

BEFORE THE HEARING PANEL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of the Proposed Waikato District Plan

STATEMENT OF EVIDENCE OF WARREN JOHN GUMBLEY (ARCHAEOLOGY)

Dated 17 February 2021

LACHLAN MULDOWNEY

BARRISTER

P +64 7 834 4336 **M** +64 21 471 490

Office Panama Square, 14 Garden Place, Hamilton

Postal PO Box 9169, Waikato Mail Centre, Hamilton 3240

www.lachlanmuldowney.co.nz

Instructing Solicitor:
Phil Hyde
Norris Ward McKinnon
Phil.hyde@nwm.co.nz

INTRODUCTION

1. My full name is Warren John Gumbley.
2. I am an archaeologist and have worked in this field in various capacities since 1983. I have a Master of Arts with Distinction from the University of Otago in prehistoric anthropology. I am currently completing a PhD with the Australian National University on the adaptation of Polynesian horticultural systems to New Zealand. I have worked in the Waikato since 1992, with the exception of two years (1994-1995) when I was the archaeologist for New Zealand Historic Places Trust based in Wellington.
3. I have been engaged by Shand Properties Ltd (**Shand**) to provide expert advice on archaeological matters in relation to the proposed Waikato District Plan zone change.

CODE OF CONDUCT

4. I have read the Environment Court Code of Conduct for expert witnesses contained in the Environment Court Practice Note 2014 and agree to comply with it. I confirm that the opinions expressed in this statement are within my area of expertise except where I state that I have relied on the evidence of other persons. I have not omitted to consider materials or facts known to me that might alter or detract from the opinions I have expressed.

SCOPE OF EVIDENCE

5. My evidence will address the following: I will consider the presence or absence of archaeology within the areas proposed for re-zoning. I will describe the nature, extent, and condition of the archaeology present within the area proposed for re-zoning. I will assess the archaeological

values associated with the identified archaeology and consider this within the national and regional contexts. I will also recommend any appropriate mitigation. I draw on data contained within my technical memorandum "Technical Memorandum: Shand Properties Blocks 1 and 6 - Archaeological Survey and Assessment", which is included as **Attachment 1** to my evidence.

SUMMARY OF EVIDENCE

6. Shand proposes to re-zone two blocks of land to enable development of these blocks. For the purposes of this evidence, these blocks of land will be referred to as Block 1 and Block 6. Block 1 is located between Great South Road and the North Island Main Trunk Railway (**NIMT**) north of East Mine Road. Block 6 is located between Russell Road and East Mine Road.
7. Block 1 contains an archaeological site recorded in the New Zealand Archaeological Association (**NZAA**) Site Recording Scheme, the national database, as S13/159 and is described as a Māori horticulture site. The site is not entered into the Heritage New Zealand List/Rārangi Kōrero. However, the site is protected under s 42 of the Heritage New Zealand Pouhere Taonga Act (**HNZPTA**) and may not be modified or destroyed without an authority granted by Heritage New Zealand (**HNZ**). It is not a scheduled site in the operative or proposed Waikato District Plan. No recorded archaeological sites have been recorded within or adjacent to Block 6.
8. I have undertaken archaeological surveys of both Block 1 and Block 6. The entire area of Block 1 was examined. Only the hill aspect of Block 6 was examined as archaeological prospecting methods are limited and generally ineffectual on swampy soils such as those found in Block 6. However, I have viewed a preliminary development scheme for Block 6 and note that

development avoids the swampy low-lying areas of the block. No archaeology was identified in Block 6.

9. The archaeology identified within Block 1 is of a type which is nationally distinctive and which I refer to as the Waikato Horticultural Complex. In simple terms, this is characterised by borrow pits from which sand and gravel alluvium was quarried from the substrate, and then transported forming gardens for the cultivation of kūmara and taro.
10. I found that the archaeological deposits within Block 1 had been superficially affected by modern cultivation (ploughing) and the recent deposition of imported fill. The former has had a general impact but is not uniform. In places the ploughing has had more impact than in others and the degree of preservation of the superficial archaeology (shallower than 30 cm), varies from moderately well-preserved to poorly preserved. The archaeology deeper than 30 cm is assumed, based on my experience, to be largely intact.
11. As part of the development of Block 1, an artificial storm-water wetland and associated earthworks are proposed to the east of the NIMT. This area also contains archaeological remains recorded in the NZAA national database as S13/160 and S13/161. Both of these represent recorded clusters of borrow pits and are probably continuations of S13/159 to the east of the railway embankment. Field investigation confirms that the Māori-made soil continues on the eastern side of the NIMT.
12. I consider that any adverse effects from development of Block 1 may be effectively mitigated by the preservation of a representative part of the site containing borrow pits and by undertaking an archaeological investigation of the balance of the archaeological deposits to record the nature and history of the archaeology to be destroyed. The proposed preservation

area is located at the northern end of Block 1 and is 3000 m². The location of the proposed preservation area is shown in **Attachment 2**.

BLOCK 1 ARCHAEOLOGY

13. The following is a summary of my archaeological assessment of Block 1. The detail of my assessment of both Block 1 and Block 6 is set out in **Attachment 1**.
14. An archaeological site has been identified within Block 1. This is a Māori horticultural site recorded in the NZAA national database as S13/159, and which was recorded in 2016. The site was identified from LiDAR data and had not been visited. S13/159 is not scheduled in either the Operative or Proposed Waikato District Plans, nor is it entered into the New Zealand Heritage List/Rārangi Kōrero under Part 4 of the HNZPT Act.
15. A single house is currently located within Block 1 but historical aerial photographs show at least one other dwelling and several additional structures existed within the block in the past, including a horse-training track. A site inspection of Block 1 was carried out to verify the status of the record and to determine the nature and condition of the archaeology found there. The inspection was pedestrian and included the excavation of 16 hand-dug test-pits, each approximately 50 cm x 50 cm. These were excavated to examine the soil profile for evidence of archaeology.
16. Block 1 is located on a relict river levee, which separates the Waikato River from the valley containing Lake Kimihia and its associated wetlands. The relict levees and channels were formed by recent pumiceous alluvium deposited following the most recent Taupo eruption 1800 years ago. On a local scale the landform consists of a series of levees interspersed by a series of palaeo-channels aligned parallel to the existing channel of the

Waikato River and are illustrative of the braided river form that existed following the flood/lahar event.

17. Typically, the soils on this recent alluvium include a brown topsoil (A horizon) overlying a yellowish-brown sandy silt B horizon of varying depth, which, in turn overlies coarse sand and gravel alluvium.
18. Of the 16 test-pits, 14 exhibited a modified soil profile characteristic of Waikato Horticultural Complex, which is a regionally distinct horticultural system that is described more fully in **Attachment 1**¹. In summary, this system involves the excavation of the sand and gravel alluvium and its transport to gardens where it was used to form structures for growing sweet potato (kūmara).
19. Sites belonging to the Waikato Horticultural Complex have two principal diagnostic attributes, borrow pits visible as distinct depressions in the ground surface of varying sizes and depths, and a topsoil enriched with sand and gravel, and charcoal. Archaeologically, two variants of this system have been identified. One of these involved the excavation of bowl-shaped depressions that were filled with sand and gravel. In the second, the sand and gravel was used to form mounds in which the kūmara were grown. In the former it is believed that mounds of the excavated loam were formed over the bowl-shaped hollows.
20. The Waikato Horticultural Complex is an intensified and labour intensive swidden agricultural system which represents an important and distinctive adaption of Polynesian horticultural practice to temperate New Zealand. The system can be found stretching along the Waikato River from Arapuni

¹ Pages 7-9 and Attachment 5.

in the south to Meremere in the north and along the banks of some of the rivers tributaries where suitable soil is present.

21. Favoured soils are well-drained loams. The resultant modified soils are distinctive and have been ascribed their own soil series called Tamahere Loam by soil scientists. I have identified over 7000 borrow pits from aerial photography and LiDAR data in the Waikato. Archaeological data indicates that approximately 4.5 million cubic metres of material was quarried and used to make the gardens these sites represent and that these collectively cover over 4000 hectares throughout the Waikato.
22. The results of the field survey of Block 1 indicate that the area has been generally subject to ploughing and other forms of modern cultivation and this has resulted in damage to the upper elements of the archaeological deposits, specifically the made soil horizon. In most of the test-pits where made soil was identified the made soil horizon had been affected to its complete depth but in 5 test-pits the lower element of the made soil was intact. Therefore, this presents a picture of a mosaic of effects to this feature of the site. In a more localised fashion items of farm infrastructure such as houses and other structures, farm tracks, and a horse-training track will also have affected this archaeological deposit.
23. The field survey also identified an extensive series of recent deposits of imported soil that has been spread over the southern two thirds of Block 1. This has had the effect of obscuring the distinctive cultural landform that was associated with this site and which is typical of sites of the Waikato Horticultural Complex on recent soils such as these. It will also have the effect of making the recovery of archaeological information through field

investigation more complicated should this measure be required to mitigate future development.

24. Further field investigation was undertaken to the east of the NIMT in the area where a stormwater wetland and associated earthworks are proposed. The same methodology was employed for Block 1 with the additional use of a screw-type soil auger to assist with determining both the presence and the edge of the Māori-made soils. The details of the results are set out in **Attachment 1**². In summary, within the area surveyed, Maori-made soils were found to extend between 30 metres and 70 metres east of the railway embankment. Part of the stormwater pond will affect Māori-made soils.
25. Sites of the Waikato Horticultural Complex also include a range of associated archaeological features. Some of these relate to the clearance of forest prior to garden development, others are crop storage pits, and areas of domestic activities representing seasonal kāinga may also be present. Burials have also been found associated with these sites. Modern cultivation is too shallow to have significantly affected these elements of the site.
26. I have assessed the site's archaeological values in relation to the identified archaeology in Block 1, including the identified archaeology east of the NIMT (see **Attachment 1** for the detailed analysis³).
 - (a) The Waikato Horticultural Complex involved the intensive practice of quarrying and transporting sand and gravel to form gardens. Similar practice has been identified in a handful of other districts in New Zealand but in each of these areas it is substantially more limited in scope and scale compared to the Waikato. If these areas were to be

² Pages 4-6.

³ Pages 7-10.

added together they would fall short of the scale found in the inland Waikato. The scale of the Waikato Horticultural System is significant in comparison to intensified agricultural systems practiced across Polynesia, both in terms of the evident labour input but also its scale. The Waikato system is also complex with two agronomic variants identified.

- (b) Most of the Waikato Horticultural Complex is concentrated in the Middle Waikato Basin with the part in the Lower Waikato Basin, of which S13/159 is a part, significantly more constrained by the limitation of suitable soils to the levees on the banks of the Waikato River.
- (c) A study I carried out for New Zealand Historic Places Trust in 2013 on the Waikato Horticultural Complex within Waipa District is the only comprehensive assessment of the state of the resource. Using the 1940s aerial photography, (which is the oldest reliable record for these sites) as a data baseline it was identified that approximately 65% of the sites had disappeared from the landscape in the preceding 70 years. I believe that this can probably be generalised to the remainder of the Waikato. The only research on sites of this type in the Lower Waikato Basin was carried out by Law (1968) in the 1960s in relation to the flood protection scheme being constructed on the lower Waikato River at the time. Law's work indicates that the flood protection scheme had a significant effect on this resource of a similar scale to that identified in the Waipa study. S13/159 represents one of the 6 or 7 remaining large clusters of borrow pits that can be identified in the LiDAR data for the Waikato River below the Taupiri Gorge.
- (d) The recent deposition of imported fill has affected the landscape values of the archaeology within Block 1 by obscuring the distinctive landform created by the borrow pits. Modern cultivation and land-

use has also had a negative impact on the preservation of the made-soil deposits and so limits the potential for the site to inform us about the agronomy of these sites in the Lower Waikato Basin. Currently sites from the Waikato Horticultural Complex in the Lower Waikato Basin have not been investigated archaeologically. Nonetheless, as noted above, there are parts of the made soil which remain partially intact and the potential remains for data that can inform us about the agronomy to be recovered. Otherwise, deeper archaeology is probably well-preserved.

REPRESENTATIVE PRESERVATION

27. I consider that any adverse effects from development on Block 1 will be effectively mitigated in part by the preservation of a representative part of the site at the north end of Block 1. Because of the level of preservation of the surface visible archaeological features and landform in the northern part of Block 1, it should be here where the representative preservation is focused. **Attachment 2** is an image showing the proposed preservation area.
28. Any preserved area should retain multiple borrow pits with adjacent Māori-made soils and also respect as much as possible the associated landform as context for the agricultural activities represented in the archaeology. If these actions are undertaken, then I consider that the development of Block 1 may be undertaken without seriously impacting the wider Waikato Horticultural Complex.
29. I also consider that further archaeological investigation should be undertaken to record the nature and history of the archaeology to be destroyed. This will entail archaeological investigations of parts of the archaeology not included in the proposed preservation area and will provide information about the history of the development of the site and the nature of the agronomy practiced.

30. Before any development activity can occur within Block 1 and the stormwater wetland area, an archaeological authority must be obtained from HNZPT as required by the HNZPTA. Conditions within the archaeological authority will specify mitigation measures to be undertaken. Given the extensive nature of the site and based on current practice on sites of this class we may reasonably anticipate that these measures will include a series of physical archaeological investigations using machinery (hydraulic excavator) and hand excavation methods distributed over various places on the site so as to produce a spatially representative record of the site.
31. On 25 November 2020, I met with HNZ Senior Archaeologist, Dr Rachel Darmody, on site with Ms Jacqueline Rogers (on behalf of Shand). The purpose of the meeting was to address issues relating to recently imported fill onto the archaeological site and to discuss appropriate mitigation measures. The nature and the context of the Shand submission was also discussed. A copy of the Archaeological technical memorandum (**Attachment 1**) was provided to Dr Darmody.
32. As a result of the meeting, it was agreed that the proposed representative element of the site in the northern part of Block 1, where no imported fill has been dumped, would be preserved as a mitigation measure. In relation to the imported fill, it was agreed that a drone survey should be conducted to permanently record the locations and extents of the imported material. This has now occurred. There will be a need to level the remaining heaps of imported material within their existing footprints prior to re-sowing it with grass. Dr Darmody confirmed that an archaeological authority pursuant to the requirements of the HNZPT will be needed before physical development works can commence.

CONCLUSION

33. No evidence for archaeology was found in the part of Block 6 that was examined. The remaining low-lying part of Block 6 is swampy and unlikely to contain substantial, if any, archaeology. However, there is always the potential for wooden or other organic material to have been deposited in the swampy ground and to have been preserved.
34. Block 1 is entirely composed of archaeological remains recorded as S13/159 which contains both surface visible features in the form of borrow pits and also subsurface archaeological remains including the topsoil itself. Altogether I consider that part of S13/159 within Block 1, along with the associated archaeological deposits east of the NIMT, to be moderately well-preserved, and of a comparable level of archaeological value. However, the northern part of Block 1 (that area north of the current house) still retains visible cultural landscape in the form of the borrow pits and landform to a degree where it may be described as well-preserved.
35. I consider that any adverse effects from development may be effectively mitigated by the preservation of a representative part of the site containing borrow pits and also archaeological investigation to record the nature and history of the archaeology to be destroyed.

Warren John Gumbley

17 February 2021

Attachment 1
Archaeological Technical Report

Technical Memorandum:

Shand Properties Blocks 1 and 6 - Archaeological Survey and Assessment.

Introduction

Block 1¹ is located between Great South Road and the North Island Main Trunk (NIMT) railway line. Block 6² is located between Russell Road and East Mine Road.

An archaeological site, S13/159, is located over the entire extent of Block 1. S13/159 is recorded in the New Zealand Archaeological Association (NZAA) Site Recording Scheme as a Māori horticulture site. The site record (**Attachment 1**) describes ninety borrow pits within the area of the site, which includes Shand Block 1 and the adjacent land parcel to the north (Part 2 Allotment 22 Taupiri Parish). The site record identifies S13/159 as associated with recorded sites S13/160 and S13/161, which are located to the east of the NIMT and would have formed part of the same horticultural complex prior to the formation of the NIMT.

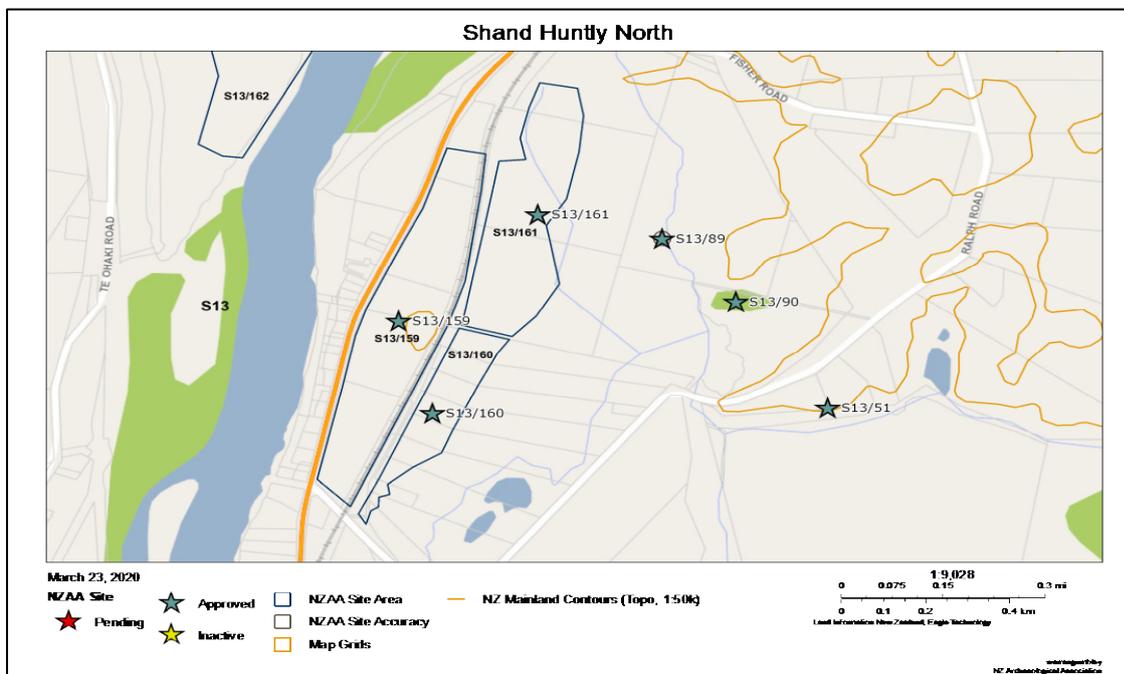


Figure 1: Map from Archsite showing the recorded extent of S13/159 and associated sites S14/160 and S13/161.

¹ Including; Lot 11 DP23455, Pt Lot 12 DP23455, Lot 1 DPS 12402, Lot 2 DPS 12402.

² Including: Lot 2 DPS 33575, Part Allotment 11 Taupiri Parish.

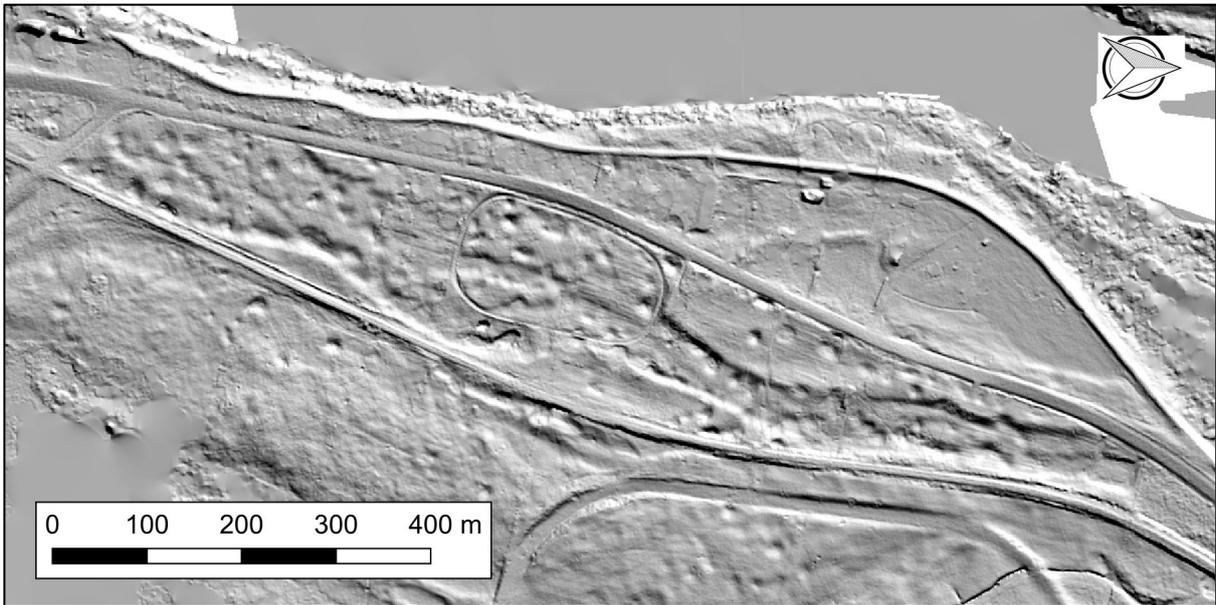


Figure 2: LiDAR derived hillshade showing Block 1 and S13/159. Borrow pits are a characteristic feature of the type of Māori horticultural site and can be recognised in this image as distinct dimples of varying sizes across the landscape. Note there are occasional borrow pits east of the NIMT and these are recorded as S13/160 and S13/161. Elements of the braided river channel landform are also recognisable as remnant palaeo-channels within Block 1. (Source: WRC 2008 LiDAR data.)

S13/159 is recorded in the NZAA Site Recording Scheme as a Māori horticulture site. The site is not listed by Heritage New Zealand under Part 4 of the Heritage New Zealand Pouhere Taonga Act 2014. However, it is protected under the same Act and may not be modified or destroyed without an authority granted by Heritage New Zealand Pouhere Taonga.

S13/159 is not scheduled in either the operative or proposed Waikato District Plans.

No archaeological sites have been recorded within or adjacent to Shand Block 6.

A description of the nature of the Waikato Horticultural Complex is attached to this memorandum (**Attachment 5**).

Landform and past land-use

Shand Block 1

Block 1 is 13.06 hectares.

Block 1 is located on a relict river levee, which separates the Waikato River from the valley containing Lake Kimihia and its associated wetlands. The relict levees and channels were formed by recent pumiceous alluvium deposited following the most recent Taupo eruption 1800 years ago (Kear & Schofield 1966). On a local scale the landform consists of a series of levees interspersed by a series of palaeo-channels aligned parallel to the exiting channel of

the Waikato River and are illustrative of the braided river form that existing following the flood/lahar event.

Information from Jackie Rogers confirmed that all of Block 1 south of the current house³ had been ploughed but, to their knowledge, the paddock north of the house⁴ had not. A horse-training track is also visible in the modern remote sensing data (**LiDAR data**) along with old and disused tracks across the block.

A single house is currently located within Block 1, but historical aerial photographs show at least one other dwelling and several additional structures within the block.

Shand Block 2

Block 6 is 17.46 ha, with approximately 10 ha of Block 6 low-lying swampy ground and the remainder hill.

Block 2 is located on hills adjacent to Russell Road and on low-lying poorly drained silty soils adjacent to East Mine Road. This area has been used for pastoral farming, including farm tracks and infrastructure. This included a now-abandoned house site on the ridge crest and an area of yards and farm buildings at the tow of the ridge spur below the house site.

A modern house and curtilage is located at 162 Russell Road within Lot 2 DPS 33575.

Fieldwork

The site inspections for both Block 1 and Block 6 were pedestrian and included the excavation of spade-dug test-pits to examine the upper soil layers. Test-pits were hand-dug with a spade and were 0.5 x 0.5 m. The depth of the test-pits varied but most were approximately 50 cm deep. In some test pits in Block 1, a Dutch-style soil auger was used to gauge the depth of the C horizon. Detailed descriptions of the test-pits are appended to this memorandum (**Attachments 2 and 3**). In one location in Block 1, a Dutch-style soil auger was used to verify the results of test-pit D.

Site inspections of Block 1 occurred on the 1 October and 6 October 2020, and on Block 6 on 6 October 2020. Only the hills were inspected on Block 6.

All location information was captured using a Garmin GPSMAP 64s with an accuracy of approximately 3 m.

³ Parcels Lot 11 DP23455, Pt Lot 12 DP23455, Lot 1 DPS 12402.

⁴ Lot 2 DPS 12402.

Results

Block 1

Sixteen spade dug test-pits and a single hand auger sample were employed during the examination of Block 1. The natural soil profile, based on experience with soils of the same series elsewhere as well as local evidence involves a dark brown A hz and a yellowish-brown B hz which are both sandy silt loams with sand component no coarser than fine. These overlie C hz of coarse sands and gravels. The thickness of the A hz is typically approximately 20 cm but it may be thinner, and the B hz can vary substantially but during the survey its base was usually between 40 and 50 cm below the ground surface. In this soil environment, Māori-made soils are readily identifiable by the distinct enrichment of the A hz with coarse sand and gravel quarried from the C hz and transported to the gardens.

Borrow pits are recognisable as near-circular depressions of varying dimensions in the ground surface. They are found on the plain surface of the levees and also in the sides and floors of the palaeo-channels that characterise the Taupo Pumice Alluvium.

Of the 16 test-pits⁵ excavated, 14 included evidence for the presence of Māori-made soils. Most of the test-pits showed evidence for the made-soil unit to have been disturbed by cultivation but in five test-pits it was clear that the lower part of the made-soil had not been affected by ploughing.

Table 1: Summary of the results from test-pits (complete descriptions appended).

Test-pit #	Māori-made soil	Notes
A	made soil present	appears disturbed
B	not modified	
C	made soil present	deeper element undisturbed
D	made soil present	marginally modified but the test-pit was located on the shoulder of a slope. Adjacent auger sample showed made soils present
E	made soil present	disturbed
F	not modified	unusually deep A hz.
G	made soil present	disturbed
H	made soil present	deeper element undisturbed
I	made soil present	deeper element undisturbed
J	made soil present	B hz may have been modified
K	made soil present	deeper element undisturbed
L	made soil present	disturbed
M	made soil present	deeper element undisturbed
N	made soil present	disturbed
O	made soil present	disturbed
P	made soil present	disturbed

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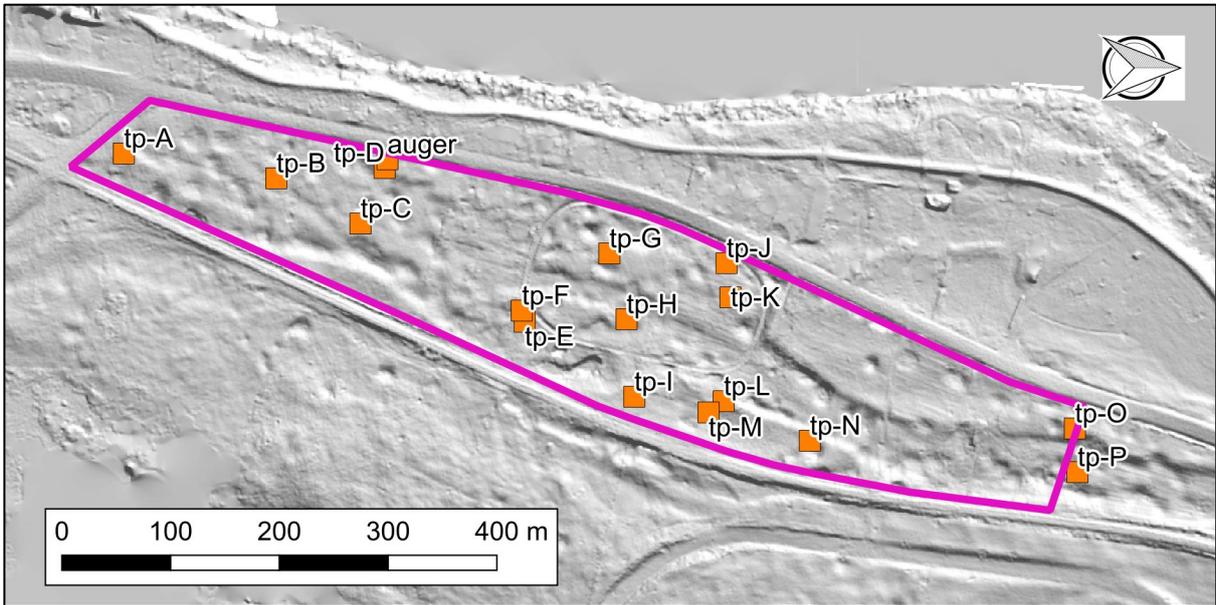


Figure 3: Map showing the locations of test-pits. Pink outline encloses Block 1.

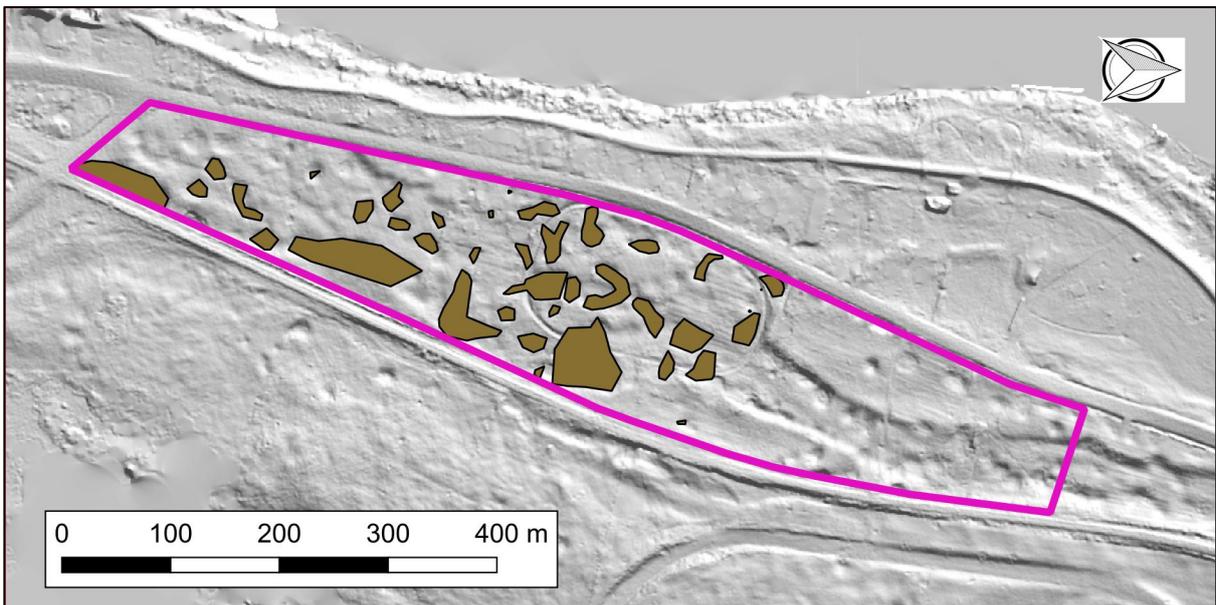


Figure 4: Map showing the locations and general extent of the larger areas of imported material.

Block 1 south of the house⁶ contained extensive areas of recently imported material (soil, sand and building rubble) which had either been spread over the ground surface or was in stock-piles. The large areas of imported material were mapped on site but small areas such as material that had fallen from vehicles was not captured. Altogether 39 areas of imported material were recorded during the fieldwork totalling approximately 1.85 ha over an area of

⁶ Parcels Lot 11 DP23455, Pt Lot 12 DP23455, Lot 1 DPS 12402.

approximately 8.5 ha. As well as significantly modifying the surface appearance of the landscape the imported material has had the effect of compromising future archaeological investigation of the Māori-made soil.

Block 6

The hill soils within Block 6 are silty clay loams with a dark brown or dark greyish-brown topsoil with a yellowish-brown subsoil. Iron nodules were common in the upper soil profiles examined indicating generally imperfect drainage.

Four test-pits were excavated on flattish areas. No test-pits provided any indication of archaeological deposits. This result is unsurprising given that unsuitability of the soil for cultivation by Māori and the general absence of useful resources within the hill zone locally.

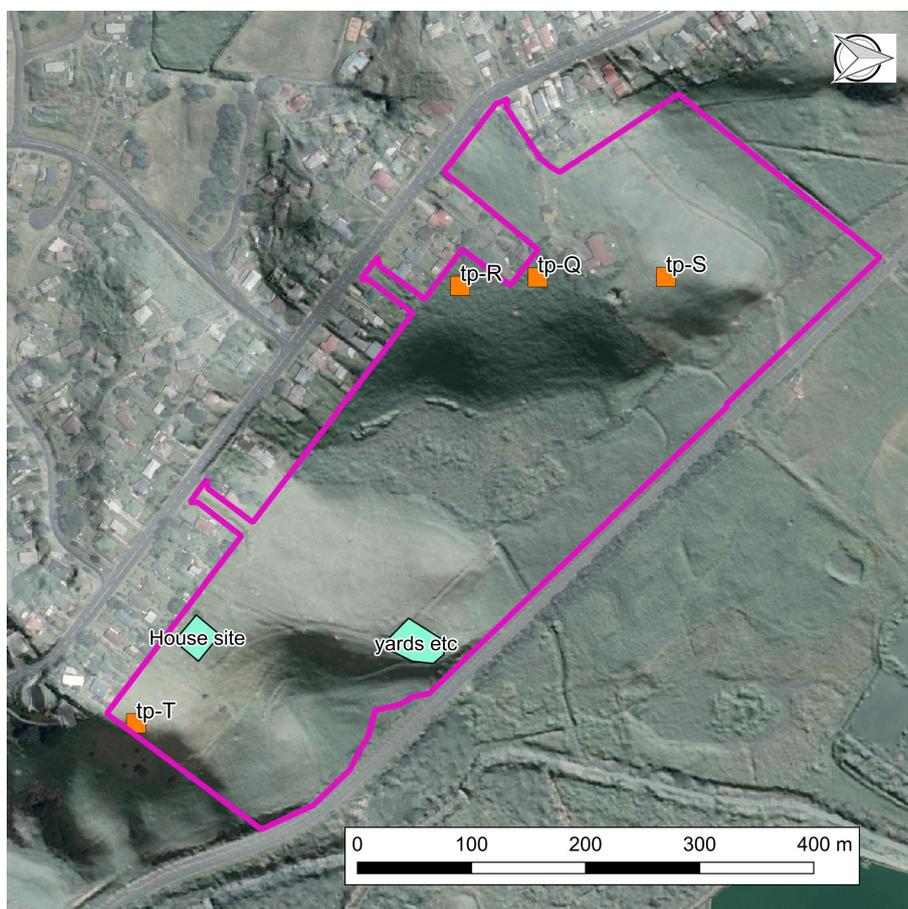


Figure 5: Map of Block 6 (pink polygon) showing the locations of the test-pits (orange squares). The location of the old house site and the abandoned yards and building are shown as pale blue polygons.

Archaeological Values

The discussion of archaeological values refers to Block 1 only. The Waikato Regional Policy Statement provides a series of 15 criteria for assessment under the following headings: Archaeological Qualities, Architectural Qualities, Cultural Qualities, Historic Qualities,

Scientific Qualities and Technological Qualities.⁷ A copy of the criteria (Table 10-1) is included as **Attachment 4**. For the purposes of this assessment, the criteria under the headings Archaeological, Historic, Scientific and Technological will be addressed. Architectural Qualities are not relevant because of the absence of heritage structures. Cultural Qualities should be addressed by mana whenua.

The assessment of heritage values is informed by both the appended document that describes the Waikato Horticultural Complex (**Attachment 5**) in detail and the results of the fieldwork.

S13/159 belongs to the Waikato Horticultural Complex, which is a characteristic agricultural system focused on the cultivation of kūmara with secondary reliance on taro. The system involves the quarrying of sand and gravel from the substrate from borrow pits and its transportation to the site of the garden to construct growing media. It is estimated that the total combined area of the Waikato Horticultural System exceeds 4000 hectares. This is distinct and labour intensive agronomy that represents the largest scale and one of the most intensive responses to the adaptation of Polynesian, and hence tropical, agricultural techniques and plants to New Zealand. Other examples of similar soil modification processes have been identified in other parts of the New Zealand (e.g. Manuaitu Peninsula at Aotea, areas in northern and southern Taranaki, the Waimea Plains of Nelson, Kaikoura around the Clarence River mouth, and in locally to the north and south of Banks Peninsula), however, all of these areas are comparatively constrained and altogether these areas do not compare to the scale of the Waikato System.

The distribution of sites belonging to the Waikato Horticultural System is distinctly patterned with sites clustering strongly to the Waikato River stretching from Arapuni in the south to Meremere in the North. A 2013 study (Gumbley & Hutchinson 2013) focused on the Waipa District found that 50% of sites were located within 500 m of the river and 80% of sites were located within 1 km of the Waikato River. Sites can also be found on some of the Waikato River's tributaries where suitable soils are present. These include the Waipa River, the Mangaone Stream system, the Mangawhero Stream and the Komakorau Stream system.

The distribution of sites also reflects the presence of suitable soil environments, which have formed on the Hinuera Formation and the Taupo Pumice Alluvium (**TPA**). Specifically, well-drained soils are targeted and on the Hinuera Formation, these are soils of the Horotiu series and on the TPA these are soils of the Waikato Series, mostly formed on the Hopuhopu member of the TPA. Occasionally, less well-drained soils are also adapted for this horticultural system but usually where the gardens have 'spilled-over' from the well-drained soils.

Archaeological research over the last 25 years has demonstrated that the system includes two variants of the agronomic process. The first was identified in the late 1990s (Gumbley & Higham 2000, Gumbley et al 2004) and manifests archaeologically as a series of bowl-shaped hollows filled with quarried and transported sand and gravel. These features are found in regularly laid out rows, either in parallel grids or in quincunx. The hollows are typically 30-

⁷ Table 10-1; Historic and cultural heritage assessment criteria: <https://www.waikatoregion.govt.nz/council/policy-and-plans/regional-policy-statement/regional-policy-statement-review/section32/10heritage/10assessment-criteria/>

50 cm in diameter and approximately 20 cm deep. Emerging evidence from soil micromorphological examination indicates that the sand-filled hollows were surmounted by a mound formed from the loam excavated from the hollows, but which were destroyed as the crops were harvested. Sites manifesting this variant have been found in Taupiri, Ngaruawahia, Horotiu, Hamilton (Chartwell, Flagstaff and CBD), Tamahere and Cambridge.

The second variant manifests as a thick (c. 25 cm) layer of transported alluvium (sand and gravel) deposited overlying a modified upper B horizon. The upper surface of the B horizon (i.e. the interface between the natural and cultural units) is irregular or even convolute, with the surface appearing 'pock-marked' from digging tool use. The alluvium layer, when well-preserved, presents as a darker upper horizon and a paler lower horizon but both are texturally the same and micromorphological examination indicates that the colour difference relates to soil forming processes post-abandonment. Analogy with ethnographic and historical references indicates that the transported alluvium was used to form mounds to grow the kūmara and that when the crop was harvested these were destroyed and that this, along with weathering, has produced the layer effect. This variant appears to have been generally employed in all locations subject to archaeological investigation and so appears to have been the more common of the two variants.

For both variants, modern cultivation can significantly affect the preservation of these archaeological deposits, particularly the upper horizons, which record the agronomic processes.

Borrow pits constitute the other main archaeological component of the Waikato Horticultural Complex and represent the remains of quarries where the underlying sand and gravel alluvium was dug. They have been examined at sites located on both the Hinuera Alluvium and the TPA, although largely on the former. These range substantially in size from less than 2 m in diameter and a similar depth, to large quarries of up to 40 m across and 3 or more metres deep. Borrow pits of 3-4 m depth are typical and those of 5-6 m depth are not uncommon on sites on the Hinuera Formation but those on the TPA are usually smaller in plan and seldom deeper than 2 m. To some extent this probably reflects the shallower base of the B horizon on the TPA and also the young and less stable alluvium, which tends to collapse into the borrow pits. Evidence from archaeological investigations indicates that most borrow pits are back-filled as the quarrying progresses, presumably to compensate for the potential collapse of the sides of the pits. Large pits have also been found to be aggregates of smaller sub-pits which often have a distinct shaft-like appearance. The average volume of borrow pits is approximately 650 m³. I have recorded over 7000 borrow pits in the Waikato from historical aerial photographs and LiDAR data. This indicates that over 4 million cubic metres of material has been quarried and used to form gardens.

The gardens also include the remains of forest clearance activities and so contain a record of the vegetation of the Waikato lowland forests. They also include the remains of ancillary activities, including crop storage pits, and domestic occupation areas (**kāinga**). The domestic areas include fireplaces and the remains of above ground structures as well as the remains of in-ground storage pits. Burials have also been found within garden sites.

While the extent of the Waikato Horticultural System ends for approximately 120 km between Arapuni and Meremere. Most of the sites relating to this system sit within the Middle Waikato Basin. The part of the system in the lower Waikato River Basin has had very limited archaeological examination by Law (1968) in relation to the flood protection project of the 1960s. The locations and extent of sites has depended on the recording of clusters of borrow pits from LiDAR data along with Law's data. It is evident from this that in the lower basin sites cluster very closely to the Waikato River where well-drained recent alluvium is present. The Taupo Pumice Alluvium and other recent soils provide the only available environment in which this system could be practiced. It is evident from the comparison of Law's data with the modern LiDAR data that the flood protection works have had a significant adverse effect on the number of the sites remaining.

In general, the Waikato Horticultural System represents the remains of an intensified swidden agricultural system based on the Polynesian or Oceanic system of agriculture. It is one of a number of adaptations employed to overcome the problems in transferring a tropically focused and adapted system to the temperate environment of New Zealand. As such, the Waikato Horticultural Complex is outstanding both within New Zealand and wider Polynesia. Specifically, the Waikato agricultural system represents a technological development that facilitated a high yielding return within a marginal environment for Polynesian agriculture.

The 2013 study of the Waikato Horticultural Complex within Waipa District (Gumbley and Hutchinson 2013) identified significant attrition of these sites, with approximately 65% disappearing from the landscape in the 70 years that had elapsed between the 1940s aerial photographic survey (the earliest reliable record of these sites) and 2013. It is reasonable to generalise the same level of attrition for the rest of the Middle Waikato Basin. Similar research has not been carried out for the lower Waikato River, therefore, it is only possible to make very a very general statement about this district. Comparison with recent LiDAR data and Law's 1960s data indicates that the levels of attrition are similar in the Lower Waikato Basin to the Middle Waikato Basin.

In this context S13/159 has been affected by modern cultivation activities that have adversely affected the preservation of the made-soil horizon. However, the results of the test-pit survey demonstrate that in places the modern cultivation has only affected the upper elements of the made soil layer and that the lower unit remains intact. In this sense the preservation of the made soil within S13/159 may be thought of as a mosaic of poor and moderate preservation. The modern cultivation will not have substantially affected the preservation of the borrow pits nor other ancillary features such as crop storage pits and kāinga.

Within the remaining cultural landscape of the Lower Waikato Basin S13/159 represents one of the 6 or 7 remaining large clusters of borrow pits/made-soils that can be identified in the LiDAR data. The visibility of S13/159 has been compromised by the recent spreading of imported material over the parts of the site.

References

Gumbley, W., Hutchinson, M. 2013. *Pre-European Maori Garden Sites in Waipa District: An assessment of the state of the resource*. Unpublished report to N.Z. Historic Places Trust.

Kear, D., Schofield, J. C. 1965. *Geological Map of New Zealand 1:63,360. Sheet N65, Hamilton*. (1st ed.). Department of Scientific and Industrial Research, Wellington.

Kear, D., Schofield, J. C. 1966. *Geological Map of New Zealand 1:63,360. Sheet N56, Ngaruawahia*. (1st ed.). Department of Scientific and Industrial Research, Wellington.

Law, G. 1968. Maori soils in the Lower Waikato. N. Z. Archaeological Association Newsletter 11:67-75.

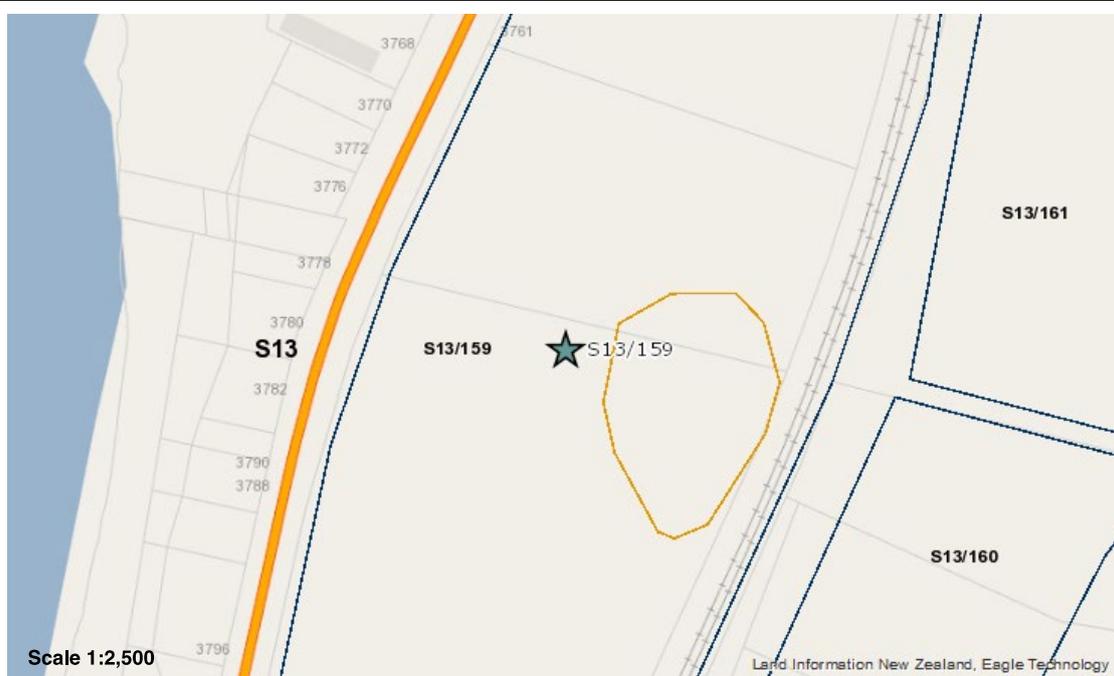
Attachment 1: NZ Archaeological Association Site Record S13/159.

NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

 <h2 style="margin: 0;">Site Record Form</h2>	NZAA SITE NUMBER: S13/159
	SITE TYPE: Maori horticulture SITE NAME(s): DATE RECORDED:

SITE COORDINATES (NZTM) Easting: 1791020 **Northing:** 5844800 **Source:** On Screen

IMPERIAL SITE NUMBER: **METRIC SITE NUMBER:** S13/159



Finding aids to the location of the site
 Between State Highway 1 and the NIMT Rail line north of Huntly. In the long paddock north of the East Mine Road.

Brief description
 Ninety borrow pits recorded from 2012 aerial photography and lidar-derived hillshade data.

Recorded features
 Borrow pit

Other sites associated with this site
 S13/160, S13/161

NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

SITE RECORD HISTORY	NZAA SITE NUMBER: S13/159
<p>Site description</p> <p>Updated 19/07/2016 (other), submitted by malcolmhutchinson Grid reference (E1791020 / N5844800)</p> <p>This site was recorded in July 2016 by M.G. Hutchinson as part of the Waikato District Plan Review Archaeological Heritage Project by Simmons & Associates. It was identified on remote sensing layers including aerial imagery from 2012, and lidar-derived elevation data flown in 2007-08.</p> <p>Ninety borrow pits visible in lidar elevation data, in a paddock beside the Waikato River.</p> <p>[[MGH-131_fig1.jpg Figure 1: The Waikato River north of Huntly, showing dense clusters of borrow pits on river levees east of the river.]]</p> <p>S13/159 is part of a cluster of 116 borrow pits visible in lidar-derived elevation data. The pits occupy a series of low river levees, slightly raised ground between the river in the west, and a low-lying wetland area at the foot of the hills to the east.</p> <p>The pits cluster together fairly densely, with 90 recorded in an area 1.3 km along the river, and up to 500 m wide. A 50 m buffer around these encloses an area of 75.8 ha.</p> <p>For administrative reasons this single archaeological site has been divided into three records. This record describes that part of the site which lies west of the NIMT Rail line. This comprises the whole paddock area north of the East Mine Road, between the NIMT and State Highway 1. Ninety borrow pits are visible here, with the 50 m buffer around them enclosing an area of 13.8 ha. The paddock includes five titles and is 14.9 ha in area.</p> <p>Land parcels affected by this archaeological site are Lot 1 DPS 12402, Lot 11 DP 23455, Lot 2 DPS 12402, Part Allot 22 Taupiri PSH and Part Lot 12 DP 23455. On screen site extent is approximate only and based on cadastral boundaries and the extent of features visible on aerial imagery attached as Figure 1.</p> <p>The NZTM coordinates for 90 borrow pits recorded as part of this site are listed below.</p> <p>no easting northing -----+----- 1 1791164 5844966 2 1791153 5845068 3 1791173 5845143 4 1791160 5845125 5 1790951 5844483 6 1791109 5845197 7 1791121 5845230 8 1791121 5845182 9 1790916 5844619 10 1790929 5844611 11 1790951 5844608 12 1790984 5844615 13 1791000 5844597 14 1791000 5844634 15 1790962 5844706 16 1790958 5844722 17 1790945 5844714 18 1790934 5844731 19 1791012 5844717 20 1791006 5844750 21 1791011 5844780 22 1790975 5844773 23 1790922 5844752 24 1790929 5844777 25 1790948 5844788 26 1790954 5844805 27 1790939 5844803 28 1790951 5844828 29 1791185 5845257 30 1791152 5845274</p> <p>Printed by: warrengumbley</p> <p style="text-align: right;">12/10/2020 2 of 5</p>	

NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

31 | 1791161 | 5845289
32 | 1790981 | 5844830
33 | 1790981 | 5844851
34 | 1791120 | 5844837
35 | 1791026 | 5844835
36 | 1791033 | 5844852
37 | 1790901 | 5844387
38 | 1790850 | 5844356
39 | 1790851 | 5844333
40 | 1790880 | 5844284
41 | 1790973 | 5844759
42 | 1790942 | 5844750
43 | 1791179 | 5845198
44 | 1791193 | 5845274
45 | 1791045 | 5844833
46 | 1791058 | 5844822
47 | 1791060 | 5844860
48 | 1791031 | 5844894
49 | 1791006 | 5844898
50 | 1790986 | 5844898
51 | 1790976 | 5844888
52 | 1790906 | 5844353
53 | 1790883 | 5844313
54 | 1790866 | 5844338
55 | 1791165 | 5845161
56 | 1791158 | 5845186
57 | 1791183 | 5845225
58 | 1791180 | 5845031
59 | 1790957 | 5844536
60 | 1790980 | 5844584
61 | 1790930 | 5844575
62 | 1790909 | 5844568
63 | 1790917 | 5844545
64 | 1790880 | 5844530
65 | 1790924 | 5844515
66 | 1790883 | 5844494
67 | 1790869 | 5844458
68 | 1790864 | 5844479
69 | 1790927 | 5844473
70 | 1790941 | 5844427
71 | 1790949 | 5844453
72 | 1790921 | 5844440
73 | 1790898 | 5844429
74 | 1790880 | 5844407
75 | 1790855 | 5844412
76 | 1790857 | 5844387
77 | 1791145 | 5845003
78 | 1791164 | 5844990
79 | 1791147 | 5844953
80 | 1791149 | 5844936
81 | 1791155 | 5844920
82 | 1791110 | 5845008
83 | 1791106 | 5844991
84 | 1791092 | 5844964
85 | 1791119 | 5845061
86 | 1791064 | 5845010
87 | 1791080 | 5845086
88 | 1791099 | 5845126
89 | 1791101 | 5845174
90 | 1790849 | 5844454

Condition of the site

NEW ZEALAND ARCHAEOLOGICAL ASSOCIATION

Updated 19/07/2016 (other), submitted by malcolmhutchinson

The site has not been visited. The following statement is an estimation formed by examining remote sensing data, the latest of which is the 2012 WRAPS aerial photographic survey.

Archaeological evidence has been truncated in the west by the state highway, a row of houses and possibly the flood control works at the riverbank. The eastern side is circumscribed by the railway line.

Modern land disturbance is visible in the hillshade images. This includes a horse training track about the centre of the paddock. Three clusters of buildings are visible in the 2012 aerial imagery. One in the north at NZTM 1791125e 5845108n, one in the centre just north of the training track at 1791029 5844929 and one south of the training track at 1790936 5844632.

References

Waikato Regional Aerial Photography Service (WRAPS 2012). Orthorectified visible-light aerial imagery.

Waikato Regional Lidar Service (WRLS 2007). 1 m resolution elevation data.

Statement of condition

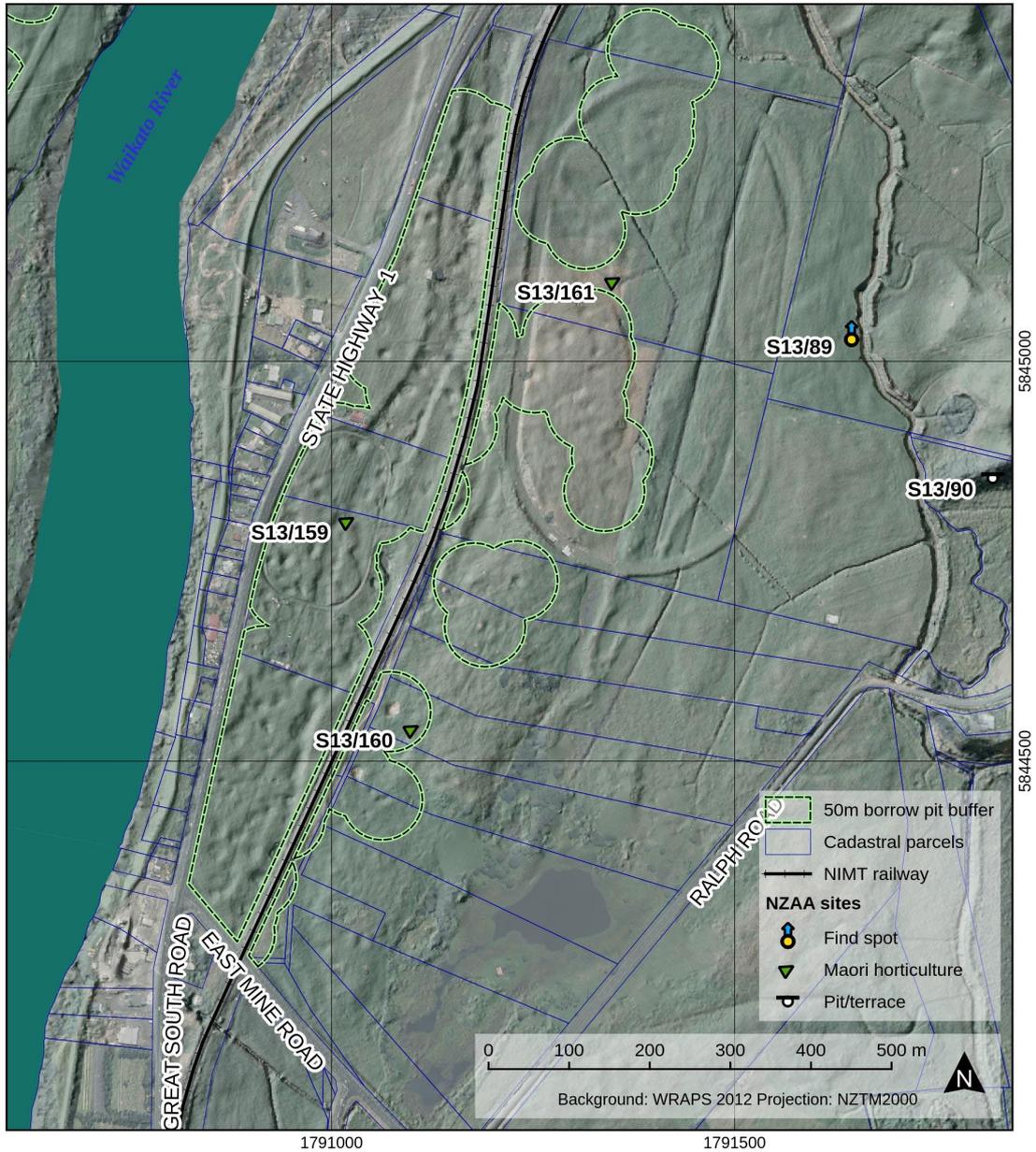
Current land use:

Threats:

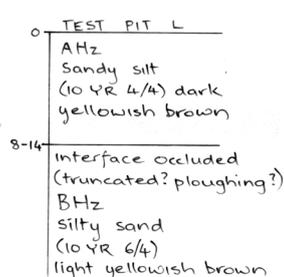
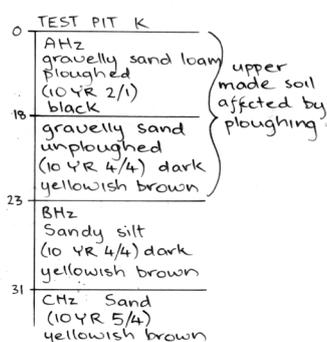
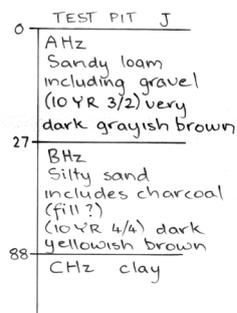
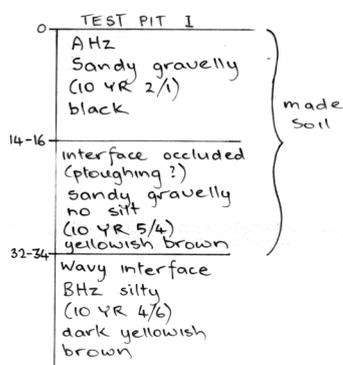
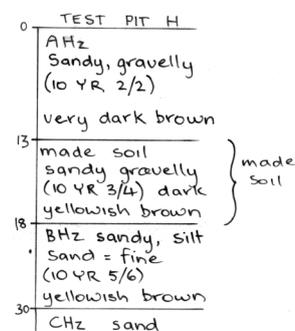
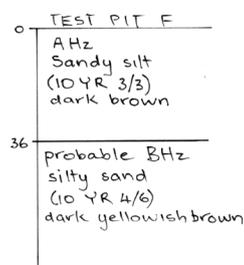
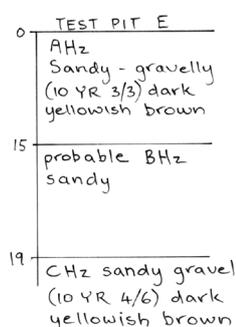
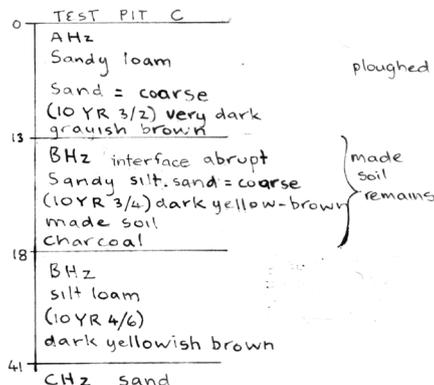
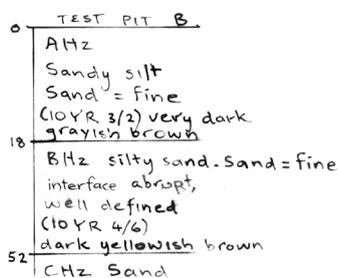
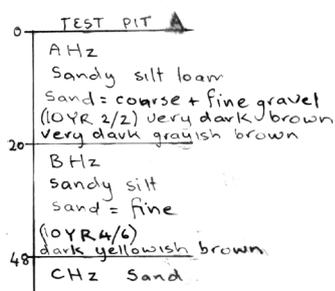
SITE RECORD INVENTORY	NZAA SITE NUMBER: S13/159
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Supporting documentation held in ArchSite

Figure 1: The Waikato River north of Huntly, showing dense clusters of borrow pits on river levees east of the river.



Attachment 2: Test-pit soil diagrams for Block 1.



TEST PIT M

0
 AHZ
 gravelly silty sand loam
 (10 YR 2/1) black

17
 generally silty sand
 (10 YR 4/6)
 dark yellowish brown

27
 BHZ
 Sandy silt
 sand = fine
 (10 YR 5/6) yellowish brown
 gets paler with depth

78
 CHZ

made soil
 (appears well preserved)

TEST PIT N

0
 AHZ
 Sandy loam (+ silt)
 (10 YR 2/1) black

27
 BHZ
 silty sand
 Sand = fine
 (10 YR 5/6)
 yellowish brown

93+
 CHZ not found

TEST PIT O

0
 AHZ
 silty sand
 sand = coarse + gravel
 (10 YR 3/3)
 dark brown

?
 wavy interface (ploughed)
 RHZ
 sand silt
 sand = fine to medium
 (10 YR 5/6)
 yellowish brown

80+
 CHZ

TEST PIT P

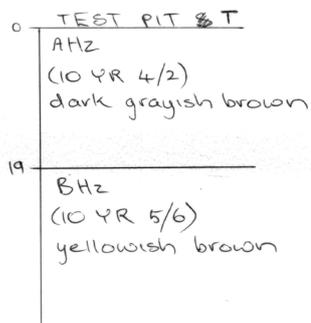
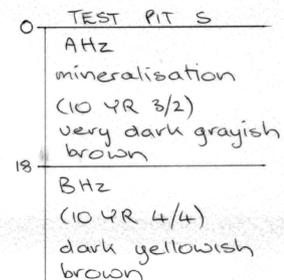
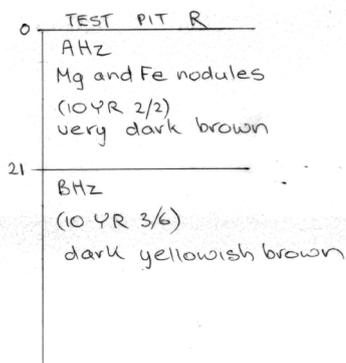
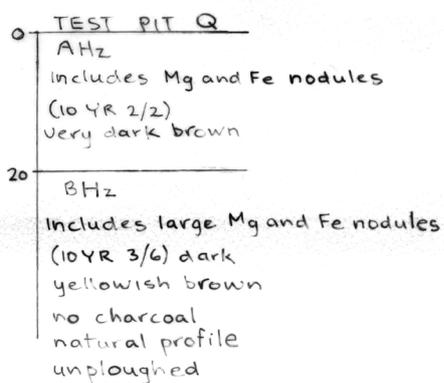
0
 gravelly sandy loam
 includes charcoal

14
 BHZ
 Sandy silt
 sand = coarse
 includes charcoal
 (10 YR 4/6) dark yellowish brown
 (10 YR 3/3) dark brown

23
 CHZ
 coarse sand + gravel

made soil
 ploughed

Attachment 3: Test-pit soil diagrams for Block 6.



Attachment 4: Waikato Regional Policy Statement Heritage Assessment Criteria.

HERITAGE

10A Historic and cultural heritage assessment criteria

Table 10-1: Historic and cultural heritage assessment criteria



Attachment 5: Description of the Waikato Horticultural Complex by W Gumbley (2020).

The Waikato Horticultural Complex: Pre-European Māori horticulture sites on the Waikato plains

By Warren Gumbley

2020

In the Waikato pre-European Māori garden sites are identified by two defining features; the presence of borrow pits, and soils heavily modified by the addition of sand and gravel; as well as charcoal. The borrow pits are near circular depressions usually between 1 and 6 metres deep (archaeological investigations indicate they were typically 3–5 metres deep originally) and often 100-300 m². It is these two features that make these garden sites so visible compared to pre-European Māori gardens in most of the rest of New Zealand. Here, the archaeological evidence is principally found in both the middle and the lower Waikato basins (Selby & Lowe 1992).



Figure 1. Borrow pit (one of 34) at site S14/27 located at Tamahere. (photo: D Lowe).

In the middle Waikato Basin, pre-European Māori garden complexes are concentrated along the Waikato River from Arapuni to Taupiri, in areas on the Horotiu Plain and along the margins of the Waipa River and its tributaries. In the lower Waikato Basin, the resource is

more poorly understood but it is known to exist on raised levees along the banks of the Waikato River in the area of Huntly-Rangiriri and possibly in some places lower down the river (Grange et al. 1939; Taylor 1958; Clarke 1977; Law 1968). The total original area of these sites is unknown but Taylor (1958) proposed an estimate of 5000 acres (2000 hectares) based on the soil survey data available in 1958. Our analysis of the available soil survey data⁸ using GIS, indicates that an estimated area of 4000 hectares is probably more accurate. The locations of the gardens are strictly associated with particular series of alluvial soils.

In the middle Waikato Basin these ‘made’ or ‘modified’ soils are classified in the Tamahere series, with the two named soil types being ‘Tamahere gravelly sand (on Horotiu soils) (TH)⁹’ or ‘Tamahere gravelly sand (on Waikato soils) (THw)’ (Bruce 1979; McLeod 1984). In the New Zealand Soil Classification (NZSC) (Hewitt 1998) the modified garden soils in the Waikato belong to the Artifact Fill Anthropic Soils class.

As well as modifying the well-drained Waikato series soils and Horotiu loams, the less well-drained Bruntwood silt loams were also modified. Less commonly the poorly-drained Te Kowhai silt loams are found to have been modified for gardening. This appears to have happened more commonly below Hamilton in areas where gardens expanded onto adjacent, poorer soils.

The Horotiu and Bruntwood loams (as well as the Te Kowhai soil) have formed on 18,000–20,000-year-old volcanogenic alluvium called the Hinuera Formation. The deposits of this formation have been overlain by a cover (500–700 millimetres) of thin multiple tephra-fall deposits since the Hinuera alluvium finished accumulating.

The Waikato series soils have formed on 1800-year old course pumiceous alluvium (Taupo Pumice Alluvium) which formed low terraces near the Waikato River (Grange et al. 1939; Taylor 1958; Lowe 1988; Singleton 1988; McCraw 2002).

Specifically, it was the sand and gravel alluvium substrate from the Hinuera and Waikato formations that was quarried from the borrow pits and used to modify the upper soil horizons (Figure 2).

Although active research is now being carried out it remains difficult to be confident of how the material quarried from borrow pits was applied to or mixed with the parent soils to form the modified soils (Tamahere loam). Until 1999 it had been assumed that this quarried material was either; (1) added to the surface of the parent soil as mulch or puke (mounds), or (2) was well mixed into upper part of the soil (i.e. topsoil and upper subsoil parts of the profile) (Figure 3).

⁸ It must be noted that the soil survey data is incomplete and does not include areas where borrow pits have been identified south of Cambridge and along the banks of the Waikato River above Cambridge.

⁹ Also sometimes annotated as Mh and Mw respectively.

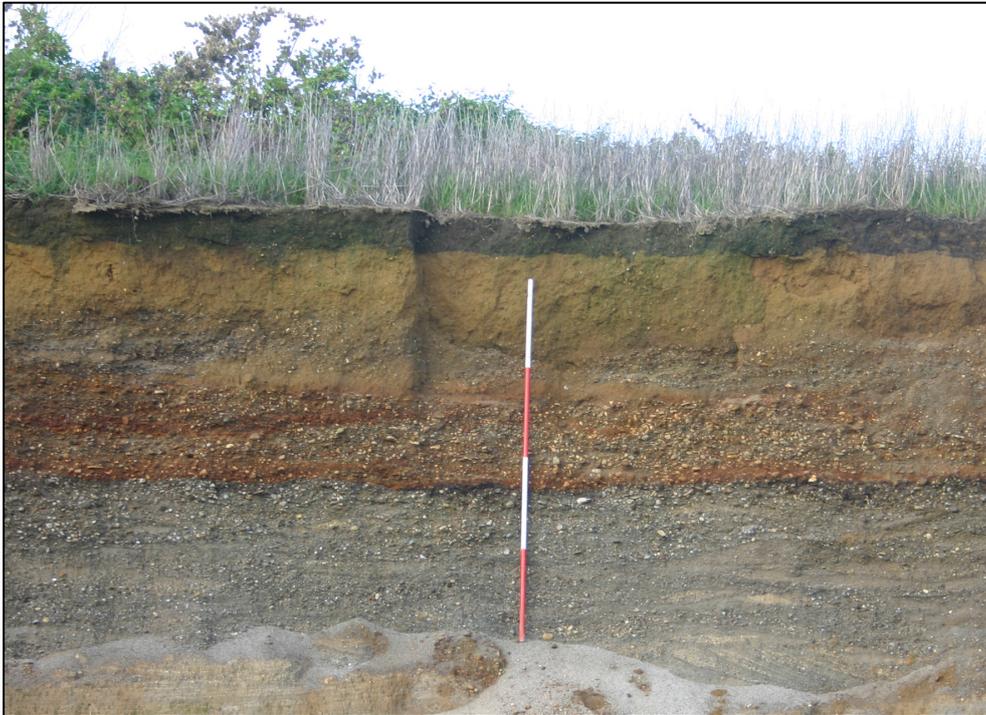


Figure 2. A photograph showing the upper horizons of Horotiu sandy loam. The upper 700-800 mm of yellowish-brown material is the accumulated volcanic tephra that overlies the Hinuera Formation alluvium. It is this alluvium that was quarried and added to the gardens. (Scale is 2 m.) (photo: W. Gumbley)

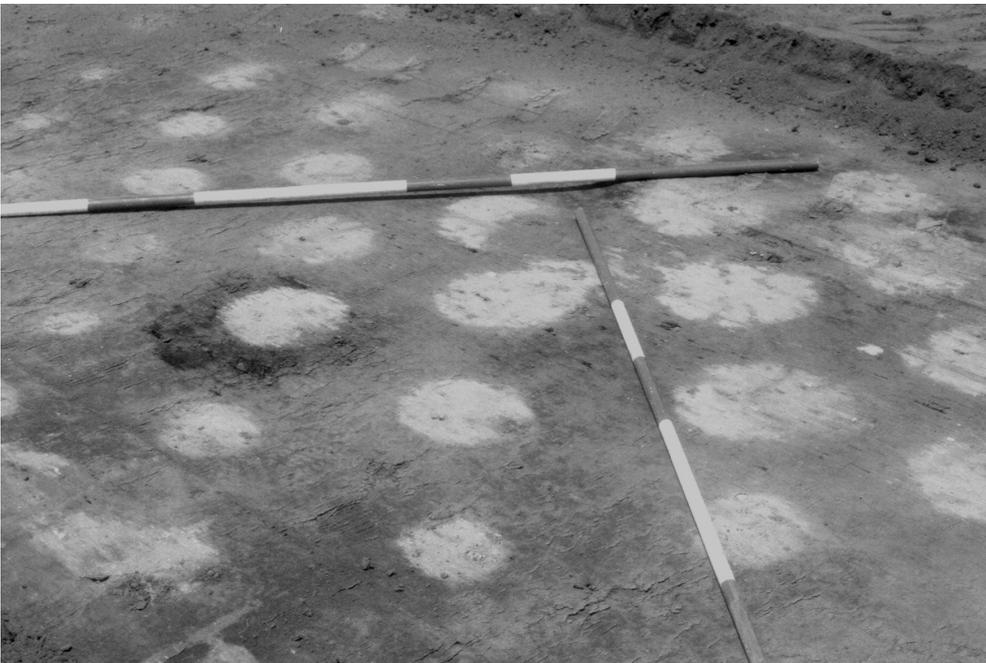


Figure 3. Photograph from S14/201 (Chartwell, Hamilton) showing the sand-filled bases of puke dug into the subsoil. (Scale intervals: 0.5 and 0.25 m.) (photo: Gumbley).



Figure 4. Photograph from S14/195 (Horotiu) showing bowl-shaped hollows forming bases for growing mounds, with the sand and gravel removed (Scales are 1 m.) (photo: Gumbley).

Archaeological investigations at an area of Tamahere soils and borrow pits (S14/201) at Chartwell in Hamilton (Gumbley & Higham 2000; Gumbley et al. 2004) revealed two adjacent areas where circular sand-filled bowls were identified at the topsoil-subsoil interface (Figure 3). Both sets of bowls, although slightly differently oriented, had similar internal organisation of the depressions where they were arranged in quincunx fashion (a form of off-set rows where four bowls are arranged around a central bowl). This conformed closely to historical references, which describe orderly gardens where kumara were grown in mounds organised in this fashion (Best 1925; Colenso 1880).

Since 1999 these sand-filled bowls, in similar arrangements, have also been found at Riverton Estate subdivision, on the northern edge of Hamilton on the east side of the Waikato River, when part of a large body of garden soils (S14/165) was investigated (Simmons 2008). The same type of feature has been found at several other sites: S14/158 and S14/198 at Taupiri (Campbell & Harris 2011; Gumbley & Gainsford 2020a) S14/468 at Ngaruawahia (Gumbley and Gainsford 2018), at S14/164 (Simmons 2013) and S14/194 (Gumbley & Hoffmann 2013) at Horotiu, S15/465 (Gumbley & Laumea 2019) and at S14/248 (Keith in prep) at Tamahere. Outside the Waikato similar features have been identified at Whangaruru Bay in Northland (J Carpenter, pers comm.); at Mahia Peninsula (Jones 2012) and, less convincingly, in Golden Bay (Barber 2004).

In a handful of sites, a distinct pattern in the upper soil horizon has been identified (S14/194, S15/424, S15/421¹⁰), which appears to reflect the absence or near absence of modern

¹⁰ Refer Gumbley & Hoffmann 2013 re S14/194; Gumbley et al 2018 re S15/421; S15/424 in preparation.

cultivation. The A-horizon is strongly enriched by sand and/or gravel and 25–40 cm thick. It is found with three units; the uppermost is the turf layer which is dark greyish-brown and includes organic material and, in terms of its particle size range, is well-sorted with a preponderance of material grading from medium sand size and finer. The middle unit is dark greyish-brown or black and includes organic matter (Figure 5). Texturally the middle unit is not sorted with a range of particle sizes represented up to coarse gravel. The lower unit contains the same range of particle sizes but has a paler matrix, yellowish-brown, reflective of the underlying B-horizon. This unit contains relatively low quantities of charcoal. The contact between the A- and B-horizons is irregular with an almost wavy appearance in places (Figure 6). The upper element (top ~ 20 cm) of the B-horizon is usually distinctly darker than the underlying material, with obvious enrichment with charcoal. It is possible that this is a buried remnant topsoil. While it is tempting to suggest that sandy and gravelly A-horizon represents the remains of sand and gravel mulch, experimental gardening carried out by Gumbley indicates an alternative explanation; that this layer represents the demolished and decayed remains of sand and gravel growing mounds that have weathered to appear like a continuous layer. Importantly, when the A-horizon material is removed by hand and the interface between the A- and B-horizons is examined with care it is clear that the irregularity visible in profile reflects the dimpled or undulating surface of the B-horizon. This dimpling appears to be an artefact of the working of the soil with tools and from the castes of tubers (of kumara?).

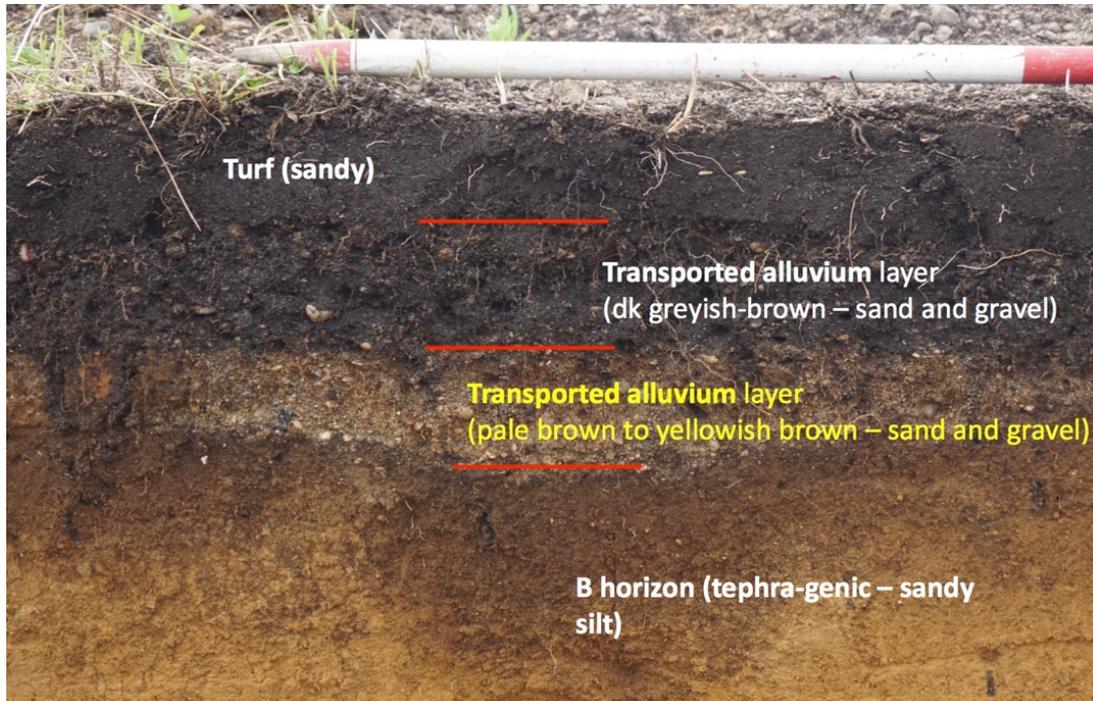


Figure 5. An example of an unmodified Māori-made soil horizon.



Figure 6. Example of the dimpled interface found at S15/374 at Ngaruawahia, garden site located on Waikato series soil (Gumbley & Gainsford 2018).

As well as the identification of the bowl-shaped hollows, other archaeological features have been found in association with gardens. These include drains where the gardens have encroached onto poorly drained soils, postholes for structures and the remains of fireplaces and umu.

We now also have direct evidence of what was grown in the gardens from the analysis of microfossils¹¹ found in the fill of bowl-shaped hollows (BSHs) and oval depressions at several sites. These analyses have found abundant kumara starch grains and also taro remains (Campbell & Harris, 2011; Gumbley & Hoffmann 2013; Hoffmann, 2011 & 2013). At site S14/222 a single possible yam starch grain was identified (Hoffmann 2011). Yam/uwhi, a tropical cultigen, has very rarely been identified in New Zealand but this find shows that this plant was also grown in the Waikato despite its sensitivity to a temperate climate.

While we now have an improving understanding of the anatomy of these sites this is based on the excavation of a handful of sites in any detail. Because of this there remains the potential

¹¹ Microfossils are the microscopic remains of plants. Pollen, phytoliths and remains of vegetation such as starch grains and xylem cells are what is analysed.

that the understanding of that anatomy can be improved substantially. We do not understand how the features found so far actually function; i.e. what their purpose was. A significant handicap lies in the lack of archaeological remains that tell us about what was present above the ground surface since this aspect of the gardens has disappeared. For example, from the presence of the bowl-shaped hollows we can safely infer that the material quarried from borrow pits was deposited in the hollows after the soil had been removed. However, it is unclear whether the sand and gravel were used to form a mound. Volumetric analysis of the modified soils for S14/201 suggests this was possible (Gumbley et al. 2004) but without similar research from other sites this evidence is weak.

In much the same way that we are unsure about how the sand and gravel were used, we remain unsure about what function the process had. Several writers have suggested that the addition of alluvial material improved the friability and heat retention of the soil, reduced the likelihood of frost damage, improved fertility, provided a disease-free growing medium, and created a sharp interface between the added materials and buried horizons to encourage larger tuber formation (Best 1925; Challis 1976; Singleton 1988). Together, it is assumed, these modifications made soils more suitable for growing the subtropical kumara in New Zealand's temperate environment (Taylor 1958).

One effect we do know occurred was that soil drainage was changed by the addition of sand and gravel. The Tamahere series soils are described as "well to somewhat excessively drained" (McLeod 1984:24), often increasing drainage in already well-drained soils (i.e. Horotiu loam and Waikato loam). Best (1925) and others remark on the desirability of free drainage for Māori when growing kumara. However, free drainage seems to have been desirable with such soil preferred, not only in the Waikato but more generally where kumara were grown in New Zealand (Best 1925). The addition of ash from burning the existing vegetation growing on the garden site probably improved nutrient levels (Grange et al. 1939; Taylor 1958), particularly potassium and nitrogen, which, together with phosphorus, are important nutrients for kumara growth (Singleton 1988).

These gardens were a major part of the economy for Waikato Māori. Their construction was part of a complex, time-consuming process and energy intensive process. First, the area where the garden was to be established had to be cleared from forest, which would have begun well in advance of the planting season (possibly 1–2 years). Then the garden had to be prepared. This stage in the process would have begun with the making of tools and baskets for digging and carrying the sand and gravel. The sand and gravel had to be quarried from the borrow pits but only after the tephra deposit (B-horizon) had been removed. Then the material had to be carried to the plots and the plots laid out and mounds formed. Following this planting could occur, followed several months after by the harvest and construction of the kumara stores.

While even the development one garden was an energy intensive activity when we also consider there were over 3000 hectares of these gardens in the inland Waikato, we can gain some understanding of the importance of these sites for tangata whenua.

Features of the Waikato Horticultural Complex

The following provides a brief description of relevant feature types associated with the Waikato horticultural complex to contextualise results from this report. The base attributes and characteristics of different features are outlined to enable an understanding of how phenomena contribute to the formation and manifestation of horticultural site in the Waikato.

Borrow pits

Borrow pits are large and readily identifiable features in the landscape. The larger borrow pits can be up to 40 metres across and they are generally 3–4 metres deep. However, the larger ones can be over 5 metres deep. Essentially, they are quarries used to access alluvial sands and gravels in the underlying substrate utilised to make gardening soils. Medium to large borrow pits are commonly an aggregation of multiple ‘shafts’. This process is also illustrated by the identification of borrow pits ~ 2 metres wide by ~ 2 metres deep as individual features¹². These, presumably, are borrow pits in their ‘youth’. Examples of quarries dug into river banks (S14/249) and into the toes of escarpment (S14/194) have also been found (Gumbley & Gainsford 2020b; Gumbley & Hoffmann 2013). Notably excavation of the sand and gravel substrate was accompanied by the immediate back-filling of the quarry shafts with a mixture of the unwanted tephritic material (re-worked B-horizon) and the sand and gravel substrate. This measure seems to have been employed to stabilise the pits from collapse and also demonstrates clearly that the fertile tephritic material was unwanted.

Bowl-shaped hollows (BSH)

The term ‘bowl-shaped hollow’ reflects the in-ground morphology of these features. The hollows are, typically, 25–40 centimetres in diameter and 20–30 centimetres deep. They are characteristically filled with sand and gravel alluvium quarried from the Hinuera Formation alluvium (C horizon). Occasionally the remains of digging stick (kō) marks can be found at their base, evident as a ‘dimple’. BSHs are usually found in groups, laid out regularly in parallel rows, in either a grid or quincunx pattern. BSHs represent the remains of structures for the growing of individual plants. It is inferred that a mound was raised above, and in which the plants were grown.

Sand/gravel layers

These are extensive charcoal enriched layers of sand and gravel, 10–20 centimetres thick (Gumbley & Laumea 2017). This phenomenon presents as a topsoil enriched with transported sand and gravel quarried from borrow pits which has also deepened the topsoil. Generally, these soils overlie a darkened B(w) horizon that sits on the principal sediments of the B-horizon. This B(w) horizon has been interpreted as buried topsoil (Grange et al 1939; Bruce 1978 & 1979). Charcoal is often found in the B(w) horizon, sometimes as obvious remains of

¹² S14/249, S14/195, S15/464, S15/641 and S15/757.

charred root systems. In other instances, the B(w) is missing and the sand and gravel layer wholly covers the B-horizon.

When the sand and gravel layer is well-preserved the topsoil divides into three elements; the turf layer ~15 centimetres thick with well-sorted medium sand and finer material; a very dark greyish brown to black layer of coarse material ~15 centimetres thick; a pale brown layer of coarse material ~ 15 centimetres thick. The darkening of the upper element is believed to be a product of soil formation processes but anthropogenic causes cannot be excluded. The uppermost element is a recent soil horizon developed under pasture turf with bioturbation accounting for the well-sorted nature of the sediments.

Fireplaces and domestic activities

Cooking and other domestic activities are found associated with horticultural sites. Fireplaces, including well-formed umu (earth ovens used to cook hāngi), are found both within and on the periphery of horticulture sites. Postholes and storage pits are also clustered with these collections of fireplaces. These have been documented at a number of sites; S14/195, S14/249, S15/757, S15/423, S15/424 (Gumbley & Hoffmann 2013; Gumbley & Gainsford 2020b); Gumbley & Laumea 2017; Gumbley et al in prep; Potts 2019).

Drains

Features relating to garden drainage have been identified at three sites in the inland Waikato, S14/194 (Gumbley and Hoffmann 2013), S14/250 (Gumbley and Gainsford 2020), S14/203 (Gumbley & Higham 1999). In each case these have been found around the peripheries of all otherwise dry horticultural sites. By this it is meant, that most of the associated horticulture had taken place on adjacent, slightly higher and well-drained soils, in particular Horotiu loam but also Bruntwood loam. In each case the drainage features were situated on poorly drained Te Kowhai silt loam. At each site the drains have been relatively shallow, narrow and generally dendritic in pattern, with smaller 'limb' channels feeding a 'trunk' unit carrying the collected water away to a nearby gully or waterway. Altogether, the patterns suggest ad hoc solutions to episodic problems rather than as a planned element of the original garden design.



Figure 7: Drainage system identified at S14/250 (Taupiri) (Gumbley & Gainsford 2020c)

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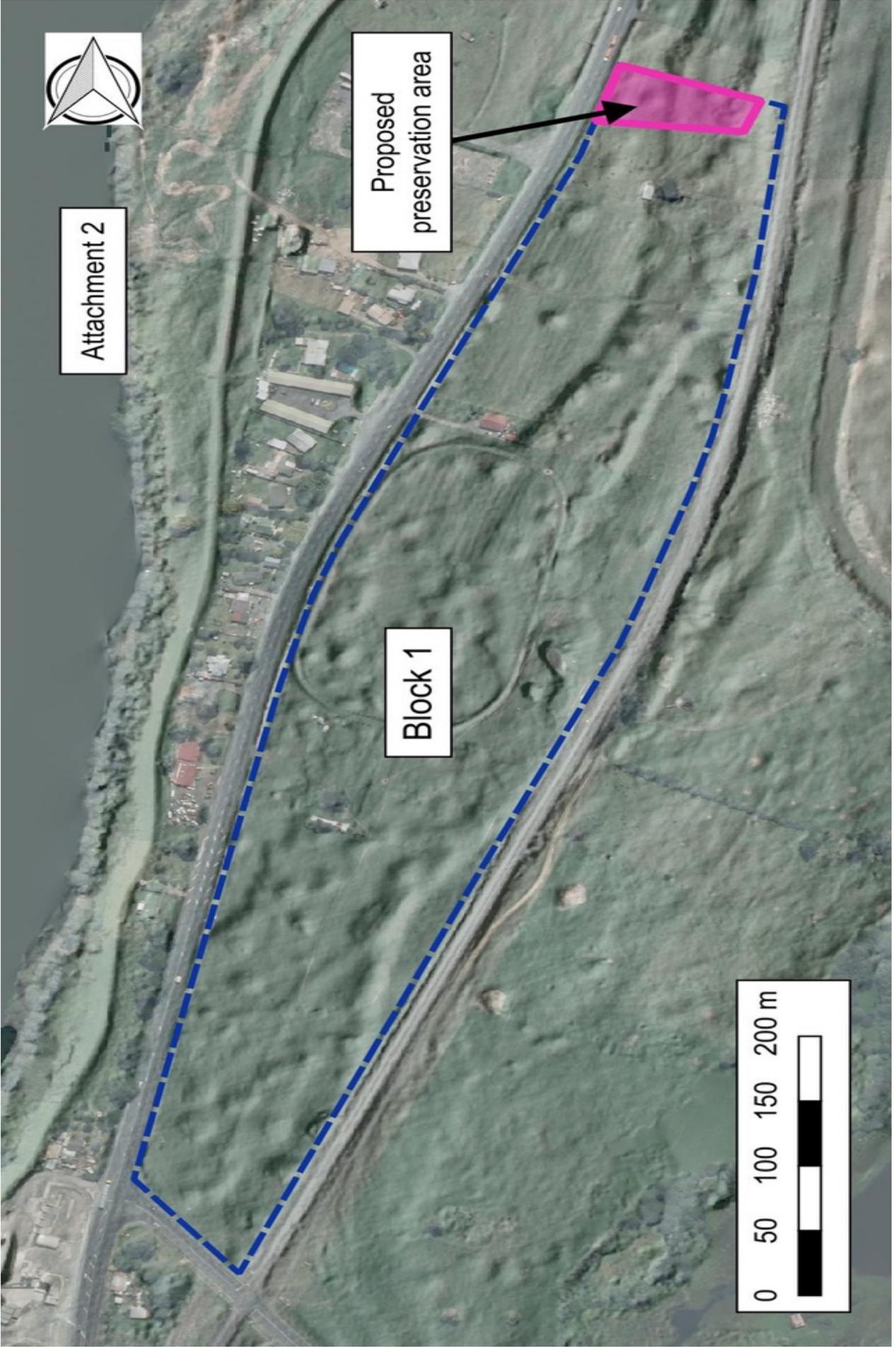
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Attachment 2

Recommended area for preservation



Attachment 2

Proposed preservation area

Block 1

