'high', 'medium', or 'lower' priority. Descriptions of the threat to each site and the control actions that are required are summarised in Appendix 1.

Immediate		High		Medium		Lower		No Threat	
WAV01	Waikite Valley	WTV01	Maungaongaonga	MKV03	Tirohanga Road	HHV01	Horohoro	MKV01	Whakamaru
WTV03	Waioapu North	WTV04	Maungakakamea	ATV02	Whangapoa Springs	WAV02	Northern Paeroa Range	TGV01	Te Maari Craters
WTV05	Waioapu South		(Rainbow Mountain)	TKV02	Murphy's Springs	WTV02	Ngapouri	TGV02	Ketetahi
OKV03	Orakeikorako	MKV02	Waipapa Stream	TKV04	Te Kopia West Mud Pools	MKV04	Paerata Road	TGV03	Emerald Lakes
OHV01	Ohaaki Steamfield West	TKV01	Te Kopia	OKV02	Akatarewa Stream	ATV03	Matapan Road	TGV04	Red Crater
TOV02	Hipaua	OKV01	Waihunuhunu	RPV01	Longview Road	ATV01	Upper Atiamuri West		
TOV08	Tokaanu Thermal Park	OKV04	Red Hills	RPV02	Wharepapa Road	TKV03	Te Kopia Northwest		
		NMV02	Ngatamariki	RPV03	Golden Springs	TKV05	Te Kopia Red Stream		
		THV01	Otumuheke	OHV02	Ohaaki Steamfield East	TKV06	Mangamingi Station		
		THV06	Crown Road	THV04	Broadlands Road	OKV05	Akatarewa East		
		THV07	Waipahihi Valley	WKV01	Te Rautehuia	NMV01	Waikato River Springs		
		WKV02	Te Rautehuia Stream	WKV06	Lower Wairakei Stream	WGV01	Whangairoheia		
		WKV03	Upper Wairakei Stream (Geyser Valley)	TOV03/TOV04/TOV05/TOV06	Tokaanu Lakeshore Wetland	THV03	Spa Thermal Park		
		WKV05	Te Kiri O Hine Kai Stream Catchment/ Wairoa Hill			THV05	Crown Park		
		WKV10	Craters of the Moon			WKV04	Wairakei Borefield		
		RKV01	Rotokawa North			WKV07	Karapiti Forest		
		RKV02	Lake Rotokawa			WKV08	Hall of Fame Stream		
						WKV09	Waipouwerawera Stream/Tukairangi		
						TOV07	Maunganamu West		
						TOV09	Tokaanu Urupa Mud Pools		
						TOV10	Maunganamu East		
						TOV11	Maunganamu North Wetland		
						TOV14	Tokaanu Tailrace Canal		



## 4.2 Pest animals

Pest animal management requirements were assessed during what was usually a single site visit (refer to Table 2). Impacts of pest animals are not always able to be identified during a single site visit, although likely impacts can be assessed based on the vegetation and landforms present. Information is often based on knowledge of pest animals that are likely to be present in the vicinity of these sites. One site, Waiotapu South (WTV05) has been identified as a high priority for pest animal control because pigs are having significant adverse effects on the geothermal wetlands. Pig trampling damage was evident throughout the wetlands of this site. Feral pigs are a medium priority for control at Waiotapu North (WTV03) and pigs, deer and deer possum require monitoring and management at Te Kopia (TKV01), Maungaongaonga (WTV01), Maungakakamea (WTV04), Red Hills (OKV04), and Waikite Valley (WAV01). These sites all have very high ecological values that may be threatened by pest animal impacts. More details about each of the sites listed in Table 2 and their requirements for pest animal control are presented in Appendix 1. Six sites that are currently grazed by stock are not considered a priority for pest animal management until fencing of geothermal habitat has been undertaken: Horohoro, Northern Paeroa Range, Matapan Road, Mangamingi Station, Akatarewa East, and Golden Springs. An additional 13 sites were considered too small for pest animal control to be practicable, or where management of pests was considered to be unlikely to greatly enhance values. These are Whakamaru, Upper Atiamuri West, Waikato River Springs, Whangairorohea, Wairakei Borefield, Lower Wairakei Stream, Karapiti Forest, Maunganamu North Wetland, Tokaanu Tailrace Canal, Tokaanu Urupa Mud Pools, Maunganamu East, Maunganamu North, and Red Crater.

Table 2: Geothermal sites in the Waikato Region where pest animal control is of 'immediate', 'high', 'medium', or 'lower' priority. Descriptions of the threat to each of these sites and the control that is required are provided in Appendix 1.

High		Medium		Lower	
WTV05	Waiotapu South	WAV01	Waikite Valley	WTV02	Ngapouri
		WTV01	Maungaongaonga	MKV02	Waipapa Stream
		WTV03	Waiotapu North	MKV03	Tirohanga Road
		WTV04	Maungakakamea (Rainbow Mountain)	MKV04	Paerata Road
		TKV01	Te Kopia	ATV02	Whangapoa Springs
		TKV02	Murphy's Springs	TKV03	Te Kopia Northwest
		OKV03	Orakeikorako	TKV04	Te Kopia West Mud Pools
		OKV04	Red Hills	TKV05	Te Kopia Red Stream
		RKV02	Lake Rotokawa	OKV01	Waihunuhunu
				OKV02	Akatarewa Stream
				NMV02	Ngatamariki
				RPV01	Longview Road
				RPV02	Wharepapa Road
				OHV01	Ohaaki Steamfield West
				OHV02	Ohaaki Steamfield East
				THV01	Otumuheke
				THV03	Spa Thermal Park
				THV04	Broadlands Road
				THV05	Crown Park
				THV06	Crown Road
				THV07	Waipahih Valley
				WKV01	Te Rautehuia
				WKV02	Te Rautehuia Stream

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High	Medium	Lower
		WKV03 Upper Wairakei Stream (Geyser Valley)
		WKV05 Te Kiri O Hine Kai Stream Catchment/Wairoa Hill
		WKV08 Hall of Fame Stream
		WKV10 Craters of the Moon
		RKV01 Rotokawa North
		TOV02 Hipaua
		TOV07 Maunganamu West
		TOV03/04/05/06 Tokaanu Lakeshore Wetlands
		TOV08 Tokaanu Thermal Park
		TGV01 Te Maari Craters
		TGV02 Ketetahi
		TGV03 Emerald Lakes

#### 4.3 Exclusion of domestic stock

The ecological values of 22 sites would be enhanced by excluding domestic stock that are currently grazing and trampling the sites (Table 3). It is an immediate priority at one site, Te Rautehuia Stream (WKV02), where stock have access to the site. At the remaining 42 sites fencing is not currently required to protect values, given the current surrounding land use (e.g. forestry and conservation land). More detailed information about each of the sites is presented in Appendix 1.

Table 3: Geothermal sites in the Waikato Region where fencing (or maintenance of fences) to exclude domestic stock is of 'immediate', 'high', 'medium', or 'lower' priority. Descriptions of each of these sites and the fencing that is required are provided in Appendix 1.

Immediate	High	Medium	Lower
WKV02 Te Rautehuia Stream	WAV01 Waikite Valley	WTV04 Maungakakamea/Rainbow Mountain (Part of site)	HHV01 Horohoro
	TKV02 Murphy's Springs		WAV02 Northern Paeroa Range
	THV06 Crown Road	MKV04 Paerata Road	WTV02 Ngapouri
	WKV01 Te Rautehuia	OKV05 Akatarewa East	MKV03 Tirohanga Road
		TKV06 Mangamingi Station	ATV03 Matapan Road
		RPV02 Wharepapa Road	OKV05 Akatarewa East
		RPV03 Golden Springs	RPV01 Longview Road
		RKV01 Rotokawa North	OHV02 Ohaaki Steamfield East
			THV04 Broadlands Road
			TOV11 Maunganamu North Wetland

#### 4.4 Other threats to geothermal areas

Threats other than those listed in Appendix 1 also occur at geothermal sites. A full description of known threats to geothermal sites in the Waikato Region are summarised in Section 10 of Wildland Consultants 2011 (Wildland Consultants Ltd Contract Report No. 2348). These include:

- Exploitation of geothermal fields for energy production;
- Tourism and recreation where it is not managed well;
- Dumping of rubbish;

- Management of neighbouring plantation forests and shelterbelts;
- Fire;
- Genetic pollution;
- Wetland infilling and drainage;
- Industrial/residential/roading development.

## 5. SUMMARY

Information about each of the 64 geothermal sites assessed in this study is summarised in Appendix 1. The threat mechanisms operating at each site, their vulnerability to those threats, the actions required to address them, and the benefits and priority of ecological management are identified. The number of sites which were ranked for immediate, high, medium, or lower priority for management for each factor is presented in Table 4. Pest plant control was identified as an immediate priority at seven sites and a high priority at 16 sites. Pest animal management is a high priority at one site, whilst exclusion of domestic stock is of immediate priority at one site and a high priority at four sites. At the single site which is a high priority for pest animal control, pest plant control is also ranked as an immediate priority (i.e. WTV05 Waioatapu South).

Table 4: Number of geothermal sites in the Waikato Region where pest animal control, pest plant control, or exclusion of domestic stock is of immediate, high, medium, or lower priority.

	<b>Immediate</b>	<b>High</b>	<b>Medium</b>	<b>Lower</b>	<b>N/A</b>
Pest plant management	7	16	13	23	5
Pest animal management	0	1	18	31	14
Exclusion of grazing domestic stock	1	4	7	10	42

Management of sites where management requirements have been identified as of immediate or high priority should be instigated as soon as practicable. Holistic management of sites should also be considered. For example, if management of one factor, e.g. pest plants, pest animals, or fencing, is to be undertaken at a particular site because it has been identified as of immediate or high priority, then it may be cost-effective to undertake other management actions at that site at the same time.

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**THREATS TO GEOTHERMAL SITES IN  
WAIKATO REGION - PEST PLANTS, PEST  
ANIMALS, AND GRAZING (STOCK)**

A description of each field in the table is provided  
in the Methods section of this report.

Site Number	Site Name	Tenure	Size (ha)	Significance Level	Key Values of the Site	Threats/Fencing	Vulnerability	Description of Threats	Action Required	Ecological Benefit	Priority	Ecological Change and Management Since Previous Assessment (Wildland Consultants 2006b)	Comments
<b>Horohoro Geothermal Field</b>													
HHV01	Horohoro	Unprotected private land	c.0.1	Local	This site contains a small example of a geothermal habitat - a nationally rare habitat type.	Pest plants	Lower	The geothermal pools are surrounded by exotic pasture species.	No action required.	Lower	Lower	Not assessed. Changes unlikely to be significant. Site appears unchanged in aerial photographs.	The site is surrounded by pasture with few indigenous geothermal species present.
						Pest animals	No threat	The site is highly modified and is currently more vulnerable to grazing by domestic stock than by pest animals.	No action required.	N/A	N/A		
						Domestic stock	Medium	The site is not fenced and stock have access to the site.	Fencing is likely to enable indigenous vegetation to establish around the hot spring if pest plants are controlled.	Lower	Lower		
<b>Waikite Geothermal Field</b>													
WAV01	Waikite Valley	Protected (Waikite Stewardship Area; Otamakokore Stream Marginal Strip; Waikite Wildlife Management Reserve) and unprotected private land	c.24.6	National	This site contains a very large population of <i>Christella</i> aff. <i>dentata</i> ("thermal"), an 'At Risk' species. It also contains populations of prostrate kanuka, <i>Nephrolepis flexuosa</i> , <i>Dicranopteris linearis</i> , <i>Hypolepis dicksonioides</i> , <i>Cyclosorus interruptus</i> , and <i>Thelypteris confluens</i> (all of which are 'At Risk'). Three 'At Risk' bird species are also present: spotless crane, North Island fernbird, and pied stilt.	Pest plants	High	The geothermal features and vegetation are discontinuous and are located within a matrix of pasture, other exotic vegetation, and small patches of indigenous vegetation. Invasive pest plants present include blackberry, grey willow, barberry, pampas, <i>Cyperus involucratus</i> , and pasture grasses. <i>Cyperus involucratus</i> is expanding in extent and ivy is smothering <i>Nephrolepis flexuosa</i> . Mexican daisy is also present. Pest plants threaten populations of 'At Risk' fern species and the quality of the geothermal vegetation present.	Control grey willow, pampas, blackberry, Mexican daisy, ivy, and <i>Cyperus involucratus</i> . A management plan to deal with the pest plant threats is urgently needed for this entire site, followed by implementation.	Immediate	Immediate	Recent work has been undertaken to raise water tables, and re-establishment to a natural alignment geothermal streams system in wetland on Landcorp farm. This has increased the area of geothermal wetland at this site. This area has also been fenced to exclude stock (funded by Waikato Regional Council). This will result in a significant vegetation change at the site in the next few years. Since 2004 some new parts of this site have also been identified.	Pest animals may threaten wetland vegetation present (see pigs at Waiotapu South).
						Pest animals	Lower	Pigs and deer may be present.	Pest animal control may enhance the ecological values of the site.	Medium	Medium		
						Domestic stock	Medium	Most of the geothermal features are fenced to exclude stock.	Fence the remaining areas that are accessible to stock.	High	High		
WAV02	Northern Paeroa Range	Unprotected private land	c.0.3	Local	Northern Paeroa Range comprises seven small geothermal features and habitat - a nationally rare habitat type. Prostrate kanuka, an 'At Risk' species, is present as occasional scattered plants.	Pest plants	Lower	Most areas of geothermally-altered soils are largely devoid of vegetation. Blackberry and grey willow are common on the margins in places.	Crack willow control would improve site values.	Medium	Lower	This site was not assessed in Wildland Consultants (2006b) geothermal surveys of geothermal vegetation in the Waikato Region. However, the site is unlikely to have undergone any significant change over this time period.	
						Pest animals	Lower	Rabbits are present.	No action required.	N/A	N/A		
						Domestic stock	Medium	Although fenced, most the features have had some impact from stock (cattle).	The site should be fenced more securely to exclude stock.	Lower	Lower		
<b>Waiotapu Geothermal Field</b>													
WTV01	Maungaongaonga	Protected (Maungaongaonga Scenic Reserve)	c.9.1	National	This site is one of the best quality remaining examples of geothermal vegetation remaining in New Zealand. It forms part of an ecological sequence from geothermal vegetation (prostrate kanuka scrub and nonvegetated raw-soilfield) through to non-geothermally influenced forest. The vegetation is of good quality and pest plants are relatively uncommon at the site. It also provides habitat for four 'At Risk' species: <i>Nephrolepis flexuosa</i> , <i>Korthalsella salicornioides</i> , prostrate kanuka, and <i>Dicranopteris linearis</i> .	Pest plants	Medium	If pest plants are not controlled and spread into this site, this will diminish the indigenous character of the site. The main pest plant species present are blackberry, radiata pine, Douglas fir, Spanish heath, gorse, and narrow-leaved carpet grass.	Pest plants (which are currently uncommon at the site) should be controlled including wilding pines, gorse and blackberry. Narrow-leaved carpet grass should also be considered for control at this site.	High	High	Not assessed. Any change to area mapped is based on remapping on better quality aerial photographs, rather than an indication of real change to extent of geothermal vegetation at this site.	
						Pest animals	Medium	Pigs and deer are likely to damage existing geothermal vegetation and have negative effects on the regeneration of the geothermal vegetation present.	This site should be monitored for pest animals and control of these species should be undertaken when necessary.	Medium	Medium		
						Domestic stock	No threat		No action required.	N/A	N/A		
WTV02	Ngapouri	Protected (Ngapouri Covenant) and unprotected private land	c.3.1	Part regional/part local	Although large parts of this site are dominated by exotic pest plants, it is a moderate-sized area of geothermal habitat - a nationally rare habitat type.	Pest plants	Lower	Much of this site is already dominated by pest plants so its vulnerability to further degradation and modification is relatively low.	Control invasive exotic plants including crack willow, Tasmanian blackwood, blackberry and wilding pines.	Medium	Lower	Little change has been noted in this area, which is well known to the authors. No change was noted in a study of recent aerial photographs.	Some parts of the geothermal vegetation and habitats that are not protected as a covenant are subject to grazing, and extensive areas are dominated by pest plants. These unprotected areas
						Pest animals	Lower	Parts of the site are grazed and/or dominated by exotic plant species,	Pest animal control may enhance the ecological	Lower	Lower		

Site Number	Site Name	Tenure	Size (ha)	Significance Level	Key Values of the Site	Threats/Fencing	Vulnerability	Description of Threats	Action Required	Ecological Benefit	Priority	Ecological Change and Management Since Previous Assessment (Wildland Consultants 2006b)	Comments
								and are not highly vulnerable to further modification by pest animals.	values of the site.				are important linkages between the protected areas of geothermal habitat, including adjacent sites to Ngapouri, which include Waitapu South, Waitapu North, and Maungaongaonga. Regular management of pest plants, particularly wilding trees should be undertaken. These areas should be regularly monitored for management issues. Formal protection and a restoration plan with subsequent implementation for these areas would enhance and protect the highly significant ecological values of greater Waitapu Geothermal Field.
						Domestic stock	Lower	Sheep have access to parts of the site, but it is already highly modified so its level of vulnerability to degradation is relatively low.	Construct <b>fences</b> and maintain existing <b>fences</b> .	Lower	Lower		
WTV03	Waitapu North	Unprotected private land and protected (Waitapu Scenic Reserve).	c.45.8	Regional	This site contains a relatively large area of a nationally uncommon vegetation/habitat type - geothermal. It also contains populations of two 'At Risk' species - prostrate kanuka and <i>Dicranopteris linearis</i> .	Pest plants	High	Pest plants dominate some areas, particularly on cooler ground. Species present include wilding pines, broom, blackberry, Spanish heath, grey willow, and cotoneaster.	Pest plant species need to be controlled, particularly wilding pines, grey willow, and cotoneaster.	High	Immediate	Several units of vegetation were identified in this survey which were not found in the 2004 survey. These were mostly found based on areas being more visible during field survey alongside recently cleared pine plantation, as well as being more visible on better quality 2007 aerial photographs. Some minor loss of geothermal vegetation has occurred in places following harvesting of pine trees, however in most instances it appears that the land manager has taken reasonable care to avoid damage to geothermal habitats. A small infestation of African feather grass ( <i>Cenchrus macrourus</i> ) has been controlled by Waikato Regional Council. This is an invasive species and follow-up inspections should take place.	Kaingaroa Timberlands initiated control work of some of these species in the areas of highest significance at Waitapu North in autumn 2005 (Wildland Consultants 2005). This work has continued since.  The unprotected geothermal vegetation at this site forms an important linkage between the protected areas of geothermal habitat. Regular management of pest plants, particularly wilding trees should be undertaken. These areas should be regularly monitored for management issues, and a restoration plan with subsequent implementation for these areas would enhance and protect the highly significant ecological values of this field. Formal protection should be considered for the best quality geothermal vegetation at this site.
						Pest animals	Medium	Pigs and deer are likely to damage and have negative effects on the regeneration of the geothermal vegetation present.	Control pigs.	Medium	Medium		
						Domestic stock	No threat		No action required.	N/A	N/A		
WTV04	Maungakakamea (Rainbow Mountain)	Protected (Rainbow Mountain Scenic Reserve) and unprotected private land	c.50.6	National	This site is a good quality example of an ecological sequence grading from geothermal vegetation (prostrate kanuka shrubland and geothermal wetland) to indigenous forest. It contains populations of eight 'At Risk' species: <i>Nephrolepis flexuosa</i> , prostrate kanuka, <i>Dicranopteris linearis</i> , <i>Schizaea dichotoma</i> , <i>Calochilus paludosus</i> , <i>C. robertsonii</i> , <i>Petalochilus alatus</i> , and <i>Stegostyla atradenia</i> .	Pest plants	Medium	Some wilding pine control has been undertaken at the site, but re-establishment remains a threat to some areas of prostrate kanuka scrub and other geothermal habitats.	Control wilding pines.	High	High	The most notable change since the previous survey is the continued control of pines by Department of Conservation. The site is in a markedly improved condition as a result. Other changes to the site are as a result of additional parts of the site being identified on better quality aerial photographs from 2007.	
						Pest animals	Medium	Pigs, deer and possums are likely to have negative effects on the geothermal vegetation.	Wild pest animals should be monitored, and controlled where necessary.	Medium	Medium		
						Domestic stock	Lower	Horses and sheep have access to small geothermal features to the north of the site, near SH38.	Small geothermal features to the north of the site, near SH38, should be <b>fenced</b> .	Medium	Medium		
WTV05	Waitapu South	Protected (Waitapu Scenic Reserve and Waitapu Stewardship Area) and unprotected private land	c.112.4	Part International/ part Regional/ part Local	This site contains one of the best representative examples of geothermal wetland and terrestrial vegetation remaining in New Zealand. However, pest plants are dominant surrounding many areas of geothermal vegetation. The wetland to the south contains largest population of <i>Cyclosorus interruptus</i>	Pest plants	High	The areas around key geothermal features are well-maintained for public viewing, but the vegetation is modified by the presence of maritime pine. Few other pest plants are present.	Pest plants at the site should be controlled, particularly the extensive parts covered with exotic pines (maritime pine, radiata pine, black pine, and strobus pine). Other pest plants that should be controlled include blackberry, black wattle, broom, gorse, and Spanish heath.	High	Immediate	Pines have been controlled in the northeast of the site, and the quality of the habitat present has greatly improved. Pest pines continue to degrade parts of the site where control has not taken place. Overall, the extent of geothermal habitat at Waitapu South is considered to be similar to 2004. The additional area mapped in Wildland	
						Pest animals	High	Pigs are having a significant negative impact on geothermal wetlands.	This site should be monitored for pest animals and control	High	High		



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					(an 'At Risk' species) at any geothermal site in New Zealand.	Domestic stock	No threat		of these species should be undertaken when necessary. No action required.	N/A	N/A	Consultants (2011) is based on new areas of geothermal vegetation and habitat identified by field survey.	
<b>Mokai Geothermal Field</b>													
MKV01	Whakamaru	Unprotected private land	<0.1	Local	Whakamaru comprises a very small example of geothermal habitat.	Pest plants	Low	The site is largely unvegetated. No pest plants were noted in 2008.	No action required.	N/A	N/A	Unknown, this site has only been surveyed in 2008.	
						Pest animals	Unknown		No action required.	N/A	N/A		
						Domestic stock	No threat	The site is not grazed by domestic stock.	No action required.	N/A	N/A		
MKV02	Waipapa Stream	Unprotected private land	c.1.1	Part National/ part Local	Waipapa Stream contains the third largest population of <i>Christella</i> aff. <i>dentata</i> ('thermal') in New Zealand. It is an 'At Risk' species.	Pest plants	High	Invasive plants include blackberry, radiata pine, Himalayan honeysuckle, Japanese honeysuckle, and mint. The site is vulnerable to invasion of wilding pines from the surrounding pine plantations, and to disturbance associated with management of the surrounding pine plantations.	Continue controlling wilding pines, and other pest plants present.	Medium	High	Some wilding pine control has been undertaken by Carter Holt Harvey and subsequently by Waikato Regional Council, in the northern part of this site. Careful management of surrounding pine plantation is required to ensure the ecological values of the site are maintained or enhanced. Logging on steep slopes surrounding the site could increase sedimentation into geothermal areas. Wildland Consultants have been involved with management of this area with Carter Holt Harvey Forests (Wildland Consultants 2005c). Additional control of pines and other pest plants (e.g. broom and blackberry) have been undertaken by Waikato Regional Council.	The neighbouring land use in the wider site has recently been converted from forestry to dairy farming. Monitoring to assess any impacts on geothermal vegetation and habitats should be undertaken.
					Pest animals	Unknown	Pest animals may be present, but effects were not observed.	Monitor, and control as necessary.	Lower	Lower			
					Domestic stock	No threat	Site surrounded by plantation forestry.	No action necessary.	N/A	N/A			
MKV03	Tirohanga Road	Unprotected private land	c.0.2	Local	Tirohanga Road is a very small area of geothermal habitat, a nationally uncommon habitat type. It provides habitat for a small population of prostrate kanuka, an 'At Risk' species.	Pest plants	Medium	Vegetation at the site is dominated by exotic pasture grasses and blackberry. The grassland is vulnerable to invasion by woody weeds e.g. blackberry, wilding pines.	Changes to geothermal vegetation that are likely to be associated with draw-off from the geothermal field should be monitored. A management plan for restoration of this site should be developed by ecologists with an understanding of the ecological values of this site.	Medium	Medium	It appears that new fencing to exclude stock has been relocated further away from the geothermal features (parts of the old fence remain). Recent spraying has killed large areas of blackberry, and there has been some loss of manuka (and possibly <i>Histioglossis incisa</i> ). Between the geothermal expressions and the fence, browntop-Yorkshire fog-paspalum grassland dominates. Waste material that had been dumped into geothermal features (noted in 2007 report) appears to have been removed from site.	Indigenous geothermal vegetation should not be sprayed with herbicide.
					Pest animals	Unknown	Pest animals may be present but no effects were observed.	No action required.	Lower	Lower			
					Domestic stock	Lower	The site is fenced but stock may still access this site.	<b>Fences</b> should be regularly inspected, and maintained as necessary.	Lower	Lower			
MKV04	Paerata Road	Unprotected private land	c.1.7	Local	A small population of prostrate kanuka, an 'At Risk' species, is present. It is the largest population of this species in the Mokai Geothermal Field.	Pest plants	Medium	Blackberry has been controlled and pine seedlings have been planted surrounding some geothermal features. These features are vulnerable to pine invasion and/or shading. Other features are already dominated by exotic species (e.g. pasture grasses) and are grazed so are not currently vulnerable to pest plant invasion.	Monitor spread of wilding pines and blackberry. Control if it is invading into geothermal vegetation.	Medium	Lower	Blackberry has been sprayed and radiata pine has been planted adjacent to and within the site. Vegetation clearance and herbicide application on some geothermal vegetation has occurred.	Areas mapped as 'B' in Wildland Consultants (2011) are grazed by cattle.
					Pest animals	Rabbits	Rabbit are present in geothermal areas with some burrows present.	Rabbit control should be undertaken in geothermal sites and adjacent pasture.	Medium	Lower			
					Domestic stock	Medium	Stock have access to many of the geothermal features at this site.	<b>Fencing</b> of all areas of geothermal vegetation and geothermal features not	Medium	Medium			

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									currently fenced to exclude stock will allow geothermal vegetation to re-establish around these features.				
<b>Atiamuri Geothermal Field</b>													
ATV01	Upper Atiamuri West	Unprotected private land	<0.1	Local	Upper Atiamuri West is a small area of geothermal habitat, a nationally uncommon habitat type. However the geothermal features are very small and highly modified, with few indigenous species present.	Pest plants	Lower	The site is already dominated by exotic plant species, notably blackberry, so is not very vulnerable to further modification by pest plants.	Pest plant control and restoration of the adjacent gully margins with geothermal habitat and features could be considered, however this site is not a priority for management.	Lower	Lower	The site wasn't assessed for the previous management report, but any significant recent change is unlikely.	
						Pest animals	No threat	Few indigenous plant species are present, and the vegetation is dominated by exotic species, so grazing pest animals are not currently a threat.	No action required.	N/A	N/A		
						Domestic stock	No threat	The site is fenced and stock are excluded.	No action required.	N/A	N/A		
ATV02	Whangapoa Springs	Protected (Whangapoa Springs Scientific Reserve) and unprotected private land	c.0.1	National	The site comprises geothermal pools with prostrate kanuka and one small population of the <i>Nephrolepis flexuosa</i> on their margins. Both species are classified 'At Risk' species.	Pest plants	Medium	Scattered blackberry is present around the northern pool. If monitoring and control of blackberry is not continued it may re-establish at this site, and impact recent restoration plantings.	Continue to control blackberry.	Medium	Medium	The condition of the vegetation surrounding these pools has greatly improved since 2003. The blackberry and broom has been controlled and planting of indigenous tree species has taken place.	
						Pest animals	Medium	Recent plantings of indigenous species may be vulnerable to grazing by pest animals.	Monitor the site and, if necessary, conduct pest animal control.	Lower	Lower		
						Domestic stock	No threat	The site is securely fenced and stock are excluded.	Ensure fences are maintained.	N/A	N/A		
ATV03	Matapan Road	Unprotected private land	<0.1	Local	This site is a very small area of geothermal habitat, a nationally uncommon habitat type.	Pest plants	Medium	Creeping bent and Yorkshire fog may encroach on the spring and thermal stream margins.	Pasture species could be controlled and the site restored using appropriate indigenous species. However, this site is not a priority for management.	Lower	Lower	Site has not been assessed previously, but is unlikely to have undergone significant recent change within the last ten years.	
						Pest animals	Unknown	Pest animals may be present, but no effects were observed.	No action required.	N/A	N/A		
						Domestic stock	Medium	The site is not fenced and is located within grazed pasture.	If the site is <b>fenced</b> it will need to be regularly inspected to detect and control pest plants, if necessary. However, this site is not a priority for management.	Lower	Lower		
<b>Te Kopia Geothermal Field</b>													
TKV01	Te Kopia	Protected (Te Kopia Scenic Reserve) and unprotected private land	c.58.8	International	This site has the best remaining, good quality, relatively large area of geothermal vegetation that forms part of an indigenous ecological sequence including geothermal vegetation (prostrate kanuka, geothermal wetland and nonvegetated raw-soilfield) through to indigenous forest. It also has one of the largest populations of <i>Dicranopteris linearis</i> and prostrate kanuka in New Zealand (both species are 'At Risk'). It also contains populations of five other 'At Risk' species: <i>Nephrolepis flexuosa</i> , <i>Calochilus paludosus</i> , <i>C. robertsonii</i> , <i>Korthasella salicornioides</i>	Pest plants	High	The invasion of wilding pines is a continuing problem in this area, and there is potential for pest plant invasion along the walking tracks. Blackberry and gorse are also present.	Control wilding pines. Blackberry and gorse should be monitored and controlled if spreading into geothermal areas.	High	High	The Department of Conservation has undertaken pest plant control (particularly control of wild pines) in the best examples of geothermal habitat.	Some control of wilding pines has been undertaken by the Department of Conservation. Requires ongoing monitoring and pine control for the foreseeable future.
						Pest animals	Medium	Pigs and deer are known to be present and are likely to damage and have negative effects on the regeneration of the geothermal vegetation.	Pigs and deer and populations should be regularly monitored and controlled when necessary.	Medium	Medium		
						Domestic stock	No threat	The reserve is fenced to exclude stock.	Fences should be regularly inspected and, if necessary, repaired.	N/A	N/A		

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					and <i>Schizaea dichotoma</i> .								
TKV02	Murphy's Springs	Unprotected private land	c.0.2	Regional	Murphy's Springs is in poor ecological condition but contains a relatively large population of <i>Christella</i> aff. <i>dentata</i> ('thermal'), an 'At Risk' species.	Pest plants	Medium	Plantation pines occur over indigenous shrubland. The site may be vulnerable to a further harvesting and planting of pines at this site.	Pines should be controlled. Pines should be felled away from geothermal features to avoid damaging indigenous vegetation and <i>Christella</i> aff. <i>dentata</i> ('thermal'), where possible.	Medium	Medium	Unknown. Not assessed in Wildland Consultants (2006b). Some felling of pine trees into geothermal areas is evident.	
						Pest animals	Lower	Possum sign has been observed at the site.	Pest animal control may reduce threats to the ecological values of the site, particularly the population of <i>Christella</i> aff. <i>dentata</i> ('thermal') present.	Medium	Medium		
						Domestic stock	Medium	The site is not fenced and cattle have access.	The site should be <b>fenced</b> to exclude stock.	High	High		
TKV03	Te Kopia Northwest	Unprotected private land	<0.1	Local	Te Kopia Northwest is a small geothermal manifestation in a gully to the north of Te Kopia Mud Pools (TKV04). It supports small populations of two 'At Risk' species: prostrate kanuka and <i>Nephrolepis flexuosa</i> .	Pest plants	Medium	Macrocarpa, blackberry, Mercer grass and creeping bent are present and have the potential to spread further if left uncontrolled.	Pest plants should be controlled.	Medium	Lower	Unknown. Not previously assessed in Wildland Consultants (2006b).	
						Unknown Domestic stock	Lower	No pest animal impacts noted.	No action required.	Lower	Lower		
						Domestic stock	No threat	The site is fenced to exclude stock.	<b>Fences</b> should be regularly inspected and maintained.	N/A	N/A		
TKV04	Te Kopia West Mud Pools	Unprotected private land	c.0.1	Local	Te Kopia Mud Pools comprises three mud pools. It is a small example of a nationally uncommon vegetation and habitat type - geothermal vegetation and habitat).	Pest plants	Lower	The site is already dominated by exotic tree species, so is not highly vulnerable to further modification by pest plants.	Control exotic trees within 10 m of the mud pools.	Medium	Medium	The farmer advised that the southern mud pool has become more vigorous in recent years. Not assessed in Wildland Consultants (2006b).	
						Pest animals	Lower	Possum sign has been observed at the site.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	No threat	The site is fenced to exclude stock.	<b>Fences</b> should be regularly inspected and maintained.	N/A	N/A		
TKV05	Te Kopia Red Stream	Unprotected private land	c.0.2	Local	Te Kopia Red Stream comprises indigenous scrub surrounding a small, geothermal stream.	Pest plants	Medium	Exotic pest plants are common, including blackberry, alder, and cotoneaster.	The site would benefit from pest plant control (particularly of alder and cotoneaster).	Lower	Lower	Unknown. Not previously assessed in Wildland Consultants (2006b).	
						Pest animals	Lower	Possoms are probably a threat.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	No threat	The site is fenced to exclude stock.	<b>Fences</b> should be regularly inspected and maintained.	N/A	N/A		
TKV06	Mangamingi Station	Unprotected private land	c.0.5	Local	Mangamingi Station supports small populations of two 'At Risk' species, prostrate kanuka and <i>Dicranopteris linearis</i> .	Pest plants	Medium	While the site is grazed, it is not highly vulnerable to pest plants.	Blackberry should be controlled. If the site is <b>fenced</b> it will be important to monitor the site for pest plants (particularly blackberry, wilding pines, and Spanish heath).	Lower	Lower	Unknown. The site has not previously been assessed in Wildland Consultants (2006b). It is unlikely to have undergone significant recent change.	
						Pest animals	Lower	The site is already grazed by sheep which requires management before pest animals would be an issue.	No action required.	N/A	N/A		
						Domestic stock	High	The site is grazed by sheep which are causing trampling damage and impacting on natural regeneration of indigenous geothermal vegetation.	The ecological condition of this site will improve markedly and populations of 'At Risk' species would be likely to expand if it is <b>fenced</b> to exclude stock.	Medium	Medium		
<b>Orakeikorako Geothermal Field</b>													
OKV01	Waihunuhunu	Unprotected private land	3.0	National	This site contains good populations of four 'At Risk' species: <i>Christella</i> aff. <i>dentata</i> ("thermal"), <i>Cyclosorus interruptus</i> , <i>Dicranopteris linearis</i> , and <i>Nephrolepis flexuosa</i> . It also contains good quality example of geothermal wetland habitat.	Pest plants	Medium	Grey willow and crack willow are common in the wetland and around the geothermal stream. Plantation pine forest bounds part of the site, so it may be vulnerable to wilding pine invasion.	Control grey willow and crack willow.	High	High	Not assessed in Wildland Consultants (2006b).	Field work may be useful to further identify pest animal threats to this site.
						Pest animals	Unknown	No pest animal impacts were noted, but pigs, deer, and possums may have impacts on the site.	No action required.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		

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OKV02	Akatarewa Stream	Unprotected private land	1.4	Regional	<i>Christella</i> aff. <i>dentata</i> ("thermal"), classed as an 'At Risk-Declining' species in de Lange <i>et al.</i> 2009) is scattered alongside stream margins throughout this site. <i>Cyclosorus interruptus</i> and <i>Dicranopteris linearis</i> , also 'At Risk' species, have been recorded in the past.	Pest plants	Medium	The site is already highly modified by pest plants such as blackberry, pampas, grey willow, buddleia, and Himalayan honeysuckle.	Implement pest plant management.	Medium	Medium	Not assessed in Wildland Consultants (2006b).	
						Pest animals	Unknown	Signs of pest animals were not apparent when the site was inspected,	Pest animal control may enhance the ecological values of the site if they are present.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
OKV03	Orakeikorako	Unprotected private land and Protected (Lake Ohakuri Stewardship Area)	c.42.4	National	This site is one of the best examples of geothermal vegetation and features in the Waikato Region. It supports populations of four 'At Risk' species: prostrate kanuka, <i>Schizaea dichotoma</i> , <i>Christella</i> aff. <i>dentata</i> ("thermal") and one of the largest populations of the <i>Dicranopteris linearis</i> in New Zealand. It also supports a number of other notable geothermal plant species and a high diversity of geothermal features.	Pest plants	Medium	Wilding pines have been controlled and have reduced in abundance and extent since previous survey in 2004. However, pampas has become established in places following pine control. The site remains vulnerable to expansion of existing pest plant infestations. Vegetation on the western side of the river has localised patches of pest plants including maritime pine, black wattle, blackberry, Japanese honeysuckle and bamboo.	Exotic pines and pampas should be removed from all geothermal areas. If pines are not removed then many of the ecological values present at this site will be markedly reduced. On the west side of the river, maritime pine, black wattle, blackberry, Japanese honeysuckle, and bamboo should be controlled.	High	Immediate	The boundaries of the site have been updated following pine control, and using the better quality 2007 aerial photographs. The most significant real change to the site is the management of pine trees on the eastern side of the river/lake, which has greatly improved the ecological character of the site. Recent control of pampas infestation has been carried out by Waikato Regional Council. Otherwise, change is considered to be minimal since the 2007 survey.	Total control of wilding pines should be implemented in the geothermal area at Orakeikorako. Some control of pampas has been undertaken since the most recent (2011) assessment was completed by Waikato Regional Council.
						Pest animals	Medium	Pigs and deer are known to be present and are likely to damage and have negative effects on the regeneration of the geothermal vegetation.	Pest animal control, particularly of pigs, may enhance the ecological values of the site.	Medium	Medium		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
OKV04	Red Hills	Protected (Lake Ohakuri Conservation Area)	c.11.4	National	This site together with Orakeikorako comprises one of the best areas of geothermal vegetation in Waikato Region. Much of Red Hills is dominated by extensive areas of prostrate kanuka, an 'At Risk' species. There are good populations of <i>Christella</i> aff. <i>dentata</i> ("thermal"), and <i>Dicranopteris linearis</i> is present (both species are classified 'At Risk').	Pest plants	Medium	Wilding pines threaten the indigenous character of the site and are likely to adversely affect indigenous geothermal vegetation through shading and tree fall.	Control populations of exotic pines (maritime pine and radiata pine) and Chinese privet.	High	High	No known changes to the extent and quality of geothermal activity at this site. Any changes made to site boundaries are based on higher quality aerial photographs, rather than any real change to geothermal extent.	Control of exotic pines has been undertaken by DOC. Total control of wilding pines should be implemented in the geothermal areas of the Red Hills, with regular monitoring and follow-up action as required.
						Pest animals	Medium	Pigs and deer are known to be present and are likely to damage and have negative effects on the regeneration of the geothermal vegetation.	Pest animal control, particularly of pigs and deer, may enhance the ecological values of the site.	Medium	Medium		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
OKV05	Akatarewa East	Unprotected private land	<0.1	Local	Akatarewa East comprises a small example of geothermal vegetation, which is a nationally uncommon habitat type. It also provides habitat for two 'At Risk' flora species: prostrate kanuka and <i>Dicranopteris linearis</i> .	Pest plants	Medium	Radiata pine is present on less geothermal-active areas of the site and Spanish heath is scattered throughout. Buddleia and blackberry are also present. Radiata pines have the potential to spread further and to shade the geothermal vegetation.	The radiata pine should be removed.	Lower	Lower	Not assessed. There is no known ecological information for this site prior to this 2011 study.	
						Pest animals	Lower	The site is grazed by domestic stock, so management of pest animals is not a priority unless the site is fenced to exclude stock.	No action required.	N/A	N/A		
						Domestic stock	Medium	This site is unfenced and grazed, although parts of the site are too steep for stock to access.	The site requires <b>fencing</b> and should be retired from grazing.	Medium	Medium		
<b>Ngatamariki Geothermal Field</b>													
NMV01	Waikato River Springs	Unprotected private land	c.0.4	Regional	Waikato River Springs includes a small population of an 'At Risk' species, <i>Christella</i> aff. <i>dentata</i> ("thermal"). North Island fernbird, which is also classified as 'At Risk', has been recorded at the site.	Pest plants	Lower	Pest plant species such as reed sweetgrass and grey willow dominate much of the site.	Chinese privet, grey willow and wilding pine could be controlled, but it is probably a major undertaking to control reed sweetgrass.	Lower	Lower	Not assessed in Wildland Consultants (2006b).	
						Pest animals	Unknown	This site is unlikely to be vulnerable to pest animals.	No action required.	N/A	N/A		
						Grazing by domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		

Site Number	Site Name	Tenure	Size (ha)	Significance Level	Key Values of the Site	Threats/Fencing	Vulnerability	Description of Threats	Action Required	Ecological Benefit	Priority	Ecological Change and Management Since Previous Assessment (Wildland Consultants 2006b)	Comments
NMV02	Ngatamariki	Protected (Ngatamariki Hot Springs Scenic Reserve) and unprotected private land	c.1.5	Regional	The site supports populations of three 'At Risk' species: <i>Cyclosorus interruptus</i> , <i>Dicranopteris linearis</i> and prostrate kanuka. It is also the best quality area of geothermal vegetation in the Ngatamariki Geothermal Field.	Pest plants	Medium	The site is surrounded by pine plantations and is vulnerable to wilding pine invasions.	Control all wilding pines.	High	High	Geothermal activity has changed the landforms and species composition of the southern part of this site. A hydrothermal eruption has reformed a geothermal lake and mud pools, and deposited hydrothermal eruption debris.	The Department of Conservation has initiated some pine control at this site.
						Pest animals	Lower	Pest animals may be present at this site.	Pest animal control may enhance the ecological values of the site	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
<b>Whangairorohea Geothermal Field</b>													
WGV01	Whangairorohea	Unprotected private land	<0.1	Local	Whangairorohea is a small site that comprises a geothermal pool within a plantation of radiata pine. The site is a small example of geothermal habitat, a nationally uncommon habitat type.	Pest plants	Lower	Spanish heath, poplar, buddleia, and blackberry are present on the margins of the pool.	Pest plant control would improve site values.	Lower	Lower	Not assessed in Wildland Consultants (2006b)	
						Pest animals	Lower	Much of the vegetation surrounding the pool is exotic and impacts are likely to be minor.	No action required.	N/A	N/A		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
<b>Reporoa Geothermal Field</b>													
RPV01	Longview Road	Protected (Molloy Conservation Covenant)	c.3.4	Regional	This is the largest continuous example of geothermal vegetation associated with the Reporoa Geothermal Field. Prostrate kanuka, an 'At Risk' species has been recorded from this site in the past.	Pest plants	Medium	Blackberry, if left uncontrolled, is likely to spread further at the site. Alteration of water tables (e.g. farm drains) may be a key issue for management of blackberry at this site.	Monitor spread of blackberry and control if it invading into geothermal vegetation.	Medium	Medium	Based on an assessment of aerial photographs, the site appears similar to the 2004 study.	Some grazing occurs around streams and constructed drains that contain geothermal water outside of the main geothermal site.
						Pest animals	Unknown	Pest animals may be present, but adverse effects have not been observed.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	Lower	Apart from the narrow strip of manuka shrubland, the site is fenced to exclude stock.	The margins of the heated creeks/channels need to remain <b>fenced</b> to exclude grazing animals. Fences should be monitored and maintained.	Lower	Lower		
RPV02	Wharepapa Road	Unprotected private land	c.3.3	Part Regional/part Local	This site contains a small population of the 'At Risk' species, prostrate kanuka, and an area of nationally uncommon habitat type - geothermal habitat.	Pest plants	Medium	Exotic species include rank pasture grasses, blackberry, and wilding pines are present. The site is highly degraded so is only moderately vulnerable to further modification by pest plants.	Wilding trees should be controlled. Blackberry should be monitored and controlled if it is spreading into geothermal areas.	Medium	Medium	More features were recorded in the 2010 survey, however these would have been present in earlier surveys.	Rubbish disposal and drainage have adverse effects at this site. Harvesting of pine trees has caused considerable damage to geothermal features at one location.
						Pest animals	Lower	Pest animals are likely to be present, but grazing by stock is currently having a greater impact.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	Medium	Most of the features are fenced but the fences are in poor condition so stock have access to geothermal features.	<b>Fences</b> should be repaired and maintained to exclude stock. Parts of the site currently grazed should be fenced.	Medium	Medium		
RPV03	Golden Springs	Unprotected private land	c.0.5	Part regional/part local	Golden Springs supports a population of <i>Christella</i> aff. <i>dentata</i> ("thermal"), an 'At Risk' species.	Pest plants	High	The populations of <i>Christella</i> aff. <i>dentata</i> ("thermal"), east of SH5 are vulnerable to pest plant invasion, but other parts of the site are already highly degraded by pest plants such as blackberry, Chinese privet, grey willow, Japanese honeysuckle and ivy.	The site is small and highly degraded but would benefit from pest plant control.	Medium	Medium	The site wasn't assessed for Wildland Consultants (2006b), but any significant recent change is unlikely.	
						Pest animals	Lower	The site is unlikely to be significantly vulnerable to pest animals, compared with impacts of farming.	No action required.	N/A	N/A		
						Domestic stock	Medium	West of SH5, the site is not fenced and is grazed. It is already highly degraded. If fenced it may improve potential habitat for <i>Christella</i> aff. <i>dentata</i> ("thermal").	The site is small and highly degraded but the parts that are grazed would benefit from <b>fencing</b> .	Medium	Medium		
<b>Ohaaki Geothermal Field</b>													
OHV01	Ohaaki Steamfield West	Unprotected private land	c.11.7	Regional	This site contains a relatively large population of prostrate kanuka, and a	Pest plants	High	The site is vulnerable to the continued spread of pest plants, particularly wilding pines and	Control wilding pines and pampas. Monitor other pest plants and control if	High	Immediate	Some wilding pine and pampas control has been undertaken at the site by Waikato Regional	

Site Number	Site Name	Tenure	Size (ha)	Significance Level	Key Values of the Site	Threats/Fencing	Vulnerability	Description of Threats	Action Required	Ecological Benefit	Priority	Ecological Change and Management Since Previous Assessment (Wildland Consultants 2006b)	Comments
					small population of <i>Dicranopteris linearis</i> (both 'At Risk' species). The site comprises a relatively large example of a nationally uncommon vegetation type - geothermal habitat.	Pest animals	Lower	pampas. Pest animals are likely to be present.	necessary. Pest animal control may enhance the ecological values of the site.	Lower	Lower	Council since 2004, however there are many areas in which pine encroachment is continuing.	
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A	An area of prostrate kanuka has recently been cleared for access tracks and laying of pipe. A prostrate kanuka population has established on bare ground near the marae, where it had been previously mapped as nonvegetated raw-soilfield.	
OHV02	Ohaaki Steamfield East	Part unprotected private land, part protected (QEII)	c.6.8	Regional	This site is a relatively large example of geothermal habitat that contains a good population prostrate kanuka, an 'At Risk' species.	Pest plants	High	Parts of the site are dominated by pest plants, particularly blackberry and wilding pines, but there are areas of prostrate kanuka scrub and shrubland and nonvegetated raw-soilfield that remain vulnerable to pest plant invasion. The recently bulldozed tracks that have been pushed into the site also provide sites for pest plant establishment.	Remove wilding pines. Monitor spread of blackberry, broom, and gorse and control invasions within prostrate kanuka scrub and shrubland and nonvegetated raw-soilfield. Monitor and control pest plants establishing on tracks.	Medium	Medium	With no geothermal wastewater dumping at the site 'artificial' geothermal water is no longer present. Vegetation change has occurred since the site was last mapped in 2004. Prostrate kanuka has become established on part of what was previously nonvegetated raw-soilfield.	
						Pest animals	Lower	Pest animals are likely to be present.	Pest animal control may enhance the ecological values of the site.	Lower	Lower	Blackberry appears to have increased in its dominance, particularly in the southern half of the fenced portion of the site.	
						Domestic stock	Lower	Most of the site is fenced to exclude stock. If the part of the site to the south (which is currently grazed by cattle) was fenced, then indigenous geothermal vegetation could expand in this area.	<b>Fence</b> the parts of the site that are grazed. However, this is not a priority management action.	Lower	Lower		
<b>Wairakei-Tauhara Geothermal Field</b>													
THV01	Otumuheke	Protected (Patuiki Marginal Strip) and unprotected private land	c.2.3	Part National/part Local	This site contains sizeable populations of two 'At Risk' species: <i>Cyclosorus interruptus</i> , and <i>Christella</i> aff. <i>dentata</i> ("thermal"). Other species present include <i>Nephrolepis flexuosa</i> and <i>Hypolepis dicksonioides</i> , which are classified 'At Risk'. This site is the best quality example of geothermal wetland surrounding Taupo township and restoration of ecological values at the site would be valuable for educational purposes.	Pest plants	Medium	The site is has already been degraded by surrounding urban land development and pest plants. However, remaining areas of indigenous vegetation are vulnerable to expansion of pest plant infestations.	Pampas and wilding pines should be controlled. Blackberry should be monitored and controlled if it spreads into geothermal areas.	High	High	Vegetation clearance has occurred near the stream mouth since 2009, included the destruction of a large portion of the <i>Nephrolepis flexuosa</i> population and a few plants of <i>Christella</i> aff. <i>dentata</i> ("thermal"). An additional geothermal stream near the Spa Hotel was recorded in 2010. In previous surveys, this area was under thick blackberry and thus was not visible. Flooding has caused dieback of blackberry on stream margins and has probably washed away some ferns recorded in earlier surveys. This flooding may provide new habitat for re-establishment of 'At Risk' fern species. Pines have also been removed from gully walls, particularly in the upper stream gully (work undertaken by Waikato Regional Council). The Council has undertaken some control of pampas at this site.	Care should be taken with any removal of pest plants to protect populations of threatened species in this area including <i>Nephrolepis flexuosa</i> , <i>Christella</i> aff. <i>dentata</i> ("thermal"), <i>Hypolepis dicksonioides</i> , and <i>Cyclosorus interruptus</i> .
						Pest animals	Unknown	No evidence of adverse effects caused by pest animals were observed at the site.	No action required.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
THV03	Spa Thermal Park	Unprotected private land	c.0.1	Local	Spa Thermal Park comprises a small area of degraded geothermal vegetation but it includes a small population of prostrate kanuka, an 'At Risk' species.	Pest plants	High	As this site appears to have cooled, exotic pest plants have spread into the site.	Control wilding pines, broom, blackberry and gorse. Not a priority for management.	Lower	Lower	Site appears similar to 2004. Site slightly larger than mapped in 2004, which is mostly related to remapping on better quality aerial photographs, rather than any real change.	
						Pest animals	Lower	Pest animals may be present, but site is not a priority for management.	No action required.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
THV04	Broadlands Road	Protected (Broadlands Road Geothermal)	c.29.8	Regional	This site contains a large area of good quality	Pest plants	High	Invasive exotic species include blackberry, wilding pines, and	Wilding pines should be controlled. Blackberry, gorse,	Medium	Medium		

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		Scenic Reserve) and unprotected private land			prostrate kanuka (an 'At Risk' species) scrub and shrubland. It also comprises a relatively large area of geothermal habitat - a nationally uncommon vegetation type.			occasional broom. The continued spread of pest plants has the potential to alter the indigenous character of the site.	and broom should be monitored and controlled if they spread into geothermal areas.				
						Pest animals	Low	Pest animals may be present at the site, but the type of vegetation present is not a priority for management.	No action required.	Lower	Lower		
						Domestic stock	Low	A very small proportion of the site is grazed.	Most of the site has been fenced to exclude stock. However small areas to the east of the reserve are accessible to stock. Existing fences should be checked and maintained.	Lower	Lower		
THV05	Crown Park	Protected (Taupo District Council Reserve)	c.0.7	Local	This small site includes a small area of prostrate kanuka shrubland. Prostrate kanuka is an 'At Risk' species.	Pest plants	High	The site is threatened by the continued spread of exotic pest plants into the site. e.g. blackberry, wilding pines.	Control of pest plants has greatly enhanced the viability of this site. Ongoing control of pest plants, including blackberry, wilding pines, flowering cherry, eucalyptus, and pampas is recommended.	Lower	Lower	This site was not inspected during the current study. In 2008 Waikato Regional Council has undertaken pest plant control at this site, particularly the removal of large exotic pines surrounding the site. Follow-up control of broom and pine seedlings has been undertaken. Rubbish has also been removed from the site by Council.	
					Pest animals	Unknown	No pest animals were noted, but may be present in low numbers.	No action required.	Lower	Lower			
					Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A			
THV06	Crown Road	Unprotected private land	c.17.5	Regional	This site contains a relatively large example of shrublands of the 'At Risk' prostrate kanuka. It also contains a small population of the 'At Risk' <i>Dicranopteris linearis</i> . Although degraded in habitat by the spread of pest plants and ongoing grazing by stock the site comprises a relatively large area of vegetation influenced by geothermal activity - a nationally uncommon habitat.	Pest plants	High	The most abundant pest plants at the site are broom and blackberry. Chinese privet, wilding pines, and buddleia are also present. This site is vulnerable to further pest plant invasion because of continual disturbance, particularly in the south-western area (motocross track and neighbouring industrial area).	If control measures are undertaken to reduce pest plants the ecological values of the site are likely to improve markedly. If areas are fenced to exclude stock they will need to be regularly monitored to detect and control pest plant invasions.	High	High	Approximately 1.5 ha of geothermal vegetation has been cleared since 2004. The loss was due, in part, to road construction and development of an industrial subdivision. Prostrate kanuka shrubland is still recovering after a fire in 2002. Parts of the western side of the new highway are now fenced to exclude stock. Recently Waikato Regional Council has commenced work to control wilding pines and broom on lands adjoining the new highway.	Activities that have caused clearance of geothermal vegetation include a motorcross track, development of an industrial area, and construction of a highway that bisects the site. Parts have also been affected by fire.
					Pest animals	Lower	Pest animals are present at the site: rabbits were observed.	Pest animal control may enhance the ecological values of the site.	Lower	Lower			
					Domestic stock	Medium	Domestic stock have access to parts of the site, where they have damaged indigenous geothermal vegetation by trampling and grazing.	Fencing to exclude domestic stock would greatly improve the ecological values of the site.	High	High			
THV07	Waipahihi Valley	Protected (Waipahihi Stream Conservation Area) and unprotected private land.	c.0.3	Regional	This site contains small populations of three 'At Risk' species: prostrate kanuka, <i>Cyclosorus interruptus</i> , and <i>Hypolepis dicksonioides</i> .	Pest plants	High	<i>Cyclosorus interruptus</i> is potentially vulnerable to invasion of pest plants. The geothermal spring is fenced and surrounds are planted with exotic trees including olive, wilding pines, and ornamental cherry. There has been some work to control blackberry. Other pest plants include radiata pine, pampas, and ivy.	A conservative approach should be taken to controlling pest plants, to minimize the risks associated with sudden exposure of <i>Cyclosorus interruptus</i> to summer heat or winter frosts.	High	High	Pest plant control has reduced the blackberry infestation below the spring area. Sinter and adjoining geothermal vegetation has been damaged following earthworks at the site by neighbouring landowner. Waikato Regional Council has undertaken some limited pest plant control at this site.	Control of pest plants should be carried out in a manner that does not threaten the small populations of the threatened fern species present.
					Pest animals	Lower	Pest animals are likely to be present.	Pest animal control may enhance the ecological values of the site.	Lower	Lower			
					Domestic stock	No threat	There is grazing to the north of this site.	No action required.	N/A	N/A			
WKV01	Te Rautehuia	Unprotected private land	c.7.7	Regional	This site is a relatively large example of geothermal vegetation and contains populations of three 'At Risk' species: <i>Nephrolepis flexuosa</i> , <i>Dicranopteris linearis</i> and prostrate kanuka.	Pest plants	Medium	The spread of pest plants, particularly wilding pines, threatens to alter the indigenous character of the site.	Removal of wilding pines which are a key threat to the site.	High	Medium	Radiata pine and maritime pine continue to invade naturally occurring geothermal vegetation, particularly prostrate kanuka scrub and shrubland. Deer are within the fenced prostrate kanuka shrubland with tracks and signs of trampling throughout. Blackberry is scattered through parts of the prostrate kanuka	Consult landowner regarding management of geothermal features at this site, in conjunction with site WKV02 (Te Rautehuia Stream).
					Pest animals	Lower	The site is not highly vulnerable to pest animals compared to impacts of domestic stock.	Pest animal control may enhance the ecological values of the site if/when stock have been excluded.	Lower	Lower			
					Domestic stock	Medium	Stock (e.g. deer) have access to parts of the site, including parts that are fenced, and have caused significant damage to geothermal	Discuss with the landowner the desirability of excluding stock from fenced geothermal vegetation.	High	High			

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								vegetation and have reduced the ability of geothermal vegetation to establish around geothermal features.	Fence the remaining unfenced areas of geothermal vegetation.			shrubland.	
WKV02	Te Rautehuia Stream	Unprotected private land, Wairakei Tourist Park, Riparian Marginal Strip	c.2.1	Regional	This site comprises several geothermal areas surrounded by riparian margins, farmland and plantation forest. It contains a population of <i>Nephrolepis flexuosa</i> and a moderate-sized population of prostrate kanuka. Both species are classified as 'At Risk'.	Pest plants	Medium	Wilding pines and blackberry are occasionally present but have the potential to spread further into geothermal vegetation and features and reduce the indigenous character of the site.	Control of wilding pines and blackberry. Monitoring will be required if/when stock are excluded.	High	High	Mixed fernland on the walls of the geothermal crater (NZTM E1867136 N5721902) appears to have been removed by natural geothermal activity (recorded in Wildland Consultants 2004). This is now predominantly nonvegetated raw soilfield with prostrate kanuka, manuka, mingimingi, blackberry, broom, <i>Lycopodiella cernua</i> , and bracken scattered around the margins.	Consult the landowner regarding management issues at this site in conjunction with site WKV01 (Te Rautehuia).
						Pest animals	Lower	The site is not highly vulnerable to pest animals because it is being trampled and grazed by domestic stock.	Pest animal control may enhance the ecological values of the site if/when stock have been excluded.	Lower	Lower		
						Domestic stock	High	The western part of this site is grazed and stock (e.g. deer) are causing significant vegetation disturbance and trampling and reducing the ability of geothermal vegetation to establish around geothermal features.	Construct fences to exclude domestic stock.	High	Immediate		
WKV03	Upper Wairakei Stream (Geyser Valley)	Protected (Wairakei Thermal Park)	c.4.7	Regional	This site contains populations of three 'At Risk' species: <i>Nephrolepis flexuosa</i> , prostrate kanuka and <i>Dicranopteris linearis</i> .	Pest plants	High	The site is already highly degraded by pest plants, but remaining areas of indigenous geothermal vegetation are vulnerable to invasion.	Pest plant control is required, including Tasmanian blackwood, wilding pines, false acacia, grape vine, pampas, tradescantia, heather, and Spanish heath.	High	High	It appears that some minor weed control has occurred on the track margins but the grape infestation has spread further into the site than the area surveyed in 2004. False acacia is present in the prostrate kanuka-mingimingi scrub on the south side of the geothermal stream.	
						Pest animals	Lower	The indigenous vegetation and geothermal features are less vulnerable to the pest animals than pest plant threats to the site.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
WKV04	Wairakei Borefield	Unprotected private land	< 0.1	Local	Wairakei Borefield comprises two small patches of prostrate kanuka surrounded by an industrial site. Prostrate kanuka is an 'At Risk' species.	Pest plants	Medium	Broom and gorse are present but the site, and regular disturbance associated with operation of the surrounding industry may provide further sites for weed establishment.	Control gorse and broom and minimise site disturbance, however this site is a low priority compared with other geothermal sites.	Lower	Lower	Not assessed in Wildland Consultants (2006b).	
						Pest animals	Unknown	No pest animals were observed at this site.	No action required.	N/A	N/A		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
WKV05	Te Kiri O Hine Kai Stream Catchment/Wairoa Hill	Unprotected private land	c.40.3	Regional	Although somewhat degraded in quality, this site comprises a relatively large area of geothermal vegetation - a nationally uncommon vegetation type. It contains populations of the following 'At Risk' species: <i>Nephrolepis flexuosa</i> , prostrate kanuka and <i>Dicranopteris linearis</i> . Some areas of prostrate kanuka have relatively few pest plants present, compared with some other geothermal sites.	Pest plants	Medium - High	As a whole the site is moderately vulnerable to pest plants. However, the cooler margins are more vulnerable to pest plant invasions than areas where soil temperature is higher. Pest plants include wilding pines, blackberry, pampas, and Spanish heath.	Control of wilding pines that are currently at relatively low densities in warmer parts of the site, is a high priority. Monitoring and control of pines and blackberry on the margins is a medium priority.	High	High	Radiata pine growth has seen mingimingi scrub (recorded in 2007) at the southern end of the site change to (exotic pine)/mingimingi-kanuka scrub. In the middle of this site, an area recorded as prostrate kanuka-mingimingi scrub in 2007 is now classed as radiata pine/mingimingi forest.	
						Pest animals	Lower	Pest animals, particularly possums are likely to be present.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
WKV06	Lower Wairakei Stream	Unprotected private land	<0.1	Regional	This site provides a small degraded areas of habitat for an 'At Risk' species, <i>Christella</i> aff. <i>dentata</i> ("thermal"). <i>Hypolepis dicksonioides</i> (also 'At Risk') has been recorded in the past.	Pest plants	Medium	This site is already in a poor ecological condition and pest plants are common including blackberry, Himalayan honeysuckle, Japanese honeysuckle, gorse, buddleia, and pampas. However, the population of <i>Christella</i> aff. <i>dentata</i> ("thermal") remains moderately vulnerable to any expansion of these infestations.	Monitor the population of <i>Christella</i> aff. <i>dentata</i> ("thermal") and control any pest plant infestations that may threaten it.	Medium	Medium	Not assessed. Any changes are not likely to be significant.	
						Pest animals	Unknown	No pest animals were observed at this site.	No action required.	N/A	N/A		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		



Site Number	Site Name	Tenure	Size (ha)	Significance Level	Key Values of the Site	Threats/Fencing	Vulnerability	Description of Threats	Action Required	Ecological Benefit	Priority	Ecological Change and Management Since Previous Assessment (Wildland Consultants 2006b)	Comments
WKV07	Karapiti Forest	Unprotected private land	c.0.6	Local	This small site contains populations of two 'At Risk' species: prostrate kanuka and <i>Dicranopteris linearis</i> .	Pest plants	Medium	The site is surrounded by pine forest, with a small infestation of wilding pines. Himalayan honeysuckle, pampas, and blackberry are also present but are mainly confined to the margins of the geothermal area. Management is a lower priority than other larger geothermal sites.	Control wilding pine and pampas in geothermal vegetation.	Lower	Lower	Not field surveyed in current study. Appears similar on 2007 aerial photographs to 2004 assessment.	
						Pest animals	Unknown	No pest animals were observed at this site.	No action required.	N/A	N/A		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
WKV08	Hall of Fame Stream	Protected (Huka Falls Scenic Reserve)	c.0.1	Regional	This small geothermal site contains a very small population of the 'At Risk' <i>Christella</i> aff. <i>dentata</i> ("thermal").	Pest plants	Medium	The blackberry and Himalayan honeysuckle around stream margins have probably reduced the extent of habitat available to <i>Christella</i> aff. <i>dentata</i> ("thermal").	Control blackberry downstream from the hot springs.	Lower	Lower	This site was not inspected for the current study but is unlikely to have had any management since the previous assessment.	
						Pest animals	Lower	The site is highly modified and is not very vulnerable to further modification by pest animals.	Pest animal control may enhance the ecological values of the site, but this is a low priority compared with other geothermal sites.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
WKV09	Waipouwerawera Stream/Tukairangi	Protected (Waipouwerawera Stream Conservation Area)	c.0.1	Local	Waipouwerawera Stream/Tukairangi is a small area of geothermal vegetation in a degraded state - however geothermal vegetation is a rare vegetation type nationally. It contains a small population of an 'At Risk' species: prostrate kanuka. <i>Dicranopteris linearis</i> has been recorded from the site in the past.	Pest plants	Medium	Pest plants have spread at the site, possibly as a response to a decline in geothermal activity. This has the potential to continue, however this site is a low priority for management compared with other larger geothermal sites.	Wilding pines, blackberry, and broom should be controlled.	Lower	Lower	An expansion of vegetation cover in the crater and a reduction in nonvegetated raw-soilfield suggests that the site has experienced reduced geothermal activity and that soil temperatures have decreased.	
						Pest animals	Lower	The site is highly modified and is not very vulnerable to further modification by pest animals.	No action required.	N/A	N/A		
						Domestic stock	Lower	The area is fully fenced and stock do not have access to this site.	No action required.	N/A	N/A		
WKV10	Craters of the Moon	Protected (Ministry of Tourism Reserve)	c.44.6	National	This site is a relatively large, good quality example of geothermal habitat and contains one of the best examples of thermotolerant vegetation zonation in response to soil temperature. Four 'At Risk' species are present: <i>Nephrolepis flexuosa</i> , prostrate kanuka, <i>Dicranopteris linearis</i> , and <i>Hypolepis dicksonioides</i> .	Pest plants	High	Pest plants occur at the site in low abundance (following recent management of pest plants), but have the potential to spread and to alter the indigenous character of the site.	Control of small infestations of wilding pines (mostly radiata pines and maritime pines) and pampas. Control eucalypts, privet, tree lucerne, buffalo grass, paspalum, blackberry, broom, and Spanish heath if/when they spread into additional geothermal areas. Control should be undertaken in a manner that minimises damage to populations of 'At Risk' plant species at the site.	High	High	Some management of pest plants has been undertaken by site managers. Techniques to discourage use of informal tracks have been implemented by the Craters of the Moon Trust.  In March 2011, Waikato Regional Council funded the control of pampas by aerial application of herbicide at this site.	Some control of pest plants has been undertaken.
						Pest animals	Lower	Pigs, deer and possums are likely to damage and have negative effects on the regeneration of the geothermal vegetation present. Rabbits and hares are also present.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
<b>Rotokawa Geothermal Field</b>													
RKV01	Rotokawa North	Protected (Lake Rotokawa Conservation Area) and unprotected private land	c.34.3	Regional	An 'At Risk' species (prostrate kanuka) covers extensive parts of this site. A few plants of <i>Nephrolepis flexuosa</i> and <i>Dicranopteris linearis</i> (also 'At Risk' species) were recorded from the site in 2004.	Pest plants	High	Wilding pines are visually dominant, and are a serious threat to plant communities on cooler geothermal ground by shading prostrate kanuka scrub and shrubland. In some areas pines are dominant over a lower indigenous tier comprising prostrate kanuka and mingimingi. Other invasive exotic plants present include broom, Himalayan honeysuckle, buddleia, pasture grasses and	Wilding pines should be controlled.	High	High	The changes to extent and boundaries mapped are based on better site information rather than real changes in the total extent of geothermal vegetation at the site.	

Site Number	Site Name	Tenure	Size (ha)	Significance Level	Key Values of the Site	Threats/ Fencing	Vulnerability	Description of Threats	Action Required	Ecological Benefit	Priority	Ecological Change and Management Since Previous Assessment (Wildland Consultants 2006b)	Comments
						Pest animals	Unknown	blackberry. Pest animals were not observed at this site in 2004, but are likely to be present, causing an impact on the vegetation present (e.g. pigs and deer).	Monitor and implement control as required.	Lower	Lower		
						Domestic stock	Lower	Stock have access to small parts of the site. Trampling can damage the geothermal vegetation.	Areas where stock have access should be <b>fenced</b> .	Medium	Medium		
RKV02	Lake Rotokawa	Protected (Lake Rotokawa Conservation Area) and unprotected private land	c.69.3	National	An 'At Risk' species, prostrate kanuka, covers extensive parts of this site. It also supports a relatively large population of <i>Calochilus robertsonii</i> , an 'At Risk' species of orchid. While the vegetation is degraded in quality it comprises one of the largest areas of geothermal habitat - a nationally uncommon habitat type. North Island fernbird and pied stilt (both classed as 'At Risk') and banded dotterel (classed as 'threatened') are present.	Pest plants	Medium	The site is already highly modified by pest plants but wilding pines are a serious threat to indigenous plant communities present, particularly on cooler geothermal ground or where prostrate kanuka scrub may be subjected to shading.	Exotic pines are visually dominant and should be controlled.	High	High	The quality of vegetation has improved over time as it re-establishes after a history of mining and road construction throughout this site. Pine and other pest plant control has improved the indigenous character of this site in recent years.	Extensive control of wilding pines and other pest plants has been undertaken by DOC, but a high density remains in some places.
						Pest animals	Unknown	Pest animals were not observed at this site in 2004, but are likely to be impacting the vegetation present, e.g. pigs and deer.	Monitor, and control as required.	Medium	Medium		
						Domestic stock	No threat	The site is fenced and neither stock nor stock damage was observed.	Ensure <b>fences</b> are maintained.	N/A	N/A		
<b>Tokaanu-Waihi-Hipaua Geothermal Field</b>													
TOV02	Hipaua	Unprotected private land	c.11.3	Regional	Hipaua is a relatively large area of geothermal habitat. It is an important habitat for an 'At Risk' species (prostrate kanuka). It is the only substantial example of prostrate kanuka in the Tongariro Ecological District. The vegetation is highly intact and displays good zonation. It is part of an extensive natural area extending from the shores of Lake Taupo to the summits of Kakaramea, Tihia and Pihanga.	Pest plants	Lower	The site is largely undisturbed by human activity and surrounded by indigenous vegetation. There appears to be some pampas on photographs provided by Environment Waikato.	Pest plant surveillance and follow-up control as required.	High	Immediate	Change in site boundaries is primarily based on improved 2007 aerial photographs.	Access to this site was not granted, so the assessment has been compiled from existing literature, digital aerial photographs (1993) and a visual inspection from SH 41. A field survey would identify management requirements for this site, which should be considered a high priority for this site if access is granted by the landowners.
						Pest animals	Unknown	Unknown. Not field surveyed recently. Pigs and deer are likely to be present.	Survey site to assess impacts.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to the site.	No action required.	N/A	N/A		
TOV03/TOV04/TOV05/TOV06	Tokaanu Lakeshore Wetland	Unprotected private land and Protected (Tokaanu Recreation Reserve)	c.42.4	National	Tokaanu Lakeshore Wetland is an extensive area of raupo reedland on the shore of Lake Taupo. One 'Threatened' and two 'At Risk' bird species have been recorded in this wetland: New Zealand dabchick, spotless crane, and North Island fernbird. Australasian bittern (Threatened-Nationally Critical) is present in the area. No threatened or at risk plant species are known from the site.	Pest plants	Lower	Pest plants are relatively rare in most of this site, with willow species (crack willow and grey willow) noted.	Grey willow and crack willow should be controlled.	Medium	Medium	Not assessed. No significant change is known to have taken place in this wetland in the last ten years.	
						Pest animals	Lower	Pest animals are unlikely to be a significant threat to this wetland.	No action required.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to the site.	No action required.	N/A	N/A		
TOV07	Maunganamu West	Protected (Tokaanu Public Garden Reserve) and unprotected private land	c.0.6	Regional	Maunganamu West is a small part of an extensive ecological sequence that extends from the shores of Lake Taupo to the summits of Kakaramea, Tihia and Pihanga. The wetland vegetation is likely to provide habitat for fernbird and spotless crane (both classed as 'At Risk'). No threatened or at risk plant	Pest plants	Medium	The main wetland is generally free of pest plants, although pest plants are present on margins and occasional crack willow is present in the wetland. This species, in particular, has the potential to spread further at this site. Other species present include blackberry and Japanese honeysuckle.	Crack willow should be controlled and the site should be monitored for other pest plants.	Lower	Lower	Not assessed in Wildland Consultants (2006b).	
						Pest animals	Lower	Pest animals are unlikely to be a threat to this wetland.	Pest animal control may enhance the ecological values of the site.	Lower	Lower		

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					species are known from the site.	Domestic stock	No threat	This site is not grazed by stock.	No action required.	N/A	N/A		
TOV08	Tokaanu Thermal Park	Protected (Tokaanu Thermal Park Recreation Reserve administered by DOC) unprotected private land	c.7.6	Part Regional/part Local	The site contains populations of three species ranked as 'At Risk' ( <i>Korthalsella salicornioides</i> , prostrate kanuka, and <i>Schizaea dichotoma</i> ). One other 'At Risk' species ( <i>Christella aff. dentata</i> ("thermal")) has been recorded in the past, but is now probably extinct at this site. This site is also part of an extensive natural area extending from the shores of Lake Taupo to the summits of Kakaramea, Tihia and Pihanga and including Lake Rotopounamu and Lake Rotoaira.	Pest plants	High	Pest plants such as Japanese honeysuckle, ivy, exotic grasses, grey willow, and bamboo threaten the indigenous character of this high profile geothermal site. The tracks are a potential invasion site.	Control the pest plant species at the site and exotic ornamental trees. Avoid planting inappropriate species at the site.	High	Immediate	Any changes to the boundary of geothermal vegetation are likely to be minor. Additional areas were added to this site in 2007, based on additional information on geothermal vegetation. However, this does not represent real change. The site was not been reassessed in the field in 2010-2011.	
					Pest animals	Lower	Pest animals are likely to be present, e.g. pigs and deer.	Pest animal control may enhance the ecological values of the site.	Lower	Lower			
					Domestic stock	No threat	Stock do not have access to the site.	No action required.	N/A	N/A			
TOV09	Tokaanu Urupa Mud Pools	Protected (Tokaanu Hot-Springs Reserve)	<0.1	Regional	Tokaanu Urupa Mud Pools is a small part of an extensive ecological sequence that extends from the shores of Lake Taupo to the summits of Kakaramea, Tihia and Pihanga. The ecological sequence includes extensive areas of geothermal habitat. Vegetation at the site comprises kanuka-dominated forest and no 'Threatened' or 'At Risk' species have been recorded.	Pest plants	Lower	The site is surrounded by indigenous vegetation and is in excellent condition. There is only scattered blackberry but it has the potential to spread further.	The site should be monitored, and pest plants should be controlled if they establish or if the blackberry spreads.	Lower	Lower	Not assessed in Wildland Consultants (2006b).	
					Pest animals	Lower	No pest animal impacts noted in 2007.	No action required.	N/A	N/A			
					Domestic stock	Lower	Horses have been taken to the site, but there were no signs of horse grazing in the area when surveyed in 2007.	No action required.	N/A	N/A			
TOV10	Maunganamu East	Unprotected private land	<0.1	Local	Maunganamu East is a very small example of geothermal habitat, a nationally uncommon habitat type. The site comprises a small area of geothermal wetland.	Pest plants	Medium	Creeping bent is abundant. Blackberry, Japanese honeysuckle, and crack willow are present.	Pest plant control may enhance the ecological values of the site.	Lower	Lower	Not assessed in Wildland Consultants (2006b).	
					Pest animals	Unknown	No pest impacts were noted.	No action required.	N/A	N/A			
					Domestic stock	No threat	Stock do not have access to the site.	No action required.	N/A	N/A			
TOV11	Maunganamu North Wetland	Protected (Tokaanu Thermal Park Recreation Reserve) and unprotected private land	<0.9	Local	Maunganamu North Wetland is a small example of a nationally uncommon habitat type. No 'Threatened' or 'At Risk' species were noted during the 2007 but it is likely to provide habitat for wetland bird species, including spotless crane ('At Risk-Relict').	Pest plants	Medium	Crack willow was common in wetland.	The ecological value of the site would be improved if crack willow was controlled.	Lower	Lower	Not assessed in Wildland Consultants (2006b).	
					Pest animals	Unknown	A full site inspection has not been undertaken but pest animals are unlikely to be a notable threat to this site.	No action required.	N/A	N/A			
					Domestic stock	Medium	The site is not fenced and stock graze to its edges in 2007.	Fence the site to exclude stock.	Lower	Lower			
TOV14	Tokaanu Tailrace Canal	Unprotected private land	<0.1	Local	Tokaanu Tailrace Canal is a small geothermal site that occurs alongside an artificial tailrace canal.	Pest plants	Lower	Crack willow is common and has the potential to spread further.	Crack willow control would improve site values, but other geothermal sites are a higher priority for ecological restoration.	Lower	Lower	Not assessed in Wildland Consultants (2006b).	
					Pest animals	Unknown	No pest animal impacts were noted.	No action required.	N/A	N/A			
					Domestic stock	No threat	The site is not grazed by stock.	No action required.	N/A	N/A			
<b>Tongariro Geothermal Field</b>													
TGV01	Te Maari Craters	Protected (Tongariro National Park)	c.4.9	International	Te Maari Crater is within Tongariro National Park. It has remained largely undisturbed since a series	Pest plants	Lower	Pest plants are very unlikely to invade the existing geothermal vegetation, which is well-buffered by Tongariro National Park.	Monitor for pest plants at five-yearly intervals.	N/A	N/A	Not assessed in Wildland Consultants (2006b).	

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					of eruptions in the 1800s. It is a good quality example of geothermal habitat - a nationally uncommon habitat type.	Pest animals	Lower	Hares and deer may graze the site.	Introduced mammals should be managed as part of the ongoing management of Tongariro National Park.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
TGV02	Ketetahi	Unprotected private land	c.8.2	National	Ketetahi Hot Springs is a very good quality example of a nationally uncommon habitat type - geothermal habitat. It is also one of series of geothermal features that extend into the surrounding Tongariro National Park.	Pest plants	Unknown	The site is largely unvegetated and pest plants are not likely to invade.	Monitor for pest plants at five-yearly intervals.	N/A	N/A	Not assessed in Wildland Consultants (2006b).	
						Pest animals	Lower	Hares and deer may graze the site.	Introduced mammals should be monitored and controlled.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
TGV03	Emerald Lakes	Protected (Tongariro National Park)	c.11.3	International	Emerald Lakes comprises three crater lakes on Mount Tongariro and are surrounded by a good quality example of geothermal habitat - a nationally uncommon habitat type.	Pest plants	No threat	Pest plants are very unlikely to invade the existing geothermal vegetation, which is well-buffered by Tongariro National Park. A small population of <i>Juncus bulbosus</i> was present in the northernmost lake.	Monitor for pest plants at five-yearly intervals.	N/A	N/A	Not assessed in Wildland Consultants (2006b).	
						Pest animals	Lower	Hares and deer may graze the site.	Introduced mammals should be managed as part of the ongoing management of Tongariro National Park.	Lower	Lower		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		
TGV04	Red Crater	Protected (Tongariro National Park)	c.0.7	International	This site contains geothermal habitat - a naturally rare habitat type.	Pest plants	No threat	Pest plants are very unlikely to invade the existing geothermal vegetation, which is well-buffered by Tongariro National Park.	Monitor for pest plants at five-yearly intervals.	N/A	N/A	Not assessed in Wildland Consultants (2006b).	
						Pest animals	Lower		No action required.	N/A	N/A		
						Domestic stock	No threat	Stock do not have access to this site.	No action required.	N/A	N/A		

LIST OF SITE WHERE NO FIELD WORK WAS  
UNDERTAKEN SINCE 2007

Site No.	Name
HHV01	Horohoro
WTV01	Maungaongaonga
WTV02	Ngapouri
TKV01	Te Kopia
OKV04	Red Hills
RPV01	Longview Road
WKV07	Karapiti Forest
WKV08	Hall of Fame Stream
WKV10	Craters of the Moon <sup>1</sup>
RKV01	Rotokawa North
RKV02	Lake Rotokawa
TOV02	Hipaua
TGV02	Ketitahi



Call Free 0508 WILDNZ  
Ph: +64 7 343 9017  
Fax: +64 7 3439018  
ecology@wildlands.co.nz

99 Sala Street  
PO Box 7137, Te Ngae  
Rotorua 3042,  
New Zealand

Regional Offices located in  
Auckland, Hamilton, Tauranga,  
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