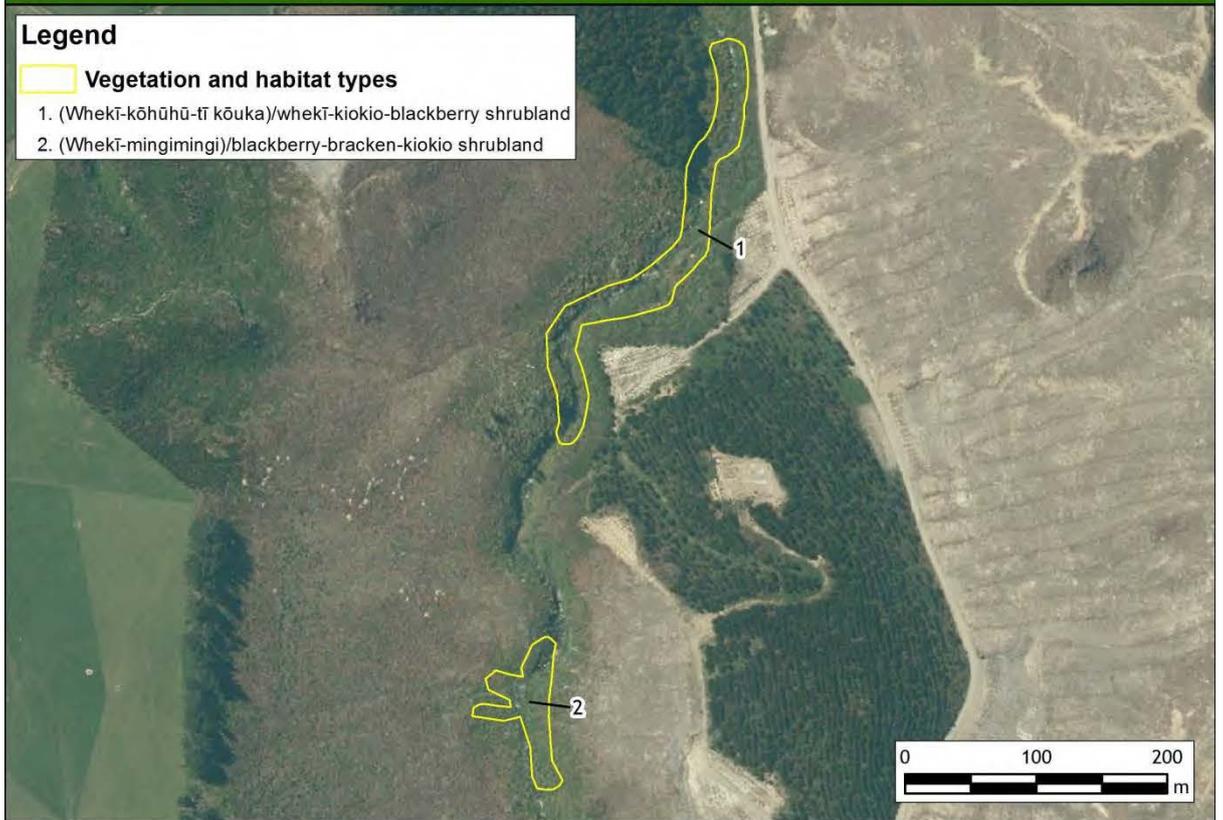


Legend

Vegetation and habitat types

1. (Whekī-kōhūhū-tī kōuka)/whekī-kiokio-blackberry shrubland
2. (Whekī-mingimīngi)/blackberry-bracken-kiokio shrubland



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Report: 3330
 Client: WRC
 Ref: 01 1459
 Path: \2013-2014\mxd\Figures
 File: Waipapa_Stream.mxd

Waipapa Stream

Wildlands
 www.wildlands.co.nz, 0508 WILDNZ

Scale: 1:5,000
 Date: 30/09/2014
 Cartographer: RPB
 Format: A4

WAIPAPA STREAM GEOTHERMAL SITE

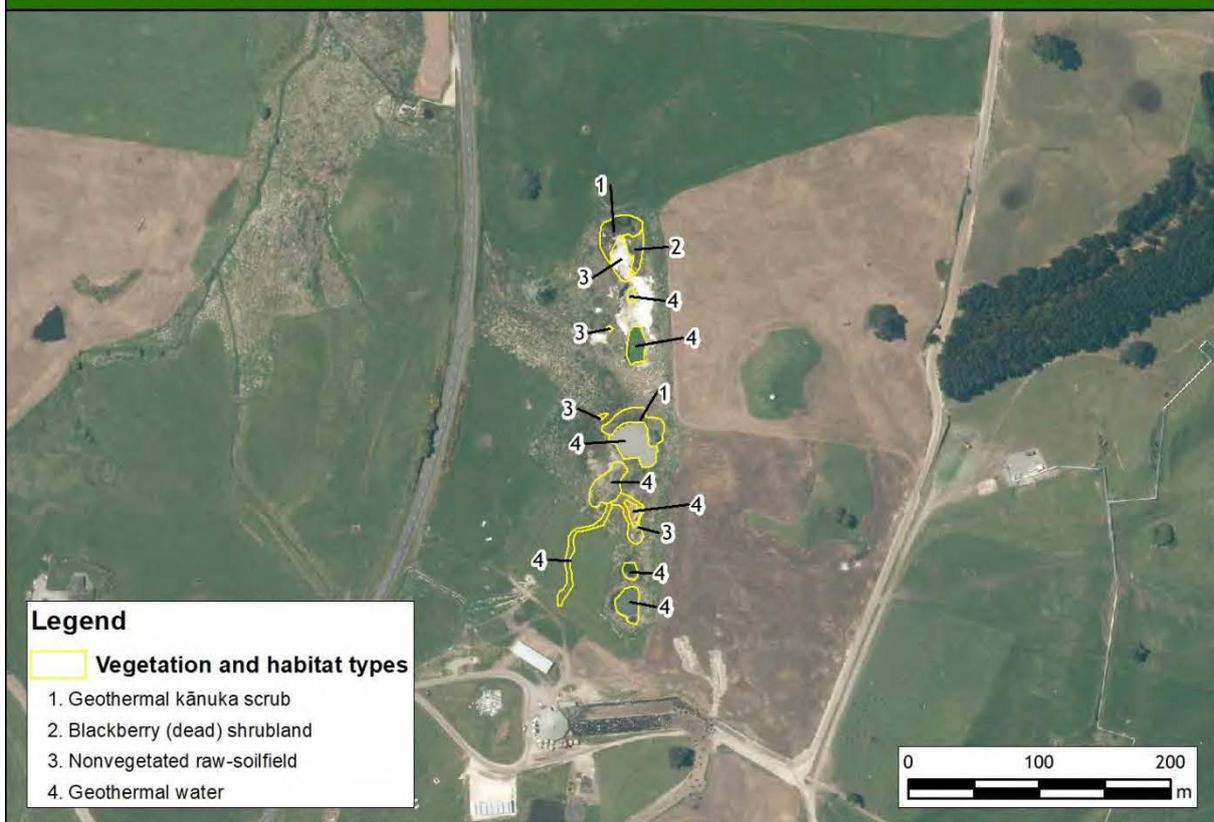
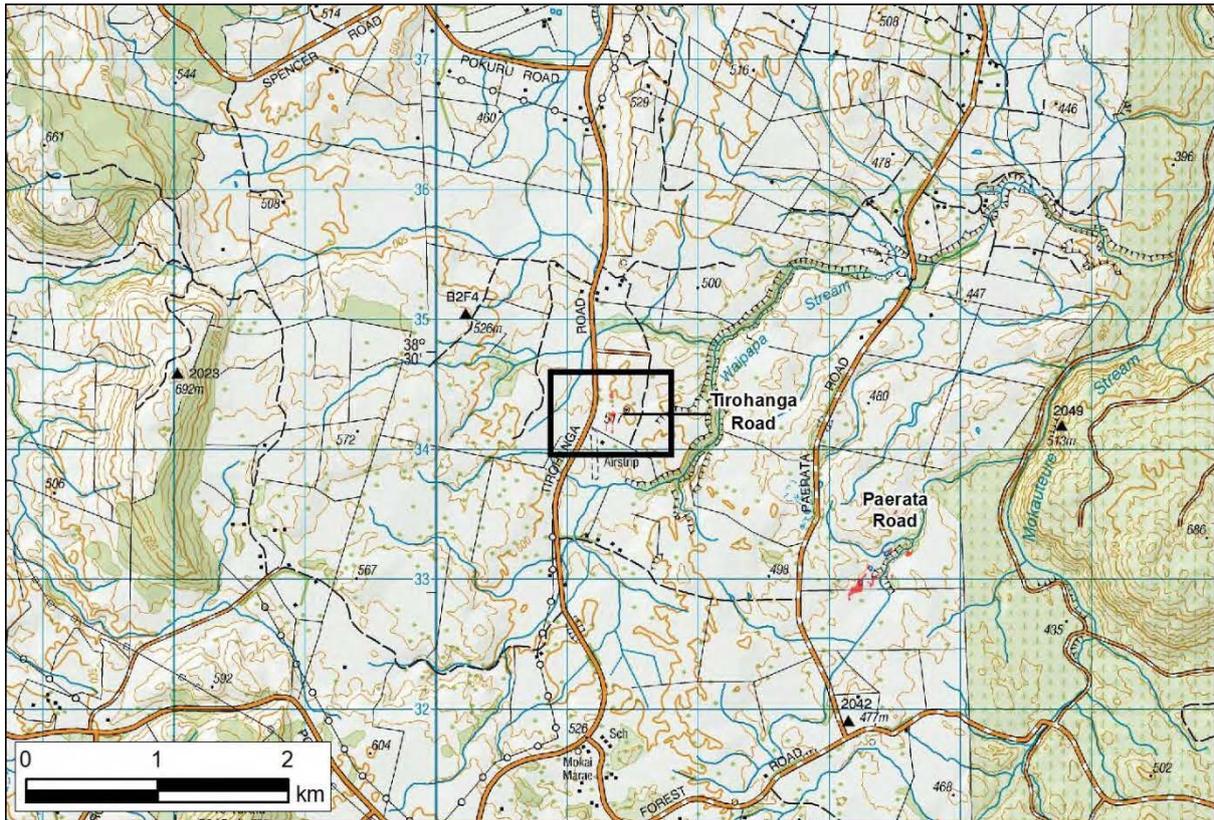
Area:	Geothermal Habitat: c.1.2 ha Geothermal Vegetation: c.1.2 ha
Geothermal Field:	Mokai
Site Description:	<p>Waipapa Stream is a series of springs and seepages located on Waipapa Stream between Lake Whakamaru and Lake Taupō, on unprotected private land. The site is surrounded by indigenous riparian vegetation and plantation forestry. Geothermal features include hot springs and seepages, creating heated tributary streams and a small heated pool. Parts of the sites are nationally significant (Wildland Consultants 2014a) due to the presence of one of the largest populations of <i>Christella</i> aff. <i>dentata</i> (“thermal”) (At Risk-Naturally Uncommon) in New Zealand and a small example of geothermal stream habitat. The dominant vegetation is mixed indigenous and exotic shrubland, comprising mostly whekī (<i>Dicksonia squarrosa</i>), kōhūhū (<i>Pittosporum tenuifolium</i>), tī kōuka (<i>Cordyline australis</i>), mingimingi (<i>Leucopogon fasciculatus</i>), and blackberry (<i>Rubus fruticosus</i> agg.), and is mostly surrounded by pine plantation. The Waipapa Stream site occurs within the Mokai Geothermal Field, and this resource has been utilised for electricity generation. The best parts of the site are of national significance (Wildland Consultants 2014a).</p>
Ecosystem Services:	<p>The site supports a range of ecosystem services, including regulation and maintenance and cultural values. Wilding pines have been controlled at the site, and some of these may have been utilised for energy (e.g. firewood) and other economic gains. The small size of the site means that provisioning and regulating services are limited. The site provides regulation and maintenance services of bioremediation in wetland habitat and riparian vegetation (unknown value). The vegetation provides mass stabilisation and control of erosion rates, and sequestration of carbon and potentially other climate change gases. The energy generation (a provisioning service) of the Mokai Geothermal Field is outside the scope of this project, as it is not extracted from the surface features of this site.</p> <p>Minor cultural services are present. The site is located on private land, within plantation forest, and thus is seldom visited by the public especially as the site is not suitable for bathing. A vehicle track has been constructed in the past to some of the features. A small area of rock art of ancient Māori style but which is known to be of recent origin (Robin Black, pers. Comm) is known by one spring. The ecological values of the site have been enhanced by control of wilding pines at the site, showing the value of the features present to the owners and the community at large. The site is of scientific interest, with 196 scientific publications on the site found through Google Scholar.</p> <p>The ecosystem services have only been assessed in this report for the unique geothermal part of the site; the stream will have values over and above these and should also be assessed.</p>



One of the largest geothermal springs at Waipapa Stream. *Christella* aff. *dentata* (“thermal”) is scattered in vegetation on the spring margin. (March 2011)



Geothermal springs are scattered over several 100 metres of stream bed and stream margins at this site. (March 2011)



- Legend**
- Vegetation and habitat types**
1. Geothermal kānuka scrub
 2. Blackberry (dead) shrubland
 3. Nonvegetated raw-soilfield
 4. Geothermal water

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Report: 4363
 Client: WRC
 Ref: 01 1769
 Path: E:\gis\EW_Geothermal_Sites_2003\2017\mxd\June 2017\
 File: Tirohanga_Road.mxd

Tirohanga Road

Wildlands
 www.wildlands.co.nz, 0508 WILDNZ

Scale: 1:5,000
 Date: 28/02/2018
 Cartographer: JO
 Format: A4

TIROHANGA ROAD

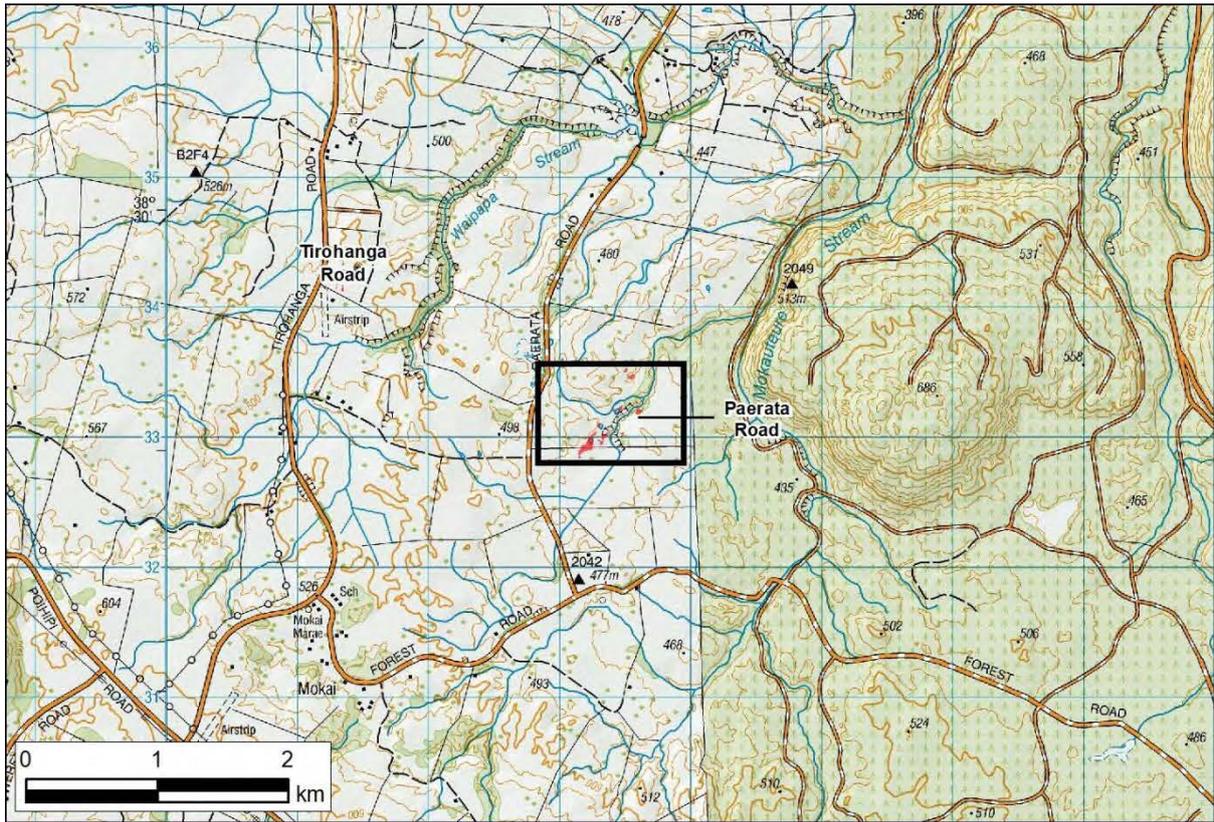
Area:	Geothermal Habitat: c.0.5 ha Geothermal Vegetation: c.0.2 ha
Geothermal Field:	Mokai
Site Description:	The Tirohanga Road site, near Mokai (between Lake Whakamaru and Lake Taupō), comprises geothermal pools, heated soil, vents and mud pools. It is of local significance for its ecological values (Wildland Consultants 2014a) as it contains nationally uncommon habitat types (geothermally heated dry soils and fumaroles), and provides habitat for a small population of geothermal kānuka (At Risk-Naturally Uncommon). Much of the vegetation is dominated by exotic species with abundant rank grasses and blackberry common, with scattered areas of indigenous vegetation. The geothermal resource around the site has been utilised for energy generation. The site is surrounded by farmland and is on unprotected private land. The site has been fenced relatively recently to exclude stock, and there is potential for habitat quality to improve. The site contained a lot of rubbish in the past, but this has gradually been removed. The Tirohanga Road site occurs within the Mokai Geothermal Field, and this resource has been utilised for electricity generation.
Ecosystem Services:	Ecosystem services at this site are limited due to the small size of the site and lack of geothermal vegetation providing limited provisioning, regulating and maintenance services. The vegetation provides a limited amount of sequestration of carbon (47.6 tC per annum) and potentially other climate change gases. Cultural services are also limited as the site is on private land within a dairy farm.



A geothermal pool with geothermal algae at Tirohanga Road. (March 2011)

A geothermal pool at Tirohanga Road with several patches of indigenous fernland (bracken and *Histiopteris incisa*) and scattered geothermal kānuka. At the time the photograph was taken, stock had access to some geothermal features at the site. (February 2007)





Legend

Vegetation and habitat types

- 1. Mānuka scrub
- 2. Geothermal kānuka shrubland
- 3. Nonvegetated raw-soilfield
- 4. Geothermal water



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Report: 4363
 Client: WRC
 Ref: 01 1769
 Path: E:\gis\EW_Geothermal_Sites_2003\2017\mxd\June 2017\
 File: Paerata_Road.mxd

Paerata Road



Scale: 1:6,000
 Date: 28/02/2018
 Cartographer: JO
 Format: A4

PAERATA ROAD

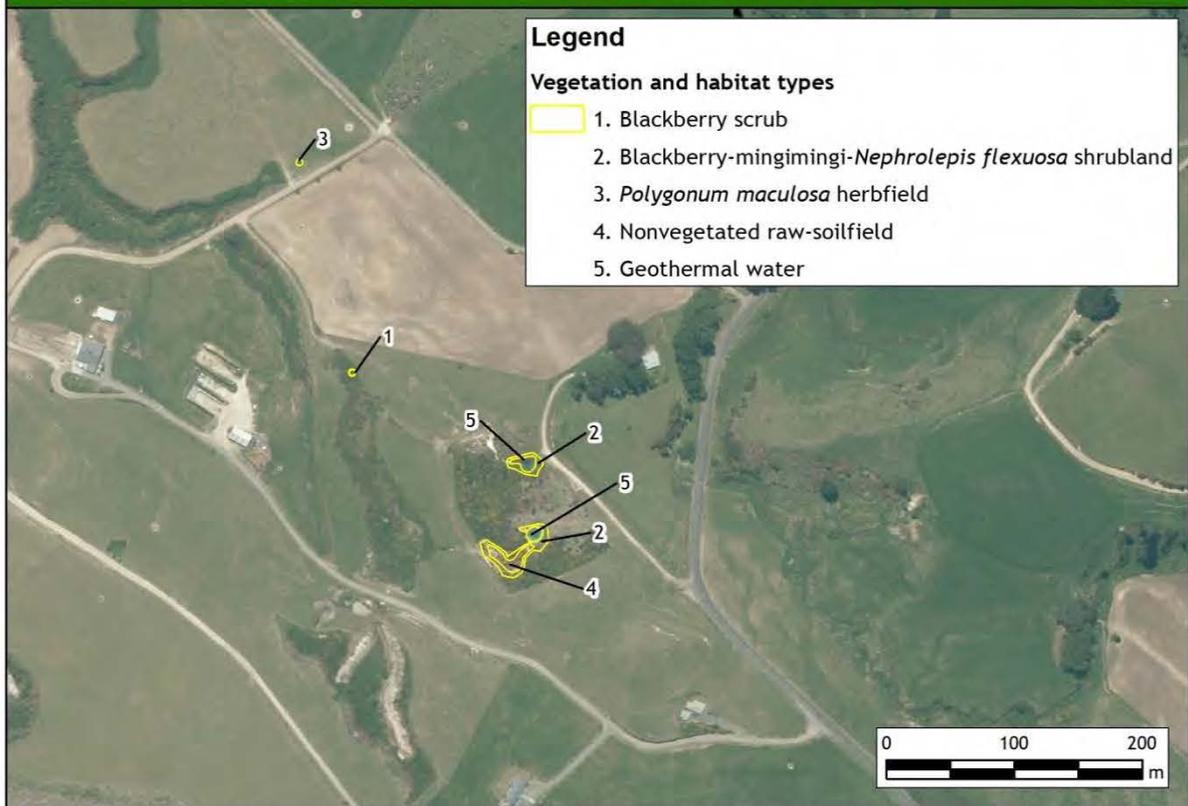
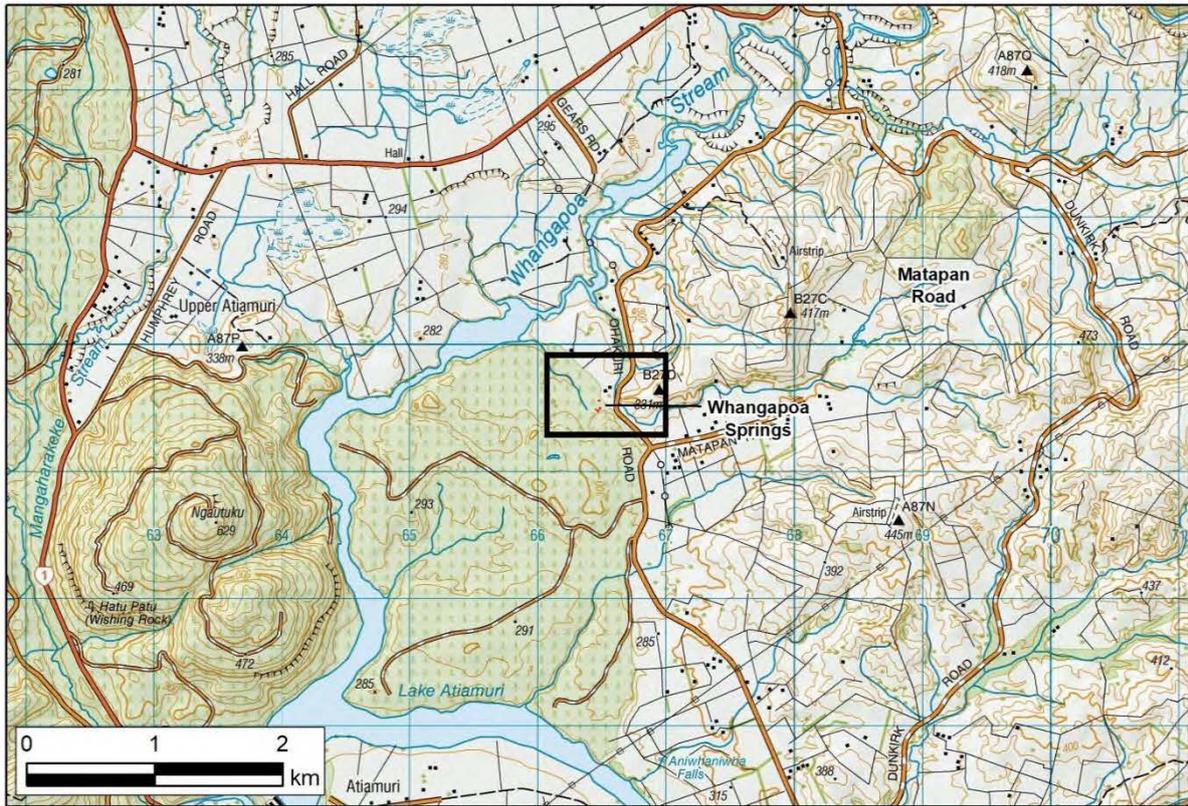
Area:	Geothermal Habitat: c.1.8 ha Geothermal Vegetation: c.1.7 ha
Geothermal Field:	Mokai
Site Description:	The Paerata Road site, near Mokai (between Lake Whakamaru and Lake Taupō), comprises geothermal pools and heated soil. It is of local ecological significance (Wildland Consultants 2014a) as it contains geothermally heated dry soils, a nationally uncommon habitat type, and a small population of geothermal kānuka (At Risk-Naturally Uncommon). The site is on unprotected private land mostly surrounded by farmland and some plantation forest. Most of the site is in poor ecological condition due to pest plant and animal species being present, clearance of indigenous vegetation, grazing by stock, and rubbish dumping, and plantation trees have been planted close to geothermal features. The Paerata Road site occurs within the Mokai Geothermal Field, and this resource has been utilised for electricity generation.
Ecosystem Services:	This small site provides limited ecosystem services that can be quantified, mainly due to its small size and lack of public access. The vegetation is likely to provide mass stabilisation and control of erosion rates, flood protection, and sequestration of carbon (285 tC annually) and potentially other climate change gases. Honey production from mānuka at the site is conservatively estimated to be worth \$320 annually. The site is located on private land and is generally not suitable for swimming, thus there are limited cultural values.



An area of geothermally influenced bare ground with some geothermal kānuka at Paerata Road. This area has not been fenced to exclude stock. (March 2011)



A mud pool at Paerata Road surrounded by geothermal kānuka scrub and some blackberry scrub. (March 2011)



- Legend**
- Vegetation and habitat types**
- 1. Blackberry scrub
 - 2. Blackberry-mingimingi-*Nephrolepis flexuosa* shrubland
 - 3. *Polygonum maculosa* herbfield
 - 4. Nonvegetated raw-soilfield
 - 5. Geothermal water

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Report: 4363
 Client: WRC
 Ref: 01 1769
 Path: E:\gis\EW_Geothermal_Sites_2003\2017\mxd\June2017\
 File: Whangapoa_Springs.mxd

Whangapoa Springs

Wildlands
 www.wildlands.co.nz, 0508 WILDNZ

Scale: 1:5,000
 Date: 23/06/2017
 Cartographer: JO
 Format: A4

WHANGAPOA SPRINGS

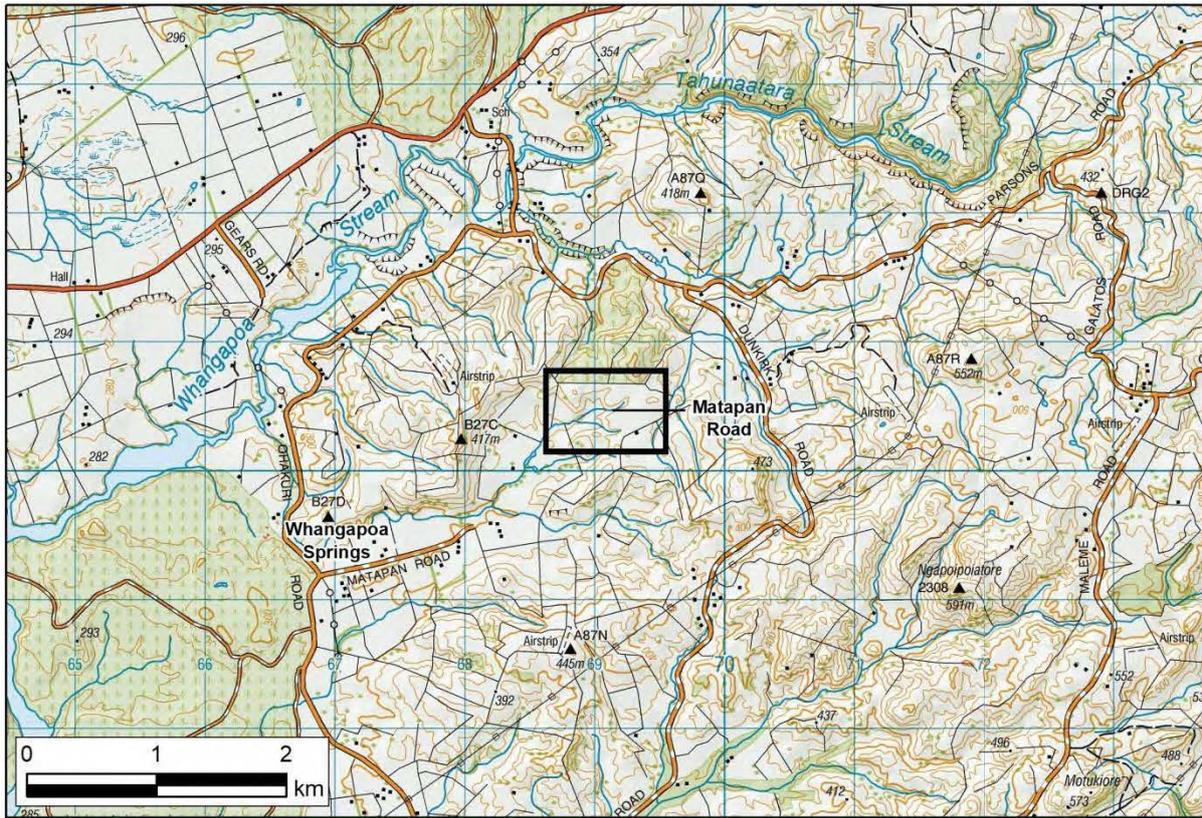
Area:	Geothermal Habitat: c.0.1 ha Geothermal Vegetation: c.0.1 ha
Geothermal Field:	Atiamuri
Site Description:	<p>Whangapoa Springs, north of Lake Atiamuri, consists of geothermal springs and hot pools. The site assessed in this report is an amalgamation of two small sites assessed in Wildland Consultants (2014a): Upper Atiamuri West and Whangapoa Springs. The land tenure is a mix of protected (Whangapoa Springs Scientific Reserve – 35% of total land area) and unprotected private land. The best parts of the site are of regional significance (Wildland Consultants 2014a) because of their geothermal features and the fact that they are protected as a scientific reserve. There are also small populations of two At Risk species present: geothermal kānuka (At Risk-Naturally Uncommon) and <i>Nephrolepis flexuosa</i> (At Risk-Declining). The site is occasionally visited by locals and adjacent landowners and has been utilised for cooking and bathing in the past, although this may no longer be occurring.</p> <p>Most of the value of this site lies in the geothermal features themselves which have been ranked as being of high value, and led to the classification of the reserve as scientific reserve under the Reserves Act.</p>
Ecosystem Services:	This very small site is generally only visited by the local community and adjacent landowners, despite the aesthetic values of the largest pools. Therefore cultural services associated with this site are few, although Wildlands (2014a) notes that there was a small wooden platform extending into a pool in 2004 which was used for cooking food, but this has now been removed. A bath is also present at another pool (Wildland Consultants 2014a). Scientific studies have been undertaken at this site, with 241 results from a Google Scholar search of titles. Regulating and provisioning services are relatively minor at this site due to its small size and lack of vegetation.



The largest pool at Whangapoa Springs has a deep blue colour and sinter deposits, and a small population of geothermal kānuka is present on its margins. (February 2011)



The second largest pool at Whangapoa springs has a small population of the At Risk *Nephrolepis flexuosa*. (February 2007)



Legend

Vegetation and habitat types

1. *Deparia* fernland
2. Yorkshire fog grassland

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Report: 4363
 Client: WRC
 Ref: 01 1769
 Path: E:\gts\EW_Geothermal_Sites_2003\2017\mxd\June2017
 File: Matapan_Road.mxd

Matapan Road

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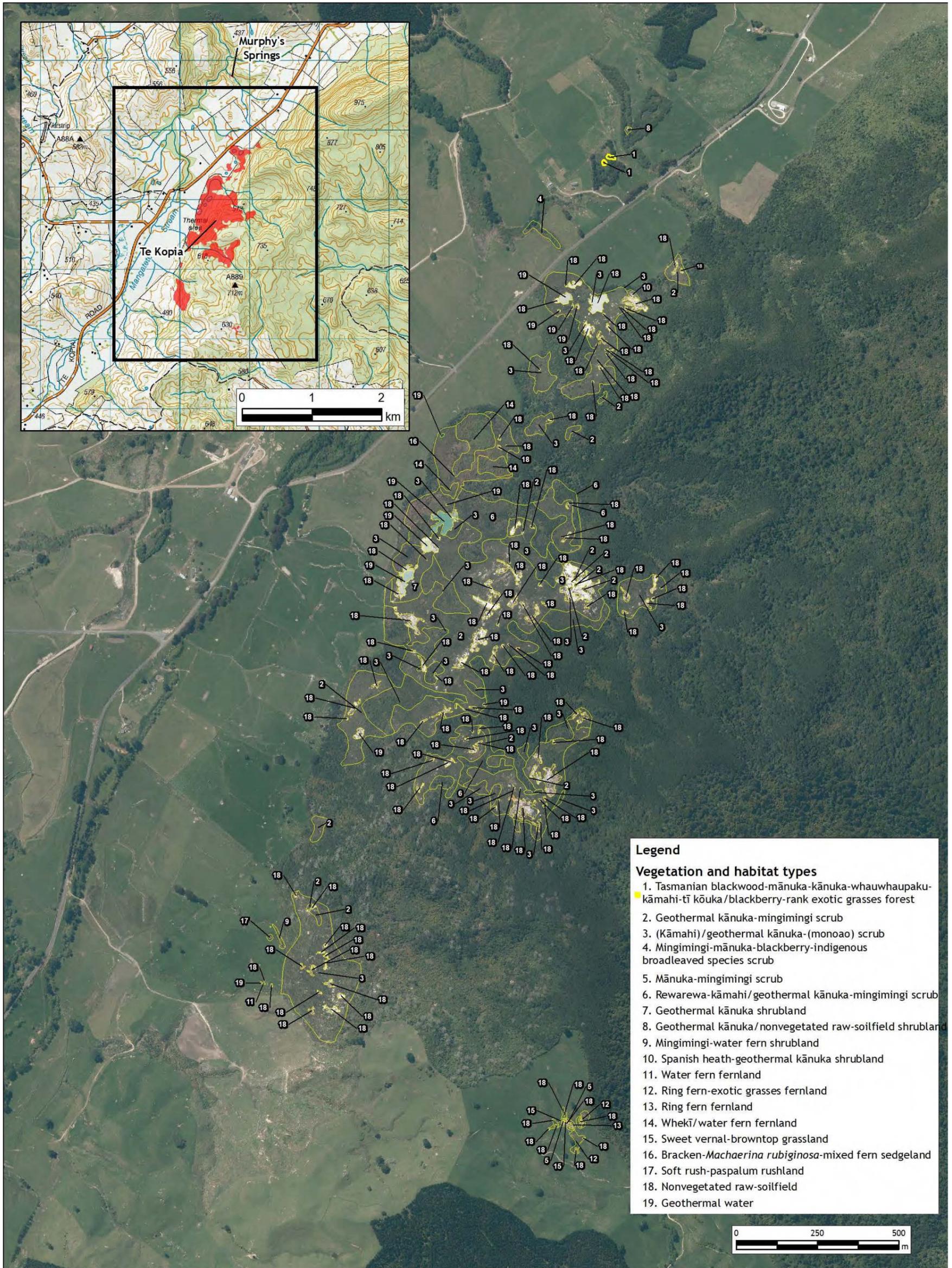
Scale: 1:5,000
 Date: 22/06/2017
 Cartographer: JO
 Format: A4

MATAPAN ROAD

Area:	Geothermal Habitat: <0.1 ha Geothermal Vegetation: <0.1 ha
Geothermal Field:	Atiamuri
Site Description:	Matapan Road, north of Lake Atiamuri, consists of a small geothermal spring, on unprotected private land. It comprises a very small example of geothermal vegetation and habitat (geothermal stream sides), a nationally uncommon habitat type. The site is unfenced and the margins are grazed. There are no At Risk species present. The site is on private land.
Ecosystem Services:	The site is on private land, and visitors are probably restricted to landowners. The geothermal habitat and vegetation have an intrinsic value, but due to its very small size its ecosystem services are difficult to assess. For the purposes of the ecosystem services study, very small sites such as this one should be assessed as part of other sites to create a larger area for assessment or removed from the study and assigned a generic value, based on size.



A geothermal spring and geothermal stream sides at Matapan Road. Some indigenous fern species are present, e.g. *Deparia petersenii*. The site is surrounded by farmland. (February 2011)



- Legend**
- Vegetation and habitat types**
- 1. Tasmanian blackwood-mānuka-kānuka-whauwhaupaku-kāmahi-tī kōuka/blackberry-rank exotic grasses forest
 - 2. Geothermal kānuka-mingimīngi scrub
 - 3. (Kāmahi)/geothermal kānuka-(monoao) scrub
 - 4. Mingimīngi-mānuka-blackberry-indigenous broadleaved species scrub
 - 5. Mānuka-mingimīngi scrub
 - 6. Rewarewa-kāmahi/geothermal kānuka-mingimīngi scrub
 - 7. Geothermal kānuka shrubland
 - 8. Geothermal kānuka/nonvegetated raw-soilfield shrubland
 - 9. Mingimīngi-water fern shrubland
 - 10. Spanish heath-geothermal kānuka shrubland
 - 11. Water fern fernland
 - 12. Ring fern-exotic grasses fernland
 - 13. Ring fern fernland
 - 14. Whekī/water fern fernland
 - 15. Sweet vernal-browntop grassland
 - 16. Bracken-*Machaerina rubiginosa*-mixed fern sedgeland
 - 17. Soft rush-paspalum rushland
 - 18. Nonvegetated raw-soilfield
 - 19. Geothermal water

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 Report: 4363
 Client: WRC
 Ref: 01 1769
 Path: E:\GIS\EW_Geothermal_Sites_2003\2017\mxd\June2017\
 File: Te_Kopia.mxd

Te Kopia

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 Scale: 1:10,749
 Date: 28/02/2018
 Cartographer: JO
 Format: A3

TE KOPIA

Area:	Geothermal Habitat: c.65.9 ha Geothermal Vegetation: c.65.1 ha
Geothermal Field:	Te Kopia
Site Description:	<p>The site assessed in this report is an amalgamation of three sites assessed in Wildland Consultants (2014a): Te Kopia, Western Te Kopia, and Mangamingi Station.</p> <p>The Te Kopia site has a high diversity of landscapes backing onto the Paeroa Range and Te Kopia Valley. Geothermal features comprise heated soils, fumaroles, mud pools, hot springs, and thermally altered clay, mud and sinter. Most of the site is of international significance for its ecological values (Wildland Consultants 2014a). It forms the best quality example of geothermal vegetation in New Zealand, and is relatively large. It is part of an ecological sequence extending from geothermal vegetation through to tall forest, including a small geothermal wetland area.</p> <p>Te Kopia has high biodiversity and geodiversity values. One of the largest populations of <i>Dicranopteris linearis</i> (At Risk-Naturally Uncommon) in New Zealand occurs here. This site also contains one of the largest populations of geothermal kānuka (At Risk-Naturally Uncommon), as well as good populations of four other ‘At Risk’ species (<i>Nephrolepis flexuosa</i>, <i>Calochilus paludosus</i>, <i>C. robertsonii</i>, and <i>Korthalsella salicornioides</i>). Work has been undertaken to control wilding pines and other pest plants and pest animals, along with fencing to protect the site from stock, which has enhanced the biodiversity values of the site. The geothermal vegetation here is virtually unchanged since 1948 (Burns 1996), and is the most intact remaining example of natural vegetation zonation (extending over c.579 metres in altitude) that includes geothermal vegetation, ranging from tall kamahi-dominant forest through to geothermal kānuka shrubland and geothermal wetland.</p> <p>The geothermal features are an attraction and are of considerable scientific interest with 18 landforms units listed in Cody (2007) including five of national importance.</p>
Ecosystem Services:	<p>Provisioning services present include potential honey production (valued conservatively at \$800 annually), and nutrition resources from hunting. The site provides regulation and maintenance services of bioremediation in wetland habitat and riparian vegetation (unknown value). The vegetation provides mass stabilisation and control of erosion rates, flood protection, and sequestration of carbon (12,828 tC annually) and potentially other climate change gases.</p> <p>The site provides a number of cultural services and is free to access by the public. A short walking track with a boardwalk has improved access to the site and includes cultural and geological interpretation and safety signage. However the majority of the site does not include formal walking tracks or safety fences or signs. The site is visible from Te Kopia Road, and provides a strong landscape feature to the area. A bike rack is present to encourage passing cyclists to utilise the new walking track. There are plans for the cycle route “Te Ara Ahi - Thermal by Bike” (which is part of the “Nga Harenga - New Zealand Trail” network of bike tracks) to follow Te Kopia Road alongside this site. The site has been very well studied,</p>

with 434 scientific publications found through a Google Scholar search. University and botanical groups are known to visit the site for educational purposes.

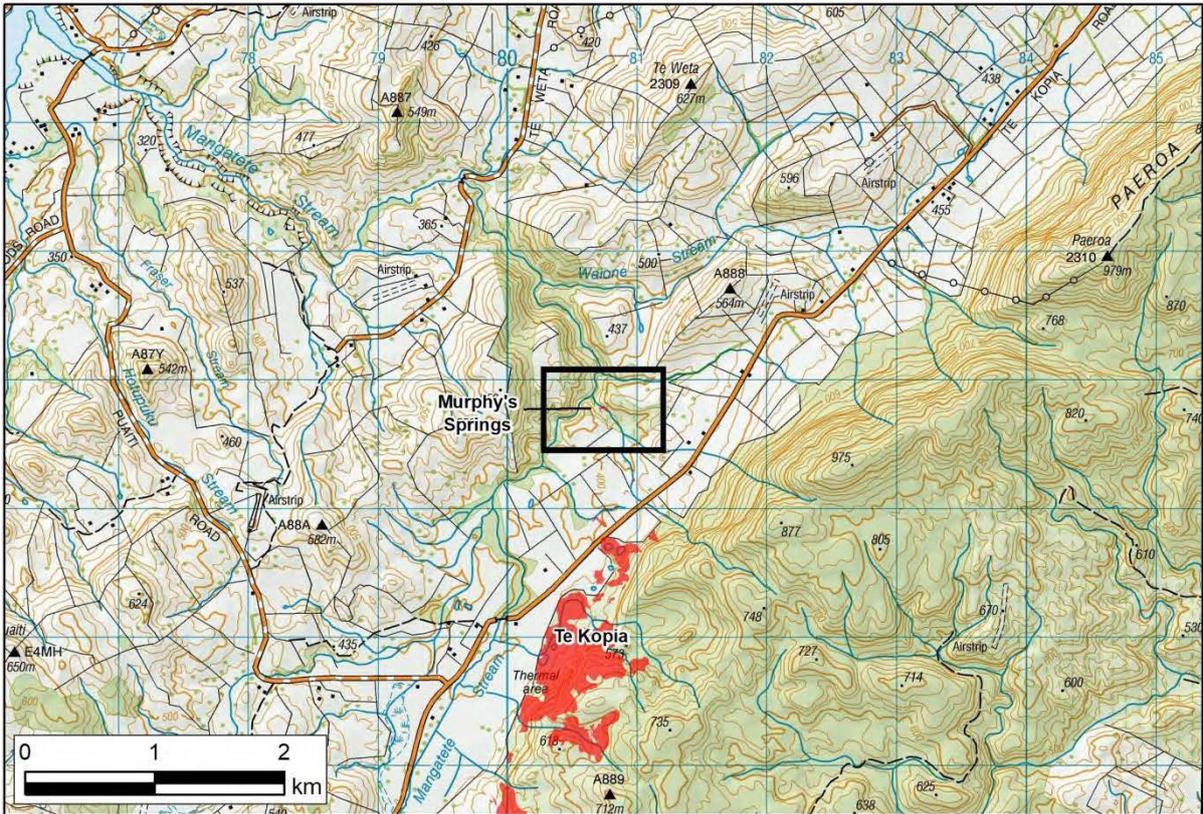


A boardwalk and viewing platform has recently been constructed at Te Kopia Scenic Reserve, with interpretation and health and safety signage. (August 2018)

A high diversity of vegetation and habitats are present at Te Kopia, including forest, geothermal scrub, ponds, wetlands, fumaroles and mud pools. (May 2014)



A large part of Te Kopia is covered in geothermal kānuka and other indigenous shrub species. Wilding pines have recently been controlled on slopes in the background of this photograph. (May 2014)



Legend

- Vegetation and habitat types**
- 1. Mixed indigenous shrubs/mixed fern species shrubland

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Report: 4363
 Client: WRC
 Ref: 01 1769
 Path: E:\gis\EW_Geothermal_Sites_2003\2017\mxd\June2017
 File: Murphy's_Springs.mxd

Murphy's Springs

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Scale: 1:5,000
 Date: 19/06/2017
 Cartographer: JO
 Format: A4

MURPHY’S SPRINGS

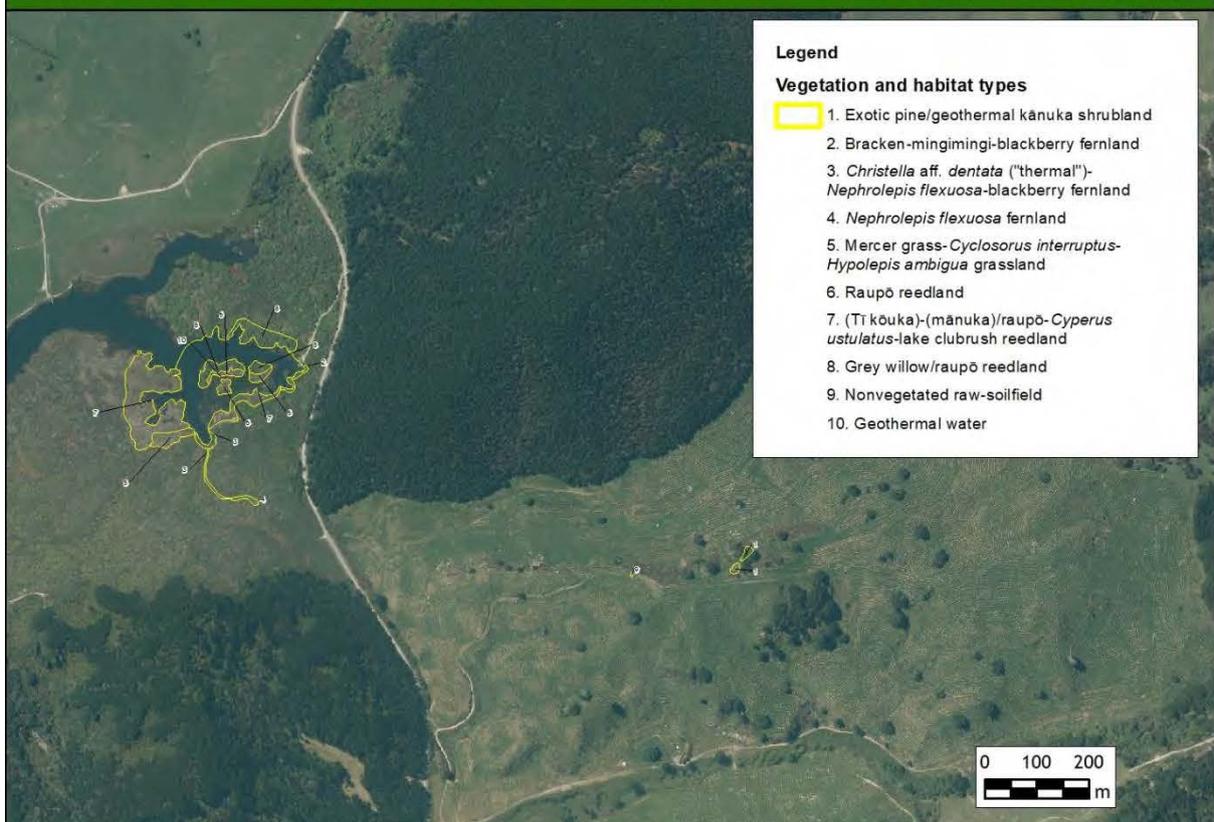
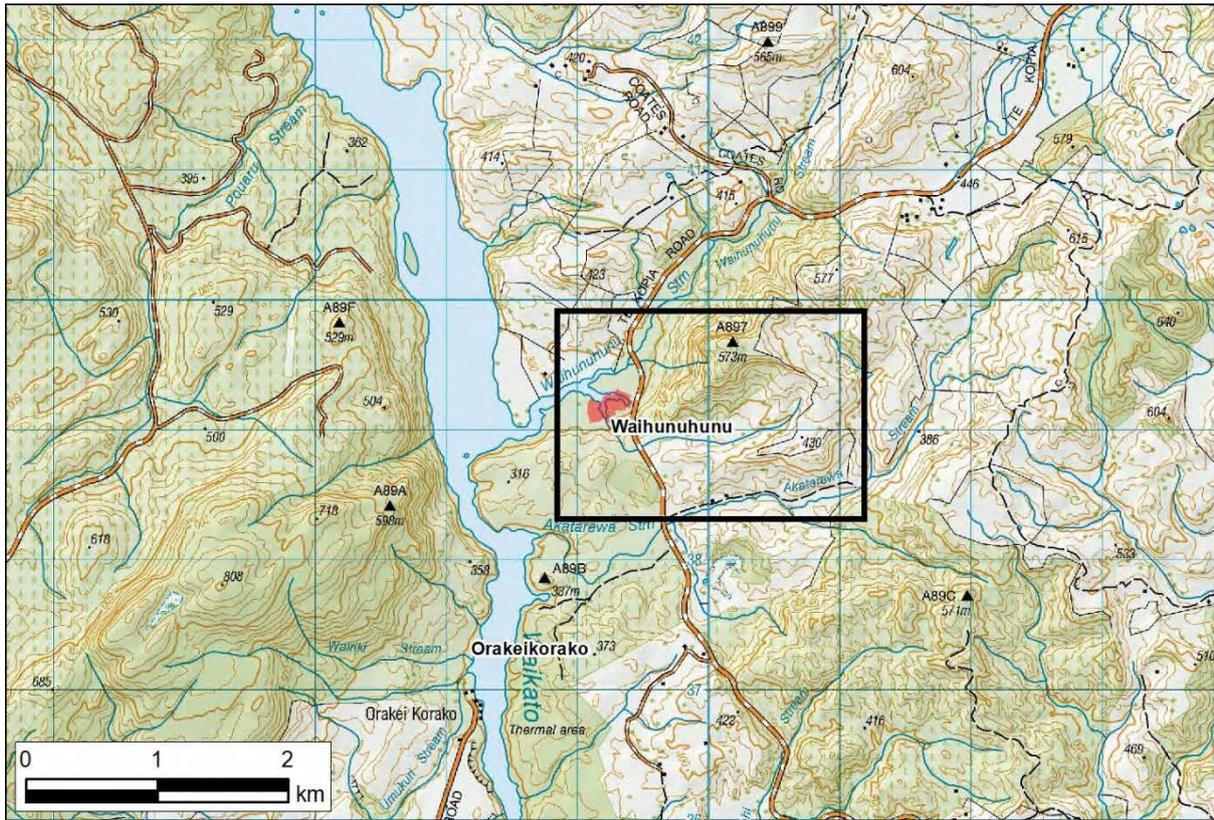
Area:	Geothermal Habitat: c.0.2 ha Geothermal Vegetation: c.0.2 ha
Geothermal Field:	Te Kopia
Site Description:	Murphy’s Springs is on unprotected private land and comprises geothermal springs and geothermal stream margins. Parts of the site are of regional and local significance for their ecological values (Wildlands 2014a). The site contains a population of an At Risk species, <i>Christella</i> aff. <i>dentata</i> (“thermal”). The adjoining land use is plantation forest, mixed indigenous and exotic scrub and pasture. During a survey in June 2010, parts of the site were in a poor ecological condition due to stock access and the presence of pest plants and animals. The geothermal features are of some scientific interest with three features listed in Cody (2007).
Ecosystem Services:	This site is very small and therefore provides limited biodiversity, geophysical, and cultural ecosystem services. Cultural services are limited as the site is on private land and it cannot be viewed from anywhere nearby (features are surrounded by pine plantation). Access to the site is restricted to landowners and workers.



A gully with geothermal springs flowing into a stream at Murphy’s Springs. (June 2010)



The geothermal Murphy’s Springs provide habitat for the At Risk fern *Christella* aff. *dentata* (“thermal”). (June 2010)



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Report: 4363
 Client: WRC
 Ref: 01 1769
 Path: E:\gis\EW_Geothermal_Sites_2003\2017\mxd\June 2017\
 File: Waihunuhunu.mxd

Waihunuhunu

Wildlands
 www.wildlands.co.nz, 0508 WILDNZ

Scale: 1:12,683
 Date: 28/02/2018
 Cartographer: JO
 Format: A4

WAIHUNUHUNU

Area:	Geothermal Habitat: c.5.5 ha Geothermal Vegetation: c.2.9 ha
Geothermal Field:	Orakeikorako
Site Description:	<p>Waihunuhunu is an amalgamation of two sites assessed in Wildland Consultants (2014a): Waihunuhunu and Akatarewa East.</p> <p>Waihunuhunu is on unprotected private land comprising geothermal streams, fumaroles and hot springs. The smaller Akatarewa East area is surrounded by pasture. The site is of national (Waihunuhunu) and local (Akatarewa East) significance for its ecological values (Wildland Consultants 2014a). The site is a good quality, representative example of geothermal habitat, which includes nationally uncommon ecosystems (geothermal stream margins, lakeshore wetland, and geothermally heated dry soils). The site is mainly in good ecological condition and provides habitat for eight At Risk species: <i>Dicranopteris linearis</i> (At Risk-Naturally Uncommon), <i>Nephrolepis flexuosa</i> (At Risk-Declining), <i>Christella</i> aff. <i>dentata</i> (“thermal”) (At Risk- Naturally Uncommon), <i>Cyclosorus interruptus</i> (At Risk-Declining), <i>Thelypteris confluens</i> (At Risk-Naturally Uncommon), spotless crane (At Risk-Declining), North Island robin (At Risk-Declining), North Island fernbird (At Risk-Declining). However, pest plants and animals are common within the site. Some pools have been used for swimming, and some features have been altered by pool users. A large amount of rubbish was present at the site in a visit in 2017.</p>
Ecosystem Services:	<p>The area may provide nutritional services through fishing and hunting, but no data is present on use. An area of raupō has potential for fibre production. The site provides regulation and maintenance services of bioremediation in wetland habitat and riparian vegetation (unknown value). The vegetation provides mass stabilisation and control of erosion rates, and sequestration of carbon (666.4 tC annually) and potentially other climate change gases.</p> <p>The site provides a number of cultural services, although the extent of these is not well known. The site provides scenic values from Te Kopia Road, and from Lake Ohakuri (boating and fishing). The site is visited for bathing with an estimate 1,700 visitors per year (Barns and Luketina 2011). The amount of rubbish at the site in 2017 indicates that use is quite high, and this is having a negative effect on the site.</p>



A relatively large population of the At Risk *Nephrolepis flexuosa* is present at Waihunuhunu. (March 2007)



The upper end of Waihunuhunu Inlet is often used by visitors for bathing, and is locally known as Paradise. (February 2014)



Glass bottles present at the side of the bathing area are a detriment to the Waihunuhunu site. (August 2017)