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Geothermal features annual monitoring report: January 2015

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Prepared by:
Claire Littler

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

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Peer reviewed by:
Katherine Luketina Date July 2015

Approved for release by:
Dominique Noiton Date July 2015

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Acknowledgement

We are appreciative of the owners and operators of the tourism facilities, land owners, and the Department of Conservation for allowing us access to monitor the geothermal features. I would also like to acknowledge Neil Berry, Macky Horotini, Katie Noakes and Olivia Petrie for their assistance in the field. Thank you.

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Executive summary

The Resource Management Act 1991 (RMA) requires that regional councils sustainably manage geothermal resources. Geothermal surface features are an important part of the geothermal resource and some cases are outstanding natural features to be protected from inappropriate use and development (RMA s6(b)). Throughout the region, most geothermal features and ecosystems are adversely affected to a greater or lesser degree by geothermal resource use or uses of land and water. Section 35(1) and (2a) of the RMA require the regional council to gather information and undertake or commission research to monitor the state of the environment as necessary to carry out its functions. Waikato Regional Council monitors the natural state of the geothermal resource and assesses what changes of state have occurred or are occurring.

This report describes the results of the quarterly monitoring schedule for the 2014 to 2015 year on the state of geothermal features throughout the region.

Uses of the quarterly and annual monitoring reports include:

- Providing Waikato Regional Council and other researchers with long-term information on the natural range of heat and mass outputs of geothermal features
- Identifying significant changes in the behaviour of features that could be precursors to extreme events such as hydrothermal eruptions
- Identifying departures from the baseline trend of feature activity so that the cause can be investigated
- Identifying unintended human-induced adverse effects on springs (e.g. litter blowing into them, road runoff, pines falling in) that can then be remediated
- Similarly, identifying threats to the features that can mitigated before they happen
- Identifying activities that may require enforcement action, such as discharge of contaminants to geothermal pools
- Counting the number of visitors to springs, to aid in quantification of the economic value of the geothermal resource to the Waikato Region.

Remediation work has been completed at Tahunaatapu pool, Whangairorohea. The pool appears to have stabilised.

No major hydrothermal eruptions or other major changes of either natural or human-induced origin were observed in the months April 2014 to January 2015.

1 Introduction

1.1 Background

Monitoring of the geothermal features in the Waikato Region was implemented in 1995. The aim of the monitoring is to observe the natural state of geothermal surface features. Assessments are made on changes that are occurring over time, as well as reporting on any threats or damage to the features. This will allow us to make more informed decisions to protect and enhance the geothermal resources and ecosystems.

1.2 Report Content

Geothermal monitoring is conducted quarterly, with a more extensive range of sites monitored annually. This report covers the monitoring period from April 2014 to January 2015. The specific sites monitored for this report are as follows:

- Golden Springs
- Ngatamariki
- Orakei Korako
- Reporoa
- Rotokawa
- Tauhara
- Te Kopia
- Waikite
- Waiotapu
- Whangairorohea

1.3 Method

Water temperature was measured using a Fluke IR gun along with a 6 m long thermocouple.

GPS co-ordinates gathered during previous site visits have been converted from NZMG to NZTM. Where co-ordinates have not been available, a Garmin GPSmap 60CSx has been used to record locations, with an accuracy of ± 5 m. Each GPS reading was taken in the same spot as the photograph.

pH indicator paper was used to determine pH, Samples were cooled before being tested, to comply with the paper's temperate range.

Where possible, water flow was estimated. The liquid flow or discharge was estimated when assessed to be realistic, i.e. that the entire flow can be seen and seepage or flow diversion is not occurring on a large scale.

The water level was recorded for some features; subject to choosing an easily identified and physically long-lived benchmark in the vicinity, or relative to the overflow level. 'Ebullience' and gas discharge are recorded, also water clarity and colour, and the general condition of the sinter is noted.

For many features, photos in both the visible and infrared spectra are shown. Composite photos of both spectra are used to give a better indication of the location of the hot areas in a feature. The photos were taken using a Mikron Thermal Imaging Camera (Model M7816), which has a temperature range of -40 °C to 500 °C.

2 Golden Springs

2.1 Pools in stream through the Golden Springs Motel

- **North Pool**
  E1888743 N5736981

There were no evident changes and no bathers at 11:06.

Table 1: Data from the North Pool, Golden Springs Motel

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
04 Feb 2014	40.2	7-8	~20	Overflowing	-	Green, cloudy
21 Jan 2015	39.4	7-8	20-30	Overflowing	-	Green, murky

Figure 1: North Pool, Golden Springs Motel in Feb 2014 (A), Jan 2015 (B)

The infrared photos show that the hottest part of the pool appears to be where it flows over the weir. This could be due to the infrared camera only showing the surface temperature, which is cooler than within the pool due to its exposure to air. The water going over the waterfall includes the deeper warmer water mixed with the cooler surface water, so it appears hotter than the surface water above and below the waterfall.

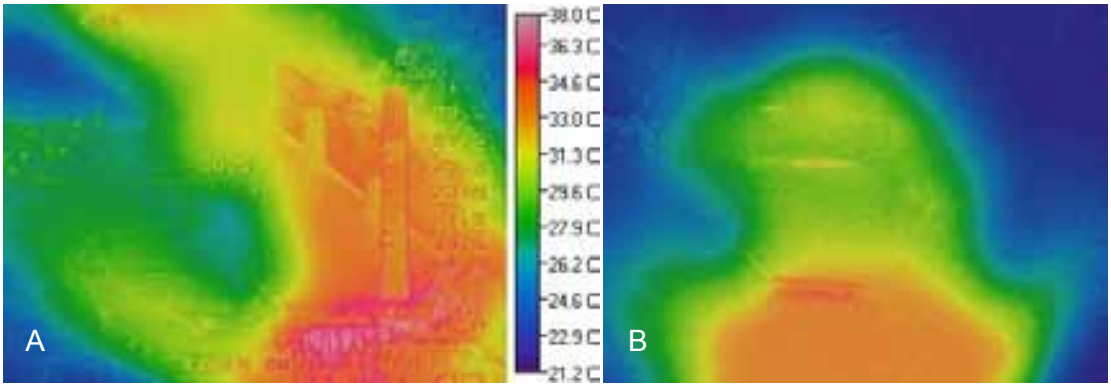

Figure 2: Infrared photos of North Pool in Feb 2014 (A) and Jan 2015 (B), Golden Springs Motel

- **South Pool**
  E1888678 N5736842

The South Pool could not be visited in January 2015 due to it being inaccessible because of fallen trees that created a hazard.

2.2 Pools across the road from the Golden Springs Motel

- **Feature 3**
  E1888846 N5737375

There were no significant changes since the previous visit. There are algal mats around the edges of the pool.

Table 2: Data from Feature 3, Golden Springs

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
04 Feb 2014	41.8	6	nd	nd	Effervescing	Cloudy, green
21 Jan 2015	42	6-7	nd	nd	Effervescing	Murky, green

Figure 3: Feature 3, Golden Springs in Feb 2014 (A), Jan 2015 (B)

The infrared image below shows that the temperature of the pool is reasonably consistent, cooling down as it nears the edge. This is show in both February 2014 and January 2015. The image taken in January 2015 is from a different angle from that taken in February 2014.

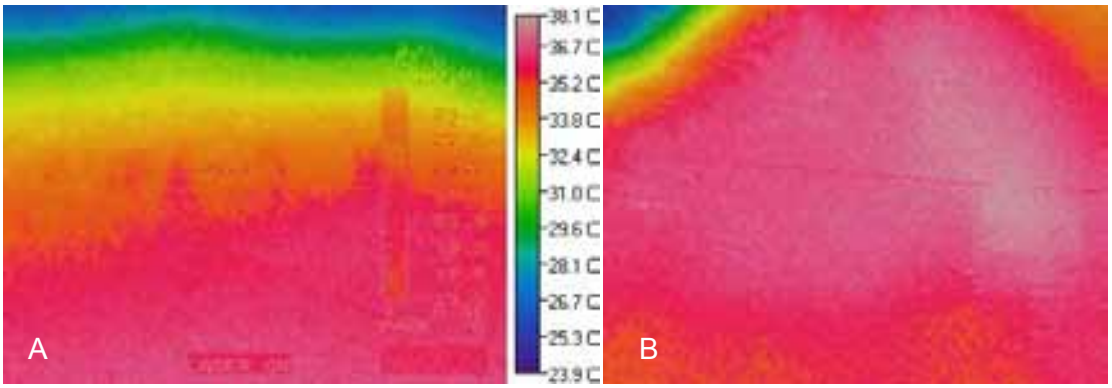

Figure 4: Infrared photo of Feature 3, Golden Springs in Feb 2014 (A) and Jan 2015 (B)

- **Feature 4**
  E1888827 N5737465

The feature was covered in algal mats. There were no measurements done in January 2015 due to my getting stung by a wasp on site.

Table 3: Data from Feature 4, Golden Springs

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
04 Feb 2014	41.0	6-7	Seep, just flowing	nd	Calm	Murky, green/grey
21 Jan 2015	nd	nd	Seep, just flowing	nd	Calm	Murky, green/grey

Figure 5: Feature 4, Golden Springs in Jan 2014 (A), Jan 2015 (B)

3 Ngatamariki

3.1 Hydrothermal Eruption Crater

- **Large pool occupying the crater**
  E1876505 N5730230; Located number 72.2098

There was an eruption at this location in April 2005. The eruption deposited a large amount of sediment in the area. The vegetation is starting to regenerate on the sediment. There is a large pool within the hydrothermal eruption crater with green and yellow algae around the edges, and a small mud pool alongside it. There is a constant bubbling around the edges of the pool with an area that continually produces steam on the far side. This steam production has been consistent throughout the year.

In July there was a temperature decrease of 1.1 ºC since the previous visit in April 2015, followed by a 2.9 ºC increase in the January visit. The pH has risen slightly from pH 6 to pH 7-8 over the period from April to January. The water level has fluctuated marginally; however, the flow seems to be consistent. The colour of the pool has changed quite markedly from green to dark green as can be seen in Figures 6 – 9. In January 2015 there was white foam over areas of the pool, possibly caused by anaerobic bacteria.

Table 4: Data from Ngatamariki Hydrothermal Eruption Crater Pool

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
29 Apr 2014	43.2	6-7	~1-1.5	Overflowing, ESG 0.083 m	Effervescing around edges, occasional elsewhere	Green, murky (~0.5 m)
11 July 2014	42.1	7	~1-1.5	Overflowing, ESG 0.080 m	Small bubbles all over the pool	Green, murky (~1 m)
28 Jan 2015	45.0	7-8	~1-1.5	Overflowing, ESG 0.095 m	Small bubbles all over pool	Dark green, murky

Figure 6: Large Pool: Overview, April 2014 (A), July 2014 (B), Jan 2015 (C)

Figure 7: Large pool gas discharge, Apr 2014 (A), July 2014 (B), Jan 2015 (C)

Figure 8: Steam at large pool, Apr 2014 (A), July 2014 (B), Jan 2015 (C)

Figure 9: Large Pool outflow in Apr 2014 (A), July 2014 (B), Jan 2015 (C)

The infrared photos below show the heat concentrated in the steaming area at the back of the pool.

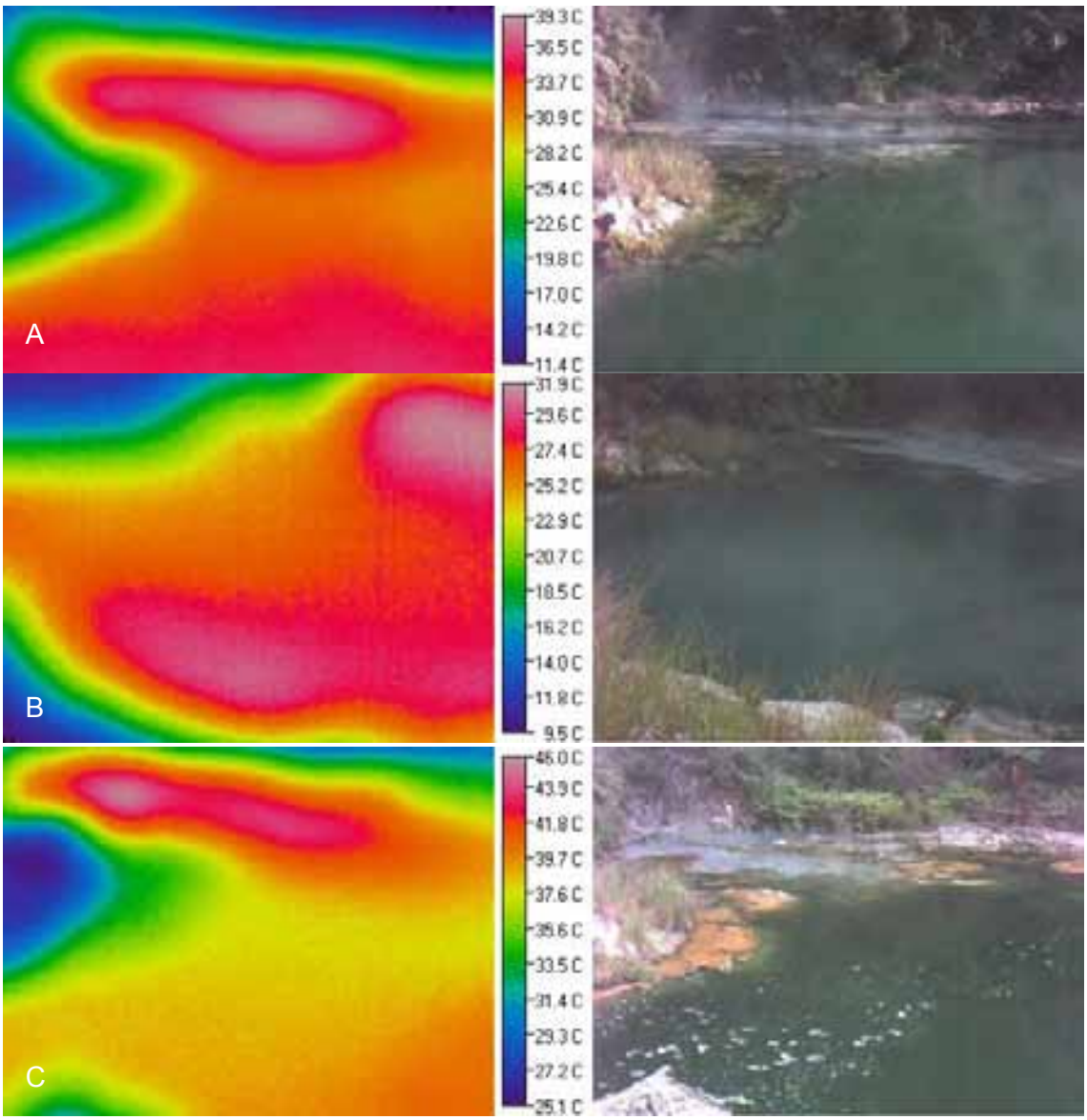

Figure 10: Infrared photos, Ngatamariki Hydrothermal Eruption Crater in Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Mud pool beside large pool**

There is a log in the pool, which has been there for some time. Although the log is discoloured, there is no visual evidence of its rotting or being dissolved. The pool level has fluctuated over the year. The temperature has increased over the period, from 48.3 °C in April 2014 to 66.0 °C in January 2015.

Table 5: Data from Mud pool beside Ngatamariki Hydrothermal Eruption Crater Pool

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
29 Apr 2014	48.3	3	nd	0.5 m below outflow	Constant discharge	Grey mud and water
11 July 2014	46.4	4	nd	0.5 m below outflow	Constant discharge	Grey mud and water
28 Jan 2015	66.0	3	nd	0.8 m below outflow	Constant discharge	Grey mud with water

Figure 11: Mud Pool, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared photos show that the pool is hottest in the areas where ebullition is occurring.

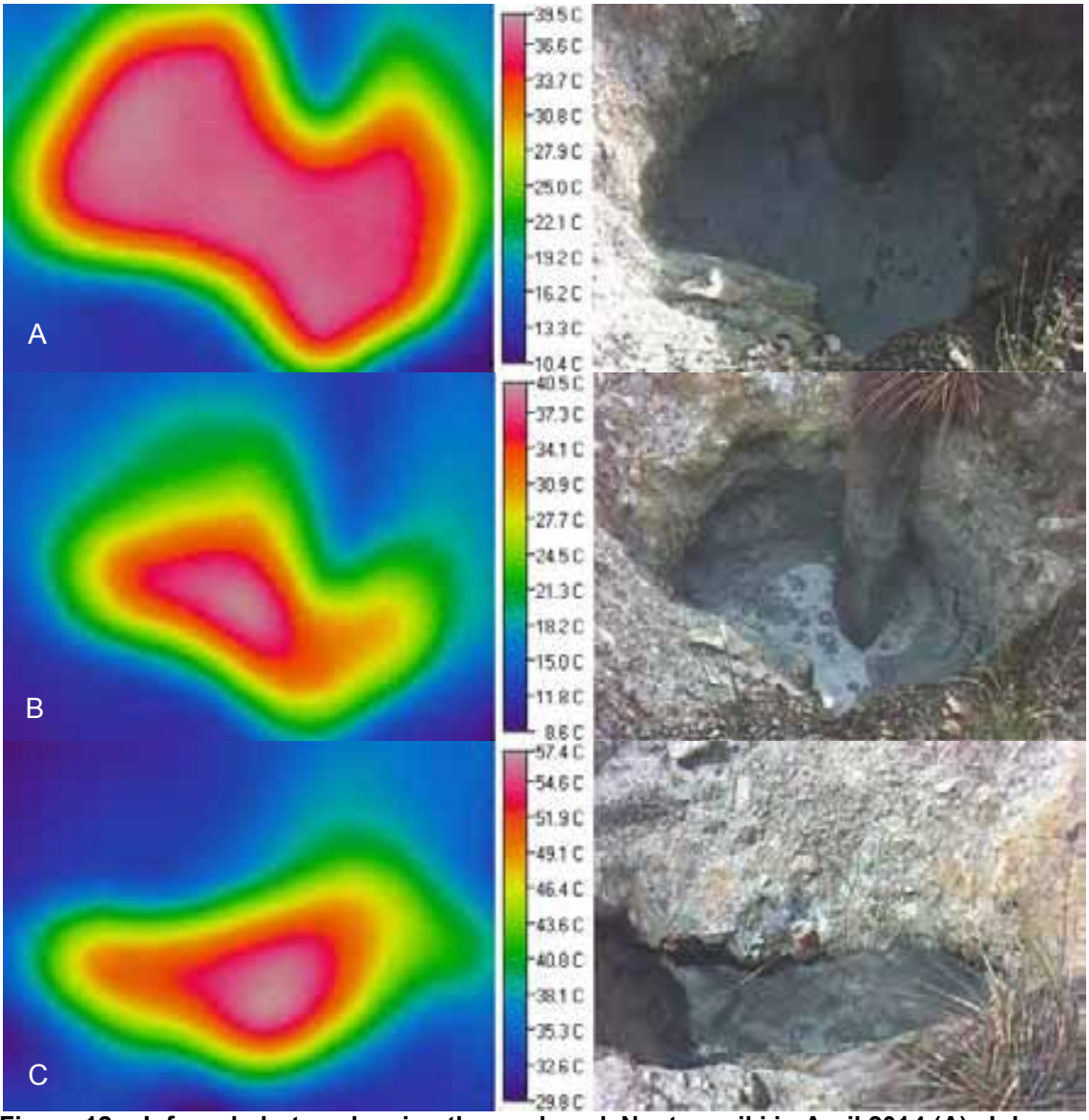

Figure 12: Infrared photos showing the mud pool, Ngatamariki in April 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Northwest Pool**

This pool was visited on 28th January 2015. It was 31.2ºC and calm. The water was black and covered in duck weed. The infrared image shows that the water is warmer than the surrounding area.

Figure 13: Northwest Pool, Jan 2015

- **Biodiversity Pool**

This pool is located amongst the trees to the right of the track leading to the hydrothermal eruption crater, just before the clearing. There were yellow algal mats on the pool present during the April and July visits. These mats had changed to a brighter orange for the January 2015 visit. The level of cover and colour fluctuated throughout the year. The temperature of the pool has increased by 11.4ºC between April 2014 and January 2015.The pH has been consistent at each visit.

Table 6: Data from Biodiversity Pool, Ngatamariki

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
29 Apr 2014	56.7	8-9	Nd	nd	Constant upwelling	Clear
11 July 2014	58.3	8	Nd	nd	Constant discharge	Clear
28 Jan 2015	68.1	8	Nd	nd	Constant discharge	Clear

Figure 14: Biodiversity Pool, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The Infrared photos below show the area of heat emanating from the deeper zone of the pool where most of the ebullition is occurring.

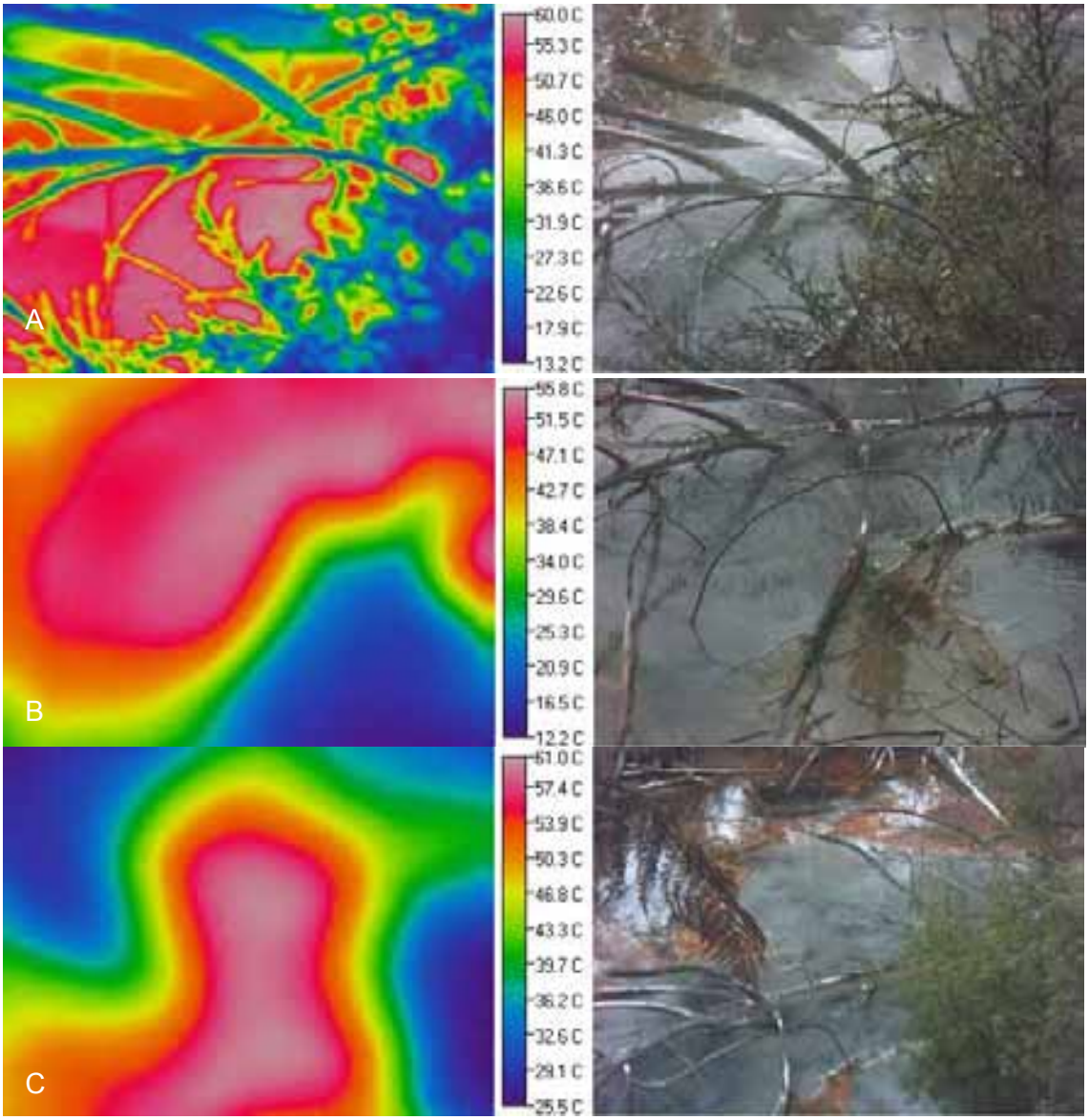

Figure 15: Infrared photos of the Biodiverity Pool, Ngatamariki in April 2014 (A), July 2014 (B) and Jan 2015 (C)

4 Orakei Korako

4.1 Orakei Korako Springs

Located number 72.2107

- **Diamond Geyser**
  E1874515 N573694

Figure 16: Diamond Geyser, Apr 2014 (A), July 2014 (B), Jan 2015 (C)

The temperature and flow have been consistent throughout the visits. The pH fluctuated between pH 5-6 and pH 7-8.

Table 7: Data from the Diamond Geyser, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 Apr 2014	85.9	5-6	Seep	Overflowing	Constant upwelling on far side of pool near outlet	Clear, blue/grey
10 July 2014	86.0	7-8	Seep	Overflowing	Constant upwelling on far side of pool near the outlet	Clear
29 Jan 2015	86.6	7	Seep	Overflowing	Constant upwelling on far side of pool near the outlet	Clear, blue/grey

Figure 17: Diamond Geyser, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared photos in Figure 18 appear to show that the heat is evenly spread across the pool.

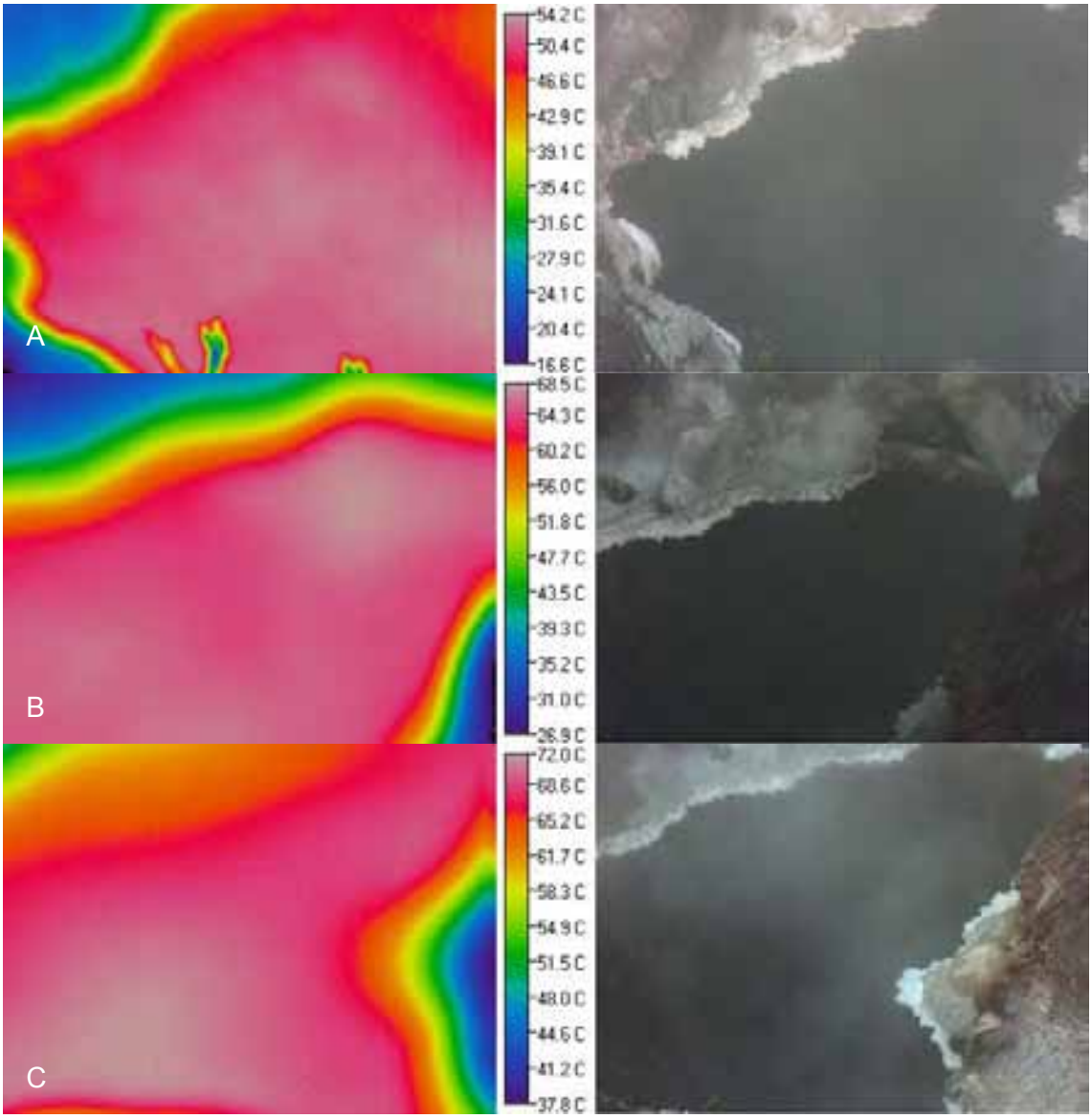

Figure 18: Infrared photos of the Diamond Geyser, Orakei Korako, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Pool beside Diamond Geyser**

The temperature has risen slightly (3.3 °C) between April 2014 and January 2015. There were fluctuations in the colour and clarity of the water.

Table 8: Data from the pool beside the Diamond Geyser, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 April 2014	81.8	5-6	Seep	Overflowing	Constant small discharge	Blue/green, cloudy
10 July 2014	84.0	5	Seep	Overflowing	Small upwelling	Murky, grey
29 Jan 2015	85.1	6	Seep	Overflowing	Small upwelling	Clear, dark grey

Figure 19: Pool beside Diamond, Apr 2014 (A), Jun 2014 (B), Jan 2015 (C)

The infrared photos in Figure 20 show that the hottest area of the pool appears to be at the front towards the outlet, although it is heated throughout the pool.

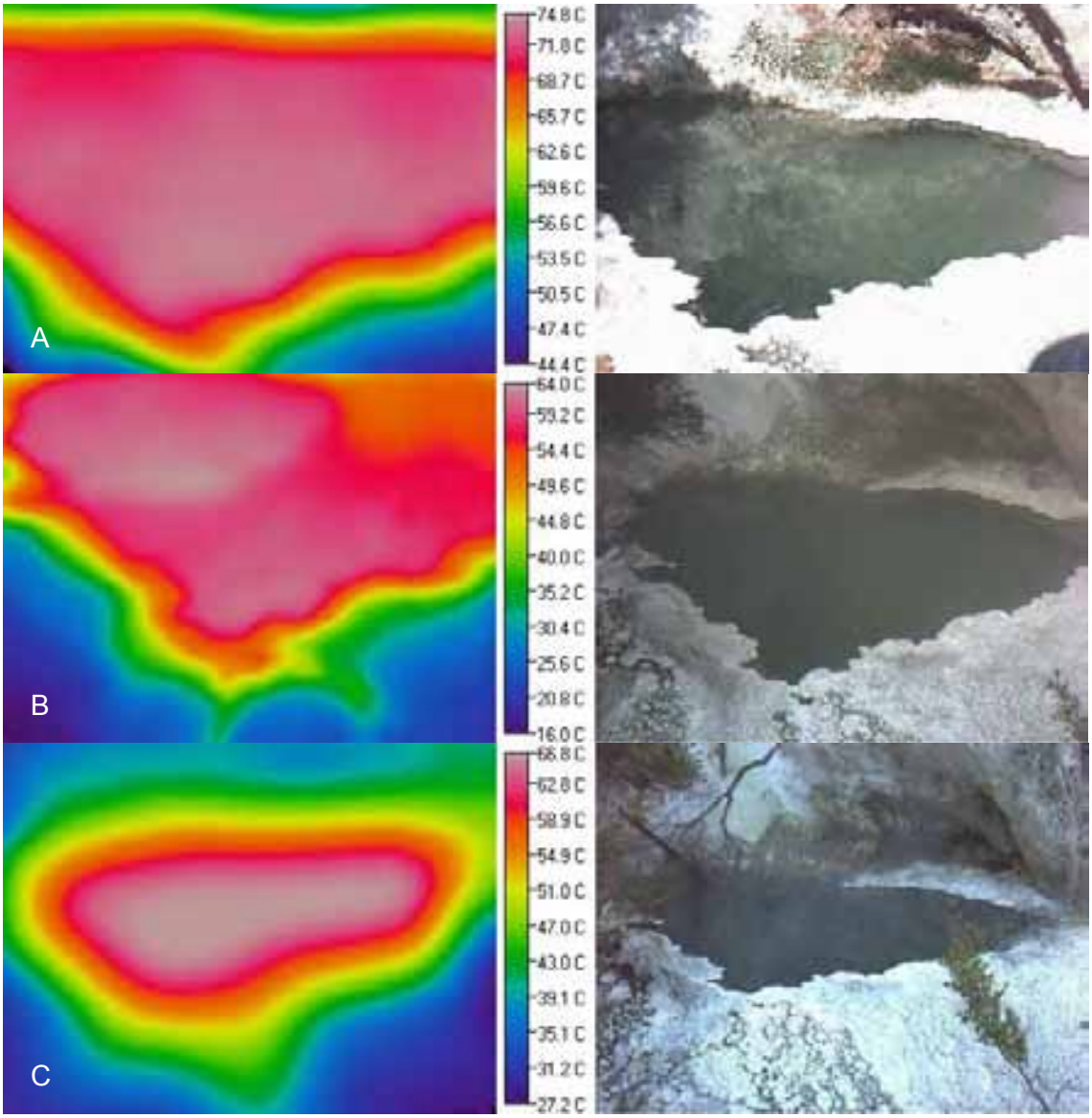

Figure 20: Infrared photos of the pool beside the Diamond Geyser, Orakei Korako in Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The small pool to the left of the diamond geyser appears to be increasing in size. A new geyser may have formed as there was an abundance of steam and flow periodically pouring down the hill. The soil structure in the area has been degraded by either the flow from above or a new fumarole opening up. The area of increased activity is on the left of the small pool (depicted in Figures 9 and 10) and in the bushes. It was not able to be accessed.

Figure 21: Small pool beside Diamond Geyser, Orakei Korako, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

Figure 22: Area of increased activity next to Diamond geyser

Figure 23: Small pool beside Diamond Geyser, Orakei Korako, April 2014 (A), July 2014 (B) and Jan 2015 (C)

In the infrared photo it appears that the hottest area of the pool is near the outlet, which is where the ebullition is most apparent.

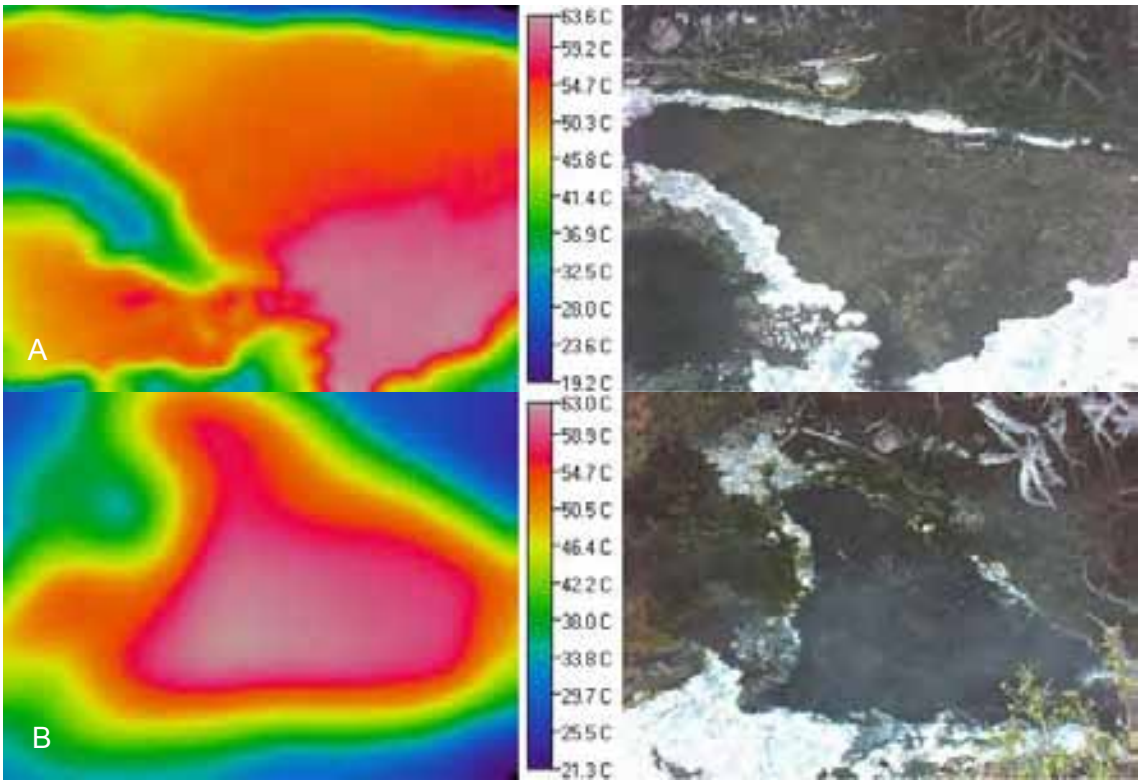

Figure 24: Infrared photo of small pool beside Diamond geyser, Orakei Korako, Apr 2014 (A) and Jan 2015 (B)

- **Bush Geyser**

April 2014: The geyser erupted at 09:15 for approximately thirty seconds. There was not much spray from the eruption. The trees have been cleared in front of the geyser, therefore it is now visible from the boardwalk.

July 2014: There was no water visible between eruptions; therefore pH could not be tested. The Bush geyser erupted once during our visit at 09:58, for one minute. No changes are evident since the previous visit.

January 2015: The bush geyser did not erupt while we were present. The temperature was 90.6 ^{o}C and there was audible discharge. Some water was visible at the bottom of the vent which was clear. An eruption was heard while we were at the Cascade Geyser, which was approximately 1 minute in length.

Table 9: Data from the Bush Geyser, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 Apr 2014	93.1	8-9	-	-	Geysering	Clear
10 July 2014	92.9	nd	-	-	Geysering	Clear
29 Jan 2015	90.6	nd	-	-	Audible discharge	Clear

Figure 25: Bush Geyser, Apr 2014 (A) and July 2014 (B)

The infrared photos in Figure 26 were taking during a quiescent stage.

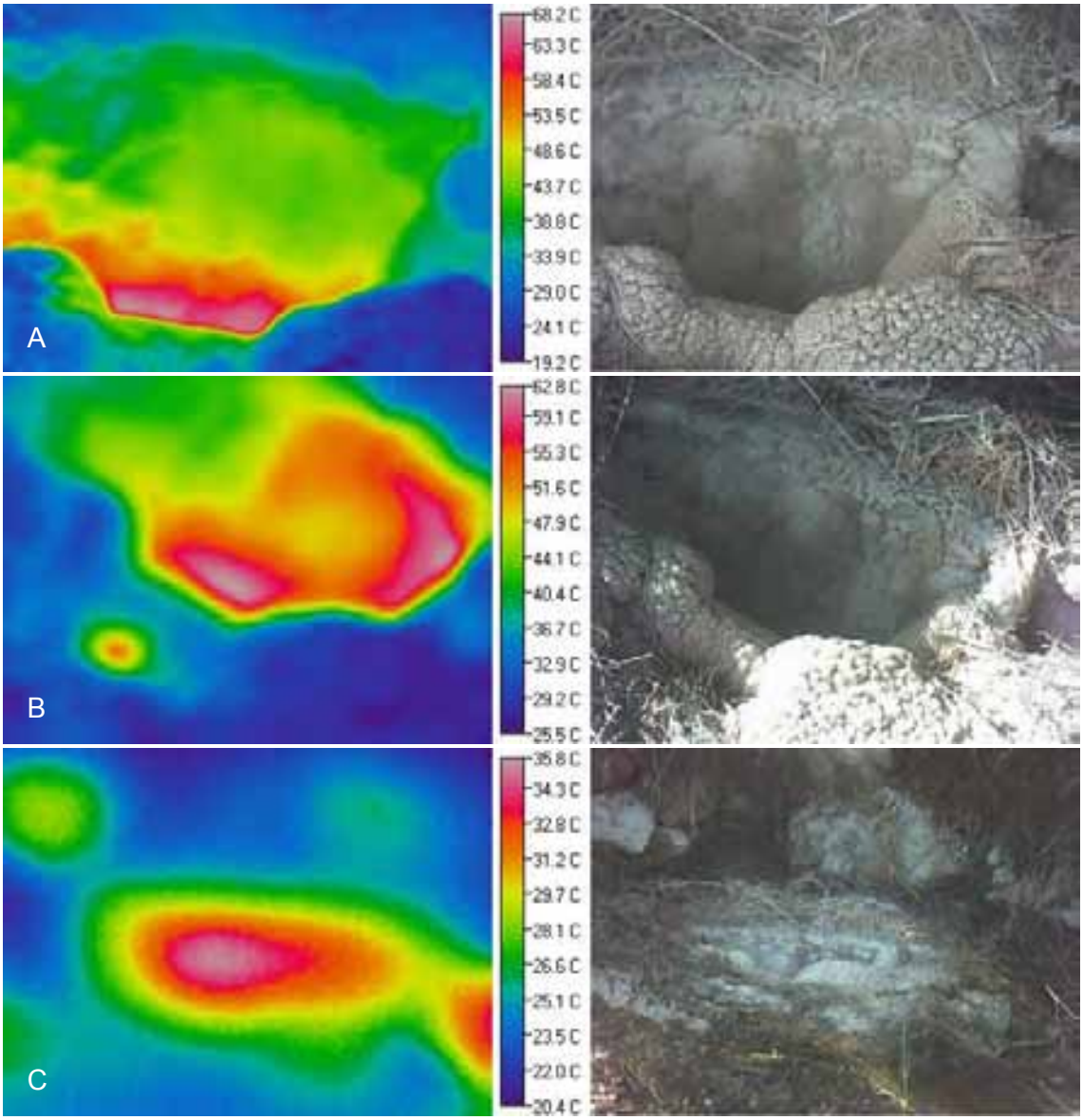

Figure 26: Infrared photos, Bush Geyser, Orakei Korako in Apr 2014 (A) July 2014 (B) and Jan 2015 (C)

- **Cascade Geyser**

April 2014: The geyser was seen to erupt three times during our visit at 09:15, 09:20 and 09:24, with only small eruptions.

July 2014: The Cascade Geyser erupted twice during our visit (at 10:04 and 10:11), with durations from 40 seconds to one minute.

January 2015: The geyser erupted twice during our visit at 09:49 and 09:55, with eruptions lasting 30 seconds and one minute respectively.

Figure 27: Cascade Geyser, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared photos in Figure 28 were taken during an eruption, and show the flow path of the water during an eruption.

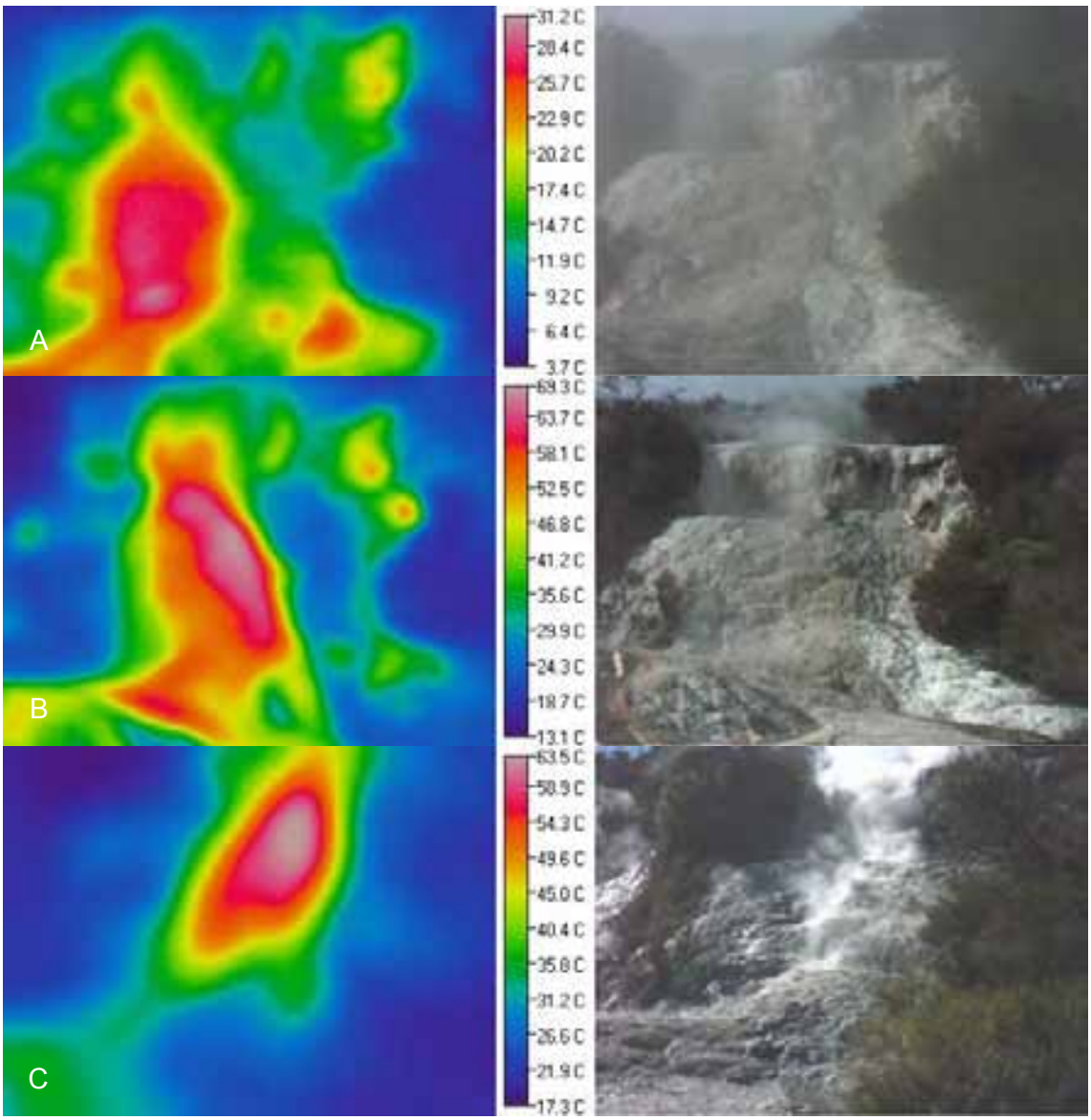

Figure 28: Infrared photos, Cascade Geyser at Orakei Korako during an eruption, Apr 2014 (A) and Jan 2015 (C)

- **Sapphire Geyser**

April 2014: The geyser erupted at 09:22 and 09:25, for twenty seconds on each occasion.

July 2014: The geyser erupted at 10:02 for 30 seconds, followed by two more eruptions at 10:06 and 10:10, both for one minute.

January 2015: The geyser erupted at 09:46 for one minute.

Figure 29: Sapphire Geyser, Orakei Korako in Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The heat from the Sapphire geyser can be seen to the left of the Cascade geyser in the Infrared photo.

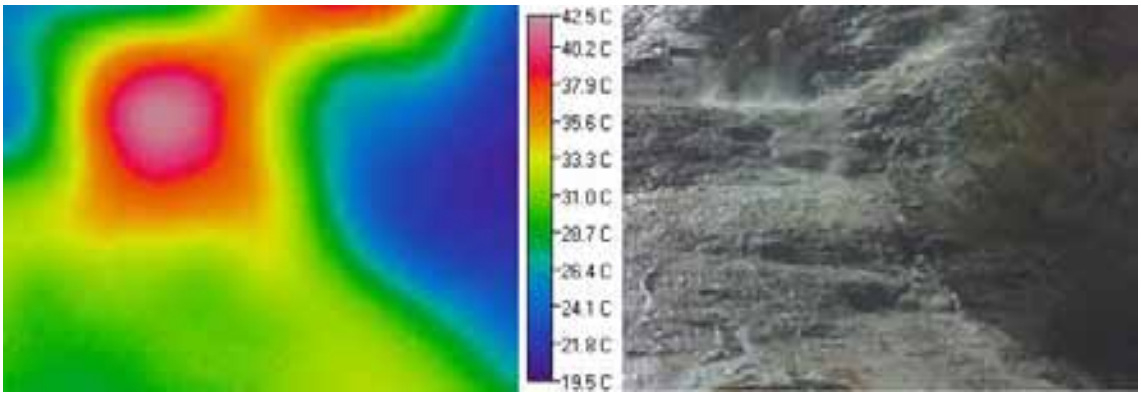

Figure 30: Infrared photo of Sapphire Geyser, Orakei Korako, Jan 2015

- **Map of Africa**
  E1874578 N5736954

Various coloured algal mats were observed on the water surface during all of the monitoring visits. The area that the mats cover tends to vary at each visit, with the least amount of cover in April 2014 and the largest cover in January 2015. The pH seems to be fairly consistent; however it could not be measured in January 2015 as the pool could not be reached due to the extensive algal mats covering the pool. The temperature seems to vary between monitoring periods, with the lowest being 30.1 ºC during the April 2014 visit and highest of 38.1 ºC during the January 2015 visit.

Table 10: Data from the Map of Africa Pool, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 Apr 2014	30.1	6-7	Seep	nd	Calm	Green, clear
10 July 2014	36.0	7	Seep	Overflowing	Calm	Clear
29 Jan 2015	38.1	nd	Seep	Overflowing	Calm	Clear, dark green

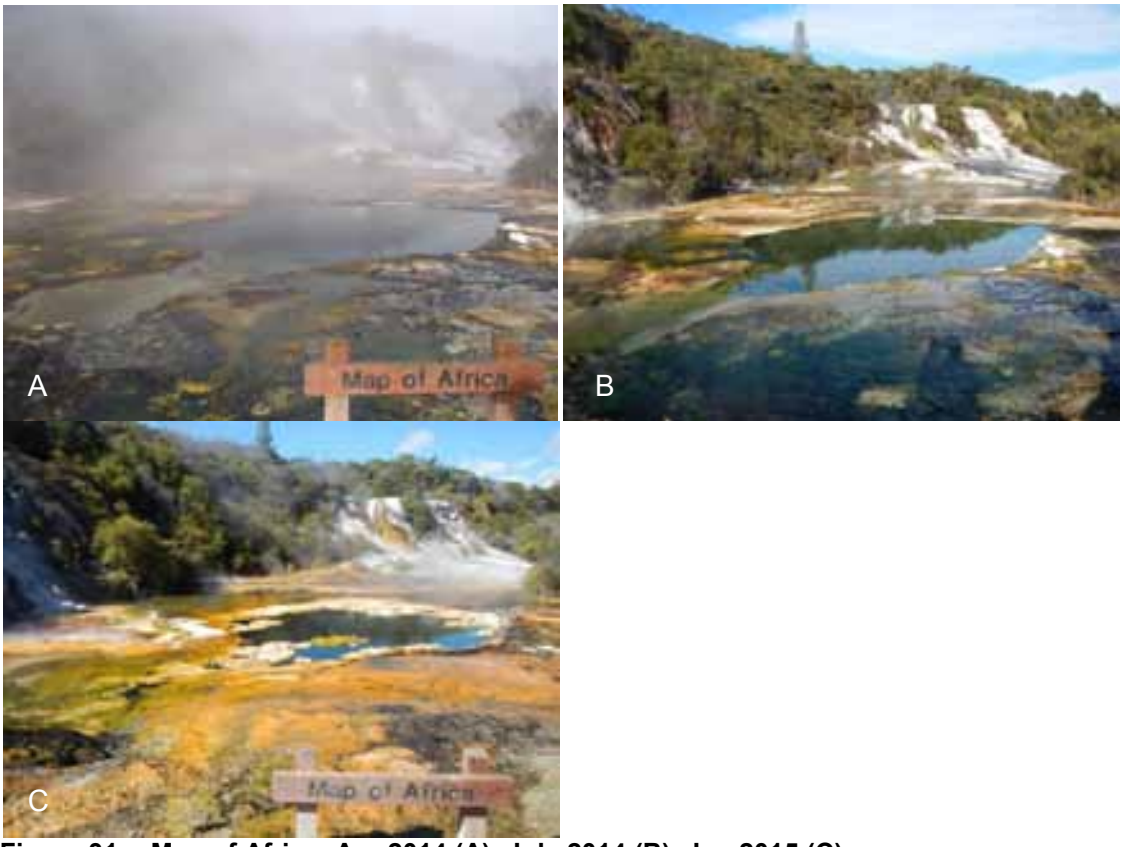

Figure 31: Map of Africa, Apr 2014 (A), July 2014 (B), Jan 2015 (C)

The Map of Africa has a relatively low temperature (as seen in Figure 32); however there are several areas of increased heat which seems to vary between visits.

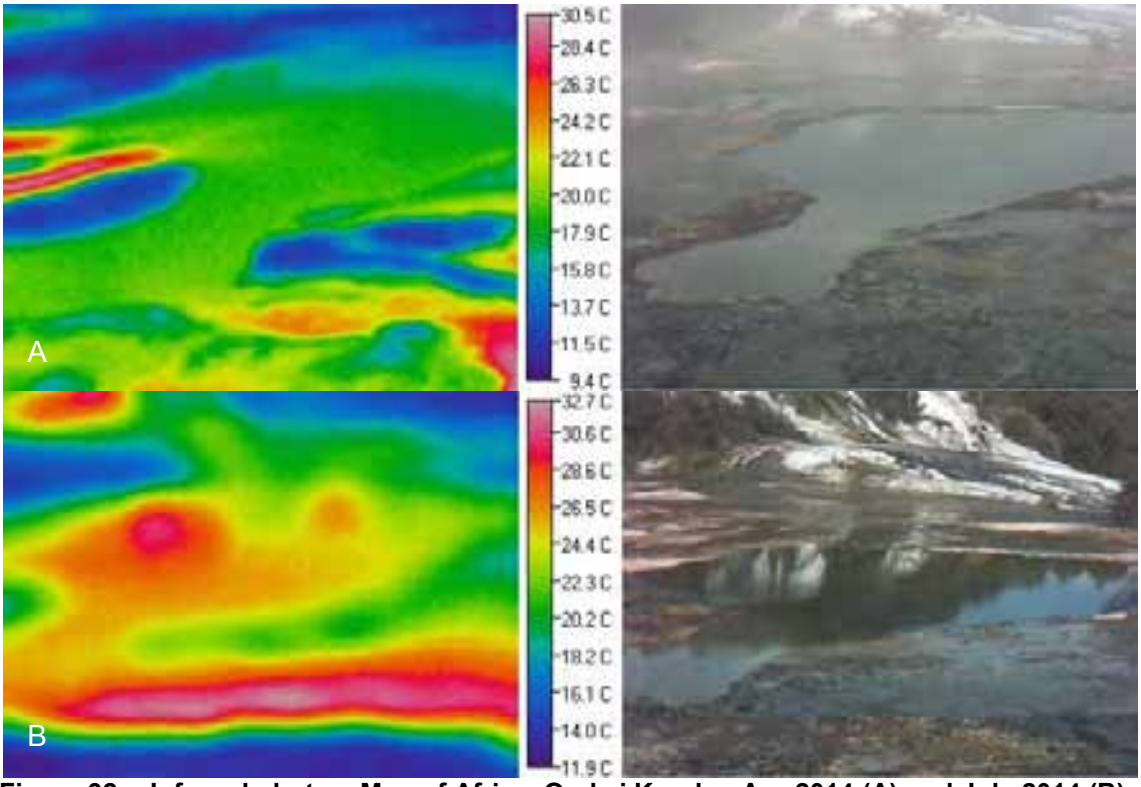

Figure 32: Infrared photos, Map of Africa, Orakei Korako, Apr 2014 (A) and July 2014 (B)

- **Devil's Throat**
  E1874599 N5736996

The vent appeared to be surging with constant bubbling during the all of the monitoring visits. The bubbling becomes more vigorous as it surges, with the flow changing from less than 0.5 l/s up to 1 l/s when surging. There were minor temperature fluctuations.

April 2014: Flow increases from <0.5 l/s to approximately 0.5 l/s while surging.

July 2014: flow <0.5 l/s before surging, 0.5-1 l/s while surging.

January 2015: It did not appear to surge during the visit.

Table 11: Data from the Devil's Throat, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 Apr 2014	96.7	6	~0.5	Overflowing	Surging	Clear
10 July 2014	97.8	6	~0.5	Overflowing	Surging	Clear
29 Jan 2015	97.5	7	~0.5	Overflowing	Vigorous	Clear

Figure 33: Devil's Throat, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Fred and Maggie's Pool**
  E1874648 N5736981

The temperature fluctuated by a maximum of 1.9 ºC. The colour has altered from grey to light blue.

Table 12: Data from Fred and Maggie's Pool, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 Apr 2014	95.3	7-8	<0.5	Overflowing	Constant upwelling near outflow	Clear, grey
10 July 2014	96.4	7	<0.5	Overflowing	Constant vigorous upwelling	Clear, grey
29 Jan 2015	94.5	8	<0.5	Overflowing	Constant upwelling near outflow	Clear, light blue

Figure 34: Fred and Maggie, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

In January 2015 the heat appears to originate from the area of upwelling and disperses from there. In April 2014 the Infrared photos below it show that the warmest area is on the southern side of the pool. However the steam can cause fluctuations in temperature across the pool as it cools quickly.

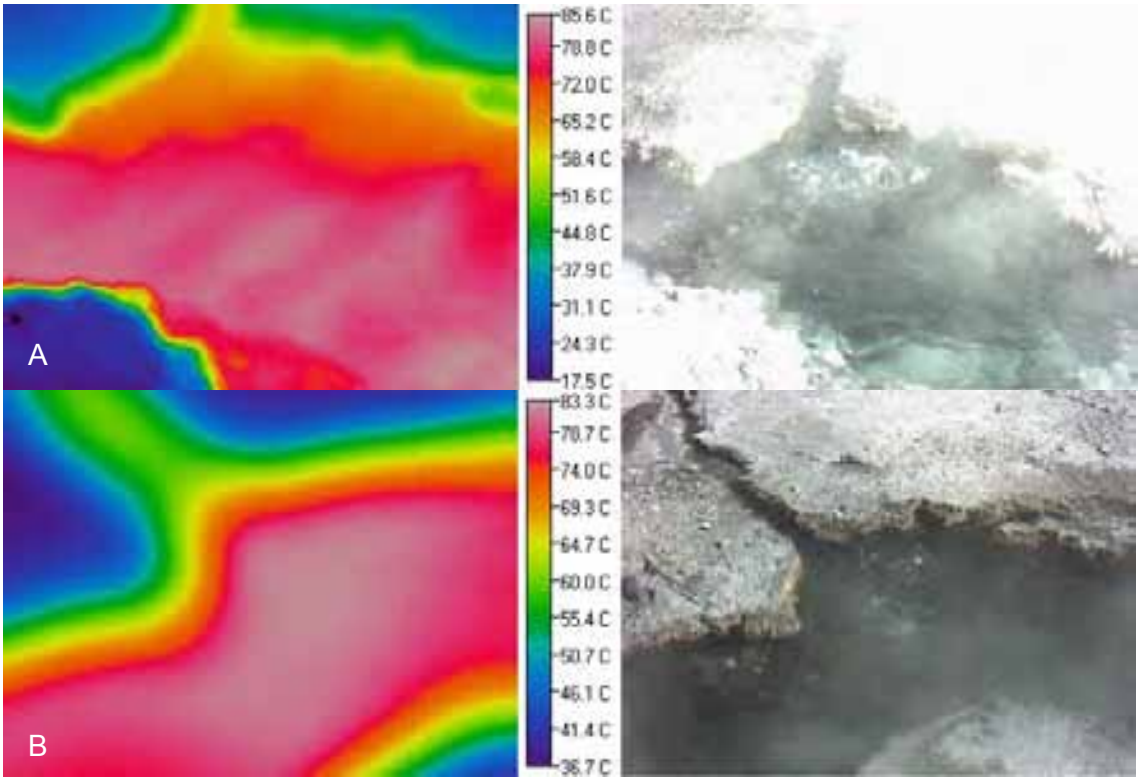

Figure 35: Infrared photos of Fred and Maggie's Pool, Orakei Korako, Apr 2014 (A) and Jan 2015 (B)

- **Wairiri Geyser**
  E1874643 N5736951

The water level has risen by 0.7 m. The temperature appears to be dropping, with a reading of 65.4 ºC in April 2014, down to 56.5 ºC in January 2015.

Table 13: Data from the Wairiri Geyser, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 Apr 2014	65.4	7	nd	1.7 m below outflow	Calm	Clear
10 July 2014	60.9	7	nd	1.1 m below outflow	Calm	Clear
29 Jan 2015	56.5	6	nd	1.0 m below outflow	Calm	Clear

Figure 36: Wairiri Geyser at Orakei Korako in Apr 2014 (A), July 2014 (B), and Jan 2015 (C)

The geyser appears to have warmed up again after a period of no activity. The hottest part of the pool changes throughout the period (as seen in Figure 37).

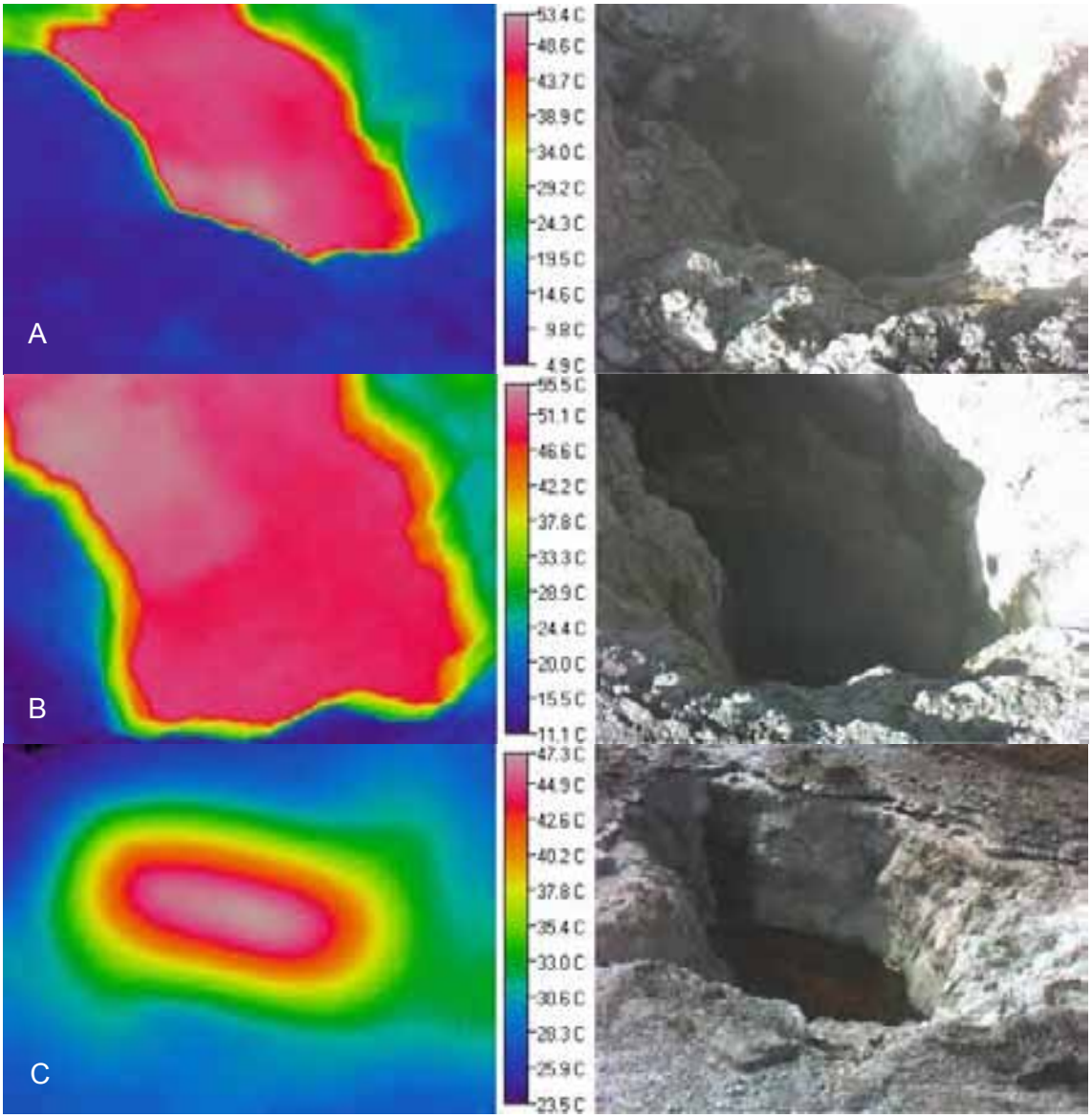

Figure 37: Infrared photos, Wairiri Geyser, Orakei Korako, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Steaming ground on the Western edge of Artists Palette.**
  E1874661 N5736910

No major changes observed.

Table 14: Data from steaming ground, Western edge, Artists Palette, Orakei Korako

Date	T(°C)
30 Apr 2014	28-58
10 July 2014	22-46
29 Jan 2015	27-62

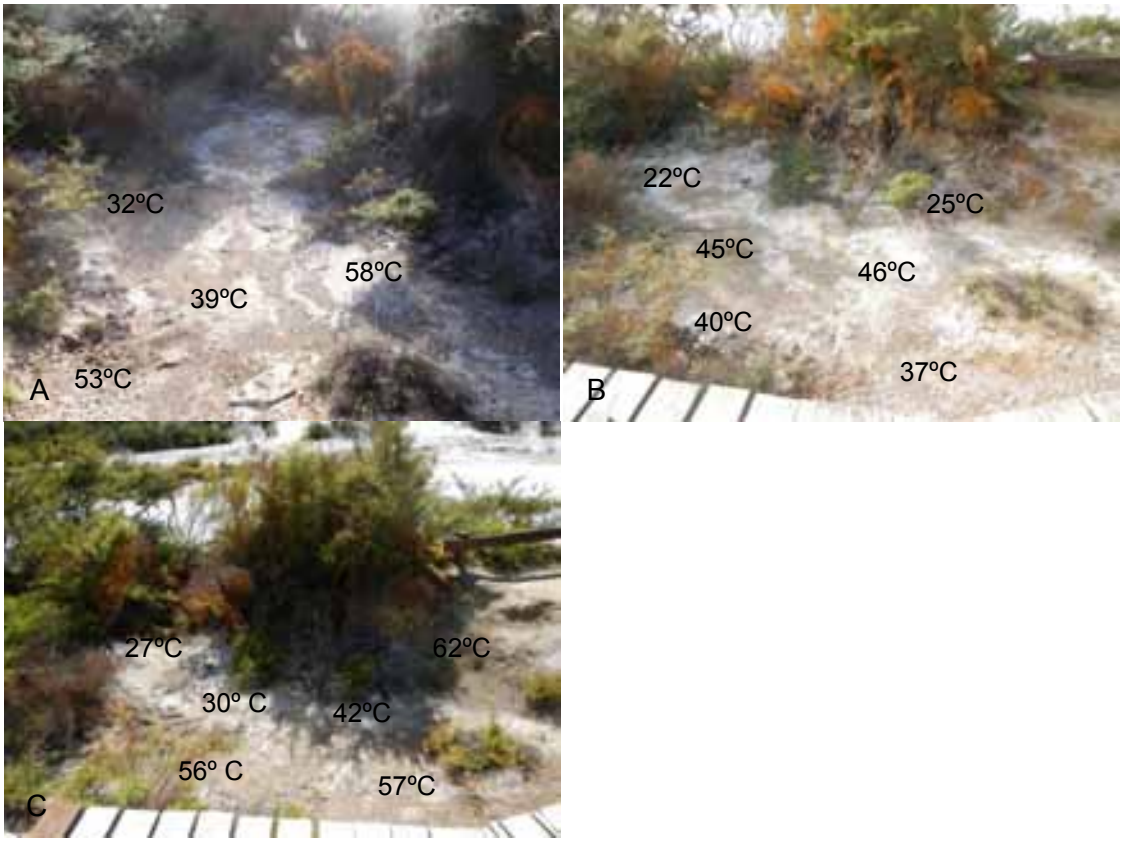

Figure 38: Steaming ground in Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The areas of hot spots seem to fluctuate throughout the period (see Figure 39).

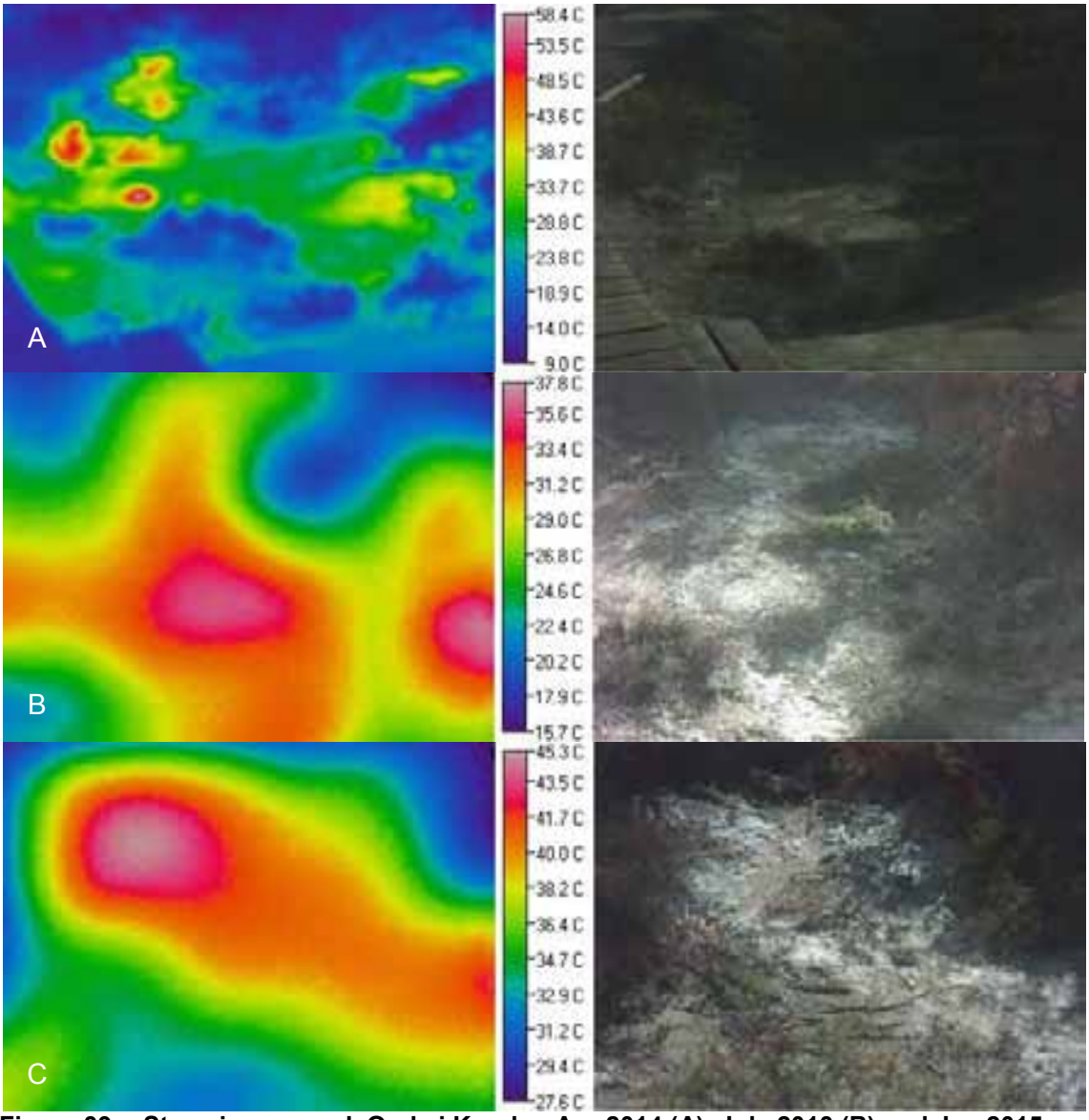

Figure 39: Steaming ground, Orakei Korako, Apr 2014 (A), July 2013 (B) and Jan 2015 (C)

- **Fumarole to left of boardwalk**
  E1874662 N5736878

The fumarole was dry during all visits. It has an average depth of 0.6 m and a diameter of ~0.7 x 1 m. There are temperature fluctuations in the fumarole over the monitoring period, ranging from the lowest temperature of 31.3 ºC in April 2014 to 50.9 ºC in July 2014. It had decreased slightly by January 2015.

Table 15: Data for the Fumarole to the left of the boardwalk, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Ebullition	Diameter (m)	Depth (m)
30 Apr 2014	31.3	-	Dry	Steam	1.0 x 0.7	~0.6
10 July 2014	50.9	-	Dry	Steam	1.0 x 0.7	~0.6
29 Jan 2015	45	-	Dry	Steam	1.0 x 0.7	~0.6

Figure 40: Fumarole, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared photos in Figure 41 show that the main area of heat fluctuates throughout the period.

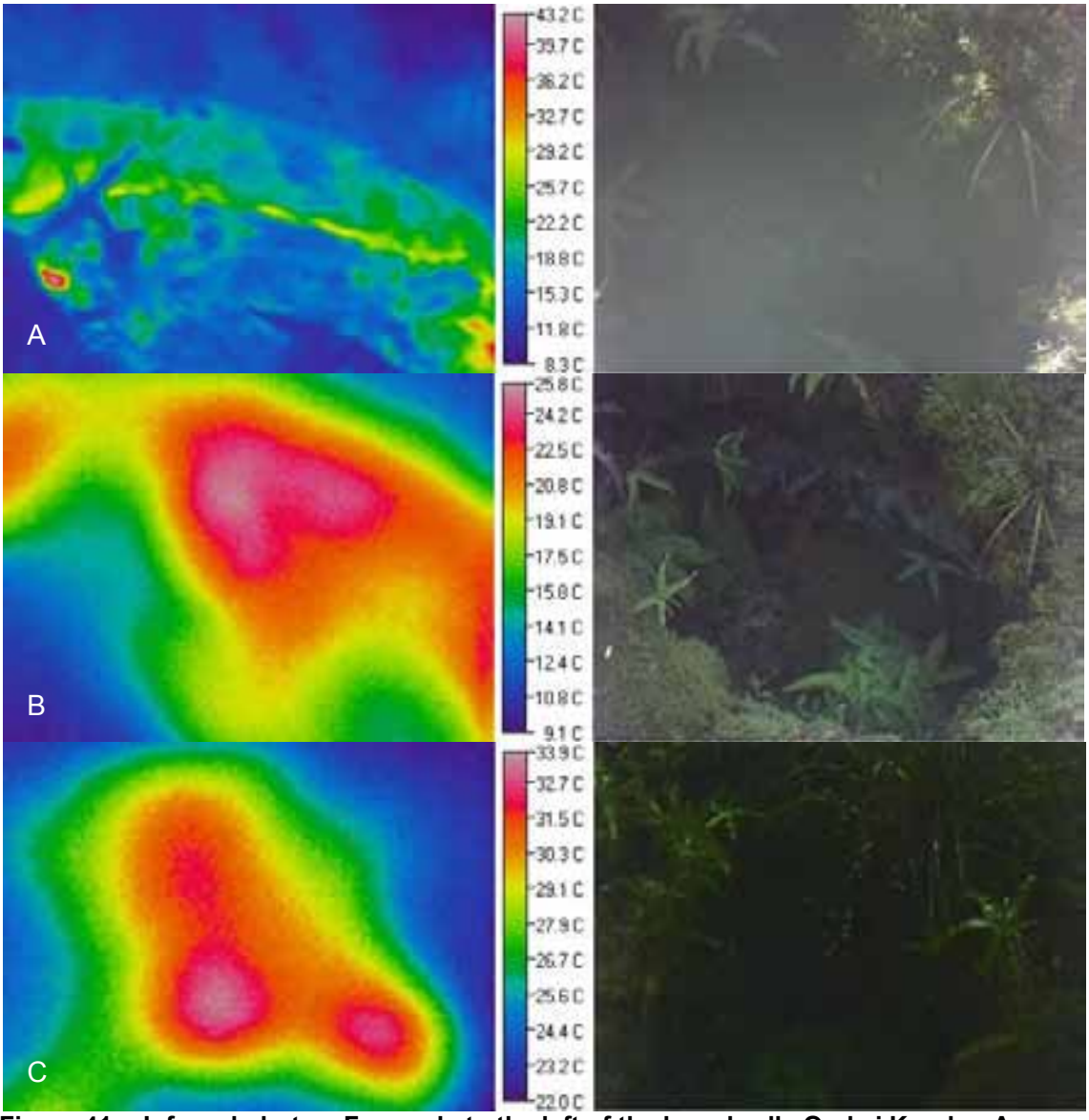

Figure 41: Infrared photos, Fumarole to the left of the boardwalk, Orakei Korako, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Two pools by the boardwalk**
  E1874670 N5736770

The water level has risen by about 1 m. There were minor temperature and colour fluctuations. The pH has risen from pH 5-6 in April 2014 to pH 7 in January 2015.

Table 16: Data from the South Pool by the boardwalk, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 Apr 2014	82.1	5-6	nd	3 m below surface	Upwelling	Clear, grey
10 July 2014	80.4	6	nd	2 m below surface	Upwelling all over	Clear (~1 m), grey
29 Jan 2015	85	7	nd	2 m below surface	Constant, small bubbles	Clear, blue/grey

Figure 42: South Pool, Apr 2014 (A), July 2014 (B), and Jan 2015 (C)

The heat is evenly spread throughout the pool.

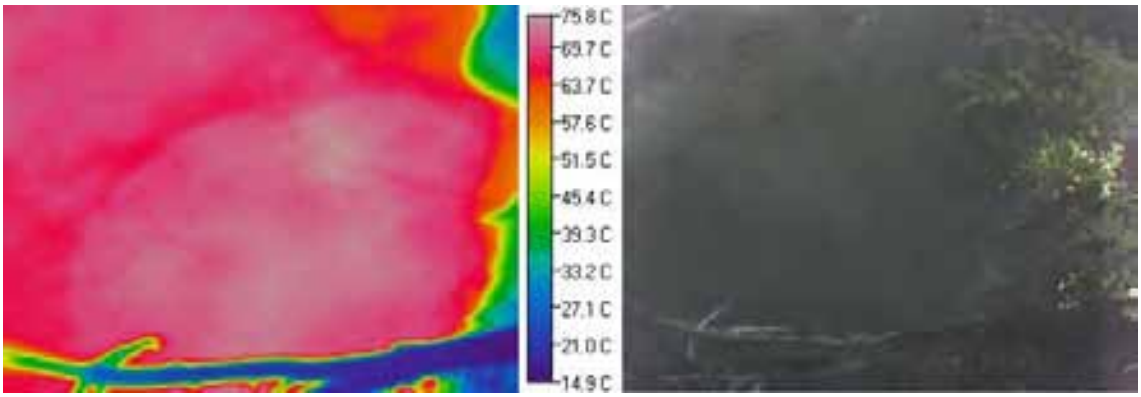

Figure 43: Infrared photos, South Pool by the boardwalk, Orakei Korako, Apr 2014

The water temperature at the North Pool has decreased from 96.6 °C in April 2014 to 89.8 °C in January 2015. The pH has fluctuated between pH 6 and pH 7. The pool could not be reached in January 2015 as the sampling stick was not long enough to reach the pool; therefore there is no pH for that visit.

Table 17: Data from the North Pool by the boardwalk, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
29 Apr 2014	96.6	6	nd	Small amount at bottom of pool	Constant discharge	Clear, grey
10 July 2014	94.8	7	nd	2 m below outflow	Constant discharge	Clear
29 Jan 2015	89.8	nd	nd	2 m below outflow	Constant small upwelling	Clear

Figure 44: North Pool, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The temperature of the pool appears to be consistent throughout the pool.

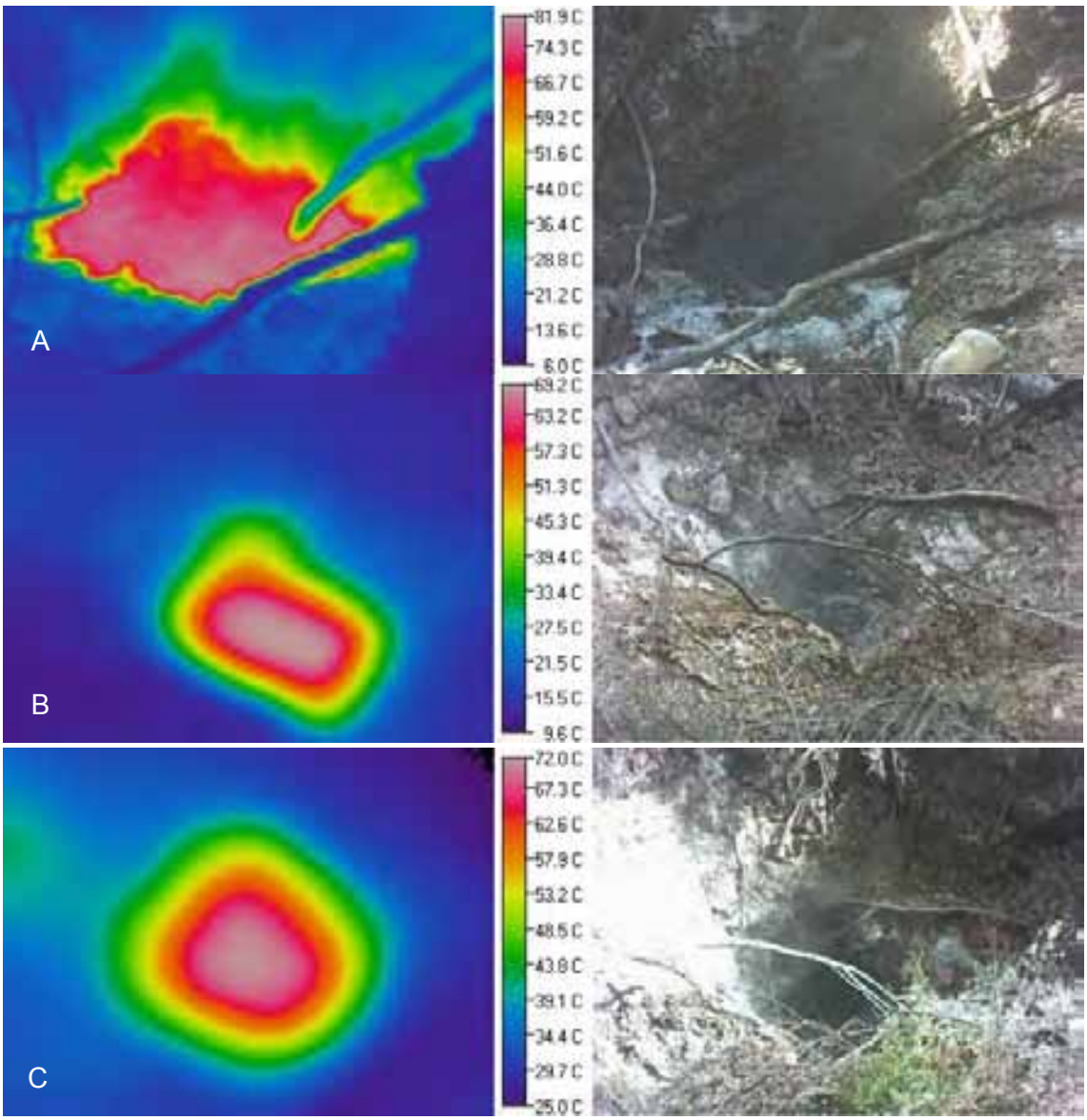

Figure 45: Infrared photos, North Pool by the boardwalk, Orakei Korako, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Artists Palette and Pyramid of Geysers**

Figure 46: Artists Palette, with the Pyramid of Geysers in the background in Jan 2015

April 2014: The water level was low in all of the pools. The hills appeared to be steaming more than usual. The small pool in front of the boardwalk was very active.

July 2014: There was vigorous discharge from the pool to the left of the geyser, and the pool was full and blue. There was audible bubbling coming from the small pool below the boardwalk. The pools to the left were a light blue in colour. The large pool in the centre was steaming, but no water was visible.

January 2015: The water level was low in the majority of the pools apart from the area to the left of the geyser. There was audible bubbling coming from the small pool below the boardwalk.

Figure 47: Composite photo, Apr 2014 (A), July 2014 (B) and Jan 2015 (D)

- **Ruatapu Cave**
  E1874752 N5736770

Due to a rock fall some years ago there is no access to Ruatapu Cave; therefore, the temperature was taken from the viewing platform with the IR gun. There have been slight temperature variations through the monitoring period. The temperature was not recorded in April 2014.

Table 18: Data from the Ruatapu Cave, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 Apr 2014	nd	nd	nd	-	Calm	Clear, Blue
10 July 2014	37.8	nd	nd	-	Calm	Clear, Blue
29 Jan 2015	41.5	nd	nd	-	Calm	Clear, Blue

Figure 48: The Ruatapu Cave, Apr 2014 (A), Jul 2014 (B) and Jan 2015 (C)

The water temperature appears to be consistent throughout the pool at the base of the cave.

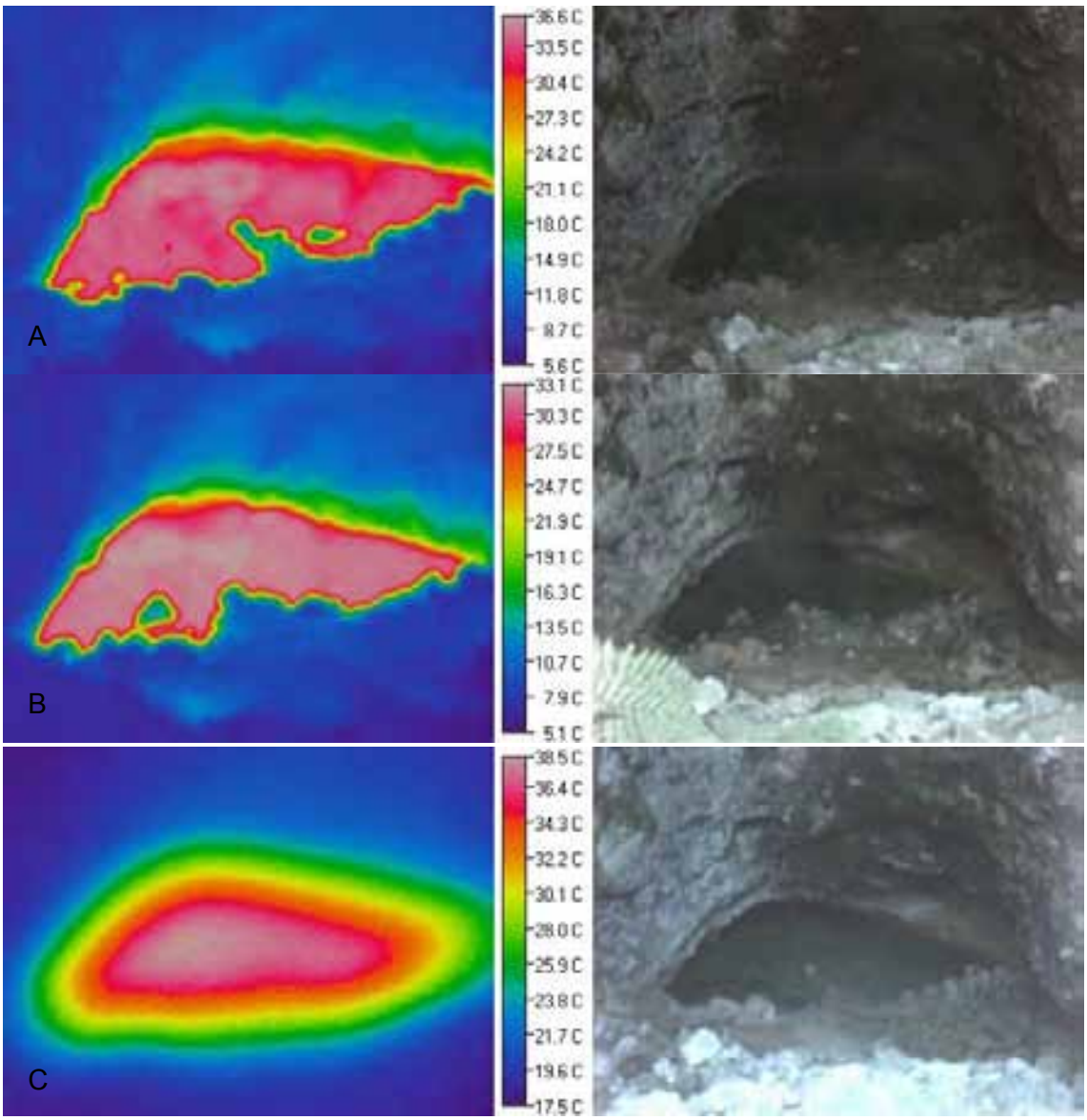

Figure 49: Infrared photo, Ruatapu Cave, Orakei Korako, Apr 2014 (A), July 2014 (B), and Jan 2015 (C)

- **Soda Fountain**
  E1874555 N5736924

The water level has remained consistent throughout the monitoring period. The pH has decreased from pH 8 to pH 7. The temperature fluctuates throughout the period; however, the low reading in January 2015 may be due to the IR gun being used because the thermocouple broke.

Table 19: Data from the Soda Fountain, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 Apr 2014	96.4	8	<0.5	o/f	Constant upwelling	Clear, blue
10 July 2014	99.4	8	<0.5	o/f	Constant upwelling	Clear, blue
29 Jan 2015	90	7	<0.5	o/f	Constant, boiling	Clear, blue/green

Figure 50: Soda Fountain, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Map of Australia**
  E1874160 N5736976; Located number 72.2998

There were marginal changes to pH, water level and flow throughout the period.

Table 20: Data from the Map of Australia, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 Apr 2014	79.8	6-7	<0.5	255 mm below top of ruler	Constant upwelling	Clear, blue (turquoise)
10 July 2014	80.1	7	~0.5-1	255 mm below top of ruler	Constant upwelling on the right	Clear, blue (turquoise)
29 Jan 2015	81.0	7-8	~0.5	250 mm below top of ruler	Constant upwelling	Clear, blue (turquoise)

Figure 51: Map of Australia, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

4.2 Waihunuhunu Inlet

- **Inlet 1**
  E1875427 N5739204

There were no bathers at the time of the surveys in April and July 2014. There were minor temperature fluctuations. There were 7 bathers present at 12:15 during the January 2015, hence no photo was taken.

Table 21: Data from Inlet 1, Waihunuhunu Inlet, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 Apr 2014	53.2	6-7	~20	O/f from pipe	-	Clear
10 July 2014	50.6	6	~25	O/f from pipe	-	Clear
29 Jan 2015	52	6	20-30	O/f from pipe	-	Clear

Figure 52: Waihunuhunu Inlet 1, Orakei Korako in Apr 2014 (A) and July 2014 (B)

The heat of the water can be seen as it gushes out of the pipe.

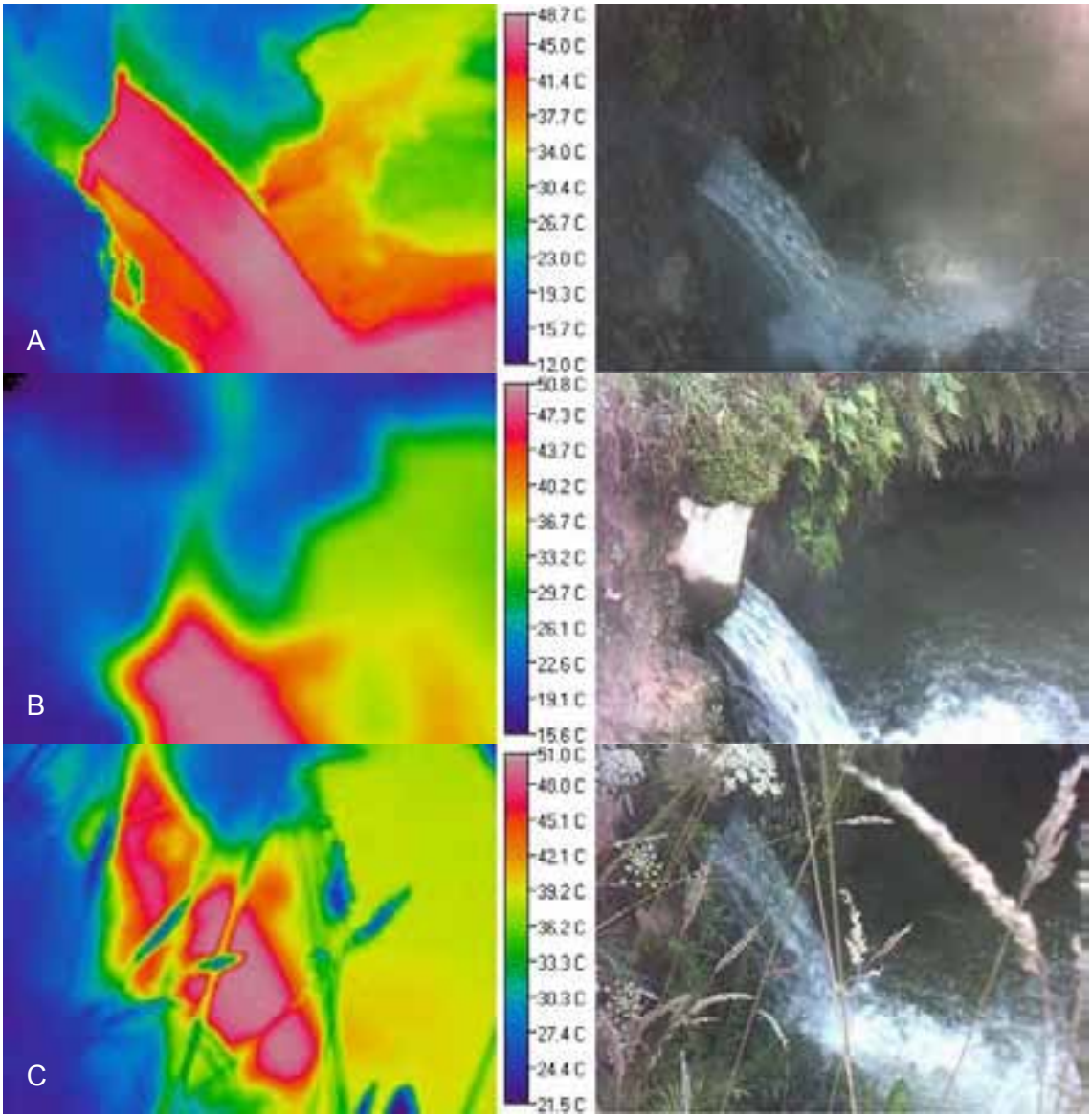

Figure 53: Infrared photos of Waihunuhunu Inlet 1, Orakei Korako, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Inlet 2**
  E1875395 N5746213

Inlet 2 was not accessible during the monitoring period for April 2014 and July 2014 due to the collapse of the path. There were no bathers at the time of the survey in January 2015. Since the January 2014 survey, the pH has dropped from pH 7-8 to pH 5.

Table 22: Data from Inlet 2, Waihunuhunu Inlet, Orakei Korako

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 Jan 2014	42.8	7-8	~5	O/f from pipe	-	Clear
29 Jan 2015	45.2	5	~5	O/f from pipe	-	Clear

Figure 54: Waihunuhunu Inlet 2, Orakei Korako in Jan 2015

The heat of the water can be seen as it flows out of the pipe.

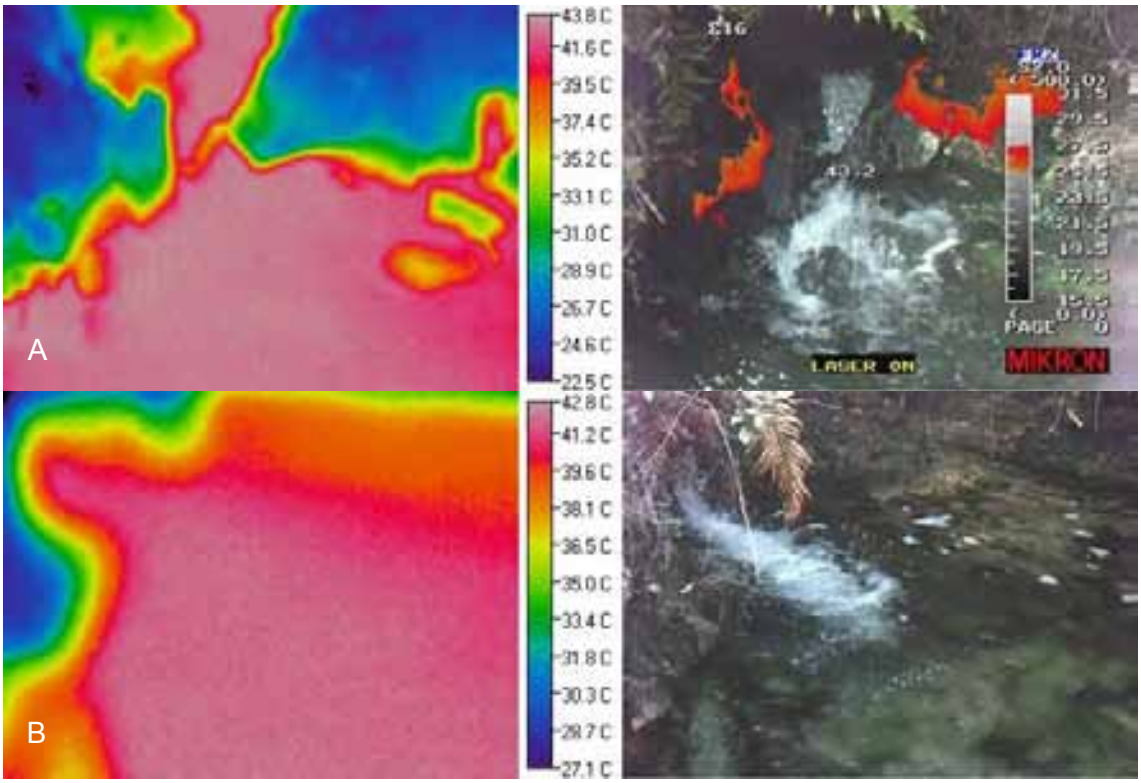

Figure 55: Infrared photos of Waihunuhunu Inlet 2, Orakei Korako, Jan 2014 (A) and Jan 2015 (B)

5 Reporoa

5.1 Butcher's Pool

- E1891720 N5738576

The algal growth near the outlet has decreased in extent since the previous visit in February 2014. There has been a colour change to a darker green. The temperature has decreased by 1.2 °C and the pH has dropped from pH 7-8 to pH 6 since the previous visit. There were no bathers at either monitoring visit.

Table 23: Data from Butcher's Pool, Reporoa

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
04 Feb 2014	41.0	7-8	nd	o/f	Effervescing all over pool	Cloudy, green
21 Jan 2015	39.8	6	nd	o/f	Effervescing all over pool	Clear, green

Figure 56: Butcher's Pool, Reporoa in Feb 2014 (A) and Jan 2015 (B)

Figure 57: Algal growth at Butcher's Pool, Reporoa in Feb 2014 (A) and Jan 2015 (B)

5.2 Wharepapa Road

- **Fumaroles**
  E1890802 N5742769

The fumaroles are situated in a paddock and are not fenced off. There have been a few temperature differences, with the majority of the fumaroles decreasing in temperature, apart from vent number 3 (see Table 24). Some of the vents have changed slightly in size. Vent 6 is dry ground which has cooled significantly since the previous visit.

The photo below shows the location of the fumaroles (vent 5 is off shot).

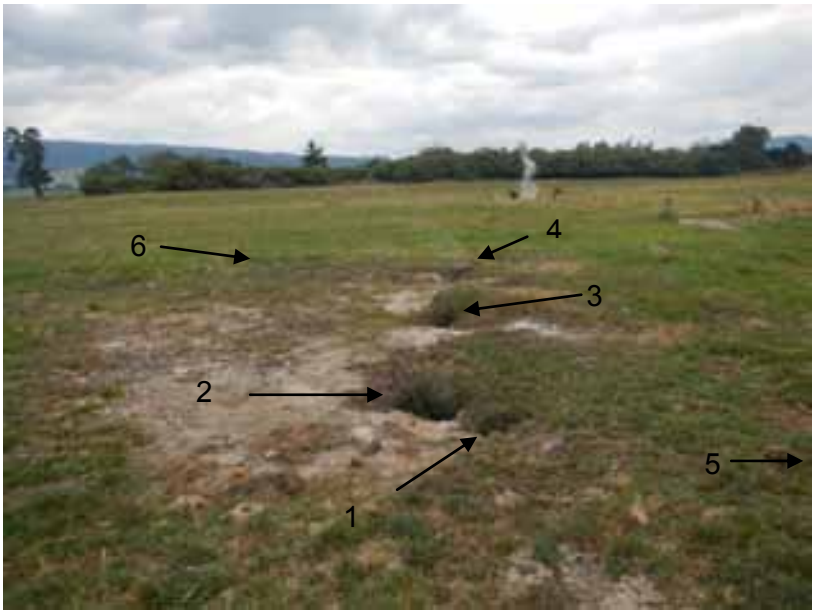

Figure 58: Overview of Fumaroles at Wharepapa Road, Reporoa

Table 24: Data from Fumaroles, Reporoa

Date	Vent	T(°C)	Flow	Depth (m)	Diameter (m)	Ebullition	Colour
04 Feb 2014	1	68.5	nd	~1.0	0.2x0.28	Audible gas discharge	Black mud
28 Jan 2015	1	50.0	nd	~1.0	0.1x0.28	Audible gas discharge	Black mud
04 Feb 2014	2	60.9	nd	~1.1	0.73x0.5	Audible gas discharge	Black mud
28 Jan 2015	2	46.9	nd	~0.9	0.6x0.45	Audible gas discharge	Black mud
04 Feb 2014	3	87.4	nd	~2.07	0.43x0.34	Audible gas discharge	Black mud
28 Jan 2015	3	75.8	nd	~1.2	0.4x0.35	Audible gas discharge	Black mud
04 Feb 2014	4	49.1	nd	~2.4	0.58x0.9	Audible gas discharge	Black mud
28 Jan 2015	4	46.7	nd	~2.4	0.5x0.7	Audible gas discharge	Black mud
04 Feb 2014	5	51.9	nd	~0.22	0.75x0.9	Audible gas discharge	nd
28 Jan 2015	5	49.8	nd	~0.3	0.6x0.5	Audible gas discharge	nd
04 Feb 2014	6	53	nd	ground level	0.88x1.07	nd	nd
28 Jan 2015	6	39	nd	ground level	0.88x1.07	nd	nd

Figure 59: Feb 2014: Vents 1 & 2 (A), 3 (B), 4 (C), 5(D), 6 (E); Jan 2015: Vents 1 & 2 (F), 3 (G), 4 (H), 5(I), 6 (J)

The infrared photos below depict the heat emanating from Vents 4, 5 and 6. Vents 4 and 5 are hottest at the bottom. Vent 6 is warm ground, which is hottest to the right of the bare patch of earth.

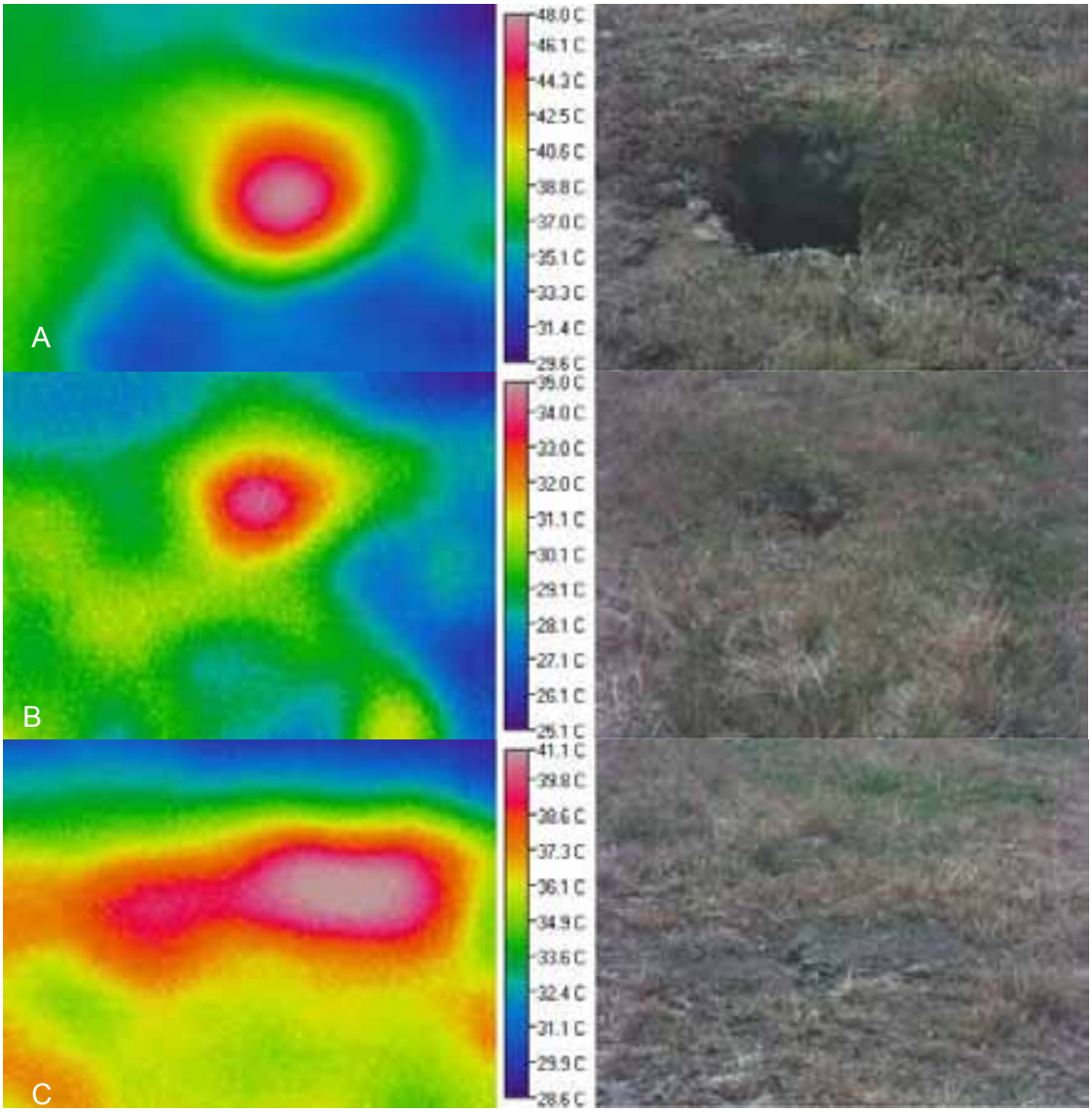

Figure 60: Infrared photos of Vents 4 (A), 5 (B) and 6 (C)

- **Figure 8 shaped pools**
  E1890786 N5742843

The small pool had an 11.5 °C temperature increase since the previous visit in February 2014. The larger pool was flowing into the smaller pool during surges.

Table 25: Data from Figure 8 shaped pools, Reporoa

Date	Pool	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
04 Feb 2014	Large	96.6	8-9	nd	-	Constant discharge, surging	Brown, murky
28 Jan 2015	Large	96.6	8	nd	-	Constant discharge, surging	Brown, murky
04 Feb 2014	Small	83.7	7-8	nd	-	Small bubbles	Brown, murky
28 Jan 2015	Small	95.2	8	nd	-	Calm	Brown, murky

Figure 61: Figure 8 shaped pools, Reporoa in Feb 2014 (A) and Jan 2015 (B)

The infrared photo in February 2014 was taken while the large pool was surging. The hottest areas of the pool appear to be where the ebullition is most apparent. In January 2015 the smaller pool appears to be hottest, however, there was a lot of steam which can affect the readings due to the steam's cooling down quickly.

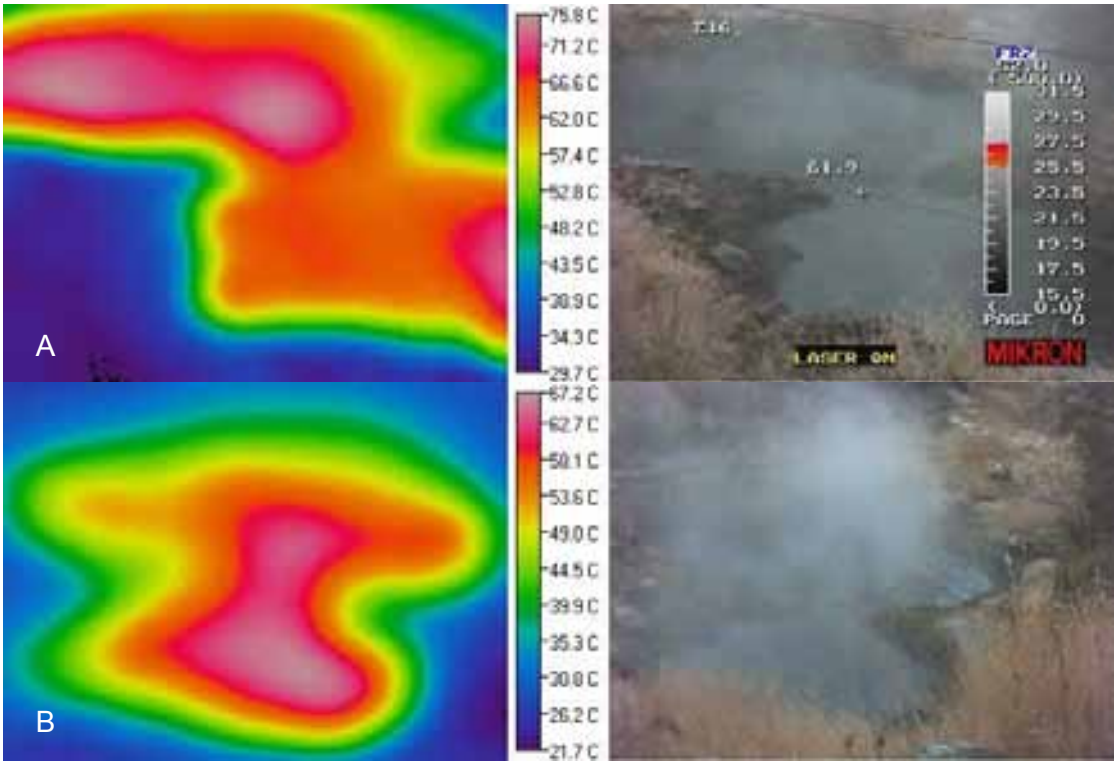

Figure 62: Infrared photo of Figure 8 pools, Reporoa in Feb 2014 (A) and Jan 2015 (B)

- **Hot Pool 3**
  E1890848 N5742777

This pool has been fenced off; however, the fence posts were black and the wires loose and broken. The outflow appears to be a man made channel leading into a drainage system. There is sinter lining the channel. There was a large amount of steam. The pH had decreased from pH 8 to pH 7 since February 2014.

Table 26: Data from Hot Pool 3, Reporoa

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
04 Feb 2014	93.7	8	1 – 2	o/f	Calm	Clear, blue
28 Jan 2015	94.0	7	1 – 2	o/f	Calm	Clear, blue

Figure 63: Hot pool 3, Reporoa in Feb 2014 (A&B) and Jan 2015 (C&D)

- **Hot Pool 4**
  E1891154 N5743025

It was too hazardous to get close enough to get a sample for pH, as the ground is unstable and the pool emits gas. The temperature was measured with the IR gun, and showed a 1.9 °C decrease in temperature since the previous visit in February 2014. The water level had dropped and the colour of the pool changed from grey to brown.

Table 27: Data from Hot Pool 4, Reporoa

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
04 Feb 2014	73.2	nd	nd	~1.2 m below rim	Constant gas discharge	Murky, grey
28 Jan 2015	71.3	nd	nd	~1.5 m below rim	Constant gas discharge	Murky, brown

Figure 64: Hot Pool 4, Reporoa in Feb 2014 (A) and Jan 2015 (B)

The hottest part of the pool appears to be to the left of the pool. In January 2015, the ground in front of the pool also appears to be warm.

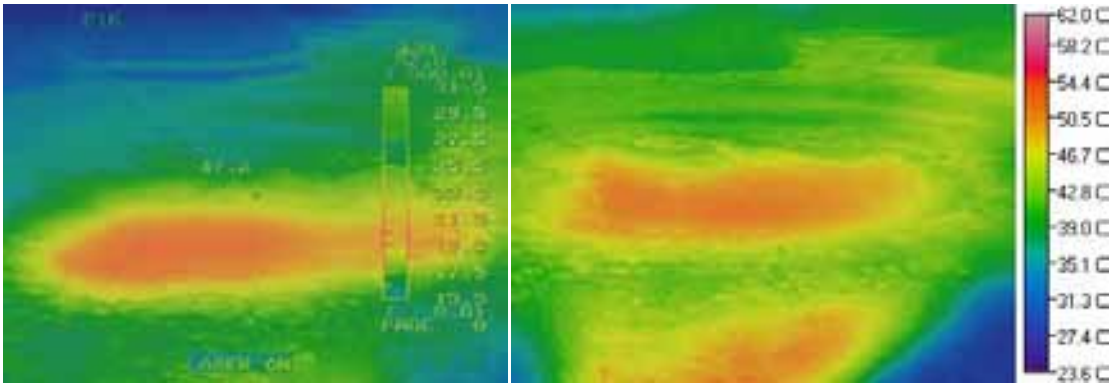

Figure 65: Infrared photos of Hot pool 4, Reporoa in Feb 2014 (A) and Jan 2015 (B)

5.3 Longview Road

- **Lake**

A large part of the lake surface was covered in a foamy substance. Matt Stott from GNS says that their understanding is that it is a eutrophic water body, meaning that it has lots of organic matter. The 'scunge' on top is most likely a combination of aerobic microorganisms and plant biomass that is being blown around the lake. The appearance of the scunge changes depending on the wind velocity and direction. There was less scunge on the surface during the January 2015 visit than in the previous visit in January 2013.

Table 28: Data from Lake, Longview Road, Reporoa

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
23 Jan 2013	31.7	3	nd	Nd	Effervescing	Green, murky
28 Jan 2015	33.7	3	nd	Nd	Effervescing	Green, murky

Figure 66: Lake, Longview Road, Reporoa in Jan 2013 (A&B) and Jan 2015 (C&D)

The infrared photo shows that the warmest area of the pool is in the foreground of the photo where most of the effervescing is occurring.

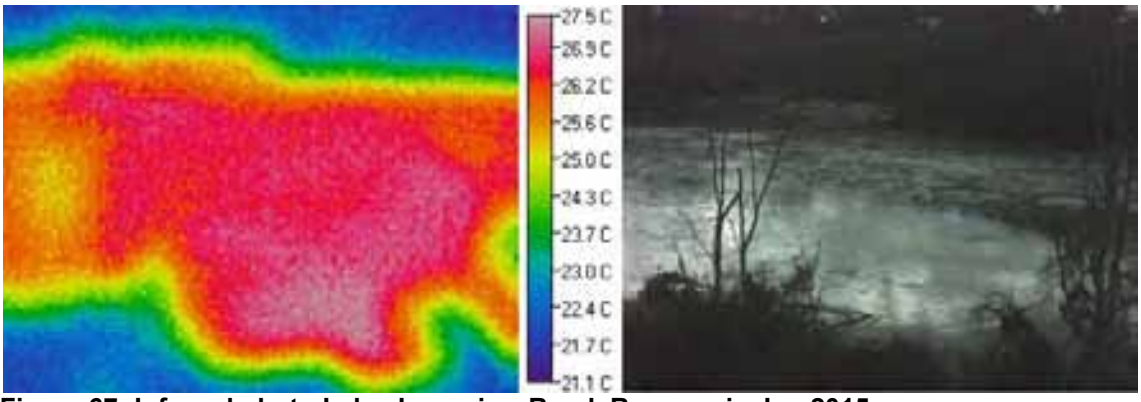

Figure 67: Infrared photo Lake, Longview Road, Reporoa in Jan 2015

- **Mud Pool**

There were various mud pools in the area; we chose to sample the large one close to the lake. The water level in February 2015 was slightly higher than it had been in February 2014. There was also a temperature decrease of 2.6 °C. The ground surrounding the mud pools was cracked and too hazardous to get close to the pool.

Table 29: Data from Mud pool, Longview Road, Reporoa

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
04 Feb 2014	27.6	3	nd	0.75 m below rim	Constant gas discharge	Murky, brown
28 Jan 2015	25.0	nd	nd	0.65 m below rim	Constant gas discharge	Murky, brown

Figure 68: Mud pool, Longview Road, Reporoa in Feb 2014 (A), Jan 2015 (B)

6 Rotokawa

6.1 Lagoon Springs

- **RK3**

There have been changes in ebullition and colour (see Table 30) between the January 2014 and January 2015 visits.

Table 30: Data from RK3, Rotokawa

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
29 Jan 2014	50.9	3	nd	Nd	Constant discharge	Cloudy, pale milky green
21 Jan 2015	51.7	3	nd	o/f	Small areas of discharge around edge of pool	Clear, green/grey

Figure 69: RK3, Rotokawa in Jan 2014 (A&B) and Jan 2015 (C&D)

- **RK4**

The wind changed during the January 2015 visit; therefore we could not get close enough to get the temperature due to high levels of gas.

Table 31: Data from RK4, Rotokawa

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
29 Jan 2014	80.2	2-3	nd	o/f into RK3	Constant discharge	Murky, grey/green
21 Jan 2015	nd	3	nd	o/f into RK3	Constant discharge	Clear

Figure 70: RK4, Rotokawa in Jan 2014 (A) and Jan 2015 (B)

7 Tauhara

7.1 Lake Taupo Shore

- **Taharepa Spring**
  E1882989 N5733159; Located number 1197.1

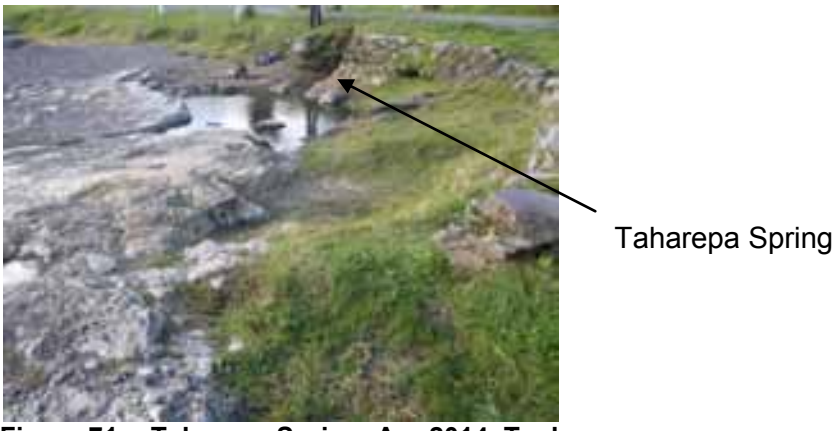

Figure 71: Taharepa Spring, Apr 2014, Tauhara

Apart from the main Taharepa Spring, there are several small springs feeding into the main pool. The spring temperature had a slight fluctuation of 6.9 ºC. There was an oily film on the water surface in July 2014.

There were no bathers present during the April and July 2014 monitoring visits.

Table 32: Data from the Taharepa Spring, Tauhara

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	57.2	5-6	seep	Nd	No gas	Clear
10 July 2014	63.3	6	seep	nd	No gas	Clear
21 Jan 2015	64.1	6-7	seep	Nd	No gas	Clear

Figure 72: Taharepa Spring, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared photos in Figure 73 show the heat emanating from the spring as it flows out of the rock and makes its way into Lake Taupo.

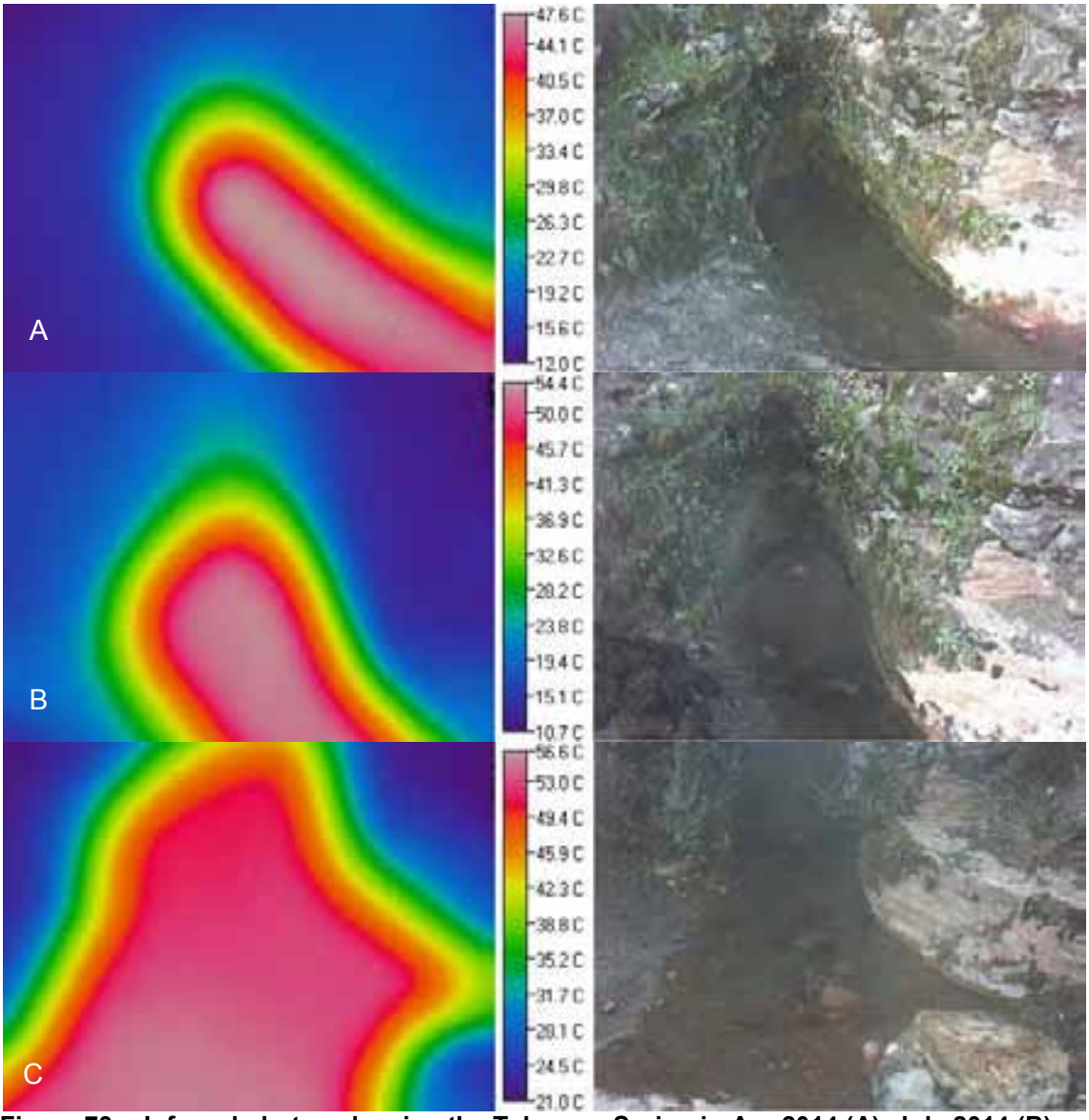

Figure 73: Infrared photos showing the Taharepa Spring in Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Rocky Point Spring**
  E1868286 N5711795; Located number 72.2988

There were no bathers near the spring at any of the monitoring visits. The lake level was above the spring in January 2015.

Table 33: Data from the Rocky Point Spring, Tauhara

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	66.0	6-7	<0.5	o/f	Constant	Clear
10 July 2014	66.7	8	~0.5	o/f	Constant	Clear
21 Jan 2015	65.2	nd	nd	-	-	-

Figure 74: Rocky Point Spring, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared photos in Figure 75 show the origin and path of the water from the spring as it flows into Lake Taupo. In January 2015 the lake level was washing over the top of the spring, therefore the heat dissipated quickly as it flowed out of the spring.

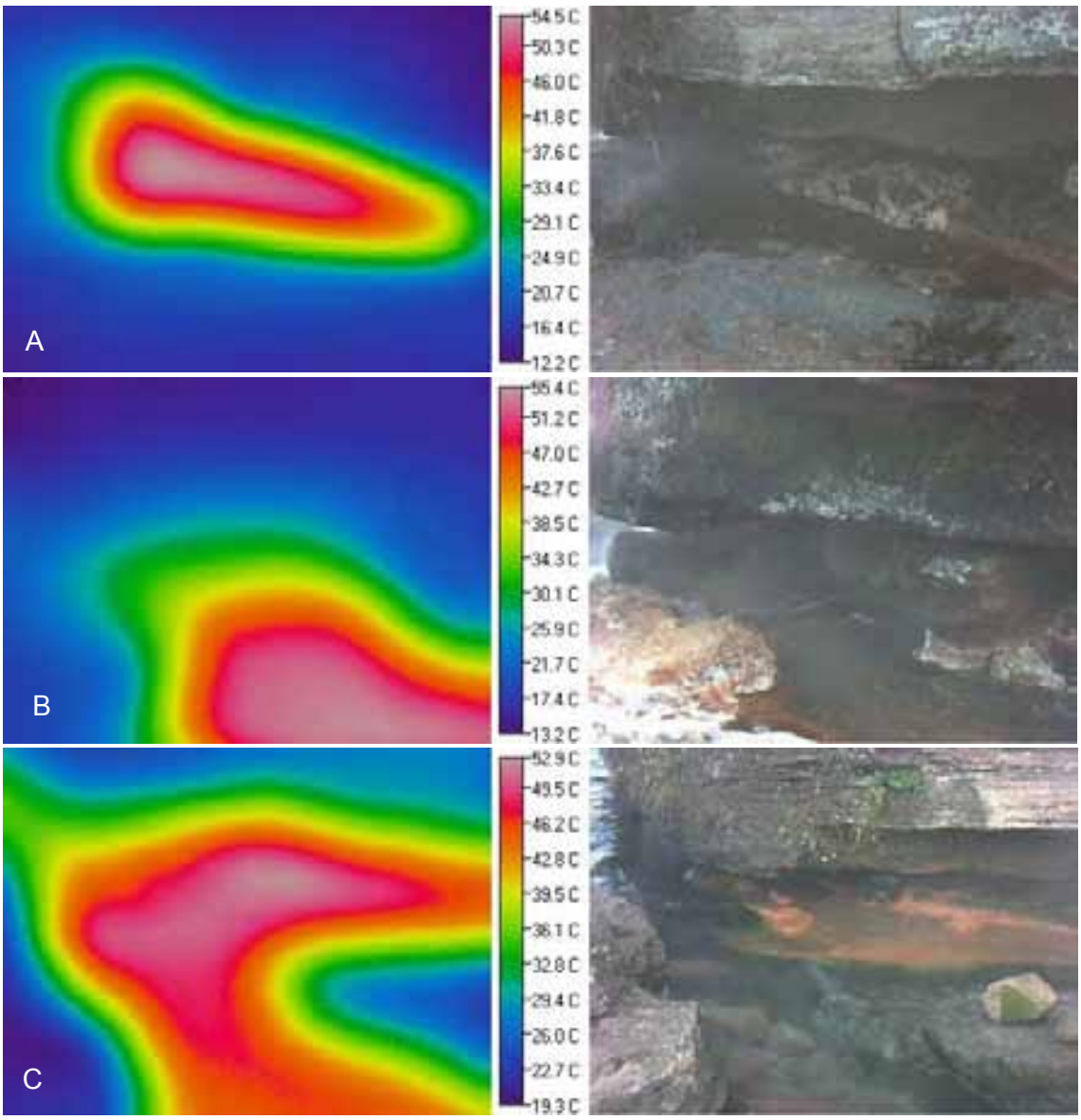

Figure 75: Infrared photos of Rocky Point Spring in Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

7.2 Otumuheke

- **End of Ponga**
  E1869102 N5715081

The site is at the end of the ponga fence next to the Spa Hotel. There were green algae on the stream bed during all visits. The temperature and pH have remained fairly consistent. The flow was less in April 2014 than usual.

In July 2014 it was noted that the bank was undercut and eroding, there was scum floating on the water and there was orange sediment on the edge of the stream.

Table 34: Data from the Otumuheke Stream, the end of the Ponga fence, Tauhara

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
29 Apr 2014	47.8	6-7	15-20	nd	Calm	Clear
10 July 2014	48.5	7	20-30	nd	Calm	Clear
17 Feb 2015	50.8	6-7	20-30	nd	Calm	Clear

Figure 76: Otumuheke Stream, Apr 2014 (A), July 2014 (B) and Feb 2015 (D)

- **Confluence under bridge**

The site is located on the bridge next to the Spa Hotel. There were algae on the bed of both streams. The right tributary appears to have iron flock. There was a significant increase in temperature of the right tributary between July 2014 and January 2015. The Otumuheke Stream was warmest in February 2015. The pH was variable in both streams throughout the monitoring period.

Table 35: Data from the right tributary to the Otumuheke Stream by the bridge, Tauhara

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
29 Apr 2014	37.9	5-6	nd	nd	Calm	Clear
10 July 2014	37.4	7	2-3	nd	Calm	Clear
17 Feb 2015	51.9	6-7	5	nd	Calm	Clear

Table 36: Data from the Otumuheke Stream by the bridge, Tauhara

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
29 Apr 2014	46.7	5	15-20	nd	Calm	Clear
10 July 2014	46.7	7	~20-30	nd	Calm	Clear
17 Feb 2015	50	6-7	20-30	nd	Calm	Clear

Figure 77: Otumuheke Stream, Apr 2014 (A), July 2014 (B) and Feb 2015 (C)

- **Spa Thermal Park**

The Otumuheke Stream runs into the Waikato River in Spa Thermal Park. Table 37 details the numbers of bathers present at the time of visiting the area.

In July 2014 there were also 6 people leaving the area that may have been bathing.

The area was not visited in January 2015.

Table 37: Data from Spa Thermal Park, Tauhara

Date	Time	No. Of Bathers	No. Of Bystanders
29 Apr 2014	12:45	39	10
10 July 2014	15:15	17	13

Figure 78: Otumuheke Stream, Spa Thermal Park, Tauhara

7.3 Waipahihi Source

- **Source Spring**
  E1869804 N5711669; Located number 72.2989

The temperature fluctuated slightly over the period.

Table 38: Data from the Waipahihi Source Spring, Tauhara

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	67.8	7-8	<0.5	Overflowing	Calm	Clear
10 July 2014	66.3	7	<0.5	Overflowing	Calm	Clear
17 Feb 2015	65.0	7	<0.5	Overflowing	Calm	Clear

Figure 79: Waipahihi Source, Apr 2014 (A) and July 2014 (B)

The infrared photos in Figure 80 show the hot area where the spring is situated and the flow path into the stream.

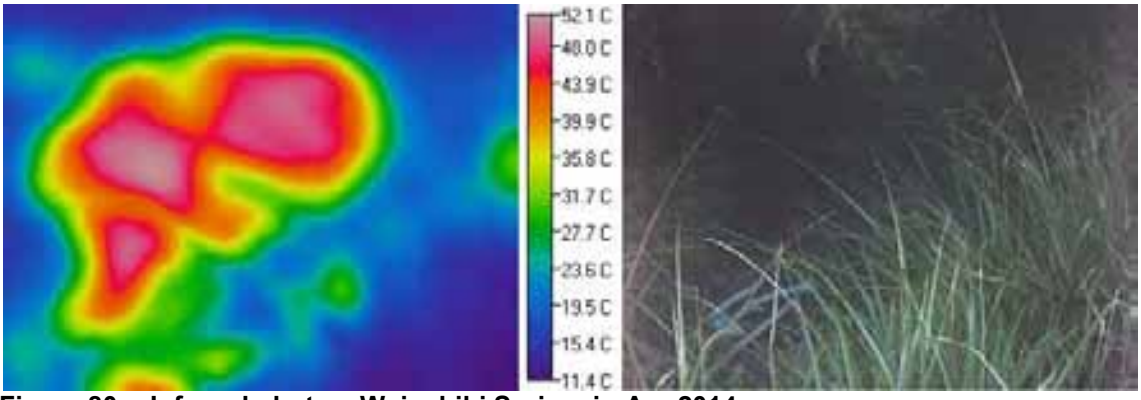

Figure 80: Infrared photos, Waipahihi Spring, in Apr 2014

- **New Spring**

This is a spring that has formed near the weir. There are new deposits of exposed sinter and the stream appears to be widening. Yellow/green algae are growing on the streambed and on the sinter. The grass around the spring has grown, making it difficult to see the spring itself. Temperature, pH and flow fluctuate slightly throughout the monitoring period; however there are no significant changes.

Table 39: Data from the New Spring, Waipahihi, Tauhara

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	63.5	6	<0.5	Overflowing	Calm	Clear
10 July 2014	63.6	7	<0.25	Overflowing	Calm	Clear
17 Feb 2015	63.9	7	<0.5	Overflowing	Calm	Clear

Figure 81: New Spring, Apr 2014 (A), July 2014 (B) and Feb 2015 (C)

The infrared photos below show the flow of the water as it leaves the spring. Another small spring to right of the photo is adding hot water. The flow from these springs joins the Waipahihi Stream just below the weir.

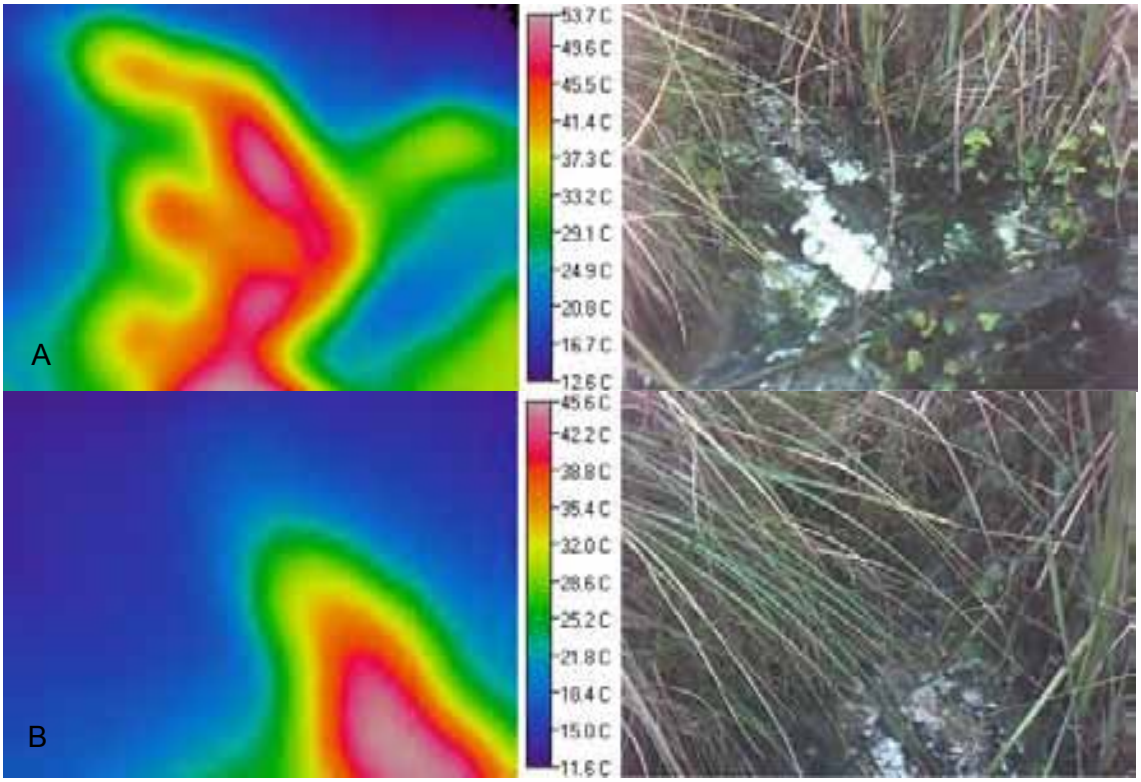

Figure 82: Infrared photos of New Spring, Tauhara, Apr 2014 (A) and July 2014 (B)

8 Te Kopia

Located number 72.2117

8.1 Mud Geyser and associated pools

- **Large pool and mud volcano**
  E1880802 N5744756

WRC staff could not access the large pool and mud volcano in January 2014 or January 2015. The Department of Conservation have installed a boardwalk into the area which provides an easily accessible vantage point for the large pool; however, this doesn't allow access to the mud volcano. The area around the pool has changed with new mud pools opening up, making it too hazardous to access the mud volcano due to limited ground visibility and increased gas discharge.

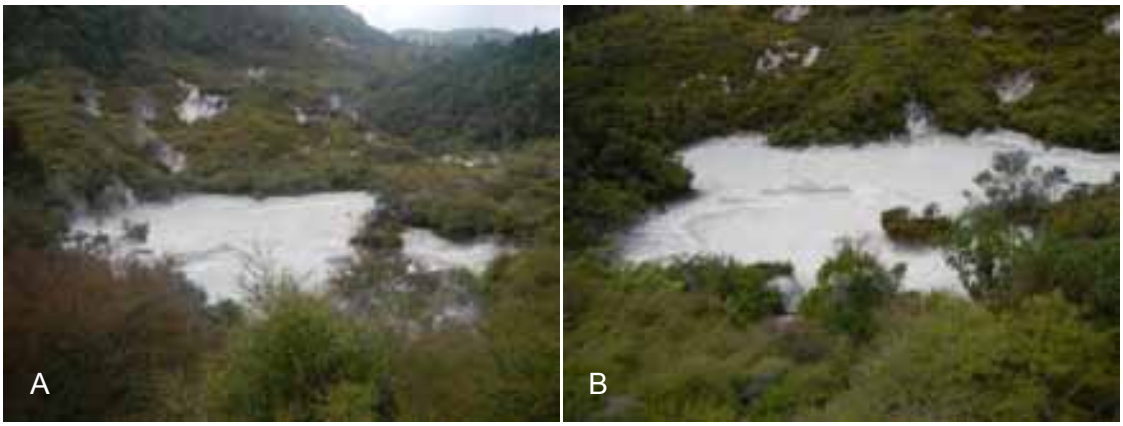

Figure 83: Large pool, Te Kopia, Jan 2014 (A) and Jan 2015 (B)

- **Large Pool and Mud Geyser on Geyser Ridge**
  E1880758 N5744696

The temperature of the pool has risen by 5.3 °C since the previous visit in January 2014. The mud geyser could not be seen due to the drop in water level and the increased sediment around the rim.

Table 40: Data from the large pool on Geyser Ridge, Te Kopia

Date	T(°C)	Flow (l/s)	Level (m)	Ebullition	Colour
30 Jan 2014	51.7	nd	~8 m below rim	Constant, vigourous	Murky, brown/grey
29 Jan 2015	57.0	nd	~8 m below rim	Constant	Murky, brown/grey

Figure 84: Large Pool and Mud Geyser, Te Kopia, Jan 2014 (A&B) and (C&D), Jan 2015

The large pool on Geyser Ridge appears to be warmest at a vent to the left of the mud geyser. Several hot spots can be seen in the January 2014 photo.

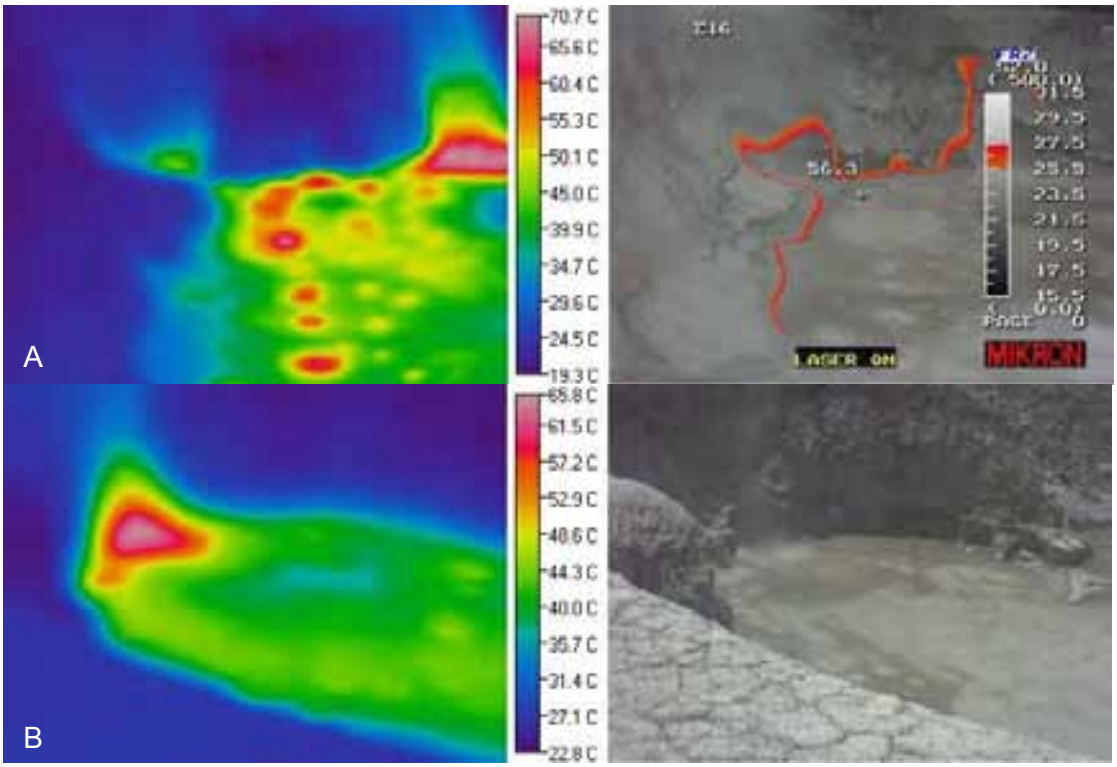

Figure 85: Infrared photos, Large Pool on Geyser Ridge, Te Kopia in Jan 2014 (A) and Jan 2015 (B)

- **Small Mud Pool on Geyser Ridge**
  E1880750 N5744694

There was a large increase in temperature (22 °C) since the previous visit in January 2014.

Table 41: Data from the small mud pool on Geyser Ridge, Te Kopia

Date	T(°C)	Flow (l/s)	Depth (m)	Diameter (m)	Ebullition	Colour
30 Jan 2014	35	Little steam	nd	~1.3 x 2.1	Calm	Light grey mud
30 Jan 2014	57	Little steam	nd	~1.3 x 2.1	Calm	Light grey mud, dry

Figure 86: Small mud pool on Geyser Ridge, Te Kopia in Jan 2014 (A), Jan 2015 (B)

The hottest part of the mud pool appears to be near the front of the pool.

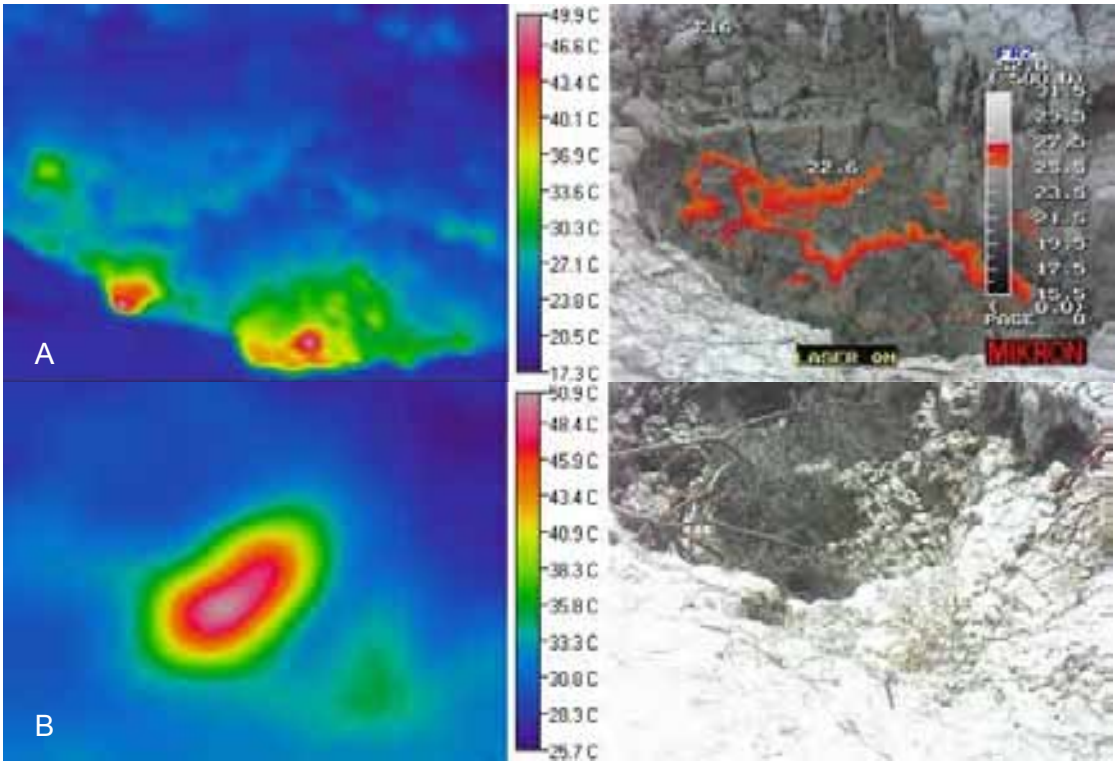

Figure 87: Infrared photos, small mud pool on Geyser Ridge, Te Kopia in Jan 2014 (A) and Jan 2015 (B)

8.2 Mud Pools (Tomos) on west of Te Kopia Road

- **TK8**

The temperature has decreased by 30.4 °C since the previous visit in January 2014. There is vigorous activity in the vent and there is mud splatter surrounding TK8. We could not access the far side of the vent (hence the differing photos in Figure 91 A&B) due to the large amount of mud splatter extending through the trees.

Table 42: Data from TK8 on Te Kopia Road

Date	T(°C)	pH	Flow (l/s)	Depth to water	Ebullition	Colour
30 Jan 2014	98.4	-	Steam	3-4 m below lower rim	Vigorous discharge	Brown/grey mud and water
29 Jan 2015	68.0	-	Steam	3-4 m below lower rim	Vigorous discharge	Grey mud

Figure 88: TK8, Te Kopia in Jan 2014 (A&B), Jan 2015 (C&D)

- **Doom**

There was vigorous activity in the vent and recent mud splatter in front of the vent. The temperature has dropped; however, it was too hazardous to get close to the vent, which means the probe may not have reached the hottest area of the vent.

Table 43: Data from Doom on Te Kopia Road

Date	T(°C)	pH	Flow (l/s)	Depth to water	Ebullition	Colour
30 Jan 2014	97.7	-	-	6 m below top rim	Vigorous discharge	Brown/grey mud and water
29 Jan 2015	89.0	-	-	6 m below top rim	Vigorous discharge	Grey mud

Figure 89: Doom, Te Kopia, Jan 2014 (A) and Jan 2015 (B)

Figure 90: Doom, Te Kopia, Jan 2014 (A) and Jan 2015 (B)

- Pools by the stream

The temperature could not be read during the January 2015 visit, as the whole are was hot and the ground was soft, making it too hazardous to reach the mud pool.

Table 44: Data from Mud pools by the stream on Te Kopia Road

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
30 Jan 2014	57	-	-	Non visible	Audible discharge	Grey mud
29 Jan 2015	nd	-	-	Non visible	Audible discharge	Grey mud

Figure 91: Mud pools by stream, Te Kopia in Jan 2014 (A), Jan 2015 (B)

The main mud pool can be seen in the infrared photo below. The heat appears to be consistent at the base of the pool; there are also several hot spots further up the bank from the pool.

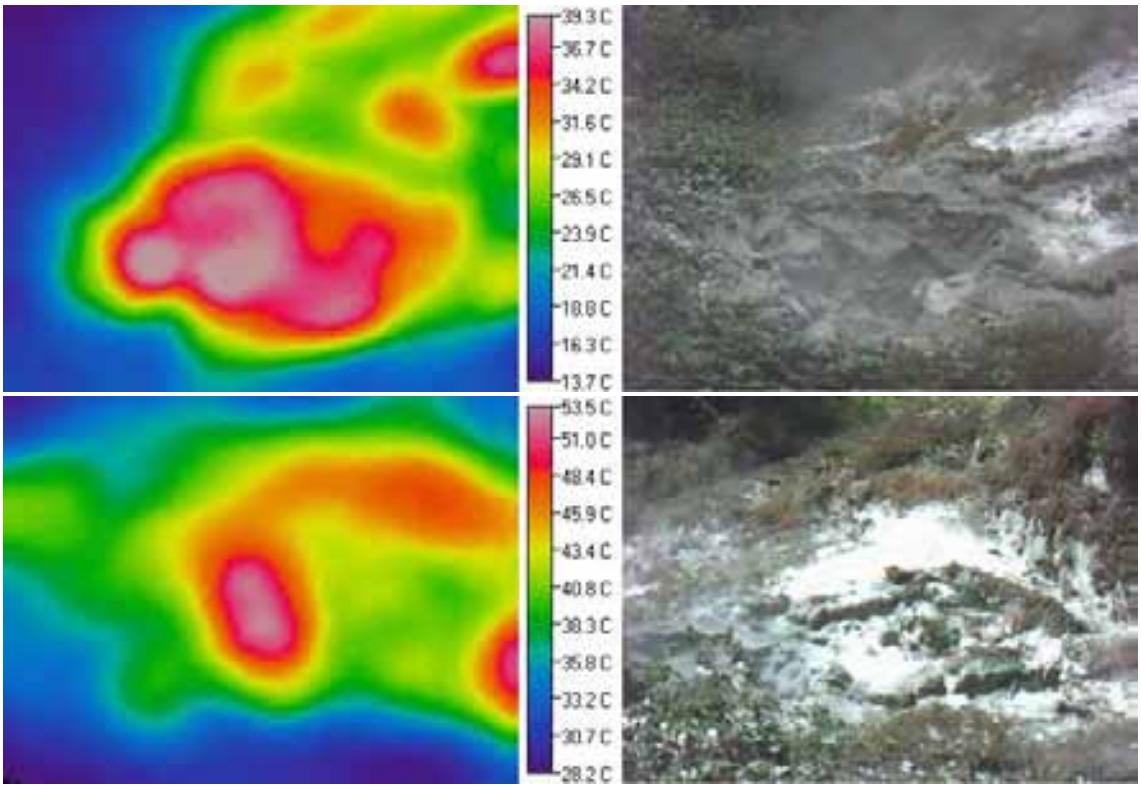

Figure 92: Infrared photos of mud pools by stream, Te Kopia, Jan 2014 (A) and Jan 2015 (B)

9 Waikite

9.1 Waikite Swimming Pool area

- **Manaroa Pool**
  E1888904 N5752722; Located number 72.4227

There have been slight temperature fluctuations over the period. The pH is consistent; however, it was not measured in April 2014 due to equipment limitations. In April 2014, the pool was surging vigorously up to one metre.

Table 45: Data from Manaroa Pool, Waikite

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	97.4	nd	~40-50	Overflowing	Vigorous upwelling	Clear, deep blue
09 July 2014	96.6	7-8	~40-50	Overflowing	Vigorous	Clear, blue
20 Jan 2015	97.0	8	~40-50	Overflowing	Vigorous upwelling in centre	Clear, blue

Figure 93: Manaroa Pool, Apr 2014 (A), July 2013 (B), Sept 2013 (C), Jan 2015 (D)

Hot Pool Supply Gully

- **Upper Supply Spring**
  E1888866 N5752705; Located number 72.4227

The spring could not be accessed in July 2014 due to a new outflow being installed at the Lower supply spring. In April 2014, a tree had fallen over and was hanging into the pool.

Table 46: Data from Upper Supply Spring, Waikite

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	93.6	7-8	Piped	Overflowing	Vigorous	Clear
21 Jan 2015	97	8	Piped	Overflowing	Vigorous	Clear

Figure 94: Upper Supply Spring, Apr 2014 (A) and Jan 2015 (B)

- **Lower Supply Spring**

  Located number 72.4228

There are two areas of discharge associated with this spring, which flow into the same pool. The temperature and pH fluctuate slightly with each visit. It July 2014 it was noted that a new outflow has been installed. More works had been done by January 2015.

Table 47: Data from Lower Supply Spring, Waikite

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	93.3	8-9	Piped	Overflowing	Vigorous	Clear
09 July 2014	94.7	8	Piped	Overflowing	Vigorous	Clear
20 Jan 2015	94.7	8	Piped	Overflowing	Vigorous	Clear

Figure 95: Lower Supply Spring, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Pool adjacent to Lower Supply Spring**

The temperature of the pool increased by 7.3 ºC between July 2014 and January 2015. The pH also dropped slightly over this time.

Table 48: Data from Pool adjacent to Lower Supply Spring, Waikite

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	80.5	7-8	<0.5	Overflowing	Upwelling	Clear
09 July 2014	80.4	7-8	<0.5	Overflowing	Constant small upwelling in centre	Clear
20 Jan 2015	87.7	7	<0.5	Overflowing	Constant upwelling	Clear

Figure 96: Pool adjacent Lower Supply, Apr 2014 (A), July 2014 (B) and Jan 2015 (D)

The infrared photo below shows that the heat of the pool originates from the centre and cools as it nears the edges.

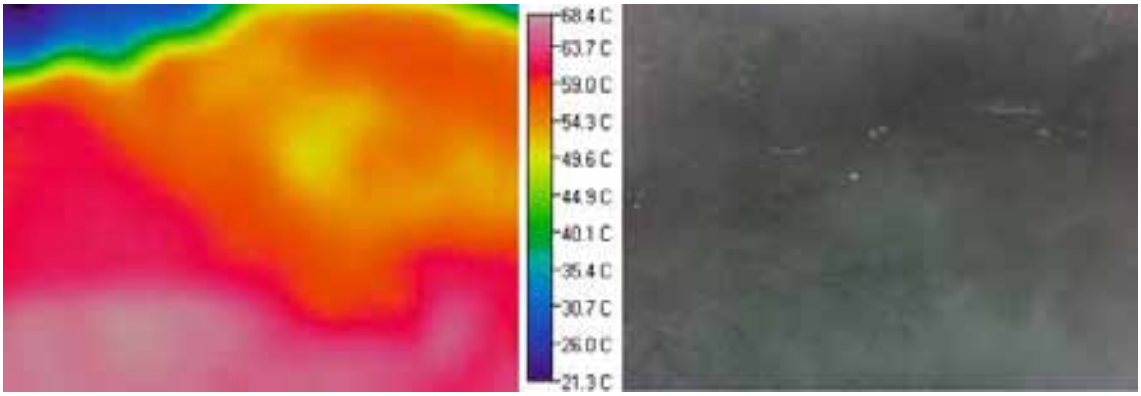

Figure 97: Infrared photo of Pool adjacent Lower Supply, Apr 2014

9.2 DOC Reserve on Landcorp Farm

- **Scalding Spring**

This spring is located in a stock paddock and therefore has been fenced off to protect stock. A slightly submerged sinter shelf extends ~1 metre from the edge before the pool becomes very deep. The clarity of the water allows visibility to a depth of at least 5 m, although the bottom of the pool is not visible at this depth. The pool flows on to a sinter terrace and forms a small stream which leads into the Otamakokore Stream. There were no major changes to the pool. The temperature fluctuated slightly over the period.

April 2014: Part of the fence had fallen over.

July 2014: The pool discharge was surging up to about 0.5 l/s

Table 49: Data from Scalding Spring, Waikite

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	93.9	7-8	<0.5	Overflowing	Upwelling @ outlet	Clear, blue
09 July 2014	92.2	8	<0.5	Overflowing	Constant upwelling near outlet, surging	Clear, blue
20 Jan 2015	92.4	8	<0.5	Overflowing	Upwelling @ outlet	Clear, blue

Figure 98: Scalding Spring, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared photo below shows that the main area of heat in the pool is near the outlet where the upwelling occurs.

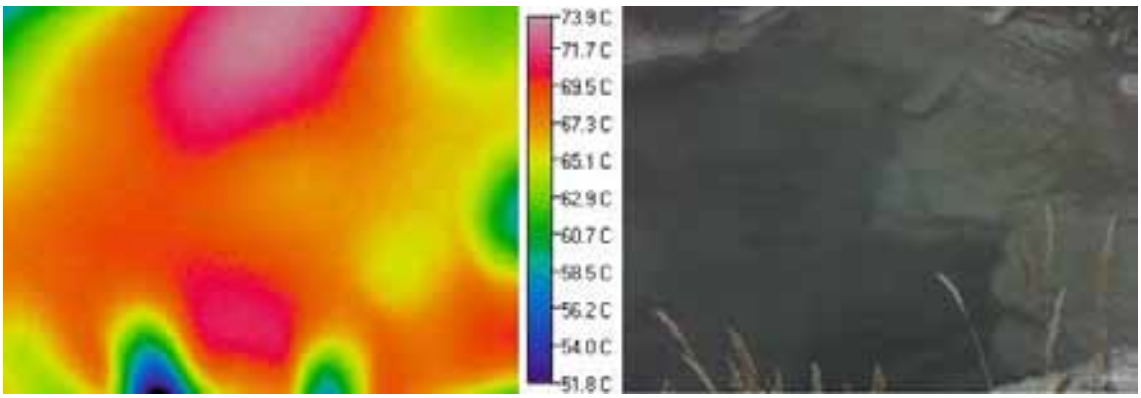

Figure 99: Infrared photo of Scalding Spring, Waikite, Jan 2015

- **Waikite Scarp and Spring**
  Located number 72.4393

The spring discharges into a small stream which flows onto the sinter terraces. There is new sinter both in the channel and on the margins of the stream. The terrace that the stream flows onto appears to have green and yellow algae growing on it.

April 2014: The vegetation appears different, there are some areas of dead plants and it looks like it has been flattened. The vegetation by the spring seems to have grown over the spring more, making it hazardous to reach the spring itself. Measurements were taken in the stream by the corner. The trees that have been planted have grown up to 2-2.5 m tall.

July 2014: The stream was too overgrown to access the spring. Some of the bracken has died off, and it was unclear whether it has been sprayed or the ground is heating up.

January 2015: Due to the die back of the vegetation we could reach the lower spring, hence the increase in temperature, as the two previous readings were taken further downstream.

Table 50: Data from Spring, Waikite Scarp

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	65.1	9-10	<0.5	-	-	Clear
09 July 2014	65.1	8-9	<0.5	-	-	Clear
20 Jan 2015	97.3	8-9	<0.5	-	-	Clear

Figure 100: Hot stream (A), and discharge area onto terraces (B) and (C), Apr 2014

Figure 101: Hot stream (A) and (B) discharge area onto terraces (C) and (D), July 2014

Figure 102: Hot spring (A), Hot stream (B) and discharge area onto terraces (C&D), Jan 2015

The warm water can be seen flowing over the sinter terrace of the Waikite Scarp in the infrared photos below.

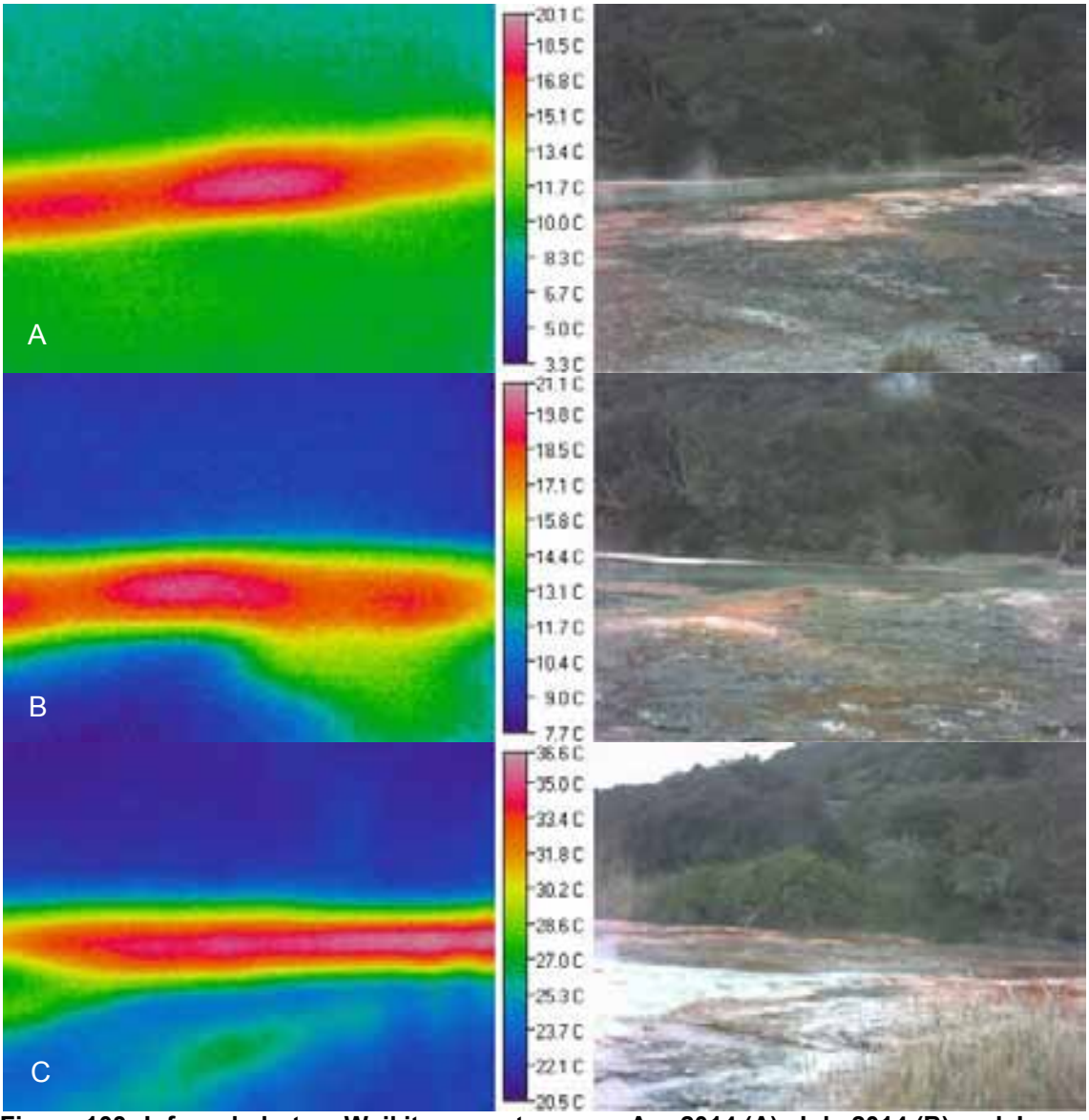

Figure 103: Infrared photos, Waikite scarp terraces, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

10 Waiotapu

10.1 Tourist Walk

- **Weather Pool**
  E1894318 N5749245

The temperature fluctuates throughout the monitoring period, ranging from 46.8 ºC to 58.9 ºC. This could be due to the amount of steam present as this will affect the reading with the IR gun. There are slight variations in the colour of the pool.

Table 51: Data from Weather Pool, Waiotapu

Date	T(°C)	Water level	Ebullition	Colour
28 Apr 2014	46.8	Overflowing	Calm	Cloudy, blue/grey
09 July 2014	58.9	Not overflowing	Occasional bubbles	Cloudy, pale/green
20 Jan 2015	48.2	Overflowing	Calm	Cloudy, pale green

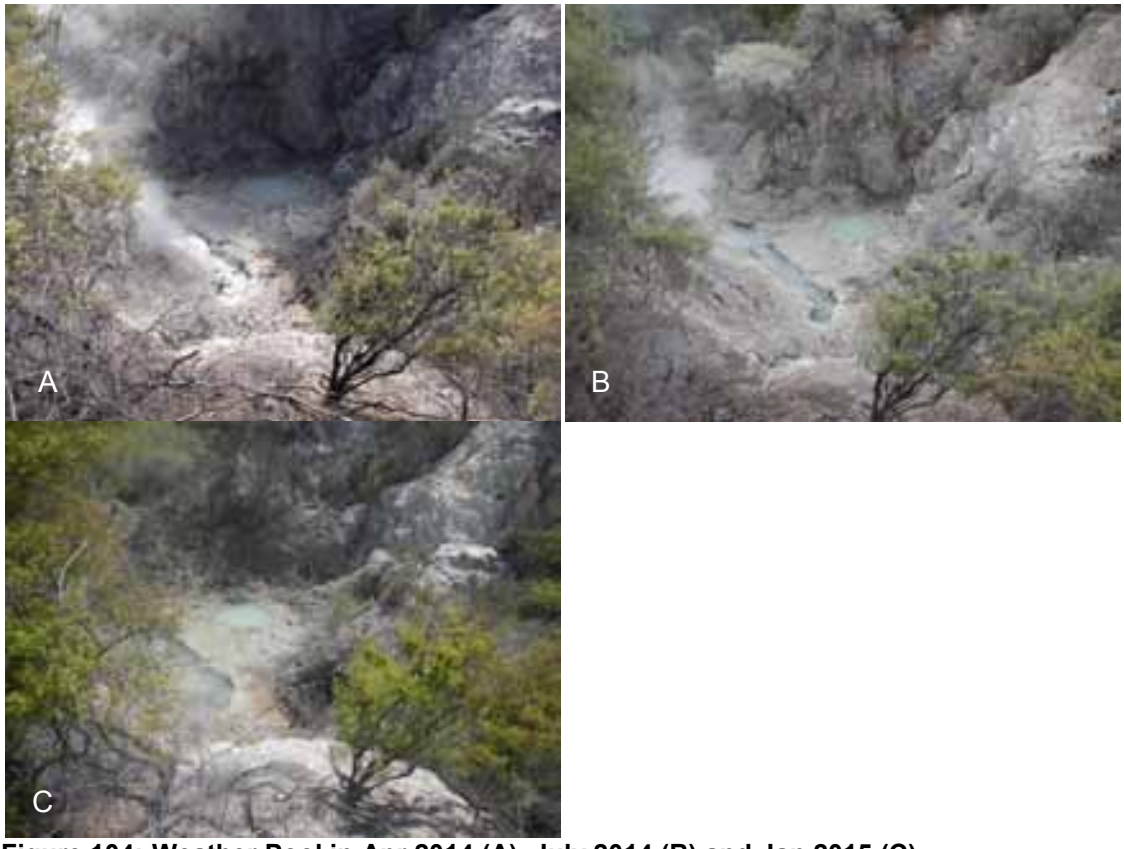

Figure 104: Weather Pool in Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared images in Figure 105 show that the hottest area of the weather pool is on the right hand side of the pool near the outlet. There is a small area of heat in front of the pool, and the hot stream beside it can be seen.

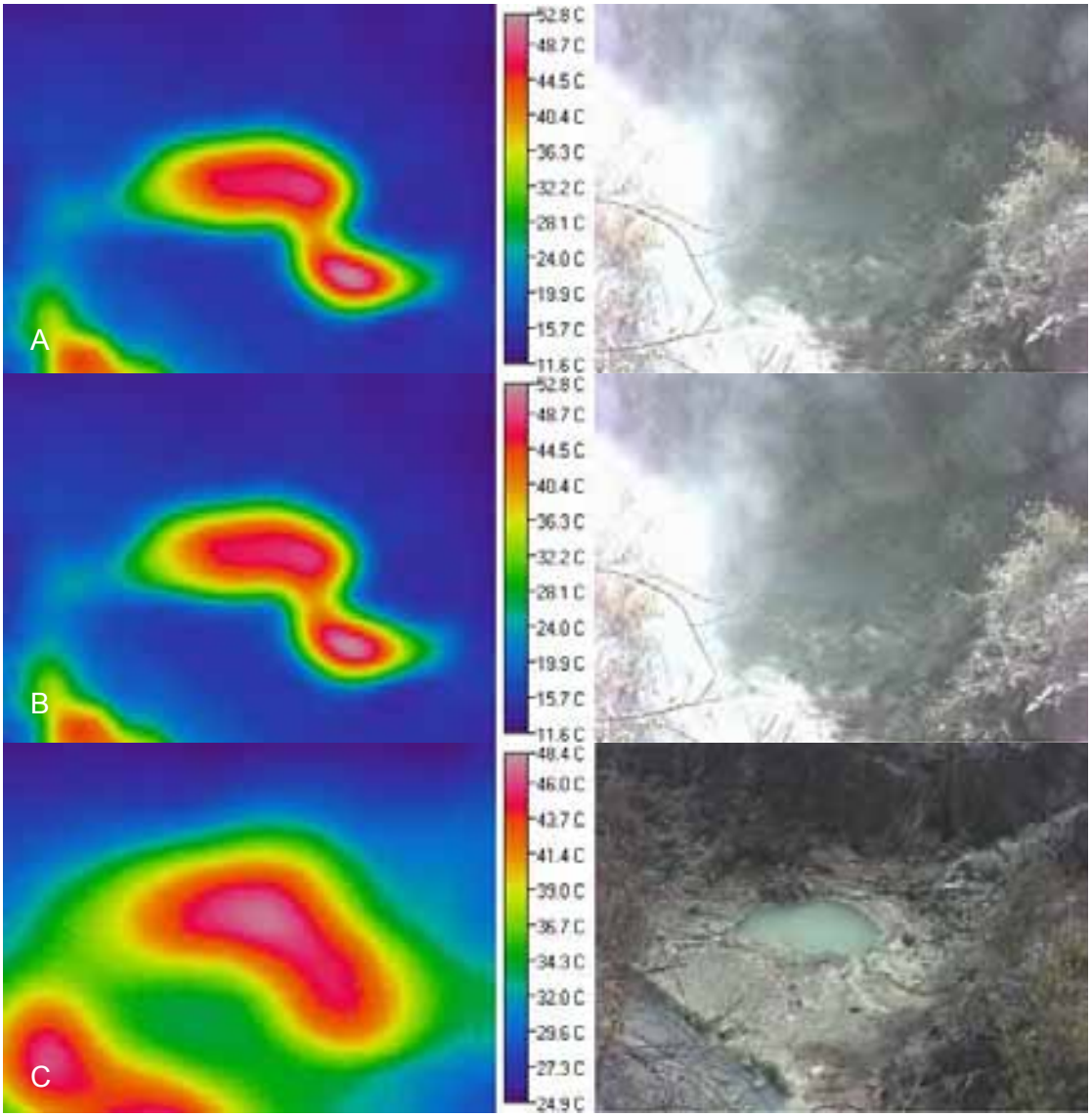

Figure 105: Infrared photos of Weather Pool, Waiotapu, April 2014 (A), July 2014 (B) and Jan 2015 (D)

- **Pool north of Jean Batten Geyser**

The pool appears to be thermally inactive, with the warmest temperature reading of 31.7 ºC throughout the monitoring period. The pH was not measured in April 2014. The colour has varied during the period.

Table 52: Data from Pool north of Jean Batten Geyser, Waiotapu

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	22.7	nd	nd	Submerged	Calm	Clear
09 July 2014	13.2	4	nd	Submerged	Calm	Cloudy, blue
20 Jan 2015	31.7	5-6	nd	Ground level	Calm	Clear

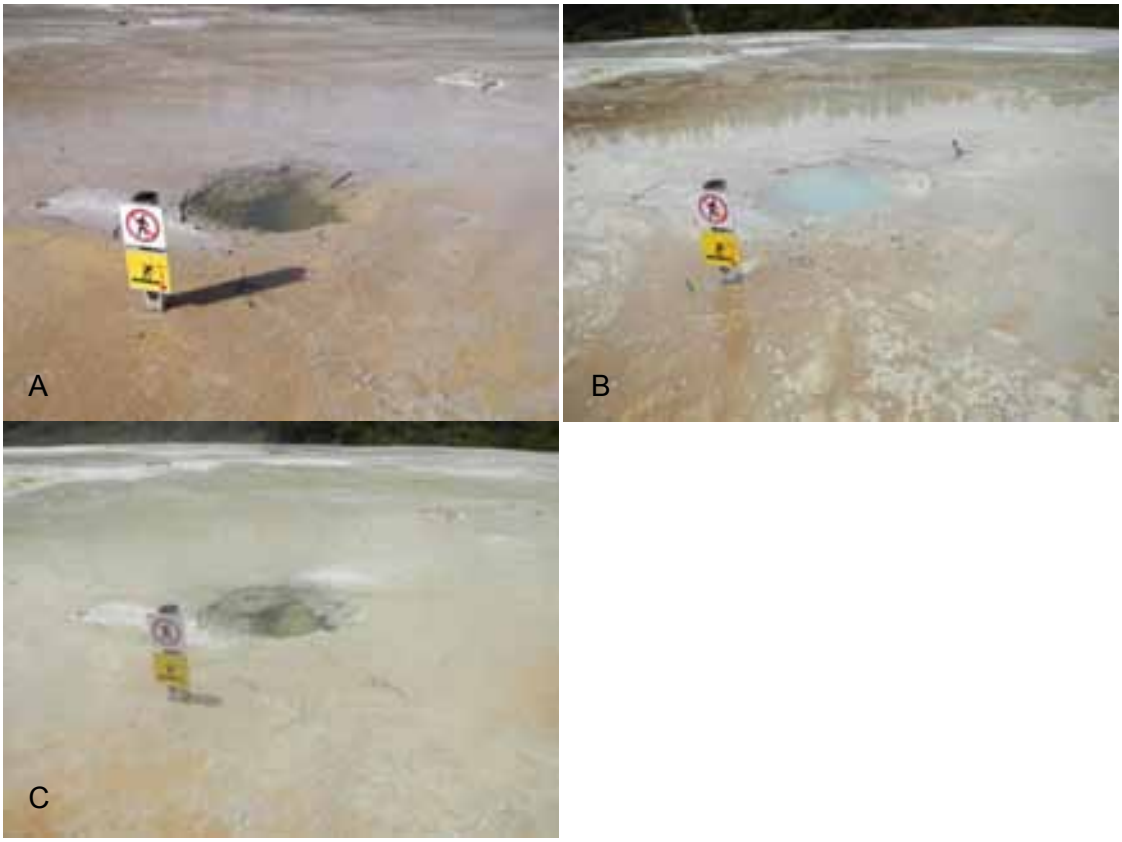

Figure 106: Pool N of Batten, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared photos below show that the ground in front of the pool was warmer than the pool in April 2014. In July 2014 there is a slight temperature difference in the pool, however, the whole area is cold.

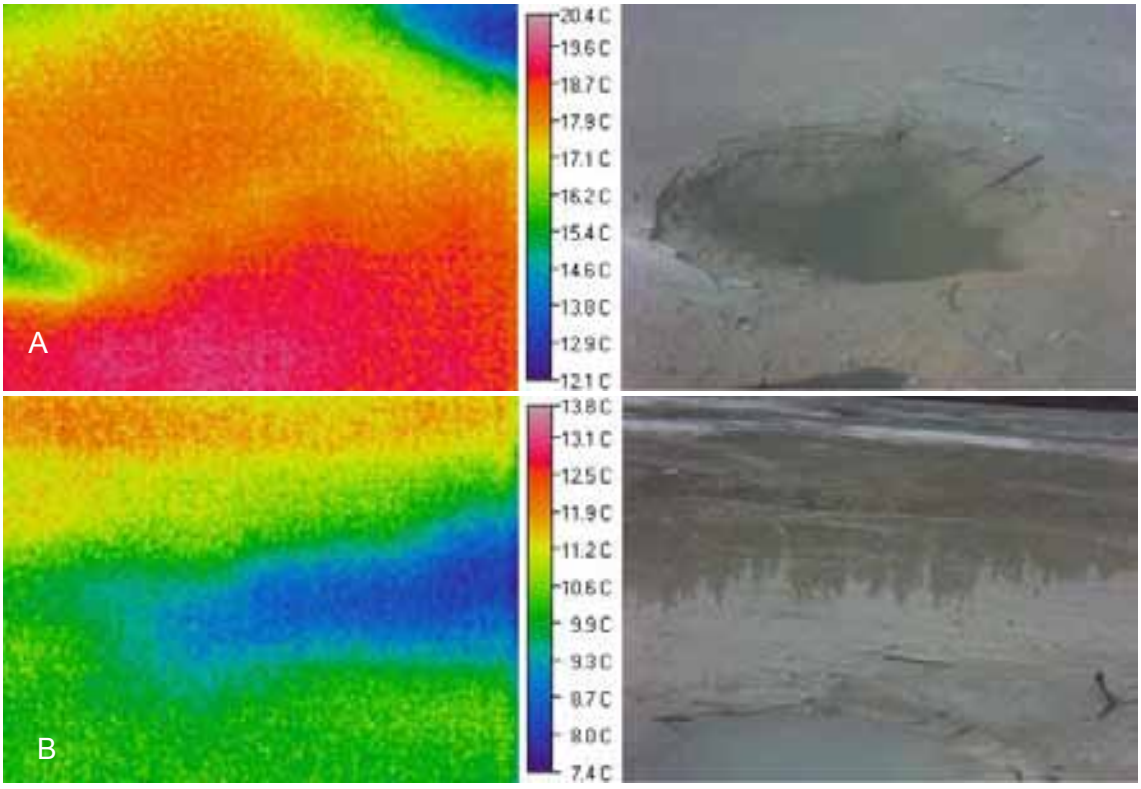

Figure 107: Infrared photos, pool next to the Jean Batten Geyser in Apr 2014 (A) and July 2014 (B)

- **Jean Batten Geyser**

The temperature was low during the April 2014 and January 2015 visit; this may be due to the thermocouple not reaching the water.

Table 53: Data from Jean Batten Geyser, Waiotapu

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	18.1	nd	Inflow from terrace	No visible water	-	-
09 July 2014	94.6	nd	nd	No visible water	Audible gas discharge (hissing), steaming	-
20 Jan 2015	36	nd	Inflow from terrace	No visible water	Audible bubbling	-

Figure 108: Jean Batten Geyser, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared photos in Figure 109 show the heat emanating from the geyser and the direction that the steam is blowing in April and July 2014. In January 2015 the ground in front of the geyser appears to be hotter than the geyser itself.

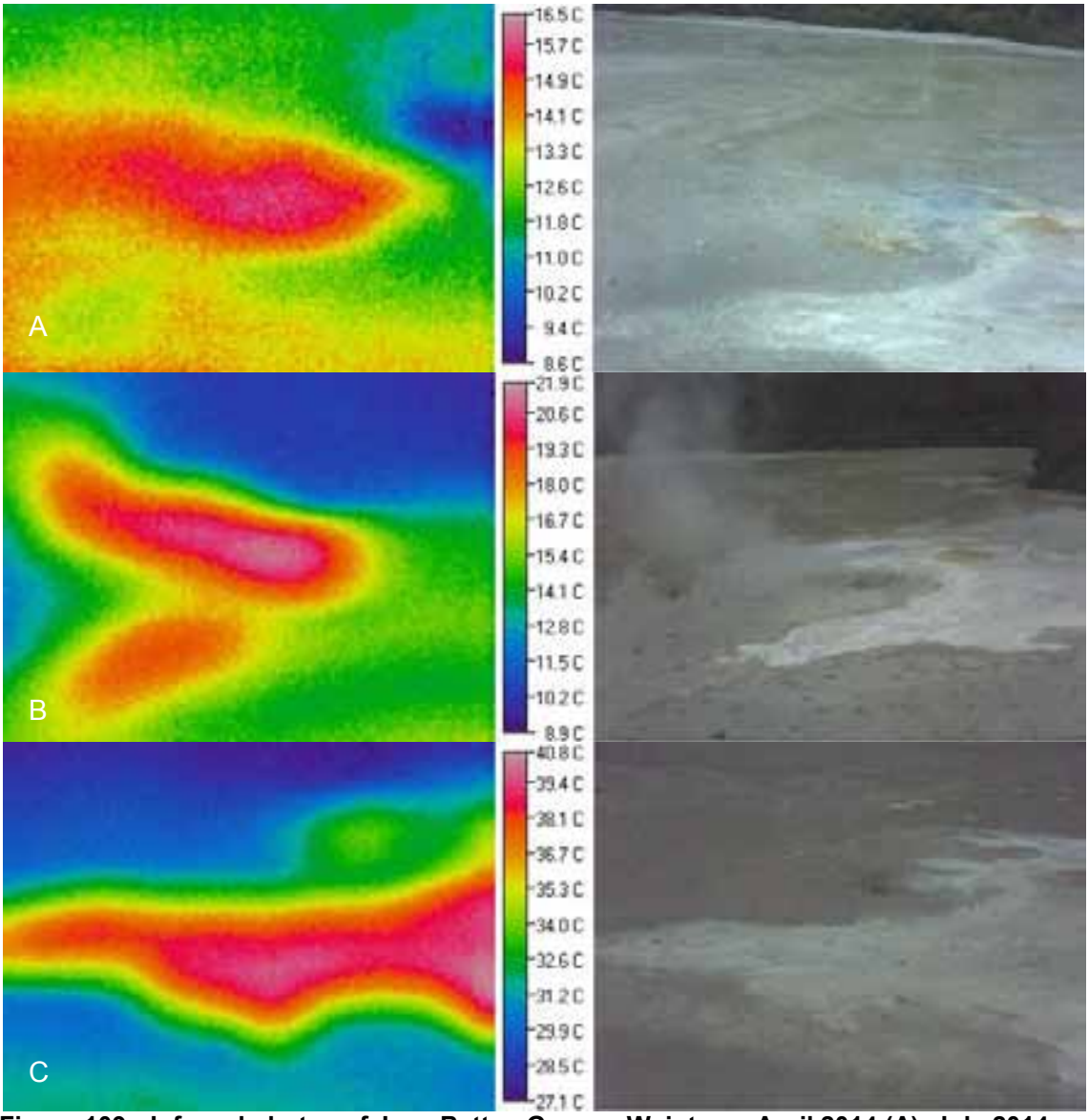

Figure 109: Infrared photos of Jean Batten Geyser, Waiotapu, April 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Sinter Terraces**

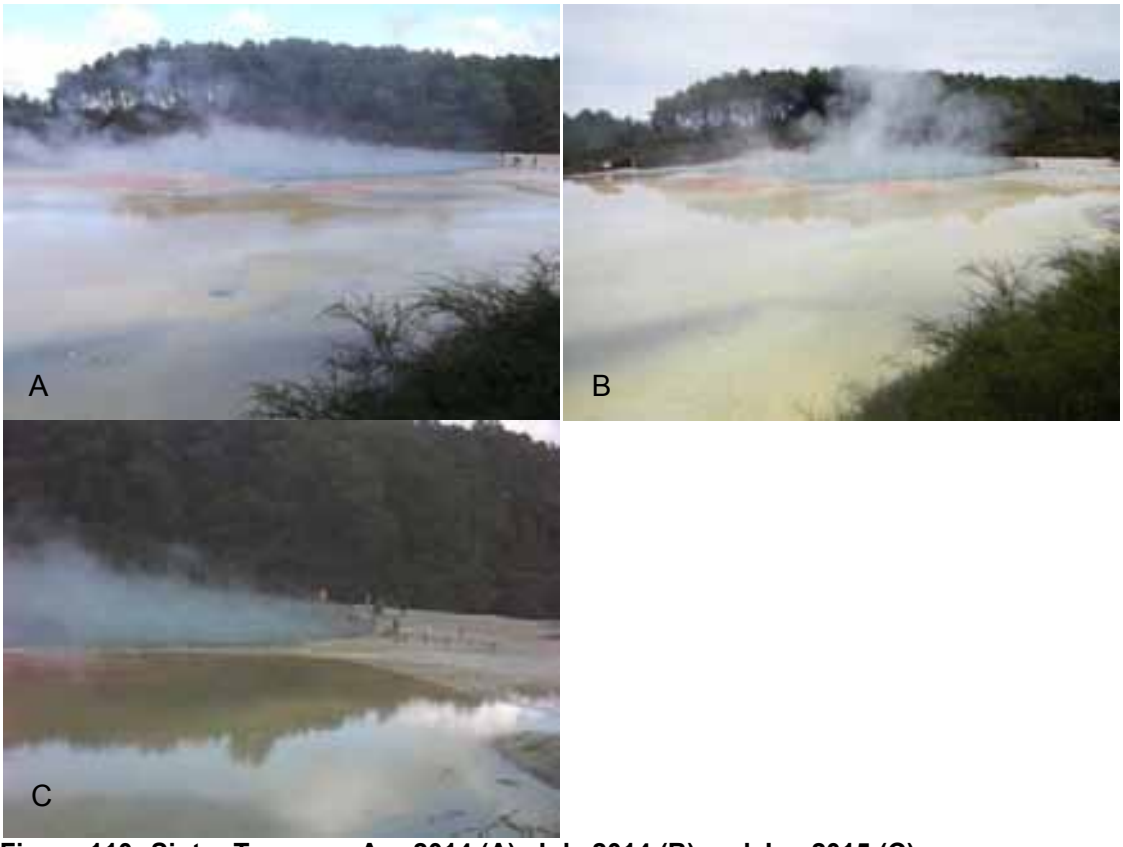

Figure 110: Sinter Terraces, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared image provides a good indication of the heat generated by the Champagne pool and its rapid dissipation over the Artists Palette.

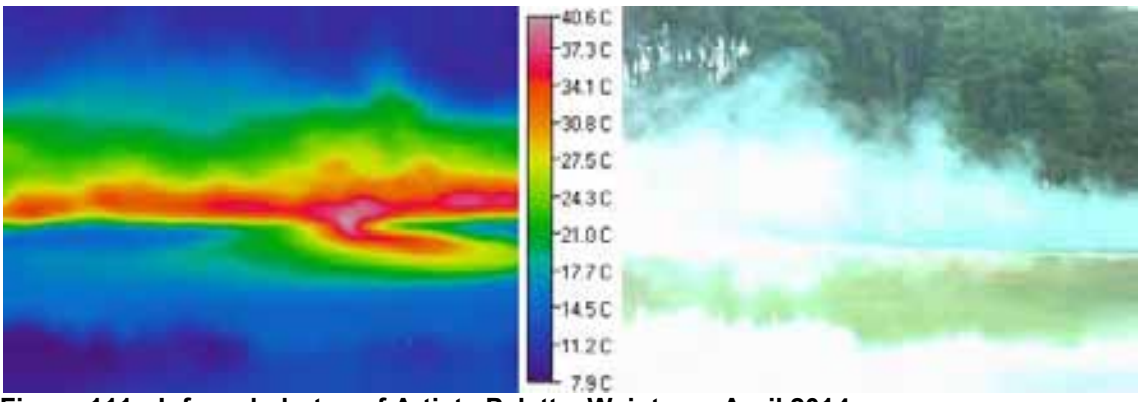

Figure 111: Infrared photos of Artists Palette, Waiotapu, April 2014

- **Sinter Terraces – Yellow coloured vent**

The colour is quite variable.

Table 54: Data from Sinter Terraces – Yellow coloured vent, Waiotapu

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	nd	nd	-	submerged	Calm	yellow
09 July 2014	nd	nd	-	submerged	Small bubbles	Cloudy, yellow/green
20 Jan 2015	nd	nd	-	submerged	Calm	Pale green/ blue

Figure 112: Yellow coloured vent, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

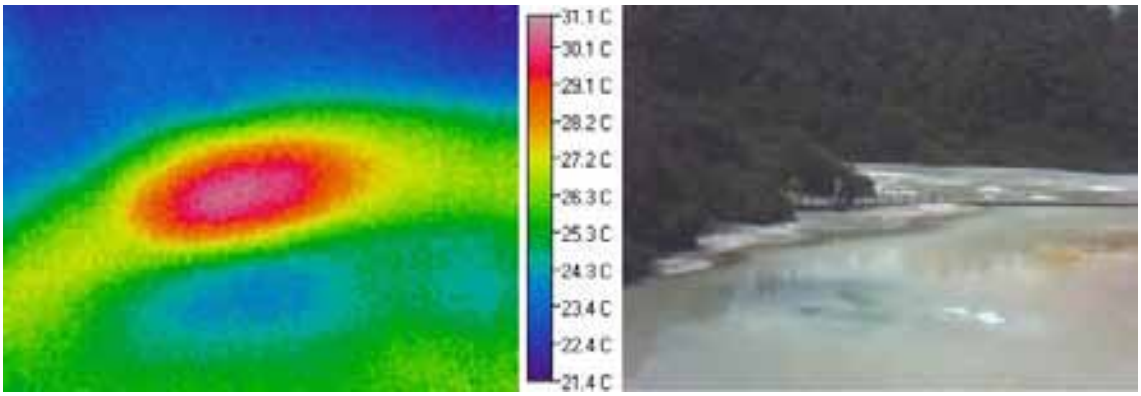

Figure 113: Infrared photos of Yellow Pool, Waiotapu, Jan 2015

- **Sinter Terraces – Foreground Pool**

The temperature is taken using the IR gun from the platform, which is some distance away so may not be accurate. The temperature of the pool has risen from 57.8 ºC in April 2014 to 68.0 ºC in January 2015. There were minor fluctuations in colour and ebullition.

Table 55: Data from Sinter Terraces – Foreground Pool, Waiotapu

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	57.8	nd	-	Submerged	Calm	Cloudy, blue/grey
09 July 2014	59.3	nd	-	Not overflowing	Effervescing	Clear, blue/green
20 Jan 2015	68.0	nd	seep	Overflowing	Effervescing	Clear, green

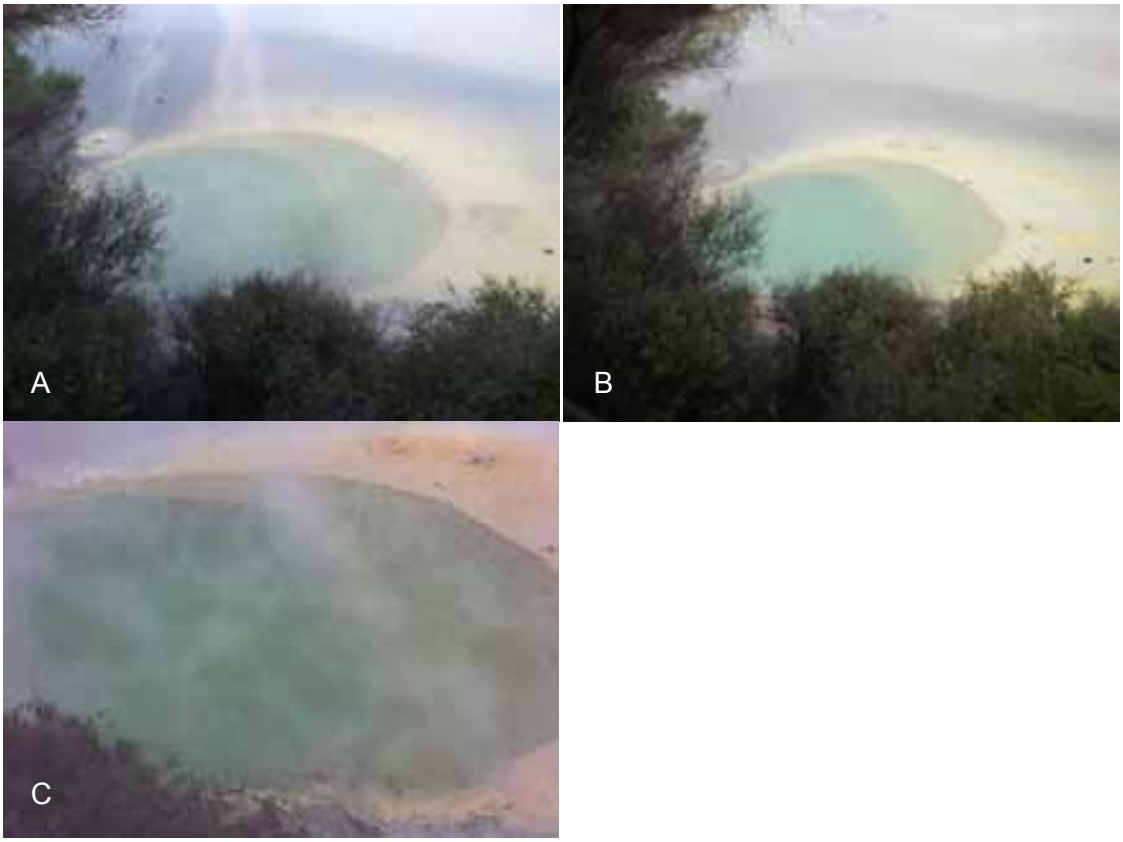

Figure 114: Foreground Pool, Apr 2014 (A), Jun 2014 (B) and Jan 2015 (C)

The pool heat seems to be evenly spread throughout the pool (Figure 115). The differences in temperature observed in the infrared photo are most likely due to the steam distorting the temperature reading of the pool itself.

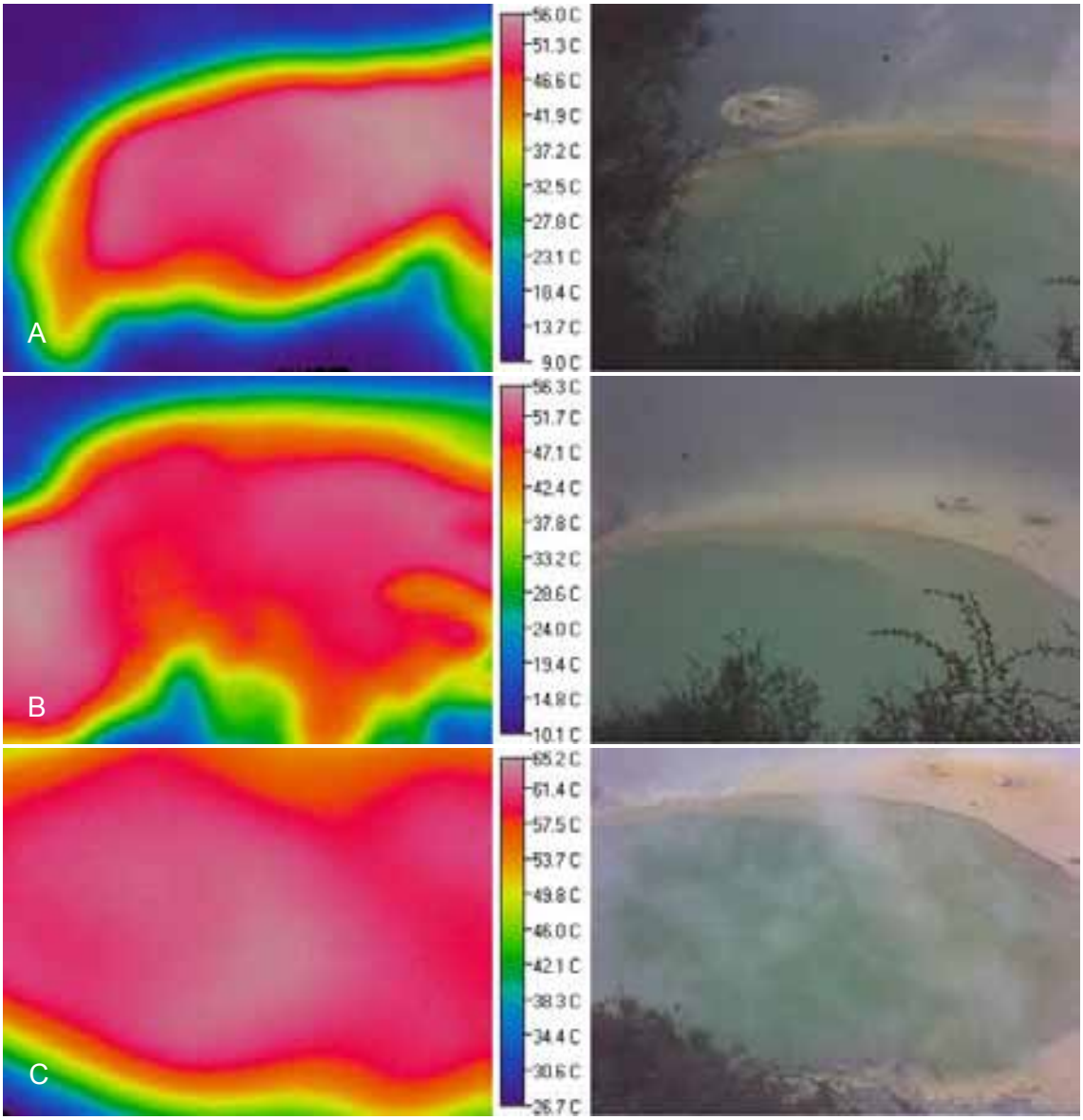

Figure 115: Infrared photos of Sinter Terraces – Foreground Pool, Waiotapu, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Waiotapu Geyser**
  E1894389 N5748720; Located number 72.3007

The pH and water level were variable throughout the monitoring period.

Table 56: Data from Waiotapu Geyser

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	79.8	5-6	-	0.3 m below overflow	Calm, steam	Clear
09 July 2014	78.8	5-6	-	0.22 m below overflow	Calm	Clear
20 Jan 2015	80.6	6	-	0.4 m below outflow	Calm	Clear

Figure 116: Waiotapu Geyser in Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

It can be seen in the Infrared image in Figure 117 that the heat is evenly spread throughout the pool.

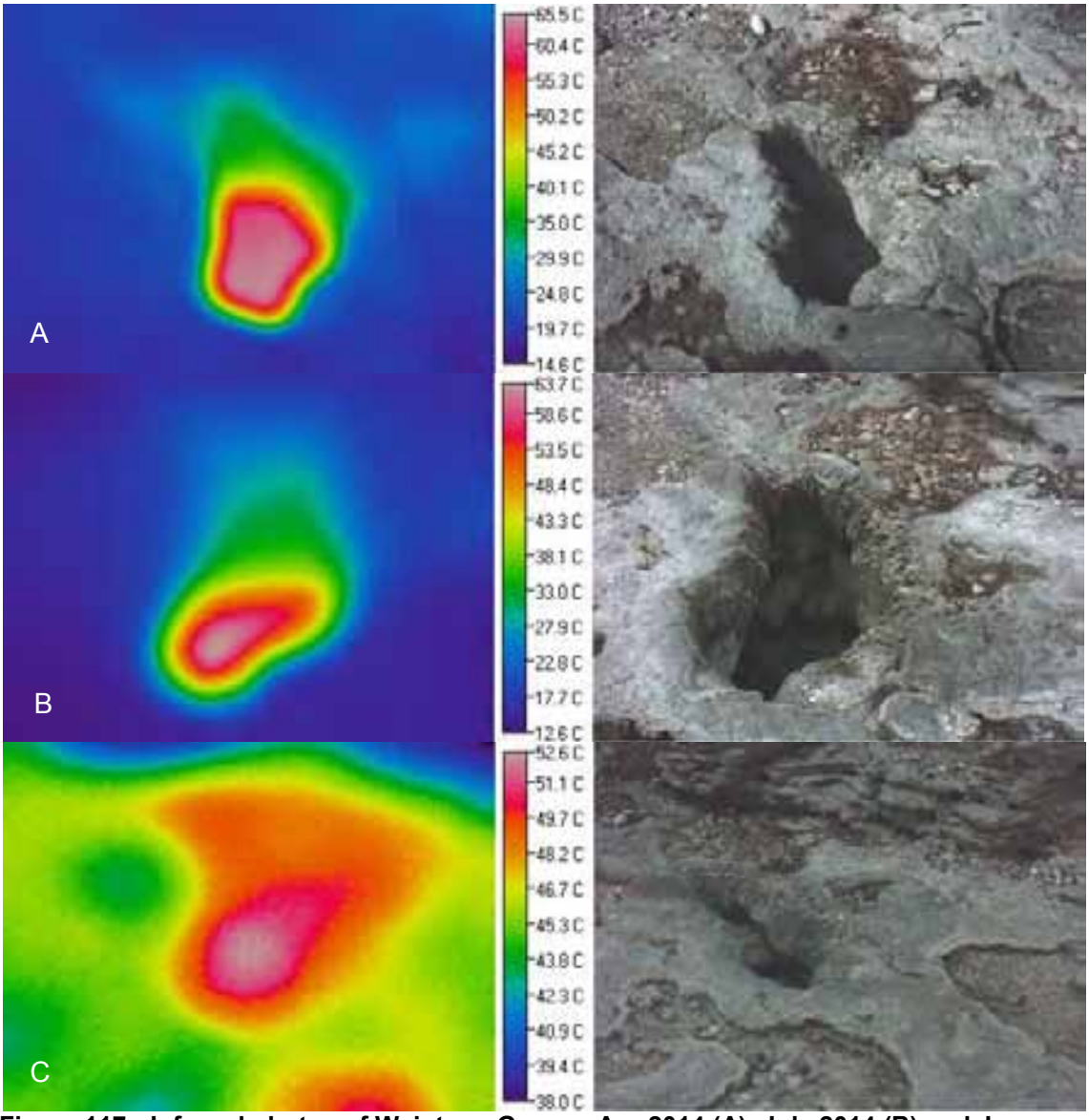

Figure 117: Infrared photos of Waiotapu Geyser, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Oyster Pool**
  E1894414 N5748668; Located number 72.4225

There does not appear to be any significant changes, apart from slight temperature fluctuations.

Table 57: Data from Oyster Pool, Waiotapu

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	66.0	5	Seep	Overflowing	Constant discharge in centre	Cloudy pale green
09 July 2014	62.9	5	Seep	Overflowing	Constant upwelling, centre and left	Cloudy, pale green
20 Jan 2015	66.2	5	Seep	Overflowing	Constant discharge	Cloudy, pale green

Figure 118: Oyster Pool, Apr 2013 (A), Jun 2013 (B) and Jan 2015 (C)

The infrared photos in Figure 119 are quite different throughout the period. In April 2014 the hottest part of the pool appears to around the edges in the foreground of the pool. In July 2014 and January 2015 the hottest part of the pool coincides with the areas of upwelling.

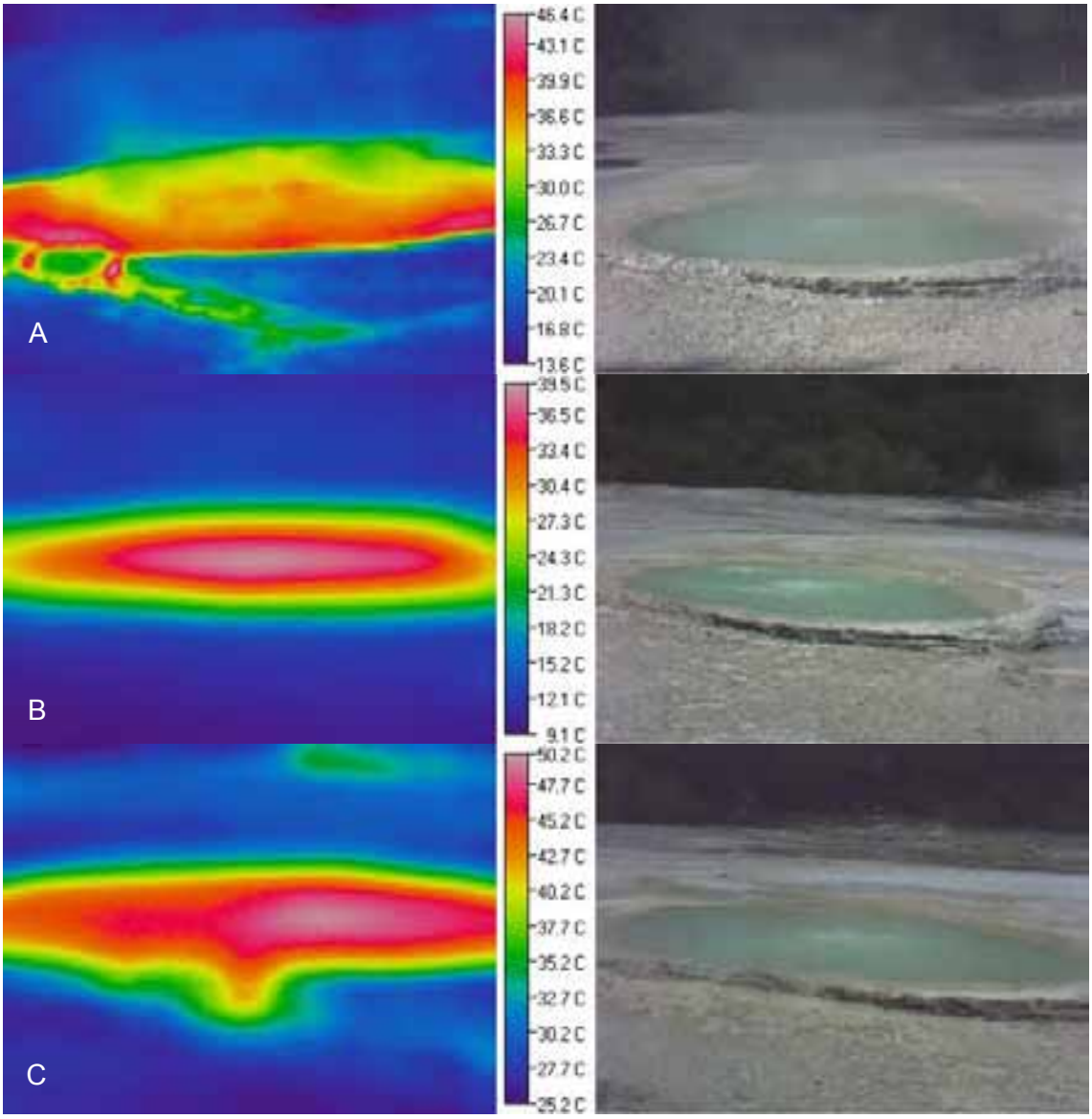

Figure 119: Infrared photos of Oyster pool, Waiotapu in Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Lake Ngakoro**
  Located number 72.4226

The pH is taken from the stream leading into the lake. The temperature has been variable throughout the monitoring period.

Table 58: Data from Lake Ngakoro, Waiotapu

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	29.9	2-3	Inflow 10-15 l/s	nd	Effervescing around the edges	Cloudy, green
09 July 2014	27.7	2	nd	nd	Effervescing around the edges	Murky, pale green
20 Jan 2015	32.0	2	Inflow 20 l/s	nd	Effervescing around edges	Cloudy, pale green

Figure 120: Lake Ngakoro, Waiotapu in Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared photo below shows the edge of Lake Ngakoro near the inlet of the stream. An area of increased temperature can be seen along the edge near where the lake is effervescing.

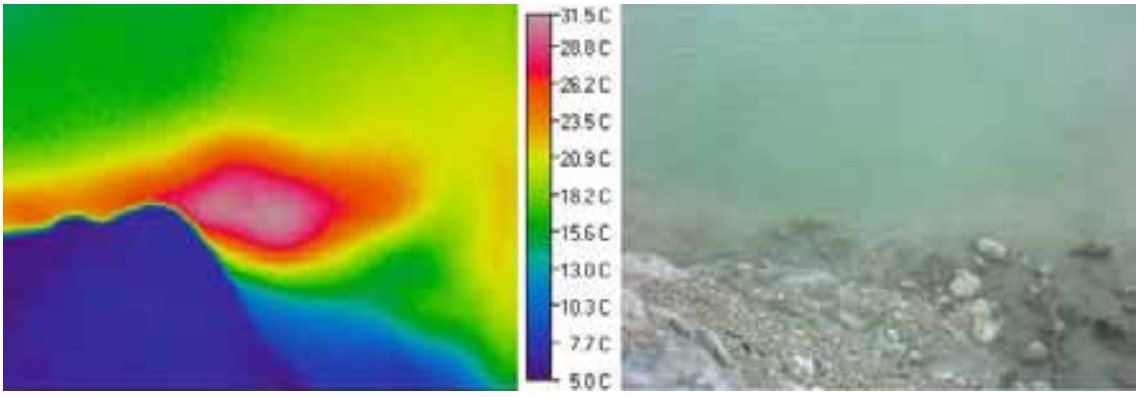

Figure 121: Infrared photos of Lake Ngakoro, Waiotapu in July 2015

- **Champagne Pool**
  E1894414 N5748950

There is orange algal growth around the edges. There are fluctuations in the temperature and pH throughout the monitoring period.

April 2014: It was difficult to see the pool, as there was too much steam.

July 2014: There were small areas of algae floating on the pool.

January 2015: It was difficult to see the pool, as there was too much steam.

Table 59: Data from Champagne Pool, Waiotapu

Date	T (°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	72.4	5-6	nd	Not overflowing	Small bubbles around edges, couldn't see rest of pool	Clear, green
09 July 2014	73.5	5	Seep	Overflowing	Effervescing around edges	Clear, green
20 Jan 2015	75.8	5	nd	Overflowing	Effervescing	Clear, green

Figure 122: Champagne Pool, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Devil's Bath**

The water level and temperature have fluctuated throughout the monitoring period. The colour has been variable.

Table 60: Data from Devil's Bath, Waiotapu

Date	T (°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	22.6	nd	Inflow ~1	2-3 m below high water mark	Calm	Murky, yellow/green
09 July 2014	18.5	nd	Inflow ~5	2 m below high water mark	Small bubbles in centre	Bright green
20 Jan 2015	36.5	nd	Inflow ~2l/s	2.5 m below high water mark	Small bubbles	Murky, bright green

Figure 123: Devil's Bath, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The heat appears to be evenly spread throughout the pool.

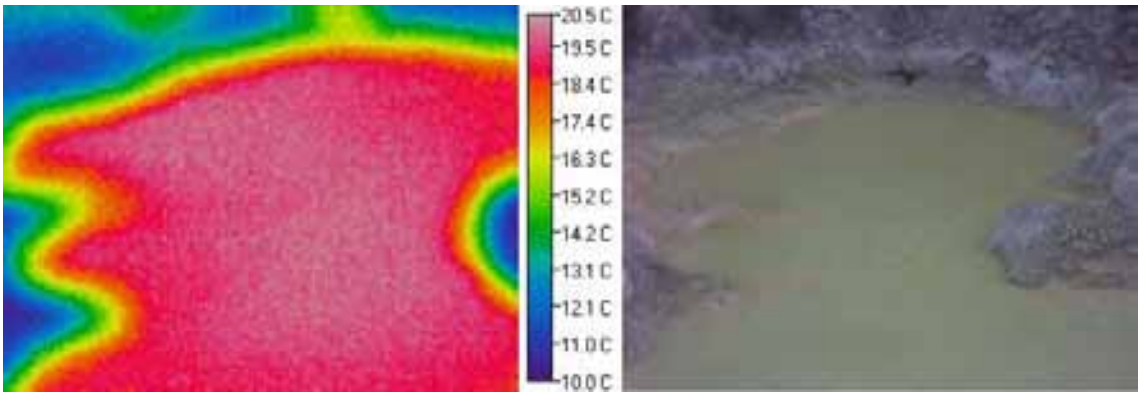

Figure 124: Infrared photos of Devil's Bath, Waiotapu, April 2014 (A)

10.2 Knox Geyser area

- **Lady Knox Geyser**

The Lady Knox Geyser erupts at ~10:15am daily, after a surfactant is dropped into the opening of the vent by the staff of Waiotapu. The eruptions we witnessed were all over 30 minutes in length. The pH is from the run-off of the geyser, and the temperature is read from about 5 m away using the IR Gun, so may not be representative of the water temperature as it erupts from the geyser, due to rapid atmospheric cooling.

The temperature of the geyser has fluctuated over the period, however, rapid atmospheric cooling would account for cooler temperatures in winter. The pH of the water flowing out of the geyser has also been variable.

April 2014: The geyser was still erupting at 11:15 when the site was vacated.

July 2014: The geyser was still erupting at 11:05 when the site was vacated.

January 2015: The geyser was still erupting at 11:15 when the site was vacated.

Table 61: Data from Lady Know Geyser, Waiotapu

Date	T(°C)	pH	Height (m)	Eruption duration	Colour
28 Apr 2014	93.6	4-5	5	Over 50 minutes	Clear
09 July 2014	74	5-6	5	Over 40 minutes	Clear
20 Jan 2015	70	nd	5	Over 50 minutes	Clear

Figure 125: Lady Knox Geyser, Waiotapu in Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The geyser's heat can be seen as it moves up the chamber and erupts from the vent. Closer to the geyser a temperature of 93.6 °C was recorded in April 2014, however, the water quickly cools as it erupts. The infrared photos are taken from the viewing platform.

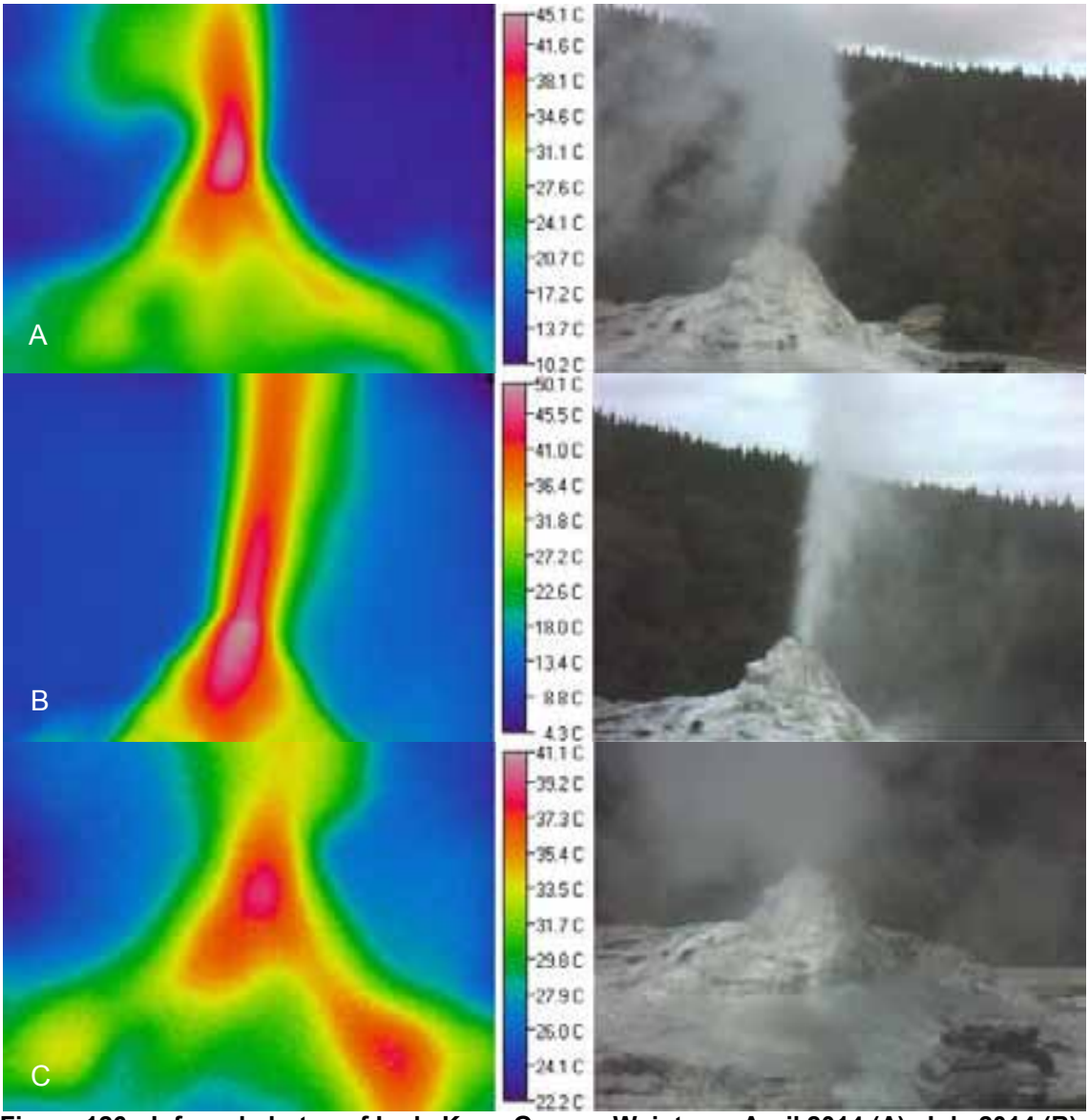

Figure 126: Infrared photos of Lady Knox Geyser, Waiotapu, April 2014 (A), July 2014 (B) and Jan 2015 (C)

- **Knox Hole Spring and Channel**
  E1895123 N5749869

The temperature and pH fluctuated over the monitoring periods.

Table 62: Data from Knox Hole Spring, Waiotapu

Date	T (°C)	pH	Flow (l/s)	Level	Ebullition	Colour
28 Apr 2014	Spring 47.8 Channel 78.2	2-3 (from channel)	<0.5 (from below spring)	Dry	Steam with an H_2S odour	Clear (from below spring)
10 July 2014	Spring 44.0 Channel 76.3	2 (from channel)	<0.25 (from below spring)	Dry	Audible discharge and steam with an H_2S odour	Clear (from below spring)
20 Jan 2015	Spring 50.0 Channel 78.6	3 (from channel)	<0.5 (from below spring)	Dry	Audible discharge and steam with an H_2S odour	Clear, yellow/grey (from below spring)

Figure 127: Knox Spring Hole and Channel, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared photos in Figure 133 show that there are two areas of heat in the vicinity of the Knox Spring hole, above and in front of it, in April, June 2014 and January 2015. The vent itself is also hot, however, this cannot be seen in the thermal image as it is situated further back in the recess.

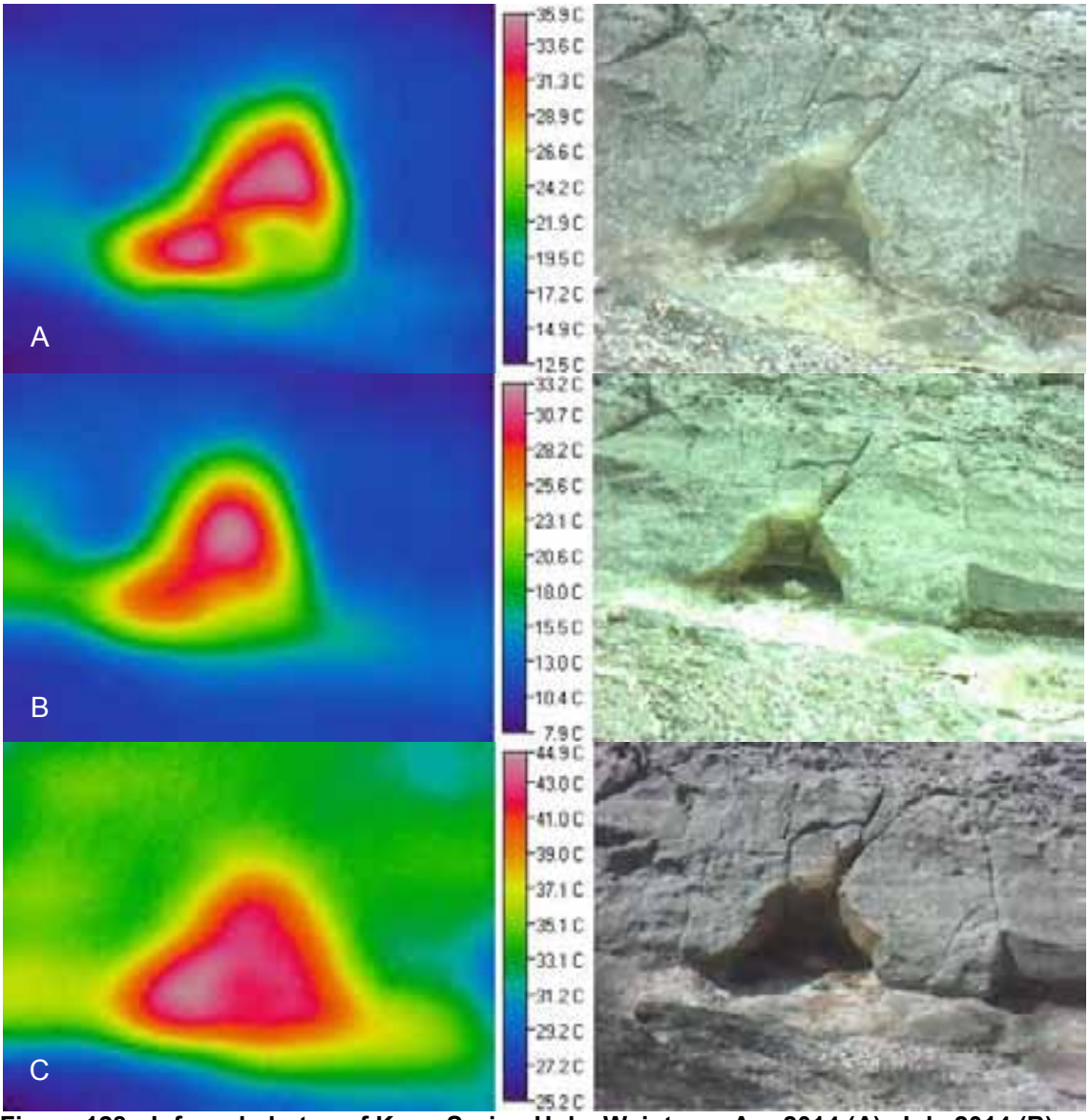

Figure 128: Infrared photos of Knox Spring Hole, Waiotapu, Apr 2014 (A), July 2014 (B), and Jan 2015 (D)

- **Hidden Pool**
  E1894833 N5749981

There were no bathers in the pool in April or July 2014. In January 2015 there was one bather above the waterfall.

Green algae were present on the walls, with a pale yellow substance precipitating from areas where water seeps from the rocks. The pool was steaming. There was a slight temperature increase between July 2014 and January 2015. pH and flow have fluctuated over the period.

Table 63: Data from Hidden Pool, Knox Geyser area, Waiotapu

Date	T (°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	37.2	2-3	~20	Overflowing	Calm	Murky (~0.5 m), brown/grey
09 July 2014	37.2	3	5-10	Overflowing	Calm	Murky, grey/brown
20 Jan 2015	40.9	2-3	~12	Overflowing	Calm	Murky, brown/grey

Figure 129: Hidden Pool, Knox Geyser area, Waiotapu in Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

The infrared photos show that the hottest part of the pool appears to be where it flows over the waterfall. This could be due to the infrared camera only showing the surface temperature, which is cooler than within the pool due to its exposure to air. The water going over the waterfall includes the deeper warmer water mixed with the cooler surface water, so it appears hotter than the surface water above and below the waterfall.

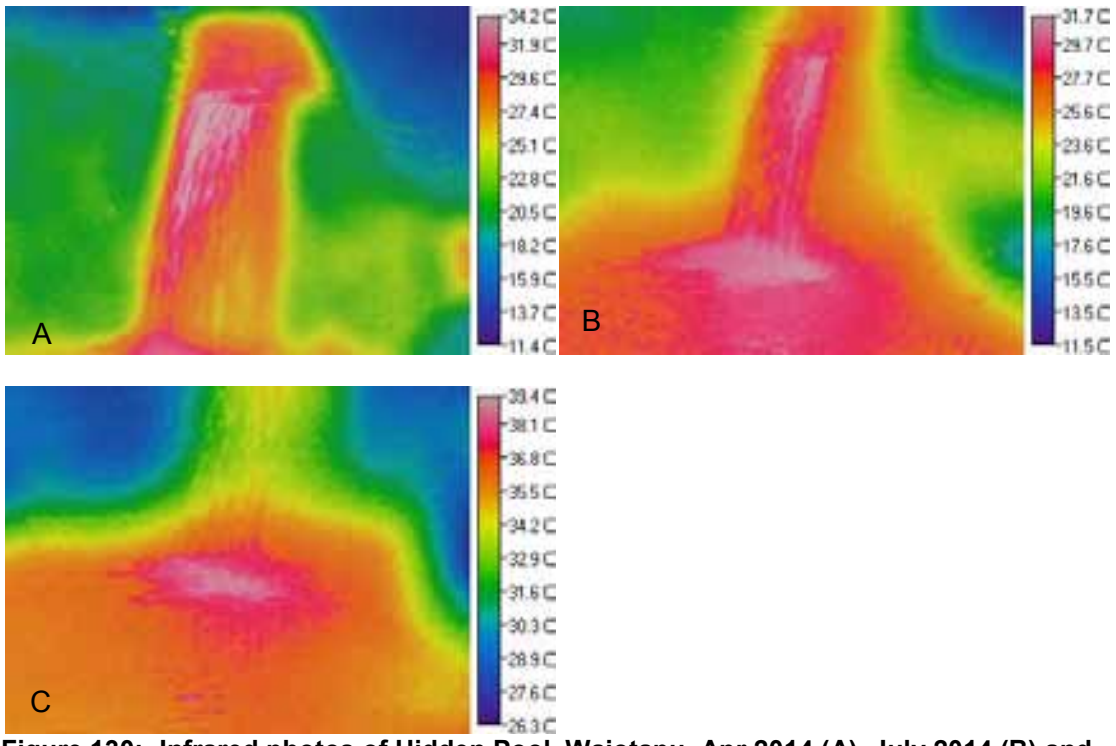

Figure 130: Infrared photos of Hidden Pool, Waiotapu, Apr 2014 (A), July 2014 (B) and Jan 2015 (D)

- **Venus Pool in creek on Lady Knox Road**
  E1895377 N5749891

This is a warm stream on Lady Knox Road. The temperature has fluctuated throughout the monitoring period.

Table 64: Data from Venus Pool, Knox Geyser area, Waiotapu

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	44.8	4	nd	Nd	Calm	Clear
09 July 2014	42.7	4	nd	Nd	Calm	Clear
20 Jan 2015	46.2	4	nd	Nd	Calm	Clear

Figure 131: Venus Pool, Waiotapu in Apr 2014 (A), Jun 2014 (B) and Jan 2015 (C)

The heat of the stream can be seen in the infrared photos in Figure 137; however the vegetation and steam may be altering the view as it is not consistent.

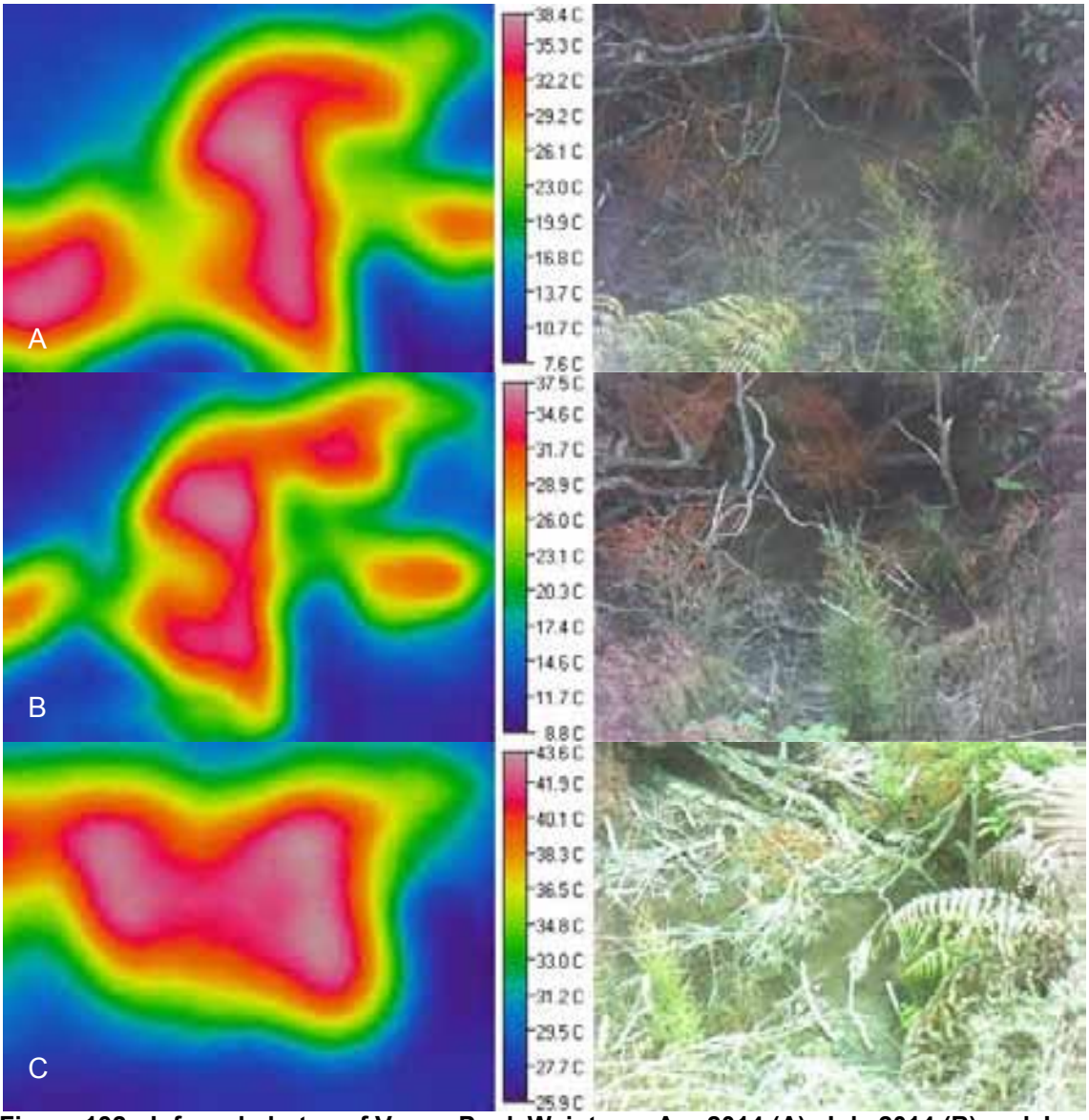

Figure 132: Infrared photos of Venus Pool, Waiotapu, Apr 2014 (A), July 2014 (B) and Jan 2015 (C)

10.3 Waiotapu Loop Road Pools

- E1893976 N5749319

Along Waiotapu Loop Road is a bridge, underneath which is a tributary of the Waiotapu Stream. There are two pools, one either side of the road. There were bathers noted during all of the monitoring visits:

April 2014: 6 bathers
July 2014: 8 bathers and one dog
January 2015: 12 bathers

Figure 133: Waiotapu Loop Road, Sept 2013

10.4 Kerosene Creek Area

- **Kerosene Creek Pool**
  E1896006 N5751572

The temperature has fluctuated over the monitoring period, with the warmest temperature being in January 2015 (43.3 ºC) and the coolest in July 2014 (30.0 ºC). The pH has fluctuated slightly.

April 2014: There were 10 bathers in the large pool downstream at 15:45.

July 2014: At 12:15 there were 5 bathers and 1 bystander at the large pool downstream, and 5 bathers leaving. At 12:35 there were 4 new bathers and 2 bystanders.

January 2015: At 15:15 there were 5 bathers and 1 bystander at the large pool downstream.

Table 65: Data from Kerosene Creek Pool, Waiotapu

Date	T(°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
28 Apr 2014	36.1	3	~160	o/f	Calm	Murky, brown
11 July 2014	30.0	3	~160	o/f	Calm	Murky, brownish
29 Jan 2015	43.3	4	~150	o/f	Calm	Murky, brown

Figure 134: Kerosene Creek Pool, Apr 2014 (A), Jun 2014 (B) and Jan 2015 (C)

The infrared photos show that the hottest part of the pool appears to be where it flows over the rocks. This could be due to the infrared camera only showing the surface temperature, which is cooler than within the pool due to its exposure to air. The water going over the waterfall includes the deeper warmer water mixed with the cooler surface water, so it appears hotter than the surface water above and below the waterfall.

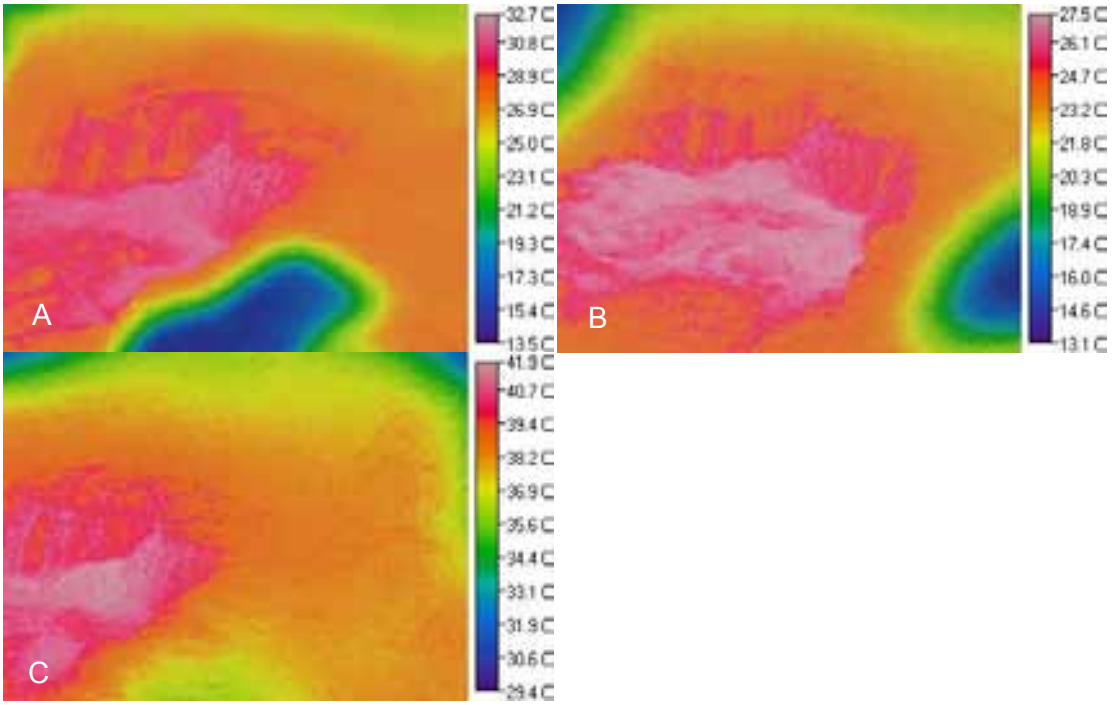

Figure 135: Infrared photos of Kerosene Creek, Waiotapu, Apr 2014(A), July 2014 (B) and Jan 2015 (C)

- **Kerosene Creek Steaming Ground**
  E1896014 N5751240

Due to bank erosion and high levels of plant growth along the path it was not possible to reach the Kerosene Creek steaming ground during the monitoring period.

11 Whangairorohea

11.1 Tahunaatapu Pool

An incident with heavy machinery at the pool in April 2012 resulted in the bank breaching. This incident has caused the level to drop by approximately one metre. Pipes were placed at the outlet to control the outflow. Remediation of the pool had been carried out by June 2013.

The pool could not be visited in July 2014. In April 2014 the temperature had decreased by 1.8 ºC since the previous visit in January 2014, but had risen by 5.5 ºC at the January 2015 visit. The level of the pool has risen by 0.2 m. The vegetation around the pool has grown to around 1 m tall. There is less algal growth in the pool than noted in previous visits; there are still long, green filamentous algae present. In January 2015 there were orange algal mats around the edges of the pool.

Table 66: Data from Tahunaatapu Pool, Whangairorohea

Date	T (°C)	pH	Flow (l/s)	Water level	Ebullition	Colour
29 Apr 2014	34.3	6-7	nd	1 m below top of jetty	Occasional upwelling	Clear, blue in centre
28 Jan 2015	39.8	7	nd	0.8 m below top of jetty	Occasional upwelling	Clear, blue/green

Figure 136: Tahunaatapu Pool, Whangairorohea, Apr 2014

Figure 137: Tahunaatapu Pool, Whangairorohea, Jan 2015

The infrared photos show that the heat is more concentrated in the front area of the pool; however steam may be affecting the image.

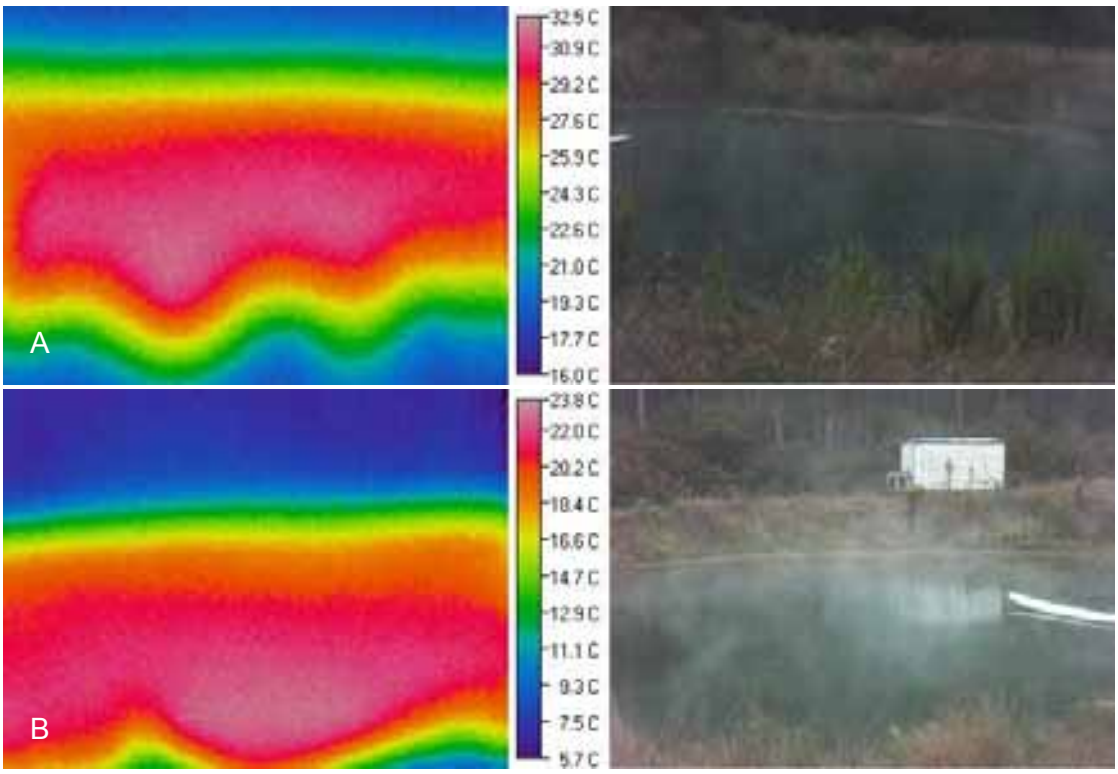

Figure 138: Infrared photos, Tahunaatapu pool, Whangairorohea in Apr 2014 (A) and Jan 2015 (B)

12 Appendix 1

The appendix for this report is an Excel spreadsheet of the observations contained in this and previous reports, Waikato Regional Council document number 2142693. This can be obtained upon request from the Waikato Regional Council.