DRAFT VERSION

Assessment of Outstanding Natural Features - Geoheritage in Waikato District

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March 2021

Report BWH 204/21

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1. Summary

This report recommends that the following sites be retained as ONF in the Waikato District Plan under a category ONF-Geoheritage:

Daff Road Jurassic plant fossils
Huriwai Beach Jurassic plant fossils
Kaawa-Ngatutura Point section
Onewhero tuff ring and crater
Moeweka Quarry Jurassic fossils
Opuatia cliffs Jurassic fossils
Pukekawa scoria cone

One existing ONF has been assessed and it is recommended to remove it from the District Plan:

Port Waikato to Tuakau Bridge Road Jurassic section

The following criteria have been used to assess, score and document the geoheritage values of eight existing Outstanding Natural Features in the Waikato District Scheme in preparation for them to be included as ONF-Geoheritage sites in a new version of the Waikato District Plan.

Geoscience Values: Geoscience significance; Rarity; Representativeness; Research potential; Group values, Geohistorical values.

Perceptual values: Scenic/aesthetic; Views and visual prominence.

Associative criteria: Tourism/recreation; Community values; Educational values; Visual legibility; Preservation/naturalness; Memorability; Ecological values; Historic or archaeological values; Indigenous cultural values.

To aid in the management of the diversity of outstanding natural features-geoheritage with different levels of robustness and fragility, the features have been placed in one of the following categories: A. Large landforms; B. Small, vulnerable landforms; C. Dynamic landforms and natural physical systems; D. Large exposures of geological material; E. Small, vulnerable exposures of geological material; F. Caves and some of the perceived threats to sites in different categories are outline.

2. Introduction

2.1 Definition of an Outstanding Natural Feature – Geoheritage used in this report

The following definition is used (Geoscience Society of New Zealand, 2019): **"An Outstanding Natural Feature is a natural landform, physical system, or exposure of geological material that has outstanding geoscience, scenic/aesthetic, tourism, recreational, community and/or educational values or rarity."** A natural landform feature is a distinct and clearly legible entity that is generally smaller than a 'natural landscape', which has a broader range of physical, ecological, cultural and perceptual values.

2.2 Structure of this study

Documented assessment and scoring sheets (Appendix 1) and GIS map layers have been prepared for all eight existing ONFs.

2.3 Source of information

2.3.1. New Zealand Geopreservation Inventory
The major source of information on geoheritage ONFs is the Geoscience Society of New Zealand's Geopreservation Inventory site at:
https://services.main.net.nz/geopreservation/
This primarily lists geoscientifically and educationally significant sites. Compilation of the Inventory began in 1983. It is built on the combined knowledge of the whole geoscience community voluntarily provided over a period of 20 years. It attempts to be a complete list of sites of geoscience significance, is periodically updated but clearly it will never be fully comprehensive. The original scheduling of these ONFs in the former Franklin District Plan originates from the Inventory, as Franklin planners decided to schedule all sites in the District that were assessed as being of International or National Importance in the Inventory in 1994.

2.3.2. LINZ topographic maps and Google Earth
These databases have been used to better map the extent of landform sites.

2.3.3. Scientific publications
Some of these sites have been described and documented in scientific journals and these have been used where they exist and are listed in the references for each site.

3. Criteria used for identifying, assessing and scoring ONFs-Geoheritage

3.1 Assessment criteria

The following criteria were used in assessing the significance of and documenting the values of these Outstanding Natural Features-Geoheritage sites.

GEOSCIENCE VALUES

(a) **Geoscience significance** - the extent to which the landform, feature or geological site contributes to the understanding of the geology or evolution of the biota in the District, Region, New Zealand or the Earth;
(b) **Rarity** - the rarity or unique nature of the feature, physical process or geological exposure within the District or Region, and few comparable examples exist;
(c) **Representative values** - the extent to which the feature is an outstanding representative example of the natural landforms, natural physical processes or geological features that strongly typify the character of an area.
(d) **Research potential** of the feature to provide additional understanding of the geological or biotic history;
(e) **Group values –** the extent to which the feature contributes to a themed group of sites of significant community value (e.g. South Auckland volcanoes group).
(f) **Geohistorical value** - the extent to which a feature is associated with an historically important natural event (e.g. earthquake, tsunami), geologically-related industry, or historically-important individual involved in geoscience research;

PERCEPTUAL VALUES

(g) **Scenic/aesthetic values** – extent of public appreciation of a natural feature's visually-striking scenic beauty, or iconicism;
(h) **Prominence of views** of the feature or views from the feature;

ASSOCIATIVE CRITERIA

(i) **Tourism and/or recreational values** – extent of a feature's use or potential use for tourism or recreation because of the feature's natural attributes;
(j) **Community values** – extent of the community's association with a natural feature which is widely known and highly valued for its contribution to local identity within its community;
(k) **Educational values** - the existing or potential value of the feature for public education;
(l) **Visual legibility** – how clearly the feature's values can be seen;
(m) **Preservation and/or naturalness** of the feature – including degree of natural degradation of values by weathering or erosion, as well as degree of modification by humans;

(n) Memorability of the feature, because of its striking visual character and setting that make such an impact on the senses that it becomes unforgettable;
(o) ***Ecological value** of the biota, including vegetation, associated with the feature;
(p) ***Historic or archaeological values** associated with the feature;
(q) ***Indigenous cultural values** - the importance of the feature or site to Mana Whenua (most appropriately undertaken by local iwi).

* Note that if a potential feature has high associative values (historical, archeological, ecological or indigenous cultural values) then it should be assessed and protected under these categories in a District Plan independently of this ONF evaluation.

Each of the criteria (a-p) have been considered and where appropriate documented for every assessed potential ONF.

3.2 ONF Assessment Scoring outline

In this study weighted scores have been given for each of the assessment criteria for each site with brief documentation supporting each score. The more important criteria for geoheritage value are weighted to give them greater significance than the lesser criteria. The scores given for all criteria for each potential ONF have been summed and the resulting total for each site gives an indication of the perceived significance of each site.

This weighted scoring scheme is based on schemes used for Auckland City Council – Inner Gulf Islands District Plan and Proposed Waitomo and Kaipara District plans. It is argued that the scoring adds rigour and more objectivity to the assessment and a method for comparing between the overall values of different sites.

Weighted scores used in values assessment:

	Significance level/	**International/**	**National/**	**Regional/**	**District/**	**Local/**
	Values assessment	**Superlative**	**Excellent**	**Very good**	**Good**	**Moderate**
	GEOSCIENCE VALUES					
a	Geoscience significance	64	32	16	8	4
b	Rarity	64	32	16	8	4
c	Representative values			8	4	2
d	Research potential			8	4	2
e	Group values			8	4	2
f	Geohistorical values		16	8	4	2
	PERCEPTUAL VALUES					
g	Scenic/aesthetic values	64	32	16	8	4
h	Prominence of views		16	8	4	2
	ASSOCIATIVE CRITERIA					
i	Tourism/recreational values	32	16	8	4	2
j	Community values	32	16	8	4	2
k	Educational values		16	8	4	2
l	Legibility and expressiveness		8	4	2	1
m	Preservation/Naturalness		8	4	2	1
n	Memorability		8	4	2	1
o	Ecological values		8	4	2	1
p	Historical or archaeological values		8	4	2	1
q	Indigenous cultural values					

Total score:

Feature Category: A. Large Landform, B. Small Landform, C. Natural system, D. Large exposure, E. Small exposure, F. Cave

4. Categories of Outstanding Natural Features - Geoheritage

4.1 Feature categories

ONFs-Geoheritage can be large and robust or small and vulnerable, they can be underground (caves) or dependent on continuation of processes beyond the limit of the feature (e.g. active sand dunes, gas seeps, springs). To assist management and decision-making for such a diverse range of features, the ONFs-Geoheritage assessed here have been categorised by type to provide a guide to the kind of values that make them significant, how susceptible to damage they may be from various activities, and how better to manage potential risks to their values. The categories described below are more or less the same as in the Auckland Unitary Plan, the Northland Regional Plan and the draft Waitomo District Plan.

A. Large landforms

These are prominent landforms that are sufficiently large and robust to withstand small-scale earthworks or constructions without significant impact. The prime values of such features may relate to the underlying geology which tells of the history of their formation or to their value to the community for their scenic/aesthetic/tourism/recreational/educational values. Major building construction, large scale earthworks (e.g., quarry or significant road cuttings; dam construction and flooding; wind farm groundwork and roads) or planting and harvesting of commercial exotic forest can significantly detract from the integrity or hide these prominent landforms.

B. Small, vulnerable landforms

Small landforms or other features that could be damaged or destroyed by relatively small-scale earthworks or constructions. The values of these often spectacular, localised landforms relate to their visual and aesthetic appeal and/or geoscientific interest or educational values. Most earthworks, buildings, constructions or commercial forest plantings would adversely impact or completely destroy the values of these highly vulnerable features and should be prohibited.

C. Dynamic landforms and natural systems

These are landforms, features or systems that rely on the continuation of natural physical processes in and beyond the feature for their continued existence. Because of this, these dynamic landforms or features are not only susceptible to direct damage, but to more distant actions that may impact the continuation of the natural processes (e.g. sand or shell supply; dune stabilisation; soil erosion in catchments; water extraction; river modifications). Permanent earthworks, building construction, commercial exotic forest plantings, or other actions could adversely affect the functioning and appearance of these features.

D. Large exposures of geological material

Outstanding natural features include rock formations and the details that can be seen in or extracted from these rocks. These details can only be seen where rock is visible at the surface either in natural or man-made exposures or cuttings. This category includes exposures of rock that are sufficiently large and robust that small-scale earthworks or road widening will have no significant adverse impact and in most cases will improve the visibility or freshness of features in the rocks. The values of these sites relate to the natural geological features that

can be seen within the rocks and the information they contain about the history of their formation, the geological origins of the district or the fossil history of the biota of New Zealand. Large-scale earthworks, construction of buildings, vegetation plantings, grass seeding or constructions of retaining walls or erosion barriers could adversely impact the visual, educational or scientific values of these exposures.

E. Small, vulnerable exposures of geological material

These are small, natural or man-made exposures of natural rock that could be damaged or destroyed by small-scale earthworks, construction or plantings. Their prime values relate to the information they contain about the history of their geological formation or the fossil biota of New Zealand. Most earthworks, building constructions, vegetation plantings, grass hydroseeding or constructions of walls or erosion barriers are likely to adversely impact the heritage values of these exposures and should be prohibited. Periodic vegetation clearance may improve their values.

F. Caves

This category includes limestone caves, marble caves and sea caves and their entrances, which may, depending upon their depth underground, be susceptible to damage from significant earthworks, constructions or quarrying above them, or from changes in their catchments that may fill them with eroded soil or starve them of water flow.

G. Volcanoes

This category contains the volcanic landforms of well-preserved Pliocene-Quaternary (younger than 5 million years ago) volcanoes that have special values to most communities as an integral part of the area's history. The values are scientific, scenic/aesthetic and the views both of these prominent features and from them. Threats to these sites are similar to large landforms, such as any significant earthworks, exotic forest plantings, major buildings, or housing subdivisions. When the area becomes surrounded by suburbia these are the major landforms that should remain untouched and be set aside as recreational reserves.

4.2 Example of activity table that relates to categories of ONF

4.2.1 Activity Table

This activity table is derived from several district plans. It applies to ONFs outside the Coastal Environment. The table relates to resource consent requirements for land use and development on ONFs-Geoheritage. It provides an indication of the sort of controls that would be necessary to adequately protect the values of the proposed ONFs as required by the RMA. There are minor differences between all these plans in the listed activities and permission levels indicated and the below example is a compromise between them.

Table 1: Activity table – Outstanding natural features overlay - Land use and development
*A-F = feature categories of 6.1

Activity	A	B	C	D	E	F	G
Construction							
Buildings and structures	D	NC	NC	NC	NC	RD	NC
Earthworks							
Removal, fill, modification of more than 5 cu m	D	Pr	D	D	Pr	D	NC
Removal, fill, modification of less than 5 cu m	P	RD	RD	D	NC	RD	D
Rural							
Grazing by stock	P	RD	RD	P	RD	P	P
Quarries of any sort	Pr	Pr	Pr	D	Pr	Pr	Pr
Forestry	RD	Pr	D	D	Pr	D	Pr
Conservation planting	P	RD	D	NC	NC	P	RD
Fences - post and wire	P	P	RD	P	RD	P	P
Fences - except post and wire	RD	D	NC	D	NC	P	RD
Utilities							
Minor infrastructure upgrading	P	RD	D	RD	NC	RD	RD

P = permitted
RD = restricted discretionary
D = discretionary
NC = non-compliant
Pr = prohibited

4.2.2 Criteria for allowing discretionary activities

The council will consider the relevant assessment criteria below for the discretionary activities listed above:

1. Whether the nature, form and extent of the proposed works or activity adversely affects the values of the ONF for which the item was scheduled:
    a. whether the activity will result in increased erosion of the ONF;
    b. for grazing applications, whether the proposed stocking intensity will result in increased erosion of the ONF, or will result in changes to the vegetation on site in ways that will affect the values for which the ONF is scheduled e.g. grazing effects on dune vegetation resulting in changes to the nature of the dunes;
    c. for fencing applications, whether the proposed fence requires ground disturbance or earthworks that will affect the values for which the ONF is scheduled;
    d. whether the activity will interfere with natural processes (e.g. forestry or vegetation planting effects the natural dynamic supply of sand to wind-blown dunes or groundwater to caves).
2. Whether the proposed works or activity will cause adverse visual effects or adversely affect visual appreciation of the ONF.
3. The degree to which the ONF has already been modified so that further modification will not cause significant additional loss of the identified values.
4. The extent to which the modification is necessary.
5. The purpose of the proposed works or activity and whether it has specific connections or relevance to the scheduled ONF.
6. What alternative methods and locations are available to the applicant for carrying out the work or activities that do not affect a scheduled ONF.
7. The extent to which the proposed works will protect the ONF from further damage or remediate it from previous damage. This excludes potential damage from the activity for which consent is sought.
8. In the case of subdivisions, the extent to which the resultant sites can be developed without affecting the values for which the ONF is scheduled.

5.0 SELECTED REFERENCES

Hayward, B.W. 1996. Precious Land: Protecting New Zealand's landforms and geological features. *Geological Society of New Zealand Guidebook* 12, 48 p.

Kenny, J.A.; Hayward, B.W. 2010. Karst in Stone. Karst landscapes in New Zealand: A case for protection. *Geological Society of New Zealand Guidebook* 15, 48 p.

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Geoscience Society of New Zealand. 2019, Best practice guide; Outstanding Natural Features. What are they and how should they be identified ; and their significance assessed and documented? Geoscience Society of New Zealand Miscellaneous Publication No 154.

Geoscience Society of New Zealand. New Zealand Geopreservation Inventory. https://services.main.net.nz/geopreservation/

APPENDIX – MAPS AND ASSESSMENT SHEETS FOR EXISTING ONF_GEOHERITAGE SITES, WAIKATO DISTRICT PLAN

A. Recommended for continued scheduling

1. Daff Road Jurassic plant fossils

		Score	Range	
	ONF Name			**Daff Road Jurassic plant fossils**
	Feature type			E. Small exposure
	DESCRIPTION OF FEATURE			A small farm quarry exposes a 10 m thick sequence through Huriwai Formation, including 2 m of rich plant fossil-bearing mudstones. Sand beds also contain wood and other scattered plant fossils.
	Locality			In farm quarry, 200 m north of Putataha trig and 400 m south of farm airstrip, 3 km south of end of Daff Road. Exposures of plant fossils are in quarry face and down bank below the quarry and farm track.
	Geoscience values:			
	a. Geoscience Significance	32	4 - 64	Most easily accessible and most robust source of extremely well preserved Jurassic plant fossils in North Island.
	b. Rarity	32	4 - 64	Well-preserved Jurassic plant and fern fossils rare in New Zealand.
GEOSCIENCE:	c. Representative	8	2 - 8	Excellent representative example of fossil Mesozoic plant fossils and different sedimentary layers.
	d. Research potential	4	2 - 8	Material easily collected for future taxonomic and paleoecologic research.
	e. Group values	0	2 - 8	not part of a high value group of sites
	f. Geohistorical values	0	2 - 16	None known.
	Perceptual values:			
	g. Scenic/aesthetic	0	4 - 64	No aesthetic value in quarry.
	h. Prominence of views to/from site	0	2 - 16	Not visible except close up.
	Associative criteria:			
	i. Tourism/recreational	2	2 - 32	Minor tourism value if owner wished to allow this.
	j. Community values	0	2 - 32	Largely unknown by local community.
	k. Educational	8	2 - 16	High educational value if owner were to allow class and group visits.
	l. Visual legibility	4	1 - 8	Easily recognised as fossil wood and plant material..
	m. Preservation/naturalness	0	1 - 8	Only visible because of farm quarrying activities.
	n. Memorability	8	1 - 8	Fossils are highly memorable to those who see or find them.
	o. Ecological values	0	1 - 8	open farmland
	p. Historic or archaeological values	0	1 - 8	None known.
	q. Indigenous cultural values		1 - 8	assessed by local iwi
	REFERENCES:			
	Land tenure			
	OVERALL EVALUATION			
	SUMMARY COMMENT:			
	Total score:	98		

2. Huriwai Beach Jurassic plant fossils

		Score	Range	
	ONF Name			**Huriwai Beach Jurassic plant fossils**
	Feature type			E. Small exposure
	DESCRIPTION OF FEATURE			Rich, well-preserved Jurassic plant and fern fossils in hard mudstones.
	Locality			In natural exposures of rock at high tide at north end of Huriwai Beach.
	Geoscience values:			
	a. Geoscience Significance	32	4 - 64	Extremely well-preserved and historically significant upper Jurassic flora. Type locality of several species. One of best localities for fossil Jurassic plants in New Zealand, particularly three species of the fern Cladophlebis. Nine species of plant plus a seed head recorded.
	b. Rarity	32	4 - 64	Well-preserved Jurassic plant and fern fossils rare in New Zealand.
GEOSCIENCE:	c. Representative	8	2 - 8	Excellent representative example of fossil Mesozoic plant fossils in their sedimentary sequence.
	d. Research potential	4	2 - 8	Material easily collected for future taxonomic and paleoecologic research.
	e. Group values	0	2 - 8	not part of a high value group of sites
	f. Geohistorical values	4	2 - 16	First visited and collected by the Father of NZ geology, Ferdinand von Hochstetter in 1859 and by the founder of the NZ Geological Survey, Sir James Hector in 1866.
	Perceptual values:			
	g. Scenic/aesthetic	0	4 - 64	No aesthetic value in quarry.
	h. Prominence of views to/from site	0	2 - 16	Not visible except close up.
	Associative criteria:			
	i. Tourism/recreational	2	2 - 32	Minor tourism value if owner wished to allow this. A long way from public access.
	j. Community values	0	2 - 32	Largely unknown by local community.
	k. Educational	2	2 - 16	High educational value but distance from public access reduces this value.
	l. Visual legibility	4	1 - 8	Easily recognised as fossil wood and plant material..
	m. Preservation/naturalness	8	1 - 8	Site naturally eroded with no human modifications.
	n. Memorability	8	1 - 8	Fossils are highly memorable to those who see or find them.
	o. Ecological values	1	1 - 8	Little lives in the high intertidal zone.
	p. Historic or archaeological values	0	1 - 8	None known.
	q. Indigenous cultural values		1 - 8	Should be assessed by local iwi
	REFERENCES:			Purser, B.H. 1961: Geology of the Port Waikato Region. NZ Geological Survey Bulletin 69, p. 30. Arber, E.A.N. 2017. The earlier Mesozoic floras of New Zealand. New Zealand Geological Survey Paleontological Bulletin 6, p. 17-18.
	Land tenure			
	OVERALL EVALUATION			
	SUMMARY COMMENT:			
	Total score:	105		

3. Kaawa-Ngatutura Point section

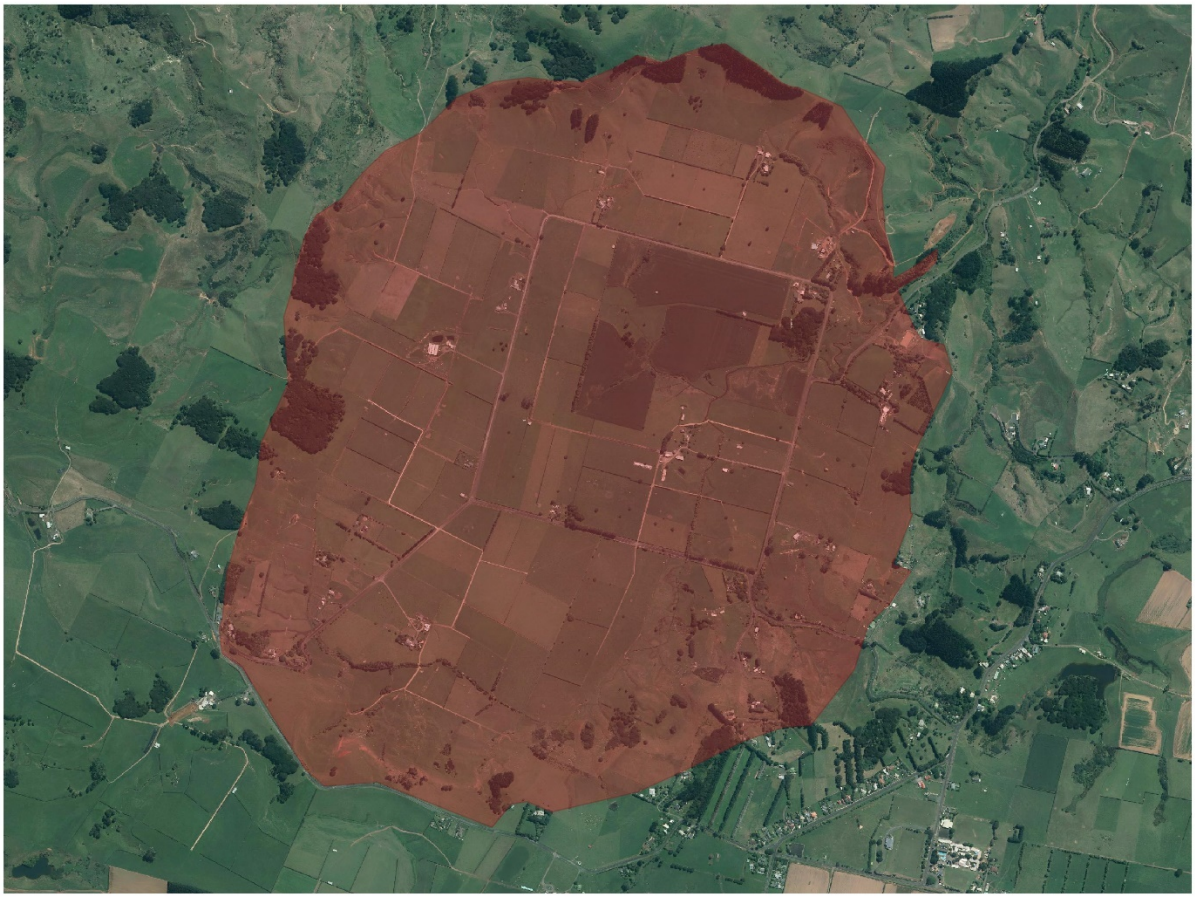
		Score	Range	
	ONF Name			**Kaawa - Ngatutura Point section**
	Feature type			B. Small landform; D. Large exposure
	DESCRIPTION OF FEATURE			Erosion of thick Pliocene basalt low has produced amazing coastal stacks and cliffs with sweeping fans of columnar joints. The cliff section behind adjacent Ngatutura Bay contains one of the most complex geological sections anywhere. It contains Oligocene, Miocene, Pliocene and Pleistocene strata that have been tilted, faulted and eroded during the time of deposition and intruded by a volcanic neck. There are rich Pliocene shellbeds and a distal ignimbrite.
	Locality			In coastal cliffs for 1 km south of Kaawa Creek mouth. Coastal section forming Ngatutura Point and adjacent sea cliffs and stacks offshore.
	Geoscience values:			
	a. Geoscience Significance	32	4 - 64	Possibly the most complex geological cliff sections in New Zealand. Type section of the Pliocene Kaawa Shell Bed Formation. Only significant Pliocene fauna in north-west North Island. Rich, diverse and well-preserved molluscs. Most impressive coastal landforms eroded into columnar-jointed basalt in New Zealand. Spectacular outcrops of dissected eruptive centre including lava flows, dikes and diatreme.
	b. Rarity	32	4 - 64	Coastal stacks composed of eroded columnar-jointed basalt rare in New Zealand. Exposed volcanic conduits also rare in New Zealand. Rich Pliocene macrofossils rare in northern North Island.
GEOSCIENCE:	c. Representative	8	2 - 8	Excellent representative examples of many geological features.
	d. Research potential	8	2 - 8	Material easily collected for future research in many fields. Number of references reflects the complexity of this site.
	e. Group values	0	2 - 8	not part of a high value group of sites
	f. Geohistorical values	0	2 - 16	None known.
	Perceptual values:			
	g. Scenic/aesthetic	32	4 - 64	The coastal cliffs and conical and vertical sided stacks are of high aesthetic value.
	h. Prominence of views to/from site	4	2 - 16	Best viewed from out at sea and from the air.
	Associative criteria:			
	i. Tourism/recreational	4	2 - 32	High tourism potential if owner wished to allow this.
	j. Community values	0	2 - 32	Largely unknown by local community.
	k. Educational	8	2 - 16	High educational value if owner were to allow class and group visits, but difficult access reduces this. Visited by several University groups every year.
	l. Visual legibility	4	1 - 8	Many aspects are understandable and others are puzzling.
	m. Preservation/naturalness	8	1 - 8	No human modifications.
	n. Memorability	8	1 - 8	Landforms and complex geology are highly memorable.
	o. Ecological values	4	1 - 8	Cliffs and steep coastal slopes ungrazed coastal vegetation.
	p. Historic or archaeological values	0	1 - 8	None known.
	q. Indigenous cultural values		1 - 8	Should be assessed by local iwi
	REFERENCES:			Spratt, P.R. 1974: The stratigraphy and paleoecology of the Kaawa Formation. MSc thesis, University of Auckland. Rodgers, K.A.; Grant-Mackie, J.A. 1978: Aspects of the geology of the Port Waikato region. Department of Geology, University of Auckland. 99p. Purser, B.H. 1961: Geology of the Port Waikato region. NZ Geological Survey Bulletin 69. Ballance, P.F.; Nelson, C.S. 1969: Differential cementation in the Waikawau Limestone (Waitemata Group), West Auckland. NZ Journal of Geology and Geophysics 12: 67-86. Heming, R.F. 1980: The Ngatutura Diatreme. NZ Journal of Geology and Geophysics 23: 569-573. Spratt, P.R.; Rodgers, K.A. 1975: The Ngatutura Volcanic, Southwest Auckland. Journal of the Royal Society NZ 5: 147-170. Briggs, R.M.; Utting, A.J.; Gibson, I.L. 1990: The origin of alkaline magmas in an intraplate setting near a subduction zone: the Ngatutura Basalts, North Island, New Zealand. J. Volcan. Geotherm. Res. 40: 55-70. van Niekerk, R. 2016. reconstructing the complex history of small-volume basaltic volcano (Ngatutura Volcano, New Zealand): the role of subsurface processes and implications for diatreme formation. thesis, Massey University.
	Land tenure			
	OVERALL EVALUATION SUMMARY COMMENT:			
	Total score:	152		

4. Moeweka Quarry Jurassic fossils

		Score	Range	
	ONF Name			**Moeweka Quarry Jurassic fossils**
	Feature type			E. Small exposure
	DESCRIPTION OF FEATURE			A small disused and grassed farm quarry with loose blocks of slightly weathered greywacke containing numerous Jurassic bivalve and brachiopod fossils of NZ stage Heterian age.
	Locality			Quarry just north of Ponganui Road, due east of Port Waikato township.
	Geoscience values:			
	a. Geoscience Significance	32	4 - 64	One of the most easily accessed and richest Jurassic mollusc and brachiopod fossil faunas of Heterian age in the North Island.
	b. Rarity	16	4 - 64	Well-preserved diverse marine Jurassic fossil faunas uncommon in the North Island.
GEOSCIENCE:	c. Representative	4	2 - 8	Good representative examples of fossil Mesozoic marine fossils.
	d. Research potential	4	2 - 8	Material easily collected for future taxonomic and paleoecologic research.
	e. Group values	0	2 - 8	not part of a high value group of sites
	f. Geohistorical values	0	2 - 16	None known.
	Perceptual values:			
	g. Scenic/aesthetic	0	4 - 64	No aesthetic value in disused quarry.
	h. Prominence of views to/from site	0	2 - 16	Not visible except close up.
	Associative criteria:			
	i. Tourism/recreational	0	2 - 32	No tourism or recreational value.
	j. Community values	0	2 - 32	Unknown by local community.
	k. Educational	4	2 - 16	Moderate educational value if owner allows access. Close to public road.
	l. Visual legibility	4	1 - 8	Fossils are readily recognisable as marine shells.
	m. Preservation/naturalness	0	1 - 8	Old quarry on side of farm track.
	n. Memorability	2	1 - 8	Fossils may be memorable because of the size of the bivalves.
	o. Ecological values	0	1 - 8	open farmland
	p. Historic or archaeological values	0	1 - 8	None known.
	q. Indigenous cultural values		1 - 8	Should be assessed by local iwi
	REFERENCES:			Purser, B.H. 1961: Geology of the Port Waikato Region. NZ Geological Survey Bull 69.
	Land tenure			
	OVERALL EVALUATION			
	SUMMARY COMMENT:			
	Total score:	66		

5. Onewhero tuff ring and crater

		Score	Range	
	ONF Name			**Onewhero tuff ring and crater**
	Feature type			G. Volcano
	DESCRIPTION OF FEATURE			This tuff ring blasted through pre-existing lava flows of the Onewhero Cone whose lavas are now preserved in the south wall and north outlet of the tuff ring. The tuff ring has no plug and bore holes have failed to detect any basalt, at least to depths of 100 m below the present floor of the crater. The volcano is dated at 880,000 years old.
	Locality			Surrounds Kaipo Flats (crater floor) NW of Onewhero township.
	Geoscience values:			
	a. Geoscience Significance	16	4 - 64	Largest tuff ring in the South Auckland field. Well preserved tuff ring and flat crater floor.
	b. Rarity	32	4 - 64	Basalt tuff rings with a diameter in excess of 2 km are rare in New Zealand.
GEOSCIENCE:	c. Representative	8	2 - 8	Excellent representative example of a large explosion crater surrounded by a tuff ring. Crater fill of sediments undoubtedly holds a long record of the climate, vegetation and
	d. Research potential	8	2 - 8	volcanic history of this district. Exposures of basalt lava and tuff hold potential for further research.
	e. Group values	8	2 - 8	Major member of the high value group of South Auckland volcanoes.
	f. Geohistorical values	0	2 - 16	None known.
	Perceptual values:			
	g. Scenic/aesthetic	4	4 - 64	Crescentic shape of tuff ring surrounding flat floor of crater has minor appeal to those who live or drive around the tuff rings perimeter.
	h. Prominence of views to/from site	4	2 - 16	Crest of tuff ring can be viewed from around its perimeter across the wide crater.
	Associative criteria:			
	i. Tourism/recreational	2	2 - 32	Minor tourism value as people drive the roads through it or visit Vivien Falls at the outlet.
	j. Community values	4	2 - 32	Onewhero community are well aware of their volcano and the name link between the volcano and their township.
	k. Educational	4	2 - 16	Moderate educational value, primarily for local schools.
	l. Visual legibility	4	1 - 8	Most people can visualise the shape of the volcano when it is explained to them.
	m. Preservation/naturalness	4	1 - 8	Tuff ring has been slightly scarred by roads and buildings on it, otherwise the landform is mostly intact.
	n. Memorability	1	1 - 8	Minor memorability.
	o. Ecological values	0	1 - 8	open farmland
	p. Historic or archaeological values	0	1 - 8	None known.
	q. Indigenous cultural values		1 - 8	Should be assessed by local iwi
	REFERENCES:			Rafferty, W.J. 1977: The volcanic geology and petrology of South Auckland. MSc, Department of Geology, University of Auckland. Waterhouse, B.C. 1978: Geological Map of New Zealand, Onewhero Sheet N51. NZ Geological Survey, DSIR. Nemeth, K.; Agustín-Flores, J.; Briggs, R.M.; Cronin, S.; Kereszturi, G.; Lindsay, J.M.; Pittari, A.; Smith, I.E.M. 2012. Monogenetic volcanism of the South Auckland and Auckland Volcanic Fields. 4th International Maar Conference MP131B: 72 pp. Briggs, R.M.; Okada, T.; Itaya, T.; Shibuya, H.; Smith, I.E.M. 1994. K-Ar ages, paleomagnetism, and geochemistry of the South Auckland volcanic field, North Island, New Zealand. New Zealand journal of geology and geophysics 37: 143-153. Gibson, A.C. 2011. Volcanology of tuff rings at Kellyville, Onewhero and Bombay, South Auckland Volcanic Field. . Unpublished MSc thesis, University of Waikato.
	Land tenure			
	OVERALL EVALUATION SUMMARY COMMENT:			
	Total score:	99		



6. Opuatia cliffs Jurassic fossils

		Score	Range	
ONF Name				**Opuatia cliffs Jurassic fossils**
Feature type				E. Small exposure
DESCRIPTION OF FEATURE				10 m high cliff face on true right bank of stream exposes Jurassic strata of NZ Stage Temaikan age containing a number of Jurassic marine fossils - including bivalves, ammonites and brachiopods.
Locality				North of Ponganui Road, on Opuatia Stream, Port Waikato. Cliff above stream in farmland
Geoscience values:				
a. Geoscience Significance		32	4 - 64	Rich, diverse and well-preserved Jurassic molluscan and brachiopod fauna that document the biota of this part of Gondwana's coast. One of the best in New Zealand. Also valuable in correlation with strata of similar age world-wide.
b. Rarity		16	4 - 64	Well-preserved diverse marine Jurassic fossil faunas uncommon in the North Island.
GEOSCIENCE:	c. Representative	8	2 - 8	Excellent representative example of fossil Mesozoic marine fossils and different sedimentary layers.
	d. Research potential	4	2 - 8	Material easily collected for future taxonomic and paleoecologic research.
	e. Group values	0	2 - 8	not part of a high value group of sites
	f. Geohistorical values	0	2 - 16	None known.
Perceptual values:				
	g. Scenic/aesthetic	0	4 - 64	No aesthetic value.
	h. Prominence of views to/from site	0	2 - 16	Not visible except close up.
Associative criteria:				
	i. Tourism/recreational	0	2 - 32	No tourism or recreational value.
	j. Community values	0	2 - 32	Unknown by local community.
	k. Educational	4	2 - 16	Moderate educational value if owner allows access. Close to public road.
	l. Visual legibility	4	1 - 8	Fossils are readily recognisable as marine shells.
	m. Preservation/naturalness	8	1 - 8	Natural cliff with no human modifications.
	n. Memorability	2	1 - 8	Fossils may be memorable especially if it is a small ammonite.
	o. Ecological values	0	1 - 8	open farmland
	p. Historic or archaeological values	0	1 - 8	None known.
	q. Indigenous cultural values		1 - 8	Should be assessed by local iwi
REFERENCES:				MacFarlan, D.A.B. 1985: Triassic and Jurassic Rhynchonellacea (Brachiopoda) from New Zealand and New Caledonia. PhD thesis, Otago University. Purser, B.H. 1961: Geology of the Port Waikato region. NZ Geological Survey Bulletin 69.
Land tenure				
OVERALL EVALUATION				
SUMMARY COMMENT:				
Total score:		78		

7. Pukekawa scoria cone

		Score	Range	
	ONF Name			**Pukekawa scoria cone**
	Feature type			G. Volcano
	DESCRIPTION OF FEATURE			A small steep-sided scoria cone with a preserved crater sitting atop a 5 km diameter shield of lava flows erupted from the same central conduit. Together with two volcanic centres to the NE, Pukekawa I cone or Smeed's Volcano and Pukekawa II or Mile Bush Volcano, this centre has built large coalescing cones of basaltic lava flows which cover an area above the west bank of the Waikato River opposite Mercer township. Pukekawa II and Pukekawa centres are inferred to have erupted along the Pukekawa Fault. The majority of Pukekawa's lava flow shield is excluded from the ONF.
	Locality			Adjacent and to the west of State Highway 22 (Tuakau Te Uku Road) just NW of Pukekawa township.
	Geoscience values:			
	a. Geoscience Significance	16	4 - 64	Possibly the best preserved small scoria cone with a summit crater in the South Auckland Volcanic Field. Youngest dated volcano in the South Auckland Volcanic Field. Southernmost volcano in the South Auckland Volcanic Field.
	b. Rarity	16	4 - 64	Scoria cones with summit craters are rare in the South Auckland Volcanic Field.
GEOSCIENCE:	c. Representative	8	2 - 8	Excellent representative example of a scoria cone with a summit crater surmounting a large shield cone of lava flows..
	d. Research potential	4	2 - 8	Material easily collected for future research to further understanding of Pukekawa and South Auckland's volcanic eruptions.
	e. Group values	8	2 - 8	One of the most iconic and high-standing volcanoes in the high value South Auckland Volcanic Field group.
	f. Geohistorical values	0	2 - 16	None known.
	Perceptual values:			
	g. Scenic/aesthetic	32	4 - 64	Most prominent cone in the South Auckland Volcanic Field.
	h. Prominence of views to/from site	16	2 - 16	Visible to and from the scoria cone for many kms in all directions.
	Associative criteria:			
	i. Tourism/recreational	4	2 - 32	Some tourism value for views from summit if owner wished to allow this.
	j. Community values	16	2 - 32	Region and township named after their volcano.
	k. Educational	8	2 - 16	High educational value if owner were to allow class and group visits or even as seen from roadside.
	l. Visual legibility	8	1 - 8	Can be readily recognised as a volcanic cone and breached crater.
	m. Preservation/naturalness	8	1 - 8	Mostly in farmed grassland but volcanic landform currently little modified.
	n. Memorability	4	1 - 8	Cone moderately memorable for locals and those who ascend it.
	o. Ecological values	0	1 - 8	open farmland
	p. Historic or archaeological values	0	1 - 8	Not known
	q. Indigenous cultural values		1 - 8	Should be assessed by local iwi
	REFERENCES:			Rafferty, W.J. 1977: The volcanic geology and petrology of South Auckland. MSc, Department of Geology, University of Auckland. Waterhouse, B.C. 1978: Geological Map of New Zealand, Onewhero Sheet N51. NZ Geological Survey, DSIR. Nemeth, K.; Agustín-Flores, J.; Briggs, R.M.; Cronin, S.; Kereszturi, G.; Lindsay, J.M.; Pittari, A.; Smith, I.E.M. 2012. Monogenetic volcanism of the South Auckland and Auckland Volcanic Fields. 4th International Maar Conference MP131B: 72 pp. Briggs, R.M.; Okada, T.; Itaya, T.; Shibuya, H.; Smith, I.E.M. 1994. K-Ar ages, paleomagnetism, and geochemistry of the South Auckland volcanic field, North Island, New Zealand. New Zealand journal of geology and geophysics 37: 143-153.
	Land tenure			
	OVERALL EVALUATION			
	SUMMARY COMMENT:			
	Total score:	148		

B. Recommended for not continuing scheduling

8. Port Waikato to Tuakau Bridge Rd Jurassic section

		Score	Range	
	ONF Name			**Port Waikato to Tuakau Bridge Rd Jurassic section**
	Feature type			D. Large exposure
	DESCRIPTION OF FEATURE			South side Waikato River, section alongside Port Waikato - Tuakau Bridge road between points 0.5 km east of Daff Road and 2 km west of Daff Road. Road, hillside and shore platform exposures of rock.
	Locality			A sequence through the sedimentary rocks that were laid down during the last part of the Jurassic Period on the coast of Gondwana. This sequence passes up from poorly exposed marine strata to partially exposed sandstone, mudstone and minor conglomerate that was deposited on land in a coastal plain environment. This section has been made the stratotype of the New Zealand Waikatoan Substage of the Puaroan Stage.
	Geoscience values:			
	a. Geoscience Significance	32	4 - 64	The published holostratotype section of Waikatoan Substage of Puaroan Stage. This is the formal reference section for sedimentary strata that were deposited during this short period of time at the end of the Jurassic Period. Easily accessible.
	b. Rarity	8	4 - 64	Continuous, unfaulted sequences of Jurassic strata uncommon in North Island.
GEOSCIENCE:	c. Representative	2	2 - 8	Good representative example of marine to non-marine Jurassic sedimentary strata.
	d. Research potential	4	2 - 8	Material easily collected for future taxonomic and international correlation research.
	e. Group values	0	2 - 8	not part of a high value group of sites
	f. Geohistorical values	0	2 - 16	None known.
	Perceptual values:			
	g. Scenic/aesthetic	0	4 - 64	No aesthetic value in quarry.
	h. Prominence of views to/from site	0	2 - 16	Not visible except close up.
	Associative criteria:			
	i. Tourism/recreational	0	2 - 32	No tourism or recreational value.
	j. Community values	0	2 - 32	Unknown by local community.
	k. Educational	2	2 - 16	Minor educational value if owner allows access. Close to public road.
	l. Visual legibility	2	1 - 8	Sediment sequence can be recognised as successive sea beds.
	m. Preservation/naturalness	1	1 - 8	Significantly modified by major road through section.
	n. Memorability	0	1 - 8	Not memorable.
	o. Ecological values	2	1 - 8	roadside scrub and estuary side vegetation
	p. Historic or archaeological values	0	1 - 8	None known.
	q. Indigenous cultural values		1 - 8	Should be assessed by local iwi
	REFERENCES:			Challinor, A.B. 1977: Proposal to redefine the Puaroan Stage of the New Zealand Jurassic System. NZ Journal of Geology and Geophysics 20(1): 17-46. Purser, B.H. 1961: Geology of the Port Waikato Region. NZ Geological Survey Bull 69.
	Land tenure			
	OVERALL EVALUATION			
	SUMMARY COMMENT:			
	Total score:	53		

This site has a low overall score. Although it is nationally important as the type section for the Waikatoan Substage, there seem to be no potential threats that would have an adverse effect on its scientific value. Most earthworks or vegetation clearance would improve its values. I therefore recommend its removal from scheduling.