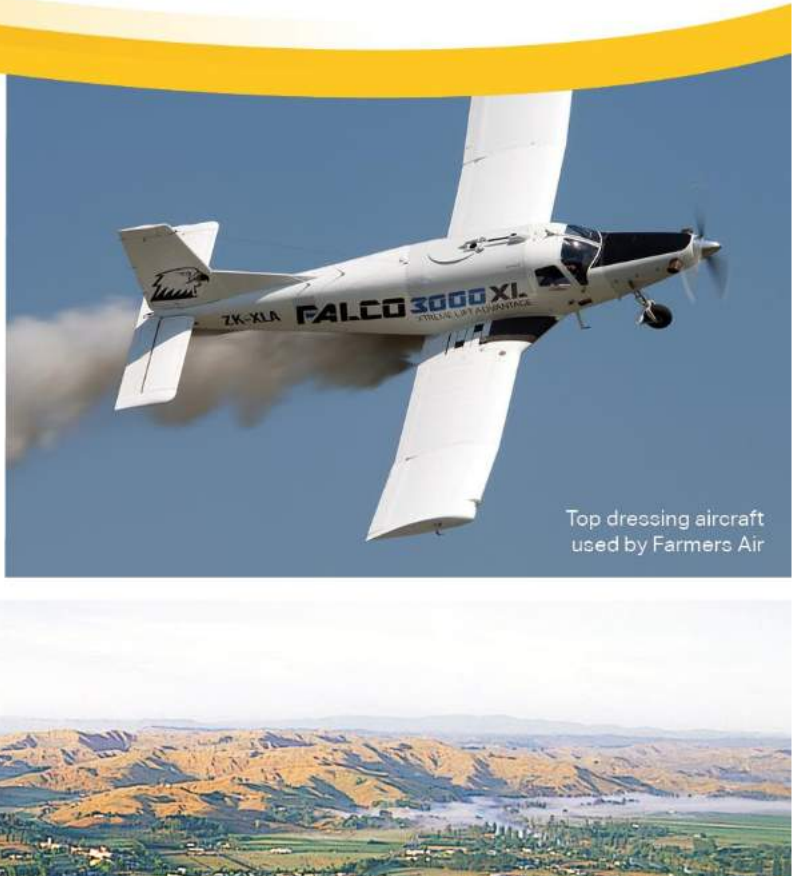
# Wairoa Airport Plan

Mustang Jet type used by Skyline Air Ambulance





Top dressing aircraft used by Farmers Air

# Contents

# 1 Foreword

The Wairoa Airport plan is a strategic planning tool with an aim to ensure the most effective and efficient development of the airport's land holdings and infrastructure over time. It is intended that all future decisions relating to the airport should take into consideration and be managed appropriately through this plan. The plan should be subject to continuous review to take into consideration the circumstances prevailing at the time and changes to airport/air transport policy.

The Wairoa Airport plan is a living document. The Wairoa District Council should continue to refine its long term strategy to ensure that the airport supports the growth and aviation capacity needs of the Wairoa District and to quickly provide for the establishment of business if the need arises.

# 2 Our Airport

## 2.1 Service Description

Wairoa Airport is a Wairoa District Council owned asset. The airport is a non-certified airstrip, classified as a Public Aerodrome by Air Transport, a division of the Ministry of Transport (NZ). Wairoa airport is located approximately 3km North West of Wairoa Township. The airport consists of one runway comprising 914m. Facilities at the airport consist of private hangers which are leased; terminal building housing local radio station, function room, kitchen and toilets with car parking behind; an aircraft taxi/apron area; and a 'Z' energy refuelling area.

The airport is primarily used by private light aircraft and helicopters, including for agricultural use. It is also used by emergency aircraft for transfer of patients into and out of the district.

Z Energy has a Jet A1 gas supply at the airport adjacent to the terminal. There is currently no aviation gas supply at the airport for light aircraft.




*Images 1 – 4 (Left to right - Aero Club Incorporated Hanger, Terminal Building, Cookson's/Ashworth Helicopters Hanger, Z Refuelling area*

### 2.1.1 The Runway

The sealed length of the runway at 914m constrains its use to aircraft in the category of 5700kg Maximum Take-Off Weight (MTOW) or less. Normally, this means that the largest aircraft to use the airport would be a light engine turboprop carrying up to 12 passengers. Currently the runway is not able to accommodate the newly purchased Skyline jet air ambulance or commercial operators which have the potential to capitalise on the opportunities Rocket Lab brings to the region along with other elements of a growing economy.

### 2.1.2 The Airport Land

The Wairoa District Council own a large area of land at the airport. These landholdings are shown in Appendix B. – Land surrounding the airport is leased to local farmers.

A recent land feasibility report by Logan Stone has highlighted that a portion of the existing car parking area is partly located on land owned by Ashworth Aviation and the access road through to the super bins encroaches on private property. The transfer of the car parking area and road access into Wairoa District Council ownership is part of the airport plan vision.

## 2.2 Customers and Stakeholders

The current airport stakeholders are:

- Airways New Zealand (Dave Jordan/Richard Fry)
- Skyline Aviation (Alex McHardy)
- Air Napier (Gary Peacock)
- Civil Aviation Authority of New Zealand (Nick Jackson)
- Massey University School of Aviation (Andrew Vialoux)
- Hawke's Bay & East Coast Aero Club (and Air Hawke's Bay – wholly owned company of the Aero Club)
- Ashworth Helicopters Ltd.
- Farmers Air Ltd (Andrew Hogarth)
- Wairoa Aero Club (Richard Tollison)

In 2016 the stakeholders and users of the Wairoa Airport were contacted for their feedback on the current state of the airport.

The feedback received from stakeholders is summarised as follows:

- There have been instances of stock incursions into the airport operational areas
- Failure of runway lighting in certain weather conditions
- There have been instances where grass mowing tractors have not followed Notice to Airman requirements (NOTAM)
- Issues with night-time visibility
- Wairoa Lighthouse causing visual distraction to pilots on final approach
- Lack of information regarding weather conditions
- Lack of information for visitors and tourists

- Lack of shelter during inclement and hot weather
- Non-aviation related vehicles using the apron and runway and causing damage to the surfacing
- Ashworth Helicopters report that since last sealing their hangar now floods during heavy rain events.
- Long grass on strip to the north of the runway
- Issue with loose chips on the runway and in particular apron/refuelling area
- Lack of runway visual markings
- Both Air Napier and Skyline have indicated that the runway length is an issue for several of their aircraft in certain weather conditions.
- Lack of Navigational visual aids to assist in making night time operations safer and easier including lack of GPS flightpath approach for runway-16
- Control of obstacles such as trees and power poles
- The Hawke's Bay and East Coast Aero Club (via Air Hawke's Bay) stated that the existing facilities on site are sufficient for their operations, and were concerned that lengthening the runway would result in increased landing charges with no benefit to them.
- Wairoa Aero Club have no planes at present but the current setup is generally ok for their needs
- Farmers Air expressed concern at length of time taken to resolve permanent fuel storage application, lack off maintenance assistance regarding hardstand areas in front of leased hangar and super bins.

## 2.3 Demand for Airport Services

The development of airport infrastructure is normally in response to a known or perceived demand. Factors that could affect demand at the Wairoa Airport include airline economics and competition, public demand for air travel, population growth/decline, the cost and convenience of alternative forms of travel, the development of new industries and businesses, and changes in the popularity of Wairoa District as a tourism destination. The latter two, tourism and new industry, have the most potential to increase the utilisation of the Wairoa airport, although at present there is limited demand.

### 2.3.1 Air Ambulance

Skyline Aviation currently operate an air ambulance service based in Napier for Hawke's Bay in conjunction with the Hawke's Bay District Health Board. One of the air ambulance aircraft utilised by Skyline is a Cessna Mustang Jet which has the potential to service Wairoa through navigational and runway upgrades at the airport (refer to aircraft and aeronautical upgrade requirements in Section 2.5 below). Although flight times from Napier to Wairoa in the Mustang jet will be only marginally quicker than a turbo prop, significant life saving time advantages could come when patients from Wairoa with life threating conditions need to be flown directly to a tertiary hospital. *(NZ Major Trauma national clinical network is implementing a new policy whereby patients will be transported directly to the hospital that is best suited for their injuries, rather than the closest)*

### 2.3.2 Rocket Lab

The establishment of Rocket Labs launch site at Mahia Peninsula could result in an increase in the utilisation of the Wairoa Airport through associated tourism and business travel. If this eventuates it is envisaged that small passenger jet aircrafts will be the most likely type to be utilised by Aviation operators.

The provision of land at the airport for the establishment of a business park could also attract industries related to Rocket Lab that would benefit from convenient access to the peninsula any other economic development.

### 2.3.3 Light Aircraft

The provision of aviation gas supply at the airport could result in an increase in light aircraft visitors such as those associated with the Wairoa Aeroclub.

## 2.4 Objectives/Service Drivers for the Airport

The key objectives for the planning of the Wairoa Airport are to:

- Ensure that existing airport continues to provide for the aeronautical needs of the Wairoa community
- Improve navigational aids to remove operational limitations associated with all fixed wing air ambulance operations at night and in bad weather.
- Ensure that the airport and its facilities can provide for jet aircraft likely to be utilised by emergency services, tourism and business travellers.
- Enable the establishment of non-airport related business in a business park campus leveraging off the location next to the airport.
- Ensure that aeronautical safety and the safety of persons is a top priority

This Airport plan supports these key objectives by:

- Ensuring that the airport is developed in a planned and coordinated fashion
- Outlining options and pathways to the maintenance and upgrade of the airport overtime

## 2.5 Runways, Taxi and Apron Upgrades

A recent report commissioned by Wairoa District Council has identified options for upgrades and improvements at the airport to:

1. Maintain airport infrastructure and improve navigation and safety
2. Accommodate jet aircraft associated with Skyline's jet air ambulance and commercial operators.

These upgrades are:

- Upgraded fencing of the airport to prevent stock incursions and unauthorised vehicle access
- Runway resurfacing
- Taxiway and apron resurfacing (see image of taxiway condition in Image 7 below)
- The provision of runway markings to assist night-time landings
- Improvements to the receiver system for the existing pilot activated lights (PAL)
- The provision of a new runway, taxiway and apron lighting system
- The provision of navigational aids which include GPS flightpath approach for runway-16, Precision Approach Path Indicators (PAPI); Visual Approach Slope Indicator System (VASIS); and the provisions of new lighted windsocks.

- The extension of the runway to cater for jet aircraft; to cater for landings in adverse weather conditions; and to cater for aircraft greater than the 5700kg Maximum Take-off Weight (MTOW) range.

Indicative costs associated with these upgrades and timeframes for the upgrades are set out in Table 1 below. Table 2 is a summary of the estimated infrastructure upgrade costs to provide for jets such as the air ambulance jet and larger turbo prop aircraft.

### 2.5.1 Runway Extensions and Land Requirements

Image 5 below and Appendix D show potential runway extension of 300m which will increase the length of the runway to 1200m. Civil aviation regulations require a minimum clear zone at the end of the runway of 240m. The Land Requirement Plan (C06-B) in Appendix E and Image 6 below shows additional land which is currently not owned by Wairoa District Council but which is needed to provide for this 240m clear zone (2.55ha). Part of the existing carparking area is located on private land (see Image 7 below).


*Image 5 – Proposed Runway Extensions*

### 2.5.2 Fencing

There are existing post and wire fences at the airport around the runway (set back approximately 50m from the runway). This fence ranges in condition, from very good to very poor condition (I.e. not stock proof). Should the runway be extended to accommodate larger aircraft, the existing fences will need to be relocated so that they are a minimum of 75m either side of the runway centreline and 240m off the end of the runway for Runway End Safety Area (RESA). The total length of new fencing equates to 2.2km. The location of this new fencing is shown on the airport plan layout drawing in Appendix A.


*Image 6 – Land requirement Plan (Lot boundaries shown in yellow)*


*Image 7 – Aerial showing the portion of the airport car park located in private ownership (shown in red)*

*Table 1 – Summary of estimated costs for the maintenance of airport infrastructure and improvements to navigation and safety*

| Item | Description of Issue Raised | Required Action | Cost ($) | Financial Year |
|---|---|---|---|---|
| **1** | Stock incursions - Runway | Ensure fences are stock proof | $15,000 | 2016/17 |
| **2** | Failure of runway lights in certain weather conditions | Relocate pilot activation receiver away from power pole, fix broken runway lights | $15,000 | 2016/17 |
| **3** | Wairoa Lighthouse causing visual distraction to pilots whilst making night time approach to airport | Investigate possible solution for deactivation and/or screening of light for the odd occasions that night time approach to airport is required. | $7,500 | 2016/17 |
| **4** | Issue with loose chips/poor surfacing on apron - planes removing chip | Resurface apron with asphaltic concrete or slurry | $195,000 to $500,400 | 2017/18 |
| **5** | Improve Night Time visibility of Runway along with navigation aids for approaches | Full upgrade of runway and taxiway edge lighting, along with flood lights for apron etc. Install PAPI's, VASIS and windsocks (Existing runway only) | $280,000 | 2017/18 |
| **6** | Only runway 34 has a GPS approach path | Have Airways investigate and design GPS approach for runway 16 *(Airways reluctant to give ROC)* | $50,000 *maximum* | 2017/18 |
| **7** | Non-Aviation vehicles using the runway and damaging surface | Install security fencing and card activated gate | $50,000 | 2017/18 |
| **8** | Lack of weather and landing condition indicators | Investigate weather broadcasts from Metservice weather station and possibility of installing Webcam on terminal building - linked to Airport Website | $15,000 | 2017/18 |
| **9** | Runway AC surfacing fatigued and cracking | Resurface Runway with Asphaltic concrete or cape seal | $411,300 to $945,990 | 2017/18 |
| **10** | Lack of runway visual markings | Upgrade runway markings | $24,230 | 2017/18 |
| **11** | Lack of shelter during inclement and hot weather for pilots and passengers | Allow access to terminal building and/or provide shade sails | $15,000 to $20,000 | 2017/18 |
| **12** | Pavement deformation and failures around Super Bin loading area | Carry out pavement repairs | $10,000 | 2017/18 |

| | | | | |
|---|---|---|---|---|
| **13** | Lack of information for tourist and visitors | Establish Wairoa District Council Airport web page or incorporate with Wairoa I-site page | $5,000 | 2017/18 |
| **14** | Control of hazards such as trees and power poles | Carry out an investigation and programme removal of hazards | $30,000 | 2018/19 |
| **15** | Issue with loose chips/poor surfacing on taxiways - planes removing chip | Resurface taxiways with asphaltic concrete or slurry | $72,900 to $187,470 | 2018/19 |

*Table 2 – Summary of estimated costs to provide for jet aircraft and larger turbo prop aircraft*

| Item | Description of Issue Raised | Required Action | Cost ($) | Financial Year |
|---|---|---|---|---|
| **1** | Runway extension to enable jet aircraft and larger passenger planes to use the airport | Extension of the runway by 300m | $1million to $1.2million | 2018 |
| **2** | Northern Taxiway not wide enough for safety limits for jets / larger turbo prop planes | Seal widen edge of northern taxi way - 1m either side | $30,000 | 2019/20 |

# 3 Wairoa Airport plan layout

The Airport plan layout is included in Appendix A and is shown as Image 9 below. The airport has been separated into zones and a description of the type of activity/use envisaged for the zone is described in Table 3 below.

*Table 3 – Summary of activities for each zone on the Airport plan layout*

| Zone | Zone Description / Activities and uses provided for |
|---|---|
| Aircraft Hangar / Terminal Zone - Existing | The existing area set aside for hangers/ terminals /airport maintenance |
| Road and Parking-Zone | Public/private car parking and business park access road. |
| Business Park-Zone | Area intended for aeronautical and non-aeronautical industry and business. |
| Fuel-Zone | This zone covers the existing refuelling station and additional land area for a second refuelling station. |
| Rail Interface-Zone | The rail interface zone includes an area of land located adjacent to the railway. The zone is currently occupied by Farmers Air for the storage and loading of fertiliser. Where possible further development of this area should be limited to activities that can utilise direct rail access. |
| Operational A-Zone | The operational A-Zone includes the runway strip (75m from the centre line of the runway), the taxi areas and apron. This zone is intended to be fenced to prevent stock and unauthorised access to the runway and aircraft operational area. |
| Grazing-Zone | The zone covers the remainder of the airport land which is suitable to grazing/cropping activities. |

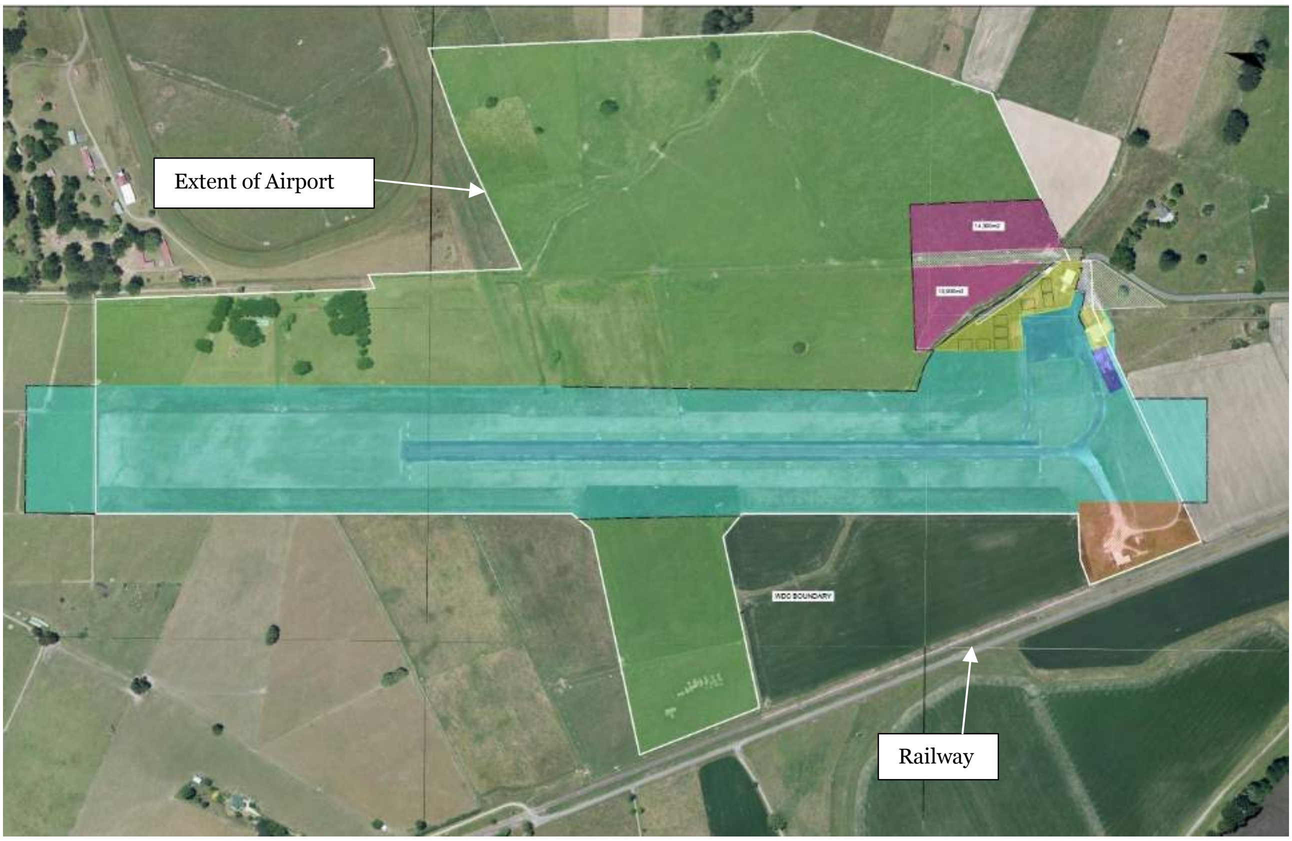



*Image 8 – Airport plan Layout (see Appendix A for a larger version of the layout plan)*

# 4 Business Park Development

A preliminary feasibility investigation has been undertaken to identify whether there are any constraints related to the development of a business park at the airport. The investigations considered the following factors:

1. Natural Hazards such as flooding and land stability (See Appendix G)
2. The provision of water supply, wastewater and stormwater services (See Appendix F)
3. The availability of power, and computer media (See Appendix H)
4. Resource Management Act requirements (See Appendix H)
5. Archaeological implications (See Appendix H)

The above investigations did not identify any barriers to the establishment of the business park at the airport. The costs associated with the extension and provision of service/utilities at the business park are as follows:

*Table 4 – Business Park Development Costs*

| SUMMARY OF ESTIMATED BUSINESS PARK DEVELOPMENT COSTS[1] | |
|---|---|
| **Description** | **Costs** |
| Extension of water mains to the Business Park | $ 88,000 |
| Wastewater disposal (on-site and reticulated) Assumes 100% occupancy of the business park | $ 250,000 - 336,000 |
| Stormwater (box culvert under proposed road) does not include treatment | $ 149,213 |
| Road extension (sealed) | $ 101,750 |
| Power Reticulation | $ 151,455 |
| Telecommunications | $ 100,000 |
| **Overall Development Cost** | **$ 926,418** |

# 5 Airport Protection and Environmental Effects Management

The key requirements for protecting airport capacity and growth are:

- The creation of flight paths and obstacle limitation surfaces; and
- District planning policies and rules which ensure compatible land use activities in close proximity to airport. This includes the exclusion of noise sensitive activities from areas which would otherwise curtail airport operations and expansion.

## 5.1 Flight Paths and Obstacle Limitation Surfaces

The protection of airspace required for aircraft to approach the airport runway and to take-off and climb to the required cruising altitude is essential to the operation of the airport.

Flight path protection for the proposed extended runway is provided by defining Obstacle Limitation Surfaces (OLS) in accordance with –

a. CAA Advisory Circular AC139-06A
b. ICAO Annex 14 – Aerodromes and ICAO Procedures for Air Navigation Services (PANS OPS).

OLS are designed to provide obstacle-free paths for any multi-engine aircraft which lose the power of an engine during take-off.

The obstacle limitation surface for the Wairoa Airport, which essentially defines the maximum heights for trees and structures, is shown on plan C08-C09-B in Appendix C and Image 9 below. No buildings, structures or trees should exceed the maximum heights as indicated on Image 9. It is recommended that the Wairoa District Council incorporate these height limitation surfaces into the Wairoa District Plan.

[1] Typically most of the costs associated with the extension of services to a development are a cost of the developer. Some of the costs in the table such as wastewater disposal and internal roadways are likely to be costs for the business.

The greatest risk to the breach of these height limits is likely to be new buildings or structures within the airport land; new farm buildings on adjacent properties; or new telecommunication masts.

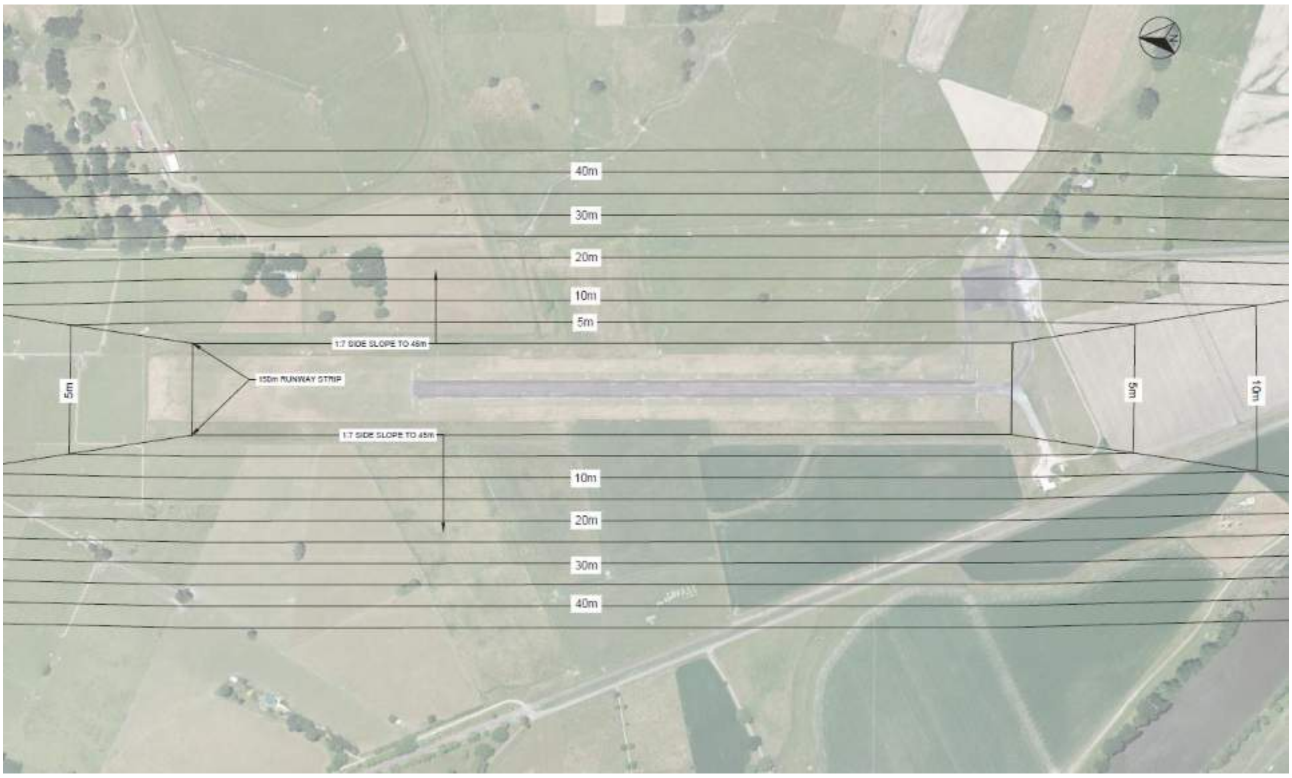



*Image 9 – Obstacle Limitation Surfaces for Wairoa Airport (the contours show the maximum height limits for structures and vegetation.*

## 5.2 Airport Noise Boundaries

Noise is the most significant adverse effect of aircraft movements on properties located close to an airport or beneath the airports approach and take-off paths. The most common objection to airport expansion and capacity utilisation is a proposed increase in aircraft noise.

New Zealand Standard 6805 is used by territorial authorities and regional government for the control of airport noise. The standard establishes maximum acceptable levels of aircraft noise exposure around airports for the protection of community health and amenity values whilst recognising the airports need to operate efficiently. It provides a guide for territorial authorities wishing to include appropriate land use controls in their district plans, as provided for in the Resource Management Act 1991.

The Standard uses an air noise boundary mechanism for local authorities to establish compatible land use planning and set limits for the management of aircraft noise at airports where noise control measures are needed to protect community health and amenity values.

The Standard suggests that noise control measures are necessary where the exposure of residential communities exceed 100 pasques (or an Ldn of 65) and may be necessary where exposure exceeds 10 pasques (or an Ldn of 55).

District plans generally have noise contour maps and associated rules for Airports and medium to large aerodromes. If the number of flights at Wairoa Airport is expected to increase in the future, particularly if there is expected to be an increase in jet and night-time flights, the Wairoa District Council should consider incorporating noise control contours and associated rules into the Wairoa District Plan.

These noise contours serve two purposes. Firstly they provide a basis for creating rules to prevent the establishment of sensitive activities (such as dwellings) within specified noise contours unless mitigation measures such as noise insulation is provided. This protects the sensitive occupiers from aircraft noise and enables the airport to grow without undue restrictions. Secondly the contours enable the District Plan to provide some control over the timing of flights (mainly night-time restrictions) to protect noise effects on sensitive users.

# 6 Ownership and Control

Potentially the Hanger zone/Business Park Zone could be subdivided into freehold lots and sold into private ownership, however lease arrangements are likely to be most favourable option for the Hanger Zone. Often business/industry prefer freehold titles as this gives them greater control over their future interests in the land. The current Airport plan arrangement does not preclude the establishment of freehold title.

# 7 Conclusion

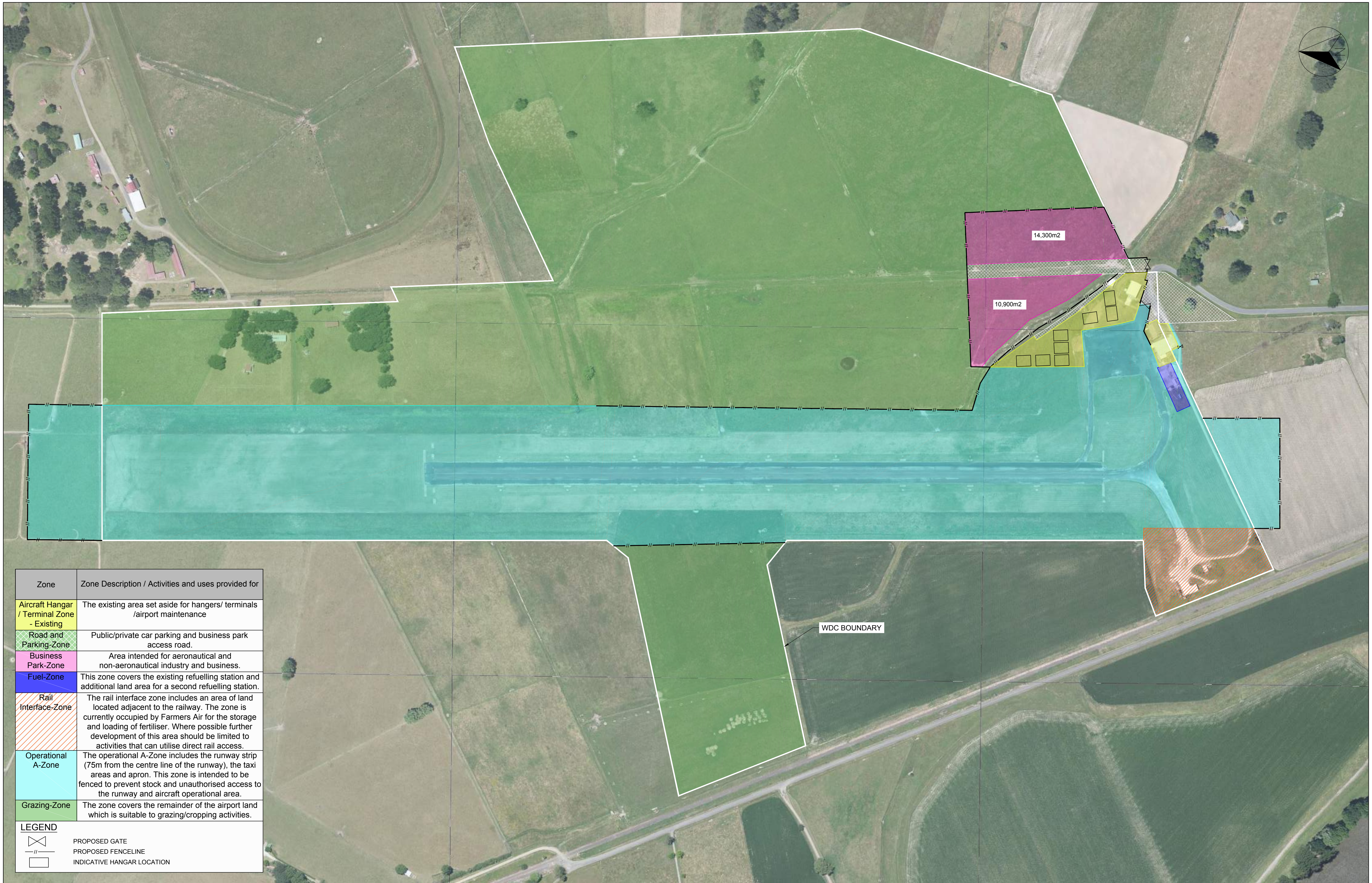
A Wairoa Airport plan layout  has been prepared to ensure the most effective and efficient development of the airport's land holdings and infrastructure over time. It is intended that all future decisions relating to the airport take into consideration the plan layout. The plan  is a living document and the Wairoa District Council should continue to refine this layout overtime due to changes in demand and other development related factors.

Appendix A

# Wairoa Airport Plan Layout





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|---|---|
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| Business Park-Zone | Area intended for aeronautical and non-aeronautical industry and business. |
| Fuel-Zone | This zone covers the existing refuelling station and additional land area for a second refuelling station. |
| Rail Interface-Zone | The rail interface zone includes an area of land located adjacent to the railway. The zone is currently occupied by Farmers Air for the storage and loading of fertiliser. Where possible further development of this area should be limited to activities that can utilise direct rail access. |
| Operational A-Zone | The operational A-Zone includes the runway strip (75m from the centre line of the runway), the taxi areas and apron. This zone is intended to be fenced to prevent stock and unauthorised access to the runway and aircraft operational area. |
| Grazing-Zone | The zone covers the remainder of the airport land which is suitable to grazing/cropping activities. |

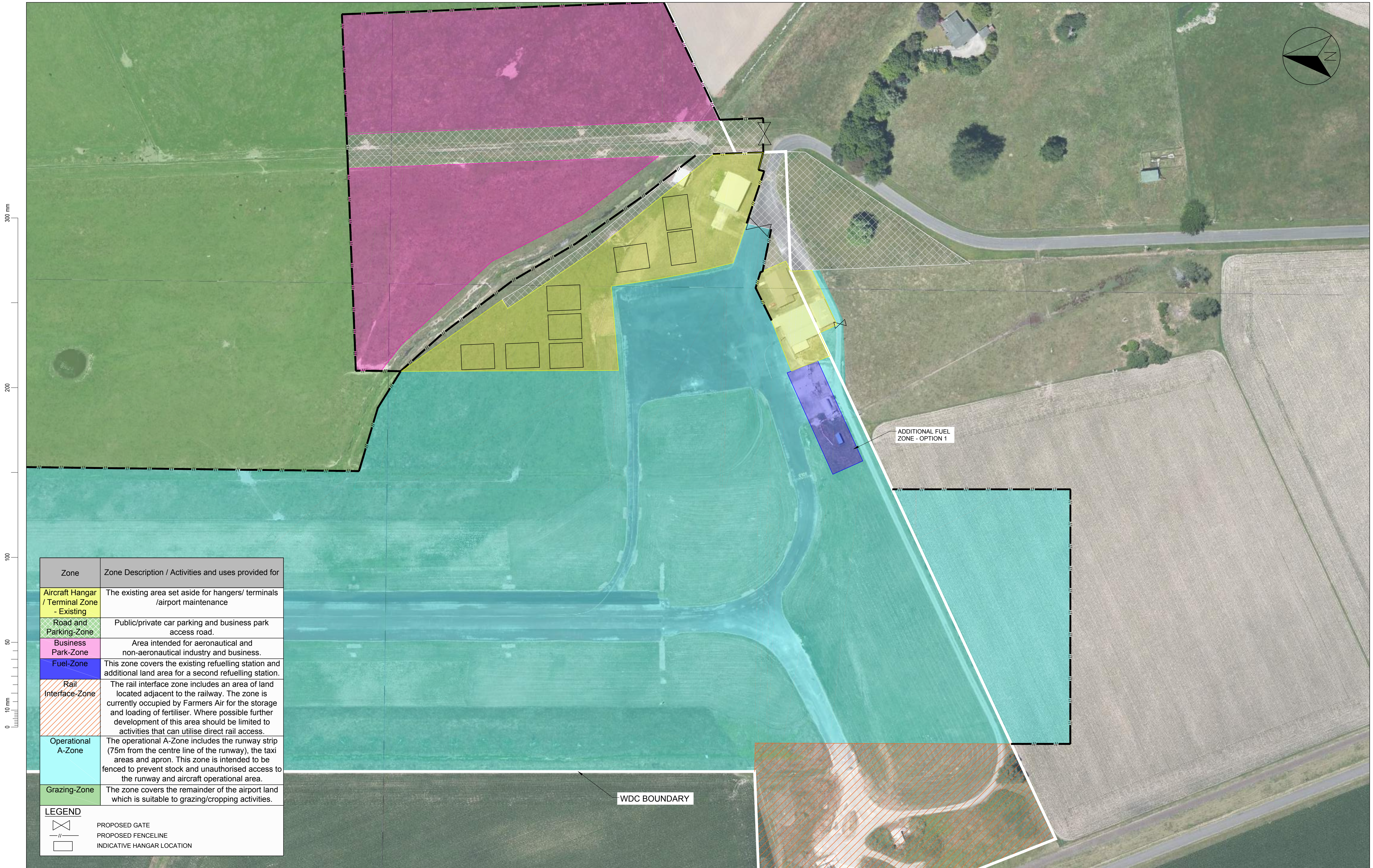
LEGEND

PROPOSED GATE

PROPOSED FENCELINE

INDICATIVE HANGAR LOCATION

# WAIROA AIRPORT PLAN




| Zone | Zone Description / Activities and uses provided for |
|---|---|
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LEGEND

- PROPOSED GATE
- PROPOSED FENCELINE
- INDICATIVE HANGAR LOCATION

# WAIROA AIRPORT PLAN

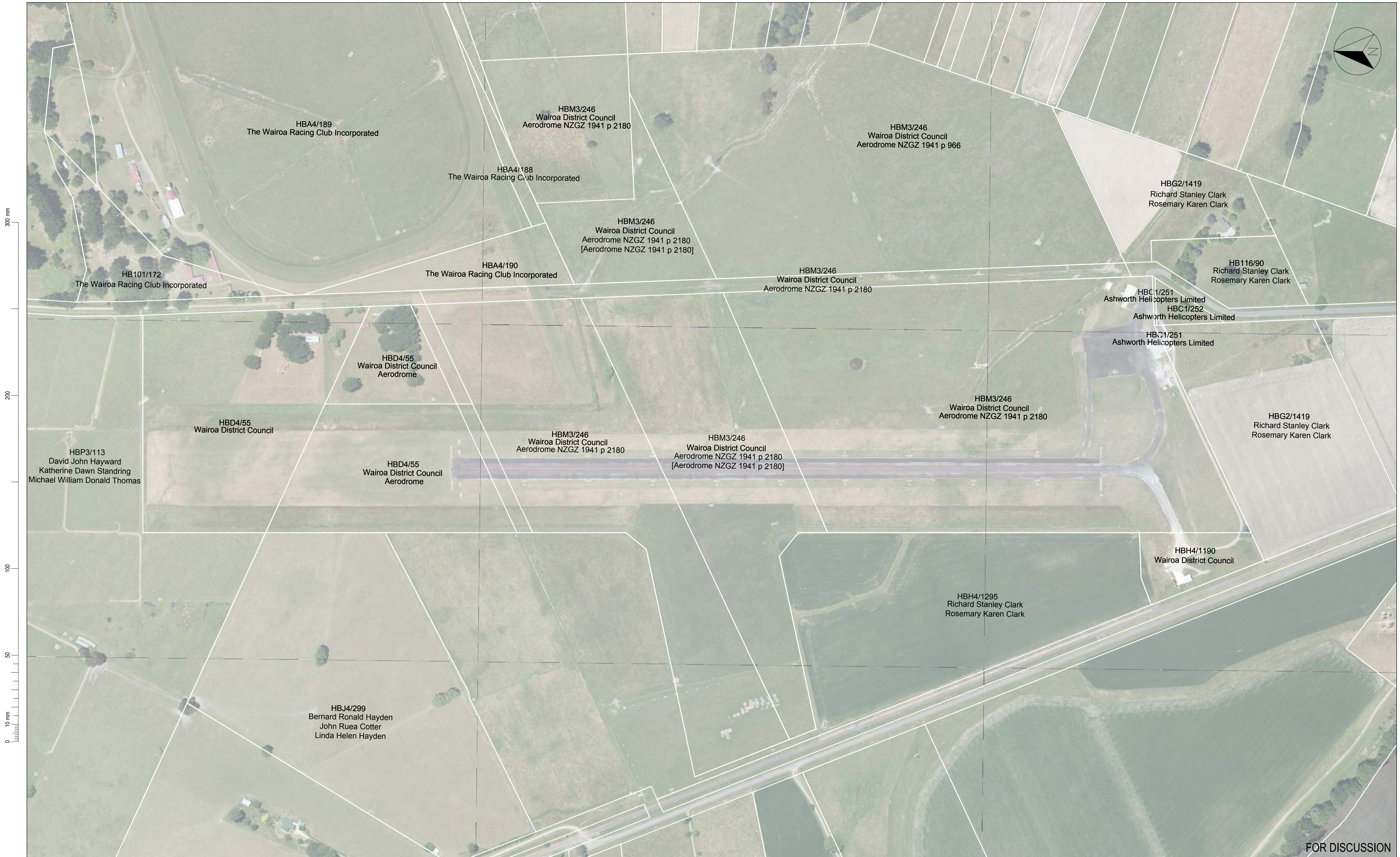
# Appendix B

# Land Ownership Plan

Mustang Jet type used by Skyline Air Ambulance



Top dressing aircraft used by Farmers Air




FOR DISCUSSION

| Revision | Amendment | Approved | Revision Date |
|---|---|---|---|
| B | ISSUED FOR MASTERPLAN | BJ | 10/03/2017 |

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| Designed | Approved | Approved Date |
|---|---|---|
| B. THOMSON | B. JONES | 11/01/2017 |
| **Drawn** | **Scales** | |
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Project
WAIROA DISTRICT COUNCIL
WAIROA AERODROME
RUNWAY EXTENSION

Sheet
PROPERTY DETAILS
CT AND OWNER

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|---|---|---|
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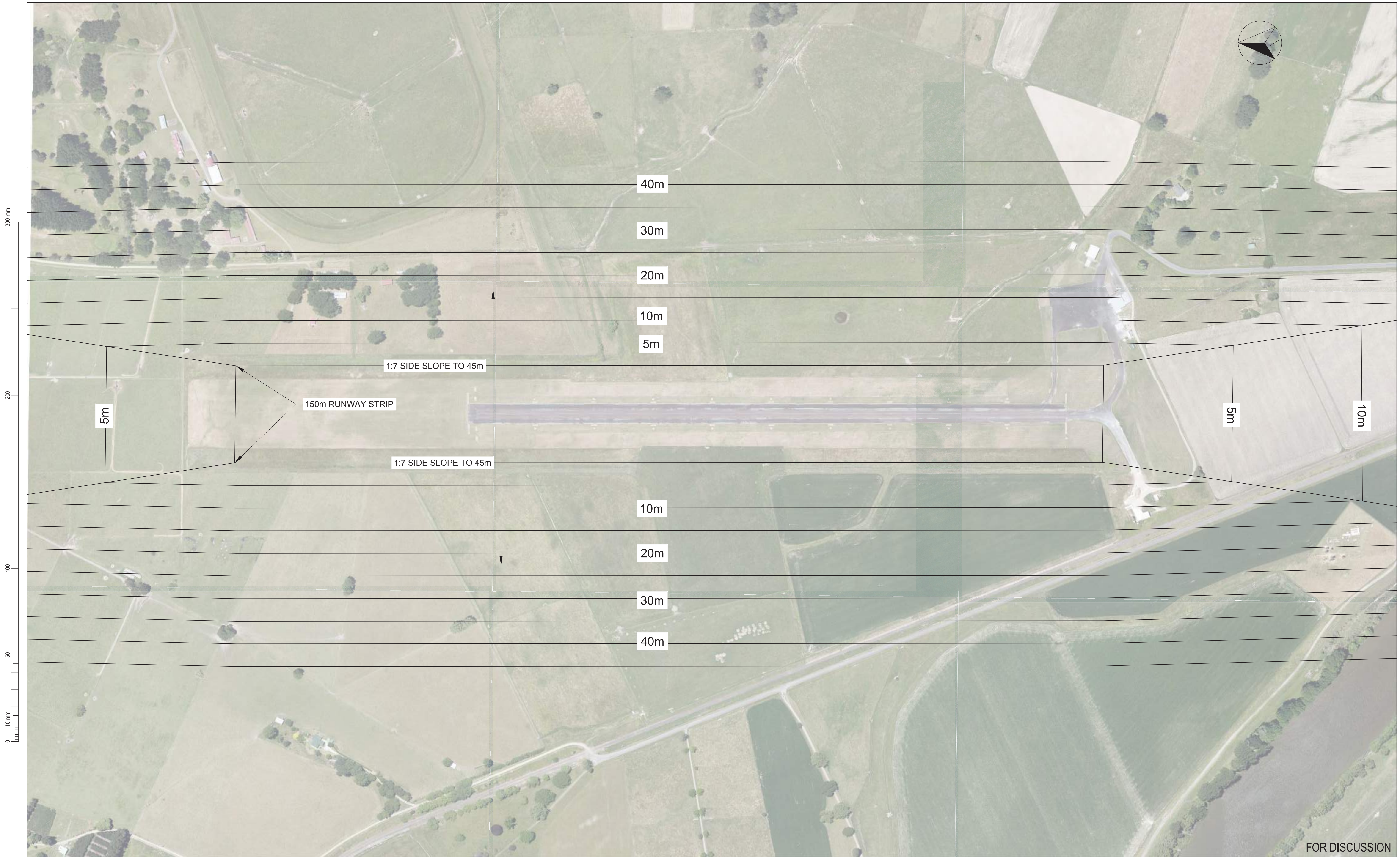
Appendix C

# Obstacle Limitation Surfaces

Mustang Jet type used by Skyline Air Ambulance


Top dressing aircraft used by Farmers Air




NOTE: LEVELS SHOWN ARE HEIGHT FROM RUNWAY CENTRELINE LEVEL

| Revision | Amendment | Approved | Revision Date |
|---|---|---|---|
| B | ISSUED FOR MASTERPLAN | BJ | 10/03/2017 |

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Project
WAIROA DISTRICT COUNCIL
WAIROA AERODROME
RUNWAY EXTENSION

Sheet
TRANSITIONAL SLOPE
OBSTACLE LIMITATION SURFACE

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FOR DISCUSSION

NOTE: FOR FULL OBSTACLE LIMITATION SURFACE DETAILS REFER TO CAA AC 139-6, SECTION 4 - OBSTACLE RESTRICTION AND REMOVAL

| Revision | Amendment | Approved | Revision Date |
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Project
WAIROA DISTRICT COUNCIL
WAIROA AERODROME
RUNWAY EXTENSION

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APPROACH SLOPE
OBSTACLE LIMITATION SURFACE

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Appendix D

# Runway Extension Drawings

Mustang Jet type used by Skyline Air Ambulance

Top dressing aircraft used by Farmers Air


1:2000 @ A1
1:4000 @ A3
0 20 40 60 80 100 120 140 160 180 200 m

| Revision | Amendment | Approved | Revision Date |
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| B | ISSUED FOR MASTERPLAN | BJ | 10/03/2017 |
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| B. THOMSON | B. JONES | 11/01/2017 |

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Project
WAIROA DISTRICT COUNCIL
WAIROA AERODROME
RUNWAY EXTENSION

Sheet
PLAN VIEW

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# Appendix E

# Land Requirement Plan

Mustang Jet type used by Skyline Air Ambulance


Top dressing aircraft used by Farmers Air


LEGEND

LAND TO BE PURCHASED

| Revision | Amendment | Approved | Revision Date |
|---|---|---|---|
| B | ISSUED FOR MASTERPLAN | BJ | 10/03/2017 |
| C | AREA C ADDED | BJ | 22/03/2017 |

WAIROA DISTRICT COUNCIL


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Project: WAIROA DISTRICT COUNCIL
WAIROA AERODROME
RUNWAY EXTENSION

Sheet: LAND REQUIREMENT PLAN

| Designed | Approved | Approved Date |
|---|---|---|
| B. THOMSON | B. JONES | 11/01/2017 |

| Drawn | Scales | Project No. | Sheet. No. | Revision |
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| B. THOMSON | NOT TO SCALE | 2-S5091.VT | C06 | C |

Original Sheet Size A1 [841x594] Plot Date 2017-04-03 at 2:36:42 p.m. Path S:\Proj\NZ\2Y\2-Y1300.DM Wairoa DC TAM\Home\2_S51870.VT Wairoa Airport\Wairoa Airport.dwg C06 (C)

Appendix F

# Preliminary Servicing Assessment Report



*2-Y1300.DM/17/01*

# Wairoa Airport Plan

**Preliminary Servicing Assessment**

**For Wairoa District Council**

*2-Y1300.DM/17/01*

# Wairoa Airport Plan

## Preliminary Servicing Assessment

## For Wairoa District Council


| | | | |
|---|---|---|---|
| Prepared By | Brylee Thomson<br>Civil Engineering Cadet | Opus International Consultants Ltd<br>Napier Office<br>Opus House, 6 Ossian Street<br>Private Bag 6019, Hawkes Bay Mail Centre,<br>Napier 4142<br>New Zealand | |
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| | | Date:<br>Reference:<br>Status: | March 2017<br>2-Y1300.DM<br>Final |
| Approved for Release by | William Gray<br>CPEng, Technical Principal | | |

# Contents

# 1 Introduction

Wairoa District Council (the Council) have identified a need for future provision of industrial / commercial development near to the Wairoa Aerodrome to support future growth in Wairoa and the surrounding area.

Opus International Consultants (Opus) have been engaged by the Council to develop a concept plan for development of a business park within the Wairoa Airport (the site), adjacent to the existing airport infrastructure. A plan showing likely development areas is provided in Figure 1.

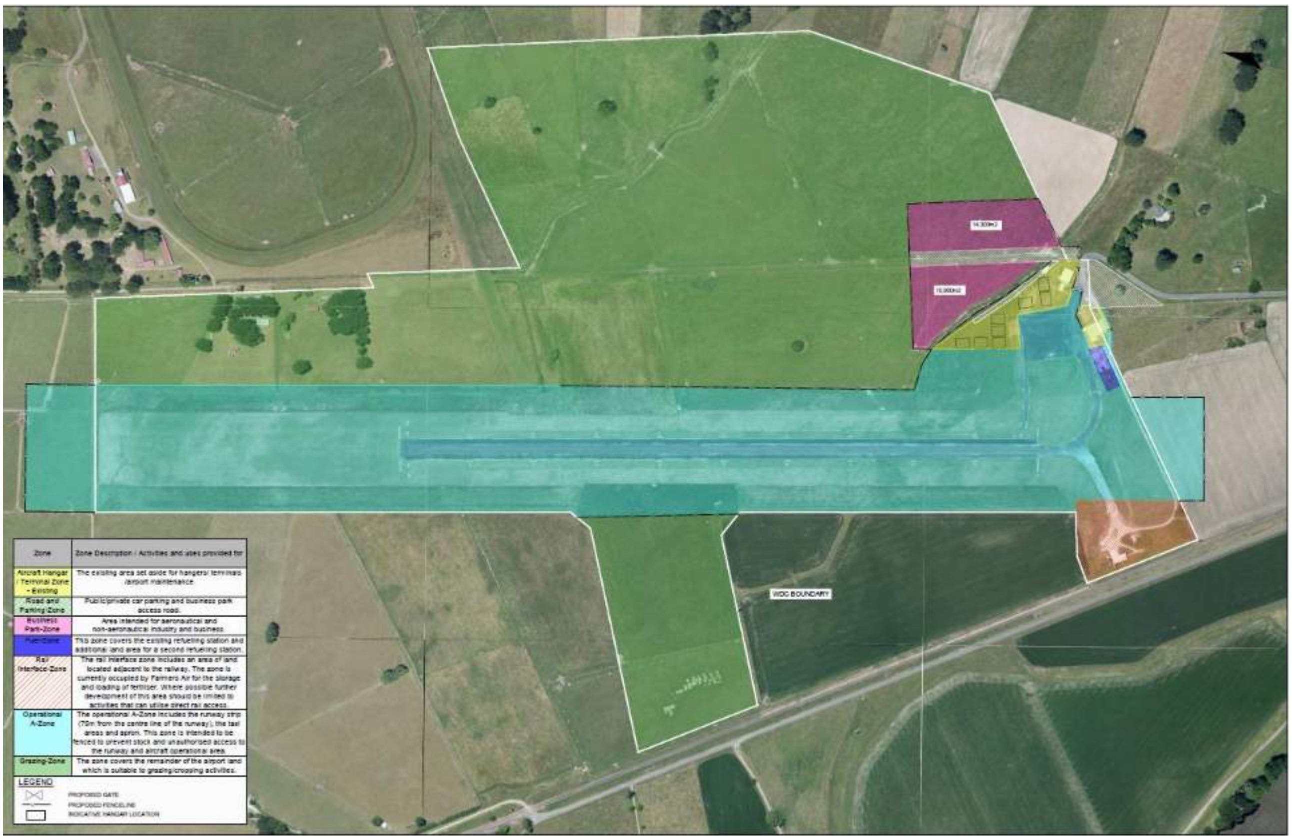


**Figure 1 : Wairoa Airport Internal Zoning Plan**

# 2 Servicing the development plan

This report will address the existing constraints and future servicing options to support the proposed development on the site, specifically:

- Water supply
- Firefighting Provisions
- Wastewater
- Stormwater

At present, Opus understands that reticulated services extending to the site are limited to potable water supply, with associated provision of firefighting supply.

Wastewater and stormwater are currently managed onsite for the limited infrastructure that exists.

The types of industry to occupy the business park area would traditionally be linked to aviation related activities, including aircraft maintenance and repair, freight handling and storage.

The Council believes that the future expansion of businesses associated with Rocket Lab for example, could bring other service related industries to the site.

# 3 Water

## 3.1 Domestic Potable Water Supply

### 3.1.1 Existing Servicing

At present, a 100mm water main connects to the existing airport terminal building from Airport Road, and terminates with a fire hydrant. A pipe lateral extends to the west along the boundary of the aerodrome and provides water supply to those buildings along this boundary. This Council managed potable supply is suitable for the existing domestic and firefighting needs on the site.

### 3.1.2 Required Servicing

The business park development on the site will require the existing 100mm water main to be extended.

The peak domestic flow requirements for the proposed business park has been estimated by Opus as approximately 4 l/s, assuming a medium intensity mixed commercial / industrial loading, based on available data from a combination of sources including Engineering Codes of Practice, and NZS4404.

The design flows could be as high as 8l/s if food and materials manufacture were to be established within the business park, however this would appear unlikely.

Opus expects that this domestic supply can be provided through the extension of the existing 100mm main infrastructure on site.

Available water pressures should be checked at the time of development, and supplemented on site by header tanks or pumping if needed. This should be considered further during detailed design.

## 3.2 Firefighting Supply

### 3.2.1 Existing Servicing

An existing fire hydrant adjacent to the terminal building and fuel storage facility appears to provide adequate firefighting capacity for the extent of existing infrastructure. The surrounding land appears un-serviced.

### 3.2.2 Required Servicing

Based on likely extent of development on the site (refer Figure 1), Opus believes an extension of the existing 100mm main with an additional 2 hydrants is required, to provide a minimum level of firefighting service of FW2 from the mains supply. This is adequate for most structures that are fitted with sprinkler systems. This should be confirmed by detailed design.

Additional fire protection could include supply from bores, and / or storage tanks which could be fed from either ground water, stormwater, or drip fed from the reticulated supply. These options should be further explored during detailed design.

# 4 Wastewater

## 4.1 Existing Servicing

The nearest likely connection to the Council reticulated wastewater network is approximately 1.8 kilometres to the south east of the site, in Ormond Road. This is a 150mm main. The network capacity at this point is not known by Opus.

The existing airport infrastructure is serviced using onsite mechanisms. With no consents listed on the title, Opus expects that the current onsite disposal of wastewater is a permitted activity under the Hawkes Bay Regional Resource Management Plan.

## 4.2 Required Servicing

If the proposed development is largely aviation and service related activities, only domestic wastewater will be generated. Site specific onsite wastewater systems can be designed to service each industry as they develop within the area. These systems will be required to be designed in accordance with HBRC guidelines Regional Resource Management Plan (RRMP) Rules 37 (Permitted) and 52 (Discretionary).

To optimise the use of the land to be rezoned, Opus recommends that the discharge field (s) be established in the adjacent allotment to the north that is currently held by the airport.

Should the development area look to extend in the future to the north, and/or the business park include “wet industries” then consideration should be given to the installation of a new pumped rising main to service the whole site, linked to the existing Council reticulated services. Such a scheme would require careful detailed design, and more upfront investment. The main benefit of the recirculated main option would be optimisation of the available land area for development.

# 5 Stormwater

The site is currently noted to be subject to inundation during the 1 in 100-year storm event, according to advice from the Hawkes Bay Regional Council (HBRC). The peak water level within the area during the 100-year storm event is modelled by HBRC to be approximately 20m RL, whilst the average existing ground level is only 19.75m RL. Hence flooding in peak storm events is expected under current conditions. HBRC recommends that additional modelling be undertaken to confirm the extents of inundation within the site and surrounding area, should the proposed development proceed.

If, as a result of future modelling, the flooding risk is confirmed, consideration should be given to elevating the new building platforms above the predicted maximum flood level by engineered earthworks. Inundation offsets will then need to be considered in detailed design.

## 5.1 Existing Servicing

At present, an open drain traverses the proposed development site. The drain has been estimated by Opus to have an average cross sectional area of $11m^2$, at a grade of approximately 0.2%. On this basis, the existing swale is estimated to be able to carry up to $16m^3/s$ when flowing full. Anecdotal evidence suggests the drain flows near full during peak storm events.

## 5.2 Required Servicing

The proposed development adds additional flows from new roof and hardstand surfaces. Opus estimates the new flows to be approximately $0.55m^3/s$ during a 5 year 10-minute storm event, and $1.2m^3/s$ during a 100 year 10-minute storm event based on an 85% hardstand surface coverage and an overall development area of 3.74 hectare.

These flows could be incorporated into the total flow within the existing drain by providing an additional 600mm of base width.

Additional mechanisms to mitigate stormwater increases generated onsite could include the collection of rainwater into storage, for either slow release (stormwater attenuation), for use within industry or as an alternative firefighting supply.

If piping of the existing open channel drain was required, to reticulate the 5-year flow would need a large diameter pipe (Opus estimates at least an 825mm pipe, assuming this is laid at a similar grade to the existing open channel drain) with all exceedance events also directed towards secondary flow paths near to or above the buried drain.

Alternatively, the existing open channel drain could remain, and continue to provide passage for the existing overland flow through the area. Stormwater collected on the development site could be reticulated separately (using for example 450mm diameter pipes) from the site to a new discharge point downstream of the existing road crossing, thus benefiting not only the development area but the wider stormwater drainage system. Concepts such as this should be considered more closely in detailed design.

# 6 Recommendations

Based on the findings discussed above, Opus believes the proposed Wairoa Airport Business Park development can be appropriately serviced through a variety of mechanisms. These servicing options will need further consideration and refinement during detailed design.

# 7 Limitations

The factual data, interpretations and recommendations contained in this report pertain to a specific project as described in the report and are not applicable to any other project or site. If the project is modified in any significant way, or if the project is not initiated within eighteen months of the date of the report, Opus International Consultants should be given an opportunity to confirm that the recommendations are still valid.

Where conditions encountered at the site differ significantly from those anticipated in this report, either due to natural variability of subsurface conditions or development/construction activities, it is a condition of this report that Opus International Consultants be notified of the changes and provided with an opportunity to review the recommendations of this report. Recognition of changed soil conditions requires experience and is recommended that an experienced engineer be employed to visit the site with sufficient frequency to detect if conditions have changed significantly.

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Appendix G

# Preliminary Geotechnical Assessment



*2-Y1300.DM/17/01*

# Wairoa Airport Plan

**Preliminary Geotechnical Assessment**

**For Wairoa District Council**

*2-Y1300.DM/17/01*

# Wairoa Airport Plan

## Preliminary Geotechnical Assessment

## For Wairoa District Council


| | | | |
|---|---|---|---|
| Prepared By | Chris Hopkins<br>Civil Engineering Technician | Opus International Consultants Ltd<br>Napier Office<br>Opus House, 6 Ossian Street<br>Private Bag 6019, Hawkes Bay Mail Centre,<br>Napier 4142<br>New Zealand | |
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| | | Date:<br>Reference:<br>Status: | March 2017<br>2-Y1300.DM<br>Issue 1 |
| Approved for Release by | Nick Stillwell<br>Development Work Group Manager | | |

# Contents

# 1 Introduction

Opus International Consultants Ltd (the consultant) was engaged by Wairoa District Council (the Council) to carry out geotechnical investigations for the potential future development of Wairoa Aerodrome (the site). The site is located at the end of Airport Road, Wairoa.

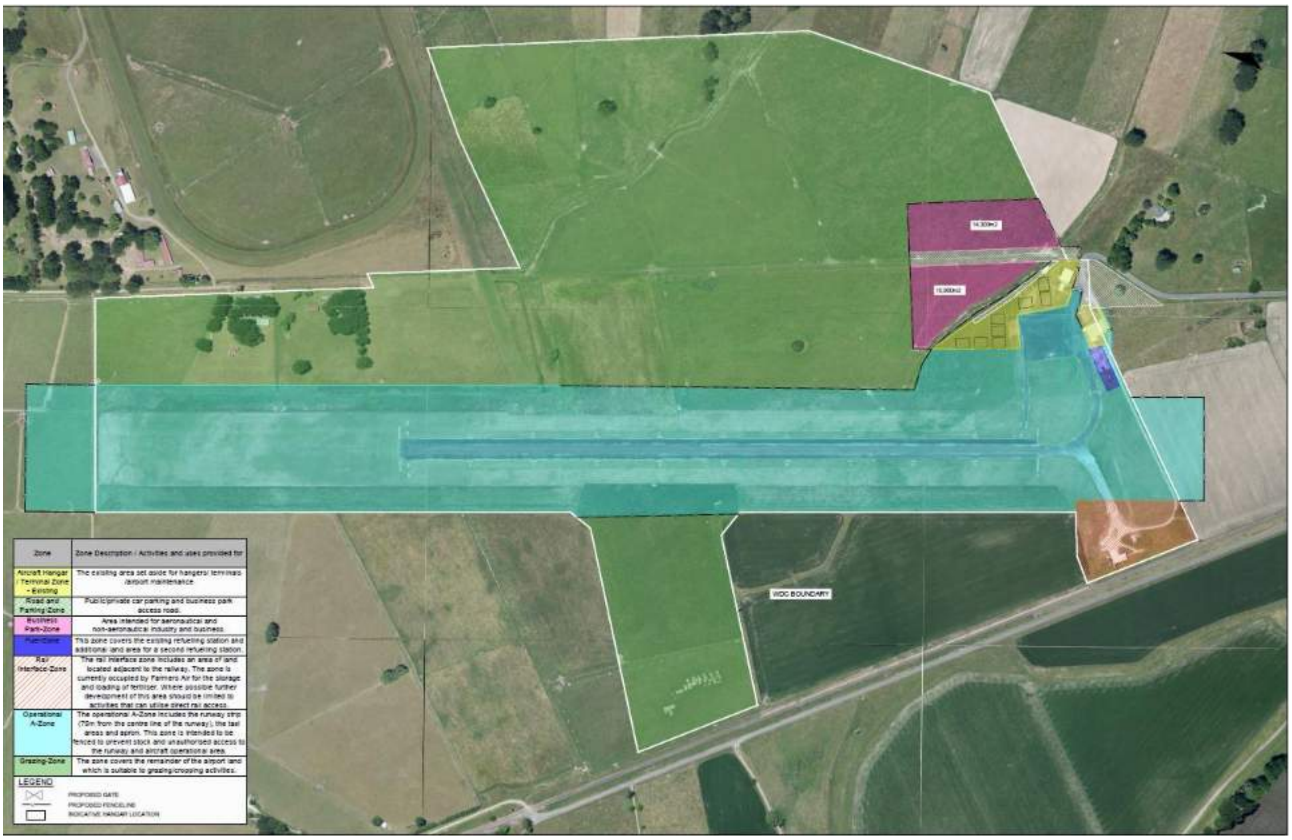


**Figure 1 : Airport Internal Zoning Plan**

# 2 This report

This report presents a preliminary geotechnical assessment of the site. This includes the results of a desktop review and site investigations.

This report in and of itself <u>does not</u> provide a suitability statement for any site development proposal (including the suitability of foundations proposed at the site). However, foundation designers may use this report to evaluate the site liquefaction hazard and near surface foundation conditions based on the information presented herein.

# 3 Desktop Study

The desktop study included consideration of: existing reports and unpublished geotechnical data for the site; available published geological maps; aerial photographs of the site; information published in Facing the Risks and the Hawke's Bay Emergency Management groups on-line

Hazard Maps. The pertinent information returned from this desktop study is presented in the following sections and the automatic report generated from the Hazard Maps web site is attached.

## 3.1 Geomorphology and Topography

The site is located on a flood plain in the lower reaches of the Wairoa River valley. The site is generally level, incised with two surface drains approximately 2 to 3 m in depth, as shown in Figures 2 and 3. A lower area of 1 to 2 m depth several metres wide runs north to south through the site. A shallow pond and rush bushes growing along the floor suggests this area is normally wet. The investigations reported herein were completed during very dry summer conditions.

**Figure 2 Dry pond in shallow depression**

**Figure 3 Existing surface drain**

## 3.2 Site Geology

The site is shown on several published geological maps and soil maps, the most current of which Mazengarb et al. (2000)[1] indicates that the site is located in the Wairoa syncline and the near surface is underlain by floodplain deposits of Holocene age (0 – 24 k years), being: poorly to moderately sorted gravel with minor sand and mud overlain by tephra; older beds are more deeply weathered.

## 3.3 Natural Hazard

The site was assessed by Opus for the following natural hazards:

- Seismic Hazard;
- Ground stability and Landform changes
- Flood Hazard and Meteorological Hazard;
- Volcanic Impact Hazard;

The following sections cover those hazards which are considered by Opus to be significant with respect to the site and the proposed development.

[1] Mazengarb, C; Spenden, I.G. (compliers); Geology of the Hawke's Bay Area; Institute of Geological & Nuclear Sciences; 1:250,000 geological map 6; 1 sheet + 60 p.; Lower Hutt, New Zealand, GNS Science.

### 3.3.1 Fault Rupture

The site is not shown to be crossed by any active or historic faults. The GNS New Zealand Geology[2] map identifies the nearest active fault as an unnamed fault about 20 km to the north east of the Site of unknown recurrence interval.

No fault avoidance zones are identified at the site on the on-line *Hazard Maps*. Therefore, ground rupture at the site due to seismic faulting is not expected.

### 3.3.2 Ground Shaking

An earthquake of moderate to high magnitude generated in the East Coast region could cause considerable ground shaking at the site, and can be expected to be experienced during the design life of any proposed building; therefore any proposed building should be appropriately designed to mitigate against the adverse effects of such potential ground shaking.

The on-line Hazards Maps show that shaking may be amplified at the site due to the underlying deposits of moderately to coarsely interlayered SILT, sandy SILT, silty SAND and SAND deposits (Wairoa River Sediments). For the purpose of design the ground shaking risk on the site is typical of that for the Wairoa river valley.

### 3.3.3 Seismic Liquefaction and Lateral Spreading

One of the more destructive secondary effects of earthquake shaking is liquefaction. Liquefaction typically occurs when loose, saturated cohesionless soils lose strength under earthquake or other applied cyclic loading. For a soil to liquefy it must also be saturated and so the level of the ground water table plays a critical role in liquefaction potential. Cohesive soils are not usually susceptible to liquefaction but may soften due to the earthquake stress loading. Sites susceptible to liquefaction may also undergo lateral spreading if a water way or free face is nearby.

The on-line *Hazards Maps* show a high liquefaction potential for this site.

### 3.3.4 Ground Stability and Landform changes

Aerial images from 1962, and 1979 available on the Retrolens website[3] were studied by Opus for evidence of geological hazards, and landform changes to the present day.

The imagery shows free surface water in the area 1962 that has largely disappeared in the 1979 imagery, showing the effect of surface drainage works that occurred in conjunction with the construction of the runway. The land beyond the runway is now grassed for agricultural use.

The overall profile of the water courses appears relatively consistent over the time period above. The presence of surface water historically indicates the land is susceptible to high ground water conditions and even flooding.

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[2] Geological & Nuclear Sciences. *New Zealand Geology Web Map* webpage. Available on-line at http://data.gns.cri.nz/af/. Accessed February 2016.

[3] Local Government Geospartial Alliance (LGGA). Retrolens webpage. Sourced from http://retrolens.nz and licensed by LINZ CC-BY 3.0. Accessed February 2016

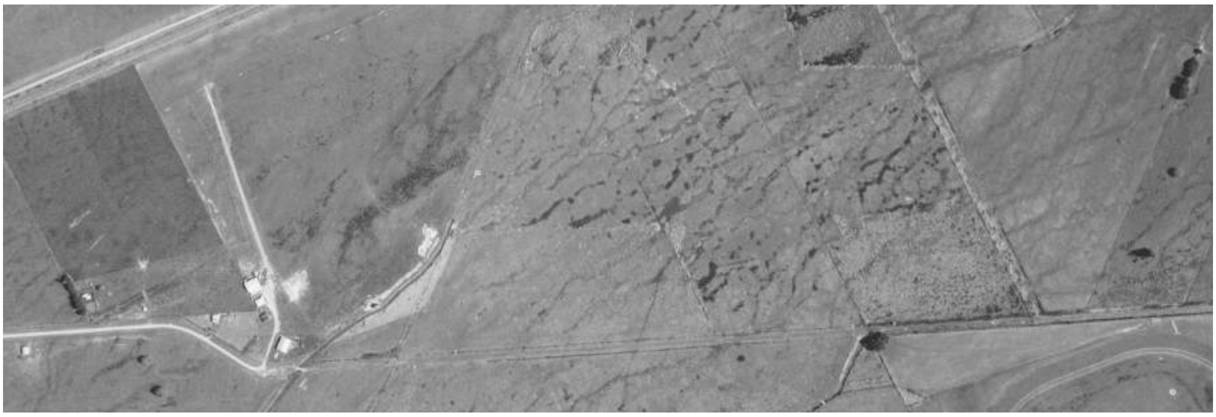

Figure 4 : Imagery September 1962

Figure 5 : Imagery September 1979

### 3.3.5 Extreme Rainfall

*Facing the Risks* indicates that the 142 year (this event was chosen by *Facing the Risks* corresponding to a 35% probability of occurring within a 50 year period) rainfall event is likely to see between 300 mm and 350 mm of rain fall at the site within any 24 hour period. This could lead to extensive, localised flooding, and overland flow conditions.

In general, the risk to the site due to extreme rainfall is not considered to be substantially more than the risk posed elsewhere near Wairoa. However, consideration during detailed design should be given to provide secondary flow paths so that stormwater/overland flows are directed away from points of concentration and buildings within the site.

### 3.3.6 Flood

The *Hazards Maps* show the 1% AEP level for river flood areas and 2% (1/50 year) AEP for floodplain risk areas. The *Hazards Maps* are indicative only but show that there is a 2% AEP flood risk at the site.

Flood mitigation and stormwater controls will need careful consideration during detailed design of any proposed development.

### 3.3.7 Extreme Winds

*Facing the Risks* and AS/NZS 1170.2:2011 discuss the general risks of sustained wind gusting as well as the concentrating effects of topographical features. The proposed subdivision is located on the Wairoa river valley, and the site is not considered to be in an exposed location.

### 3.3.8 Volcanic Impact Hazard

Whilst there are no active volcanoes in the Hawke's Bay region, volcanic ash erupted from volcanoes to the west and northwest can be expected to fall on the site. *Facing the Risks* estimates that 0-1 mm thick tephra falls can be expected once every 10-20 years, while 1-5 mm thick tephra falls can be expected every 100 years. This risk is considered to be low to medium in its impact, and consistent with the level of risk at other similar locations in the region.

# 4 Site Testing

On 18 January 2017 staff from Opus Napier completed site investigations including six mechanically excavated test pits (TPs), Dynamic Cone Penetration (DCP: Sala) and Hand Auger (HA) tests and four Cone Penetration Tests utilising a piezoelectric cone (CPTu), at the locations shown in Figure 6. Test Pit 4 was subsequently abandoned on direction by our Napier based archaeologist, due to the potential risk of damage to artefacts.

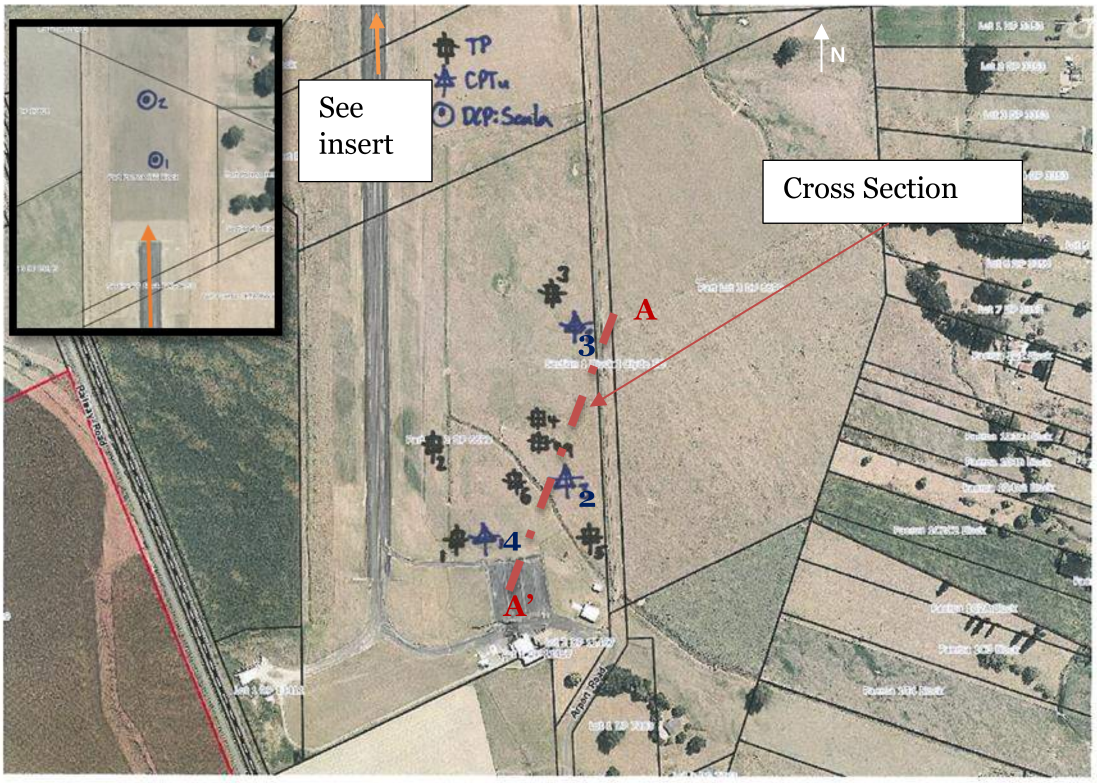


**Figure 6 : Testing Location Plan**

The bore logs of five wells drilled near the site obtained from the Hawkes Bay Regional Council were also used in the Opus desk top study.

DCP: Scala testing and hand held Shear Vanes were conducted where appropriate as part of the TP investigations to assist with characterisation of the near surface the soil strength and bearing capacity. No laboratory testing was conducted.

The results of the site testing and analysis are appended to this report. Further testing may be required during detailed design.

## 4.1 Liquefaction Analysis

The CPTu were terminated at a depths of approximately of 18m. Utilising a commercial grade electronic dip meter, the groundwater level was measured between depths of 1.4 -2.0m below the existing ground surface immediately following completion of the CPTu. The CPTu data was analysed utilising the computer software CLiq[4]. The liquefaction analysis results are factual only, and no engineering judgement has been applied other than as explicitly described within this report.

For the liquefaction analysis, AS/NZS 1170:2002 was applied to determine the design earthquake return period, whilst the *Bridge Manual*[5] was applied to determine the design earthquake magnitude (*M*) and peak ground acceleration (PGA) values. The *M* and PGA values developed via application of the *Bridge Manual* are considered to be more appropriate for liquefaction analyses than those developed via application of AS/NZS 1170:2004 alone because the *Bridge Manual* values are not magnitude-weighted values. The following were assumed for this analysis:

- A site Soil Class of "C" (Shallow Soil);
- Near fault factor N(T,D) of 1.0
- An Importance Level (IL) 2 and 3 based on Table 3.2 of AS/NZS1170.0:2002; and
- A building Design Life of 50 years.

Based on this application, the parameters presented in Table 1 were determined for the site for Ultimate Limit State (*ULS*) and Serviceability Limit State (*SLS1*) design earthquakes

**Table 1: Earthquake Shaking**

| Limit State | Return Period | Design Earthquake Magnitude | Design Earthquake PGA |
|---|---|---|---|
| *SLS1* | 25 years | 6.2 | 0.09 g |
| $ULS_{IL2}$ | 500 years | 6.4 | 0.36 g |
| $ULS_{IL3}$ | 1000 years | 6.5 | 0.47 g |

Default assessment values were utilised within CLiq during the liquefaction analysis. These include, but are not limited to, assuming the existing ground is level, assuming the groundwater level during earthquake shaking is equivalent to the groundwater level observed during the site

4 GeoLogismiki (2006). *CLiq (version 2.0.6.83)* [Software]. Available from http://www.geologismiki.gr/

5 NZ Transport Agency. *Bridge Manual.* 3rd Ed. Amendment 3. Manual No. SP/M/022. May 2016.

testing, utilising the Boulanger & Idriss (2014)[6] calculation method, utilising a soil behaviour type index ($I_C$) cut-off of 2.6, applying clean sand and overburden corrections, automatic calculations for soil unit weights and applying automatic corrections to the input data at soil transition layers. Refer to Robertson & Wride (1998)[7] for the definition of $I_C$ and for a discussion on its applications. Site-specific calibration of the fines content estimated by the Boulanger & Idriss (2014) method was not conducted. Therefore, the fine fitting parameter ($C_{FC}$) value was set to zero. The index parameters referred to as "liquefaction-induced free-field vertical volumetric strain" were estimated by CLiq for the *SLS1* and *ULS* design seismic events using the method of Zhang et al. (2002)[8].

The liquefaction analysis generally indicates that interbedded SAND, silty SAND, sandy SILT layers are potentially liquefiable. CLAY and silty CLAY layers may be susceptible to cyclic softening, but any potential earthquake-induced strain in these layers is not included in this liquefaction analysis at this stage. Volcanic soils (i.e. Pumice SAND) may undergo liquefaction but there is currently limited research on the behaviour of these soils and so is not included in this analysis.

Table 2 presents the liquefaction-induced vertical free-field volumetric strain index values estimated for the SLS and ULS design earthquakes.

**Table 2: Summary of Liquefaction Analysis Results**

| **Description** | ***SLS1*** | ***ULS*** |
|---|---|---|
| CPT-2 (assumed groundwater table at 1.98mbgl) | Liquefaction not anticipated | 90mm |
| CPT-3 (assumed groundwater table at 1.66mbgl) | Liquefaction not anticipated | 20mm |
| CPT-4 (assumed groundwater table at 1.40mbgl) | Liquefaction not anticipated | 50mm |

NZGS Guidelines (Module 3, Table 5.1) provides a general guidance of the performance level of the liquefied deposits. In the extreme ULS event the performance level at the site is likely to be L2 and to have a moderate effect with the characteristics described as "liquefaction occurs in layers of limited thickness (small proportion of the deposit, say 10 percent or less) and lateral extent; ground deformation results relatively small in differential settlements."

[6] Boulanger, R.W. and Idriss, I.M. *CPT and SPT Based Liquefaction Triggering Procedures*. University of California at Davis Center for Geotechnical Modelling Report No. UCD/CGM-14/01. April 2014.

[7] Robertson, P.K. and Wride, C.E. (1998). "Evaluating cyclic liquefaction potential using the cone penetrometer test". *Canadian Geotechnical Journal*. Vol. 35. No. 3. pp. 442-459.

[8] Zhang, G., Robertson, P.K. and Brachman, R.W.I. (2002). "Estimating Liquefaction induced Ground Settlements from CPT for Level Ground". *Canadian Geotechnical Journal*, 39(5): 1168-1180.

## 4.2 Ground Model

The information gained from the desktop studies and the recent site investigations and testing have been used to develop the indicative ground model for the soils up to an approximate depth of 20 m at the site given in Table 3.

**Table 3 Ground Model**

| Layer No. | Approximate Thickness of Layer (m) | General Soil Description | Typical Consistency (DCP blows/100 mm) [Peak / Remoulded Shear Strength, in kPa] |
|---|---|---|---|
| 1 | 0.4 | Topsoil | - |
| 2 | 0.7-1.4 | Sandy SILT, dry, non-plastic | Stiff to very stiff (3-8 blows/100 mm) [200+ kPa] |
| 3 | 0.15- 0.3 | Tephra (Pumice SAND), moist to saturated | Medium dense to very dense (4 to 24+ blows/100 mm) |
| 4 | 0.6 – 1.5 + | Clayey SILT/Silty CLAY, wet, slightly plastic, with wood fragments in upper layer | Soft (1 to 4 blows/100 mm) |
| 5 | 0.3 | Tephra (Pumice SAND), saturated | Medium dense |
| 6 | 3 - 12 | CLAY | Soft (1 to 4 blows/100 mm) qt <1 MPa |
| 7 | 0 – 13+ | Interbedded CLAY & silty CLAY, Silty SAND and Sandy SILT | qt 1 - 8 MPa |
| 8 | 0 - 12 | CLAY | qt <1 MPa |
| 9 | 4+ | Silty SAND and Sandy SILT | qt 1 - 4 MPa |

The Opus investigations indicate that the depth to the water table is between approximately 1.2 m to 2.2m, following very dry summer conditions. This is expected to rise in winter and following heavy rainfall events.

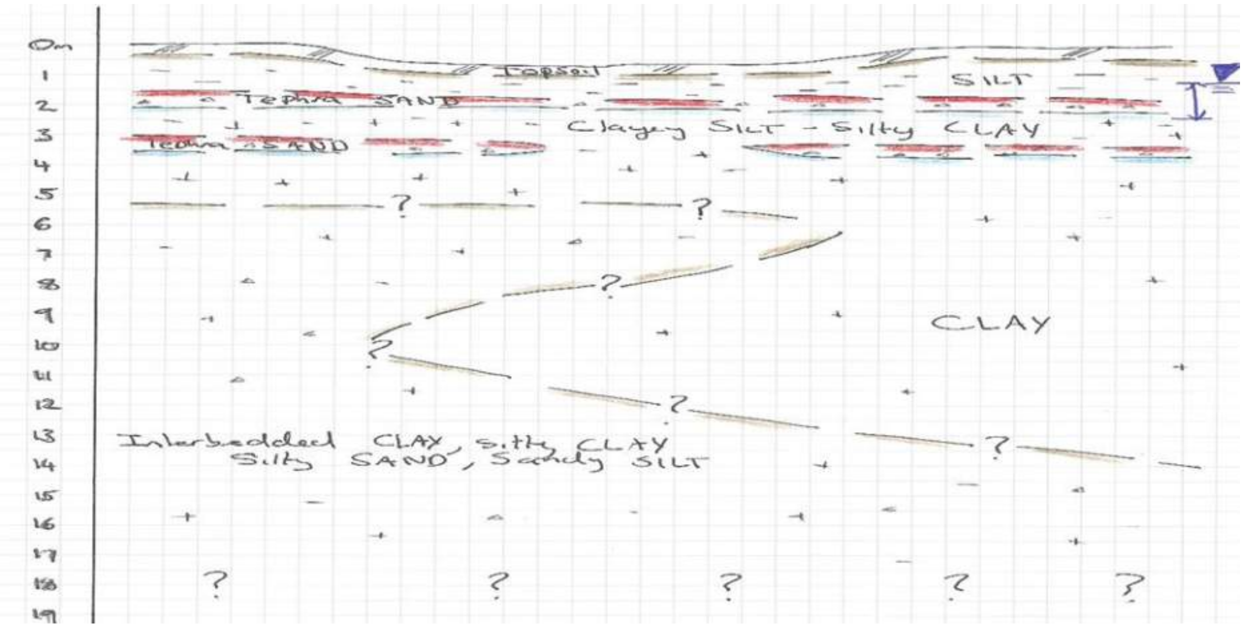


**Figure 7 Indicative soil layering of Cross Section A-A'**

The general soil profile that could be expected (refer Figure 7) varies at the site but is consistent with the geological maps for the area. The well logs in the area, available online on the HBRC intramaps website, indicate that layers of clays, sands and gravels may continue for depths in excess of 50 m but SILTSTONE may be encountered earlier at an approximate depth of 30m.

## 4.3 Bearing Capacity

For light timber structures "Good ground" as defined in NZS3604:2011 is unlikely to be present at the site, given the depths to and variations in the groundwater levels, and presence of expansive moisture sensitive fine grained soils in the near surface subsoils.

Site Specific Engineering (SED) foundation design will be required for new building foundations. This can include braced shallow piles supporting elevated timber floors, or near surface ground improvement options (e.g. geogrid reinforced granular hardfill) supporting RibRaft™ slab on ground foundations.

## 4.4 Settlement

The soft, wet subsoils encountered during the investigations indicate that settlement may be a significant detailed design issue. The induced soil settlement depends on the new loading to occur from structures or embankments (or both).

If the site needs to be built up by engineered earthworks for example to mitigate flooding effects time related pre-loading of the soil will be required to help mitigate future settlement effects.

## 4.5 Pavement Subgrade

While airport pavements have different loadings and requirements than for road pavement the DCP: Scala testing provides useful information to guide future pavement works.

Two Scala penetrometer conducted at the end of the runway yielded a minimum blow count of 8 per 100mm at 0.8m depth correlating with a design CBR of 8%, following dry summer conditions.

During the site visit the stock owner informed the Opus staff that in winter months the grass end of the main runway becomes' boggy' and the ground was observed to be rough and slightly rutted.

This suggests that future pavement subgrade design values could be much less than the reported CBR of 8%, requiring careful consideration during detailed design.

# 5 Recommendations

From a geotechnical perspective, any future development at the site must consider the following:

- The site subsoils may become saturated during wet periods and as result of flooding. Site development should carefully manage stormwater and the flood risk. Soil bearing capacity is reduced in saturated soils
- Development options, specifically infrastructure and underground services, should consider the likely effects of moderate soil liquefaction during an extreme earthquake event
- Bearing capacity of the soil for shallow foundations are unlikely to be on "Good Ground" in accordance with NZS 3604:2011. Building foundations will need Specific Engineering Design
- Embankment and overall site level increasing earthworks should involve pre-loading to mitigate future settlement effects
- New pavements will encounter soft, wet subgrade conditions, the effects of which will need to be mitigated by appropriate design and construction methods.

# 6 Limitations

The factual data, interpretations and recommendations contained in this report pertain to a specific project as described in the report and are not applicable to any other project or site. If the project is modified in any significant way, or if the project is not initiated within eighteen months of the date of the report, Opus International Consultants should be given an opportunity to confirm that the recommendations are still valid.

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# 7 Appendix A

Site testing results

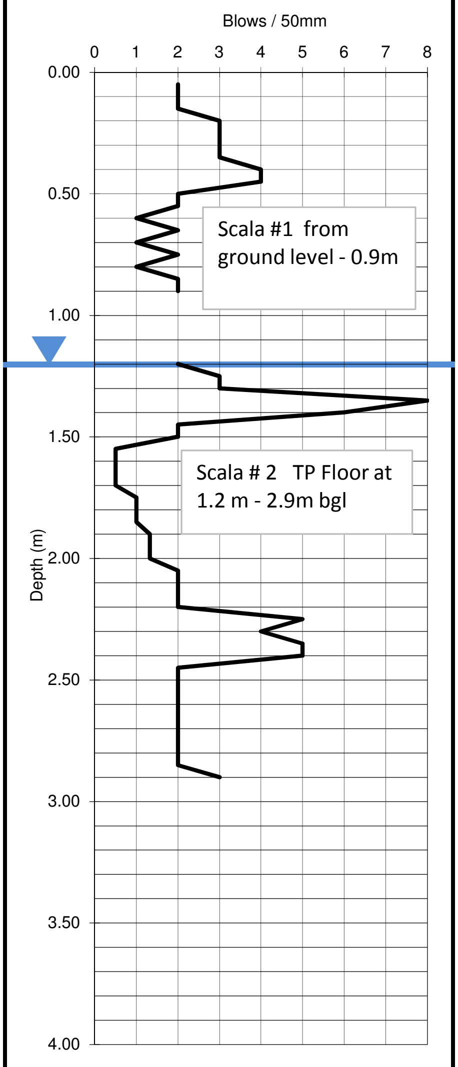
# TEST PIT TEST REPORT

OPUS

| | |
|---|---|
| Project : | **Wairoa Airport Development** |
| Location : | **39°054.9 S 177°24'21.3E 6m WGS 1984** |
| Client : | **Wairoa District Council** |
| Contractor : | **Opus - Napier** |
| Test number : | **1** |
| Shear vane number : | **DR955** |
| Shear vane correction : | **1.655** |
| Water level (m): | **1.2** |
| Reduced level (m): | **Existing Ground** |

| | |
|---|---|
| **Project No :** | **2-Y1300.DM** |
| **Task No :** | **001WA** |
| **Client Ref No :** | |

## Scala Penetrometer




## Test Results

| Depth (m) | Shear Strength (kPa) | Soil Description |
|---|---|---|
| 0.35 | | Topsoil, dark brown, stiff, dry |
| 0.75 | 200 + | Sandy SILT, grey with orange mottles, stiff, dry, non plastic |
| 1.20 | | Medium SAND, grey brown, medium dense, wet, (Pumice), charcoal fragmer |
| 1.50 | | as above but fine |
| 2.5+ | | SILT, blue grey, soft, wet, low plasticity |

End Test pit - Filling with water

| **Test Methods** | |
|---|---|
| Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2 | Field Descriptions of Soils and Rocks by |
| Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001 | NZ Geotechnical Society Dec 2005 |

Date tested : 18/01/17
Date reported : 24/01/17

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**Approved** **C.Hopkins**

Designation : *Geotechnical Technician*
Date : 30/01/17




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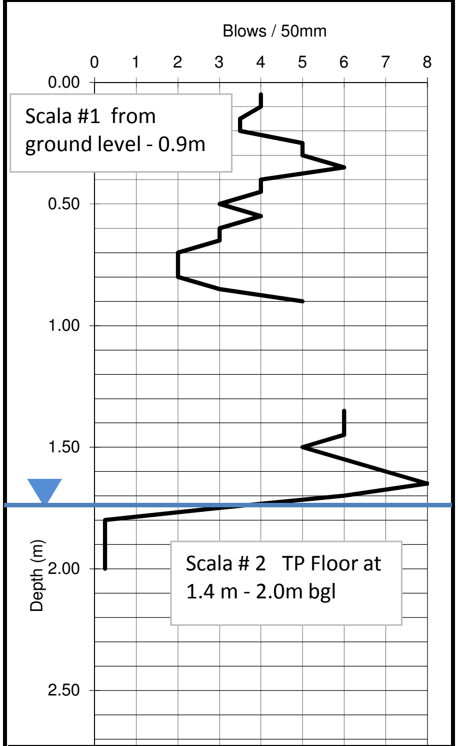
# TEST PIT
# TEST REPORT

OPUS

| | |
|---|---|
| Project : | **Wairoa Airport Development** |
| Location : | **39°051.3 S 177°24'19.6E 6m WGS 1984** |
| Client : | **Wairoa District Council** |
| Contractor : | **Opus - Napier** |
| Test number : | **2** |
| Shear vane number : | **DR955** |
| Shear vane correction : | **1.655** |
| Water level (m): | **1.75** |
| Reduced level (m): | **Existing Ground** |

| | |
|---|---|
| **Project No :** | **2-Y1300.DM** |
| **Task No :** | **001WA** |
| **Client Ref No :** | |

**Scala Penetrometer**




**Test Results**

| Depth (m) | Shear Strength (kPa) | Soil Description |
|---|---|---|
| 0.38 | | Topsoil, dark brown, stiff, dry |
| 0.65 | | Course SAND, orange grey, dense, moist, (Pumice) |
| 1.20<br>1.75 | | Medium SAND, grey , medium dense, wet, (Pumice), charcoal fragments,<br>as above but fine |
| 2.00 | | SILT, blue grey, soft, wet, low plasticity, preserved wood |
| 2.70 | | SILT, blue grey, soft, wet, low plasticity, |
| 2.90 | | Medium SAND, grey , medium dense, saturated, (Pumice) |
| 3.3+ | | SILT, blue grey, soft, wet, low plasticity, |
| End at 3.3m at target depth | | |

| **Test Methods** | |
|---|---|
| Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2<br>Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001 | Field Descriptions of Soils and Rocks by<br>NZ Geotechnical Society Dec 2005 |

Date tested : 18/01/17
Date reported : 24/01/17

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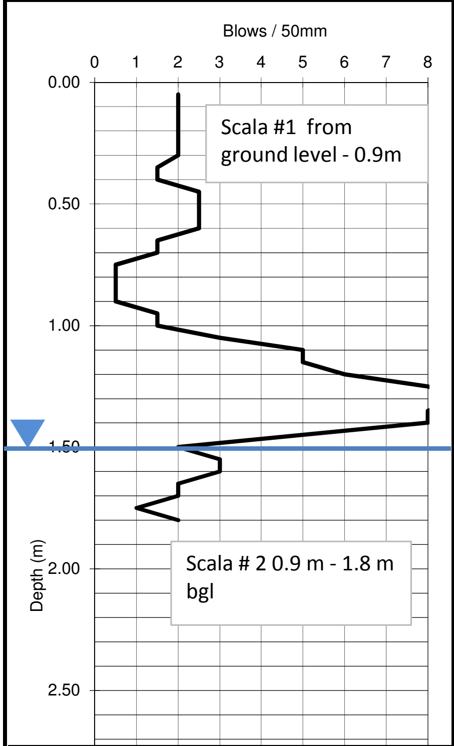
# TEST PIT
# TEST REPORT

Project : **Wairoa Airport Development**
Location : **39°046.1 S 177°24'25.5E 4m WGS 1984**
Client : **Wairoa District Council**
Contractor : **Opus - Napier**
Test number : **3**
Shear vane number : **DR955**
Shear vane correction : **1.655**
Water level (m): **1.5**
Reduced level (m): **Existing Ground**

| | |
|---|---|
| **Project No :** | **2-Y1300.DM** |
| **Task No :** | **001WA** |
| **Client Ref No :** | |

**Scala Penetrometer**




**Test Results**

| Depth (m) | Shear Strength (kPa) | Soil Description |
|---|---|---|
| 0.35 | | Topsoil, brown, stiff, dry |
| 0.45 | | Fine SAND, light grey, medium dense, dry, (Pumice) |
| 0.85 | | SILT, light brown, firm, moist, non plastic |
| 0.95 | | SILT, brown, soft, wet, non plastic, (paleo topsoil?) |
| 1.40 | | Medium fine SAND, grey brown, dense, moist, charcoal fragments, (Pumice) |
| 1.45 | | SILT, blue grey, soft, wet, low plasticity, preserved wood |
| 3.10 | | SILT, blue grey, soft, wet, low plasticity, |
| End at 3.1m at target depth | | |

| **Test Methods** | |
|---|---|
| Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2<br>Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001 | Field Descriptions of Soils and Rocks by<br>NZ Geotechnical Society Dec 2005 |

Date tested : 18/01/17
Date reported : 24/01/17

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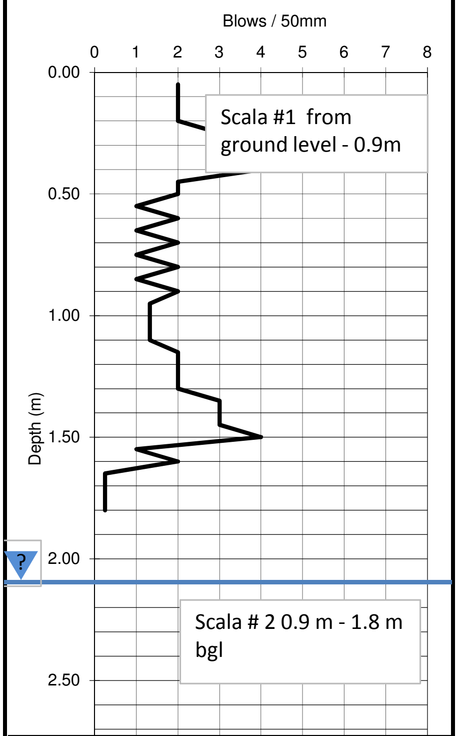
| TEST PIT<br>TEST REPORT |
|---|

OPUS

| | |
|---|---|
| Project : | **Wairoa Airport Development** |
| Location : | **39°051.6 S 177°24'25.0E 4m WGS 1984** |
| Client : | **Wairoa District Council** |
| Contractor : | **Opus - Napier** |
| Test number : | **4a** |
| Shear vane number : | **DR955** |
| Shear vane correction : | **1.655** |
| Water level (m): | **Some seepage at 2.1m** |
| Reduced level (m): | **Existing Ground** |

| | |
|---|---|
| **Project No :** | **2-Y1300.DM** |
| **Task No :** | **001WA** |
| **Client Ref No :** | |

**Scala Penetrometer**




**Test Results**

| Depth (m) | Shear Strength (kPa) | Soil Description |
|---|---|---|
| 0.20 | | Topsoil, brown, stiff, dry |
| 0.45 | | SILT, grey, stiff, dry, non-plastic |
| 0.70 | | Course SAND, whitish grey, medium dense, dry (Pumice) |
| 1.25 | | Medium SAND, grey brown, medium dense, moist, (Pumice) |
| 1.60 | | SILT, blue grey, soft, wet, low plasticity, preserved wood |
| | | SILT, blue grey, soft, wet, low plasticity, |
| 2.80+ | | |

End at 2.8m at target depth

| **Test Methods** | |
|---|---|
| Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2<br>Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001<br>Field Descriptions of Soils and Rocks by NZ Geotechnical Society Dec 2005 | Note: TP4 was not completed as directed by archaeologist |

Date tested : 18/01/17
Date reported : 24/01/17

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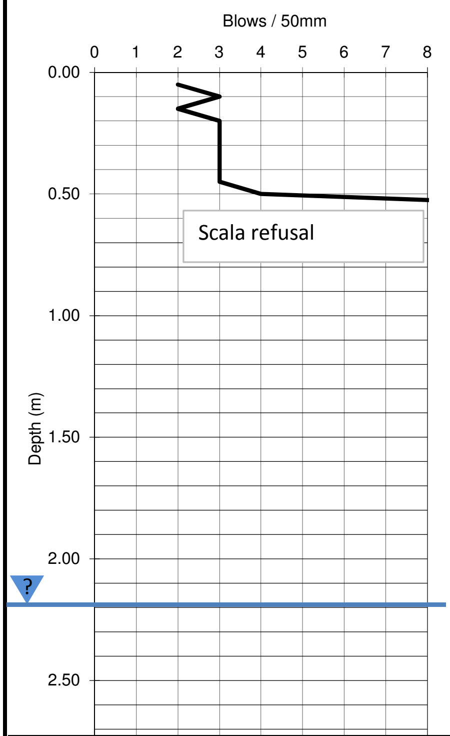
**TEST PIT**
**TEST REPORT**

OPUS

| | |
|---|---|
| Project : | **Wairoa Airport Development** |
| Location : | **39°054.6 S 177°24'27.5E 4m WGS 1984** |
| Client : | **Wairoa District Council** |
| Contractor : | **Opus - Napier** |
| Test number : | **5** |
| Shear vane number : | **DR955** |
| Shear vane correction : | **1.655** |
| Water level (m): | **Some seepage at 2.2m** |
| Reduced level (m): | **Existing Ground** |

| | |
|---|---|
| **Project No :** | **2-Y1300.DM** |
| **Task No :** | **001WA** |
| **Client Ref No :** | |

**Scala Penetrometer**




**Test Results**

| Depth (m) | Shear Strength (kPa) | Soil Description |
|---|---|---|
| 0.25 | | Topsoil, brown, stiff, dry |
| 0.40 | | Sandy SILT, grey orange mottles, stiff, dry, non-plastic |
| 0.60 | | Course SAND, whitish grey, dense, dry (Pumice) |
| 0.90 | | As above but light brown |
| 1.35 | | Fine SAND, grey, dense, moist, (Pumice) |
| 1.50 | | SILT, blue grey, soft, wet, low plasticity, preserved wood |
| 1.90 | | SILT, blue grey, soft, wet, low plasticity, |
| 2.20 | | Medium SAND, brown, medium dense, saturated |
| | | SILT, blue grey, soft, wet, low plasticity, |

End at 3.1m at target depth

| **Test Methods** | |
|---|---|
| Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2<br>Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001 | Field Descriptions of Soils and Rocks by<br>NZ Geotechnical Society Dec 2005 |

Date tested : 18/01/17
Date reported : 24/01/17

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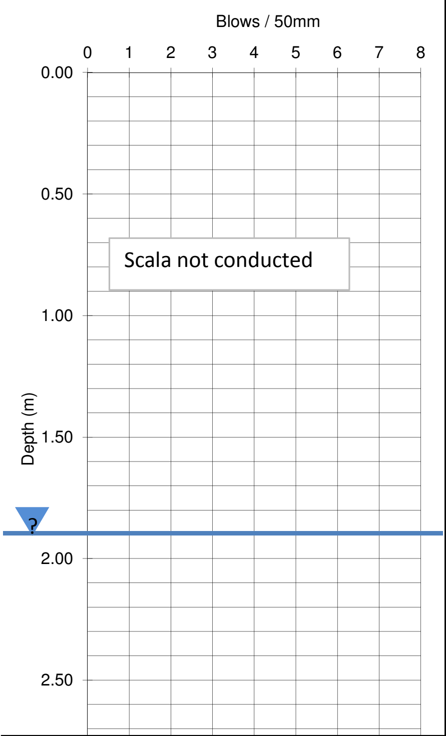
# TEST PIT
# TEST REPORT

OPUS

| | |
|---|---|
| Project : | **Wairoa Airport Development** |
| Location : | **39°052.6 S 177°24'23.7E 4m WGS 1984** |
| Client : | **Wairoa District Council** |
| Contractor : | **Opus - Napier** |
| Test number : | **6** |
| Shear vane number : | **DR955** |
| Shear vane correction : | **1.655** |
| Water level (m): | **Some seepage from 1.9m** |
| Reduced level (m): | **Existing Ground** |

| | |
|---|---|
| **Project No :** | **2-Y1300.DM** |
| **Task No :** | **001WA** |
| **Client Ref No :** | |

**Scala Penetrometer**




**Test Results**

| Depth (m) | Shear Strength (kPa) | Soil Description |
|---|---|---|
| 0.25 | | Topsoil, brown, stiff, dry |
| 0.55 | | Medium SAND / SILT mix, grey brown, stiff, dry, non-plastic |
| 0.80 | | Medium SAND, brown, medium dense, moist, (Pumice Sand) |
| 1.30 | | Medium SAND, brown, medium dense, moist, (Pumice Sand) |
| 1.60 | | Fine SAND, grey, dense, wet, (Pumice Sand) |
| 1.90 | | Fine SAND, grey, dense, wet, (Pumice Sand) |
| 2.30 | | SILT, blue grey, soft, wet, low plasticity, preserved wood |
| 2.60 | | SILT, blue grey, soft, wet, low plasticity, |
| 2.90 | | Medium SAND, grey, medium dense, moist, (Pumice Sand) |
| 3.00+ | | SILT, blue grey, soft, wet, low plasticity, |

End TP at 3.0m at target

**Test Methods**

| | |
|---|---|
| Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2<br>Shear Strength using a Hand Held Shear Vane: NZ Geotechnical Soc Inc 8/2001 | Field Descriptions of Soils and Rocks by<br>NZ Geotechnical Society Dec 2005 |

Date tested : 18/01/17
Date reported : 24/01/17

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Designation : *Geotechnical Technician*
Date : 30/01/17

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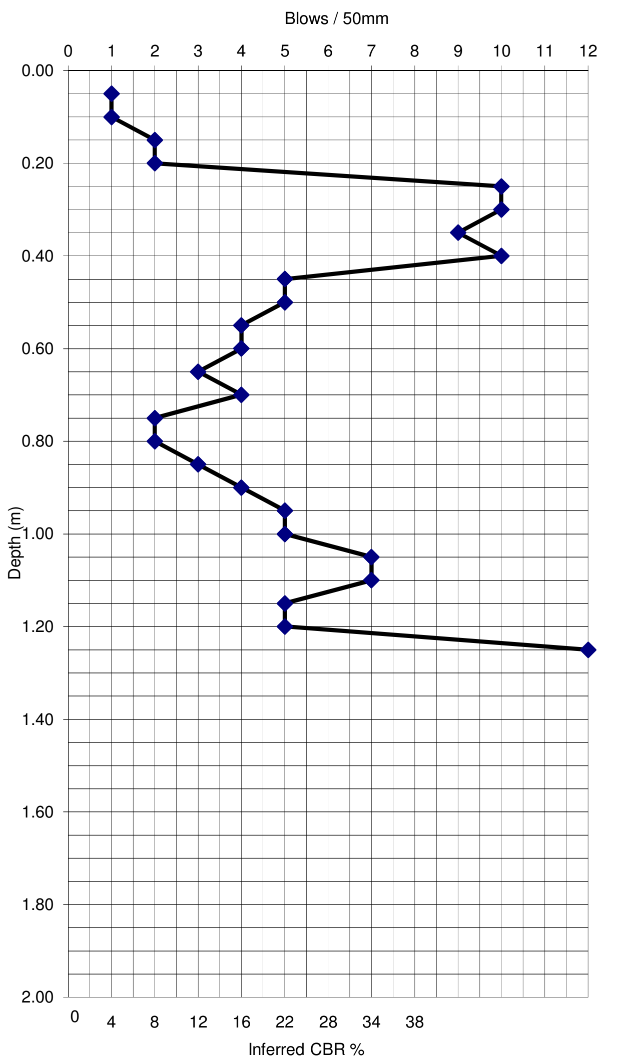
Website www.opus.co.nz

| SCALA PENETROMETER TEST REPORT |
|---|

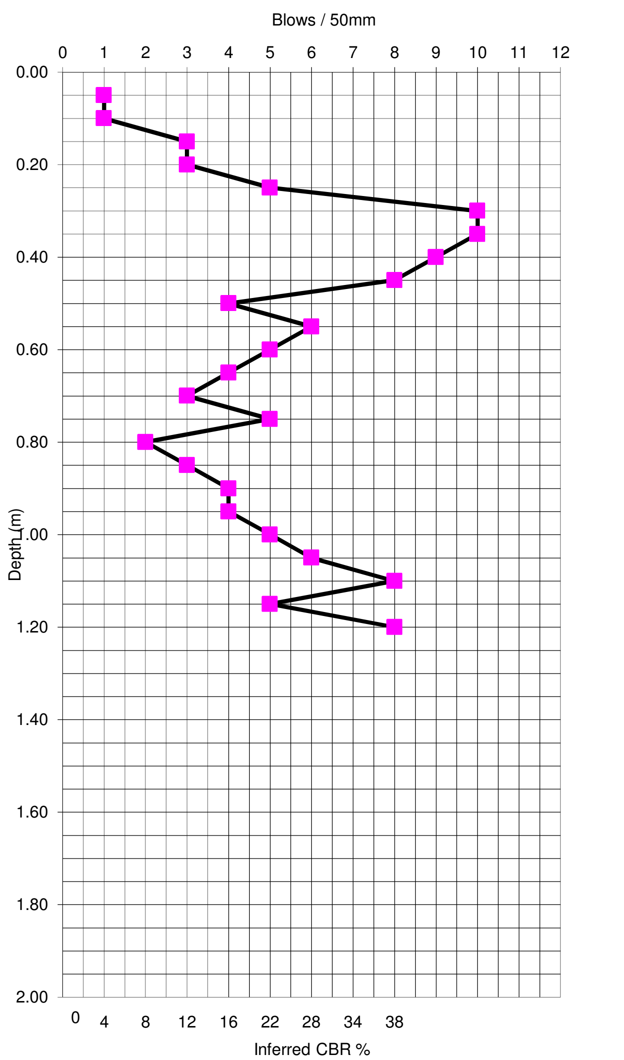
| | |
|---|---|
| **Project :** | **Wairoa Airport Development** |
| **Location :** | **39 00 23.3 S 177 24 14.8 E and** |
| **Client :** | **Wairoa District Council** |
| **Contractor :** | **Opus - Napier** |
| **Water level (m):** | **Not established** |
| **Reduced level (m):** | **Existing ground** |

| | |
|---|---|
| **Project No :** | **2-Y1300.DM** |
| **Lab Ref No :** | **001WA** |
| **Client Ref No :** | |

**Scala Penetrometer 1**




**Scala Penetrometer 2**




| Test Methods | Notes |
|---|---|
| Determination of Penetration Resistance of a Soil, NZS 4402 : 1988, Test 6.5.2<br>Inferred CBR values taken from Austroads Pavement Design Manual 2004 | |

Date tested : 18/01/17
Date reported : 01/02/17

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Designation : *Geotechnical Technician*
Date : 01/02/17

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# 8 Appendix B

Liquefaction Analysis Outputs

OPUS
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Opus House, 6 Ossian Street
Ahuriri
Napier 4110

# LIQUEFACTION ANALYSIS REPORT

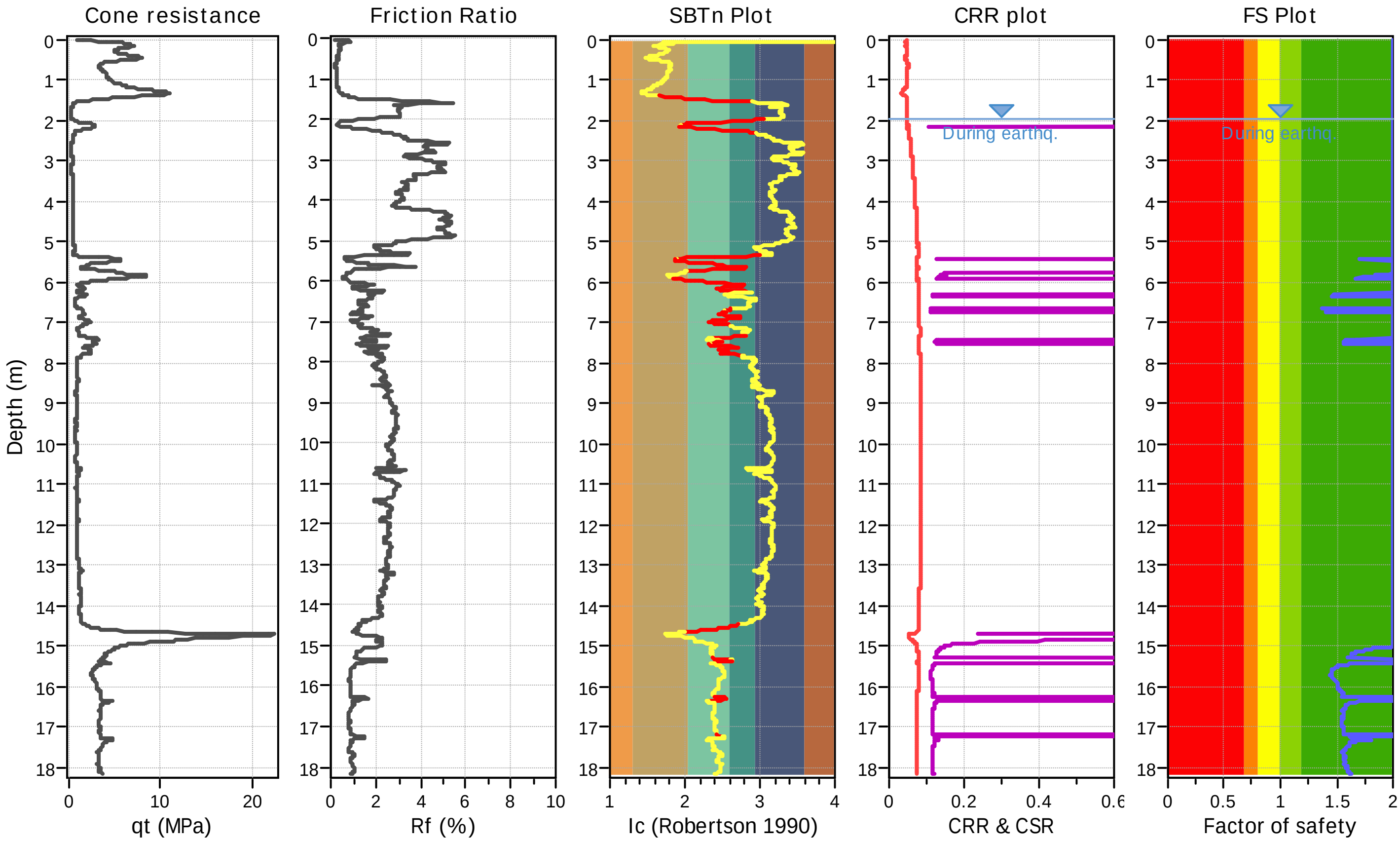
Project title : Liquefaction Assessment

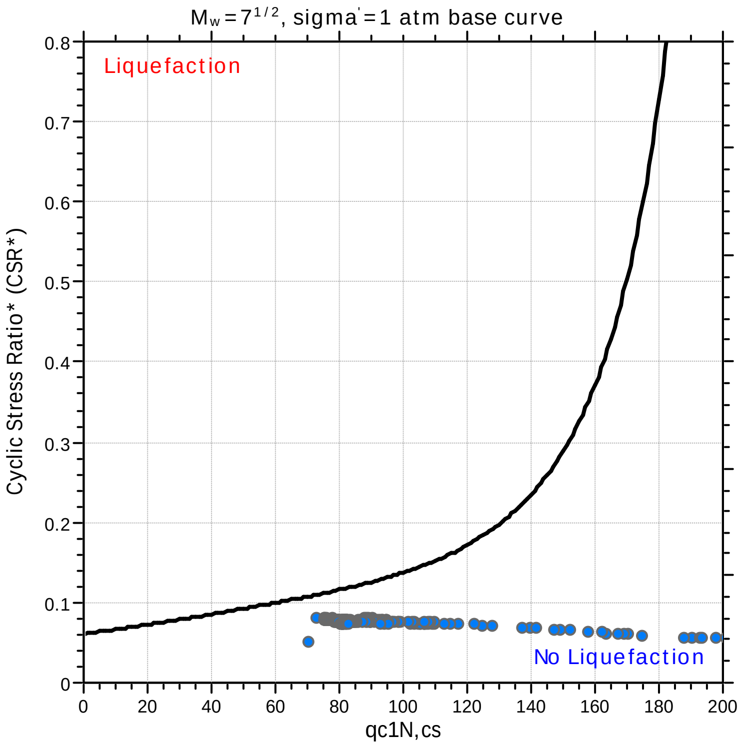
Location : Wairoa Aerodrome

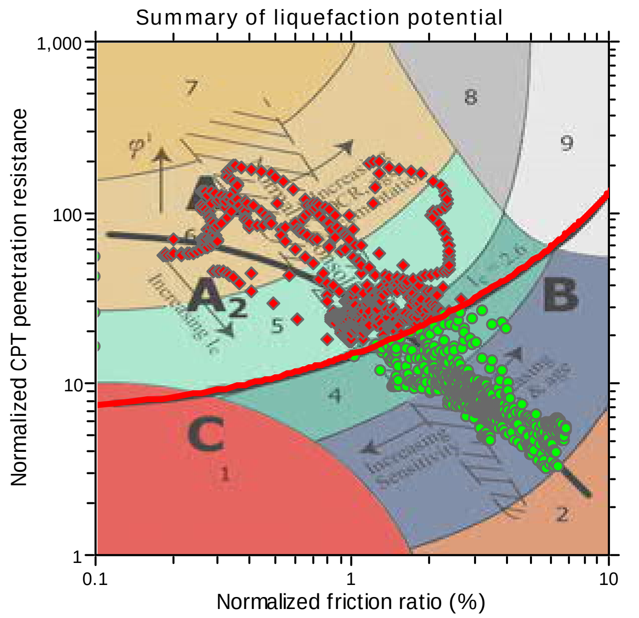
CPT file : CPT-2_SLS_6.2M_0.09g

## Input parameters and analysis data

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | G.W.T. (in-situ): | 1.98 m | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | B&I (2014) | G.W.T. (earthq.): | 1.98 m | Fill height: | N/A | Limit depth applied: | No |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | N/A |
| Earthquake magnitude $M_w$: | 6.20 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method |
| Peak ground acceleration: | 0.09 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

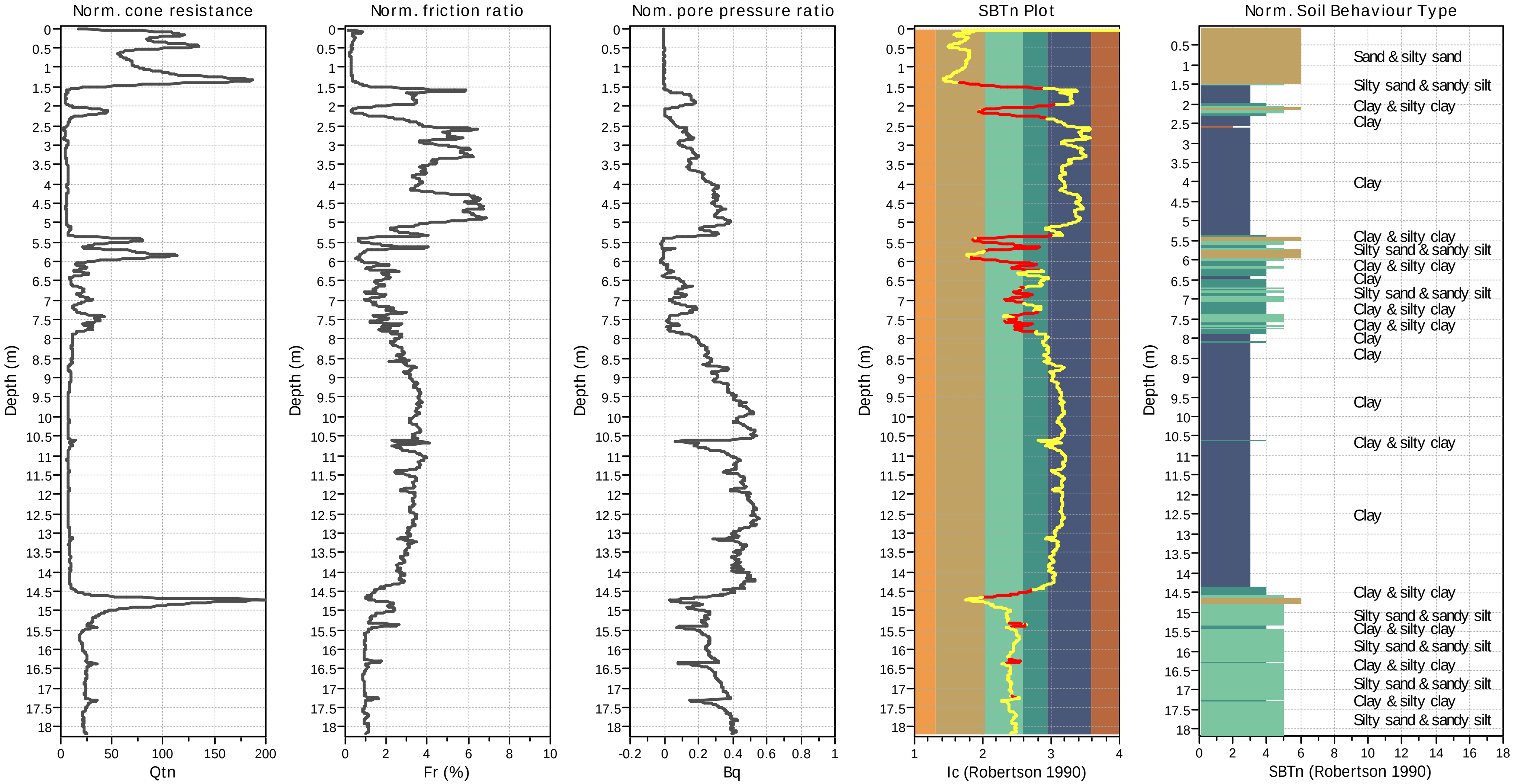



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

# CPT basic interpretation plots (normalized)



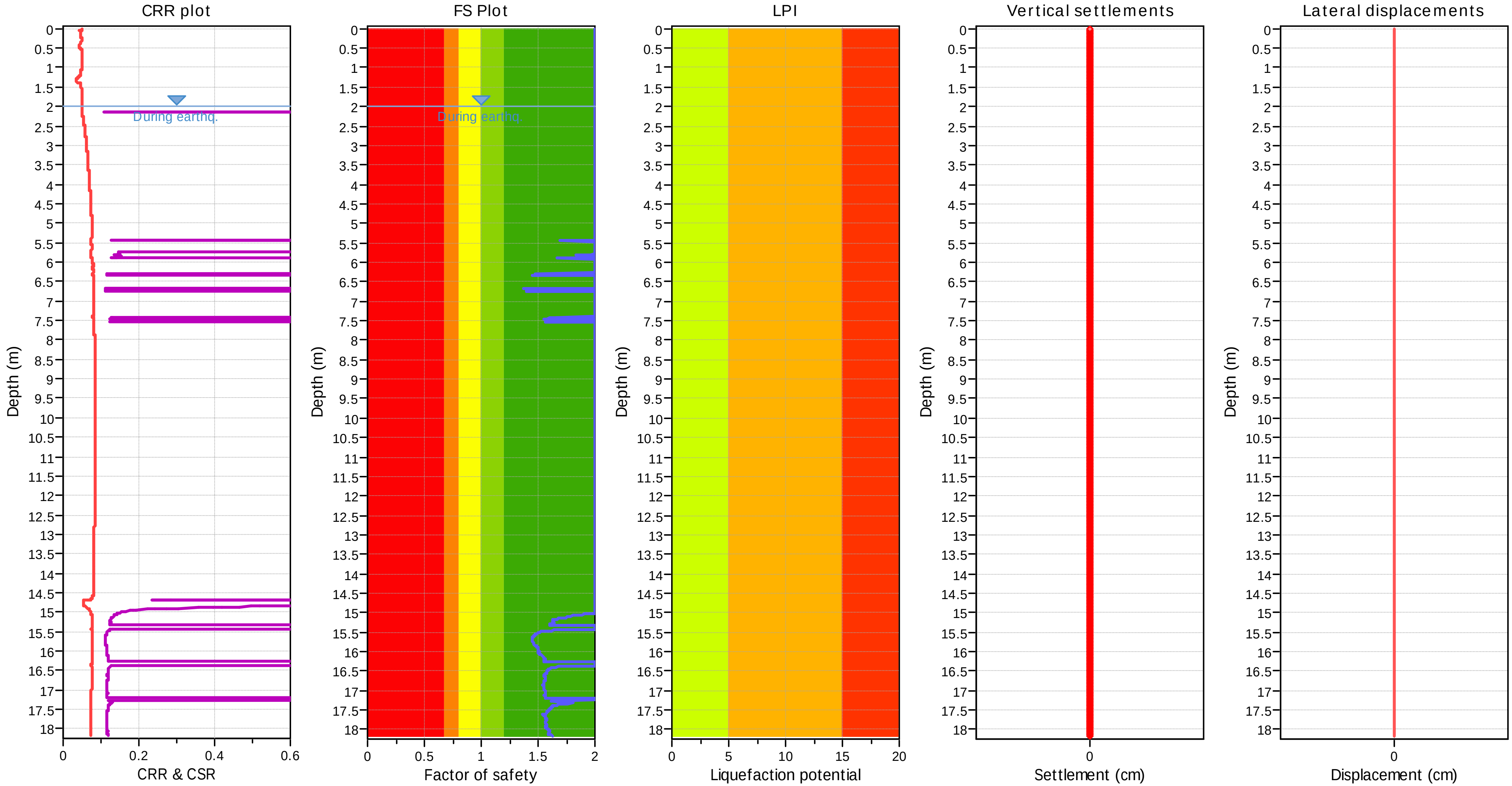

## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | Depth to GWT (erthq.): | 1.98 m | Fill weight: | N/A |
| Fines correction method: | B&I (2014) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.20 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.09 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.98 m | Fill height: | N/A | Limit depth: | N/A |

### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | Depth to GWT (erthq.): | 1.98 m | Fill weight: | N/A |
| Fines correction method: | B&I (2014) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.20 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.09 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.98 m | Fill height: | N/A | Limit depth: | N/A |

**F.S. color scheme**

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

**LPI color scheme**

- Very high risk
- High risk
- Low risk

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Opus House, 6 Ossian Street
Ahuriri
Napier 4110

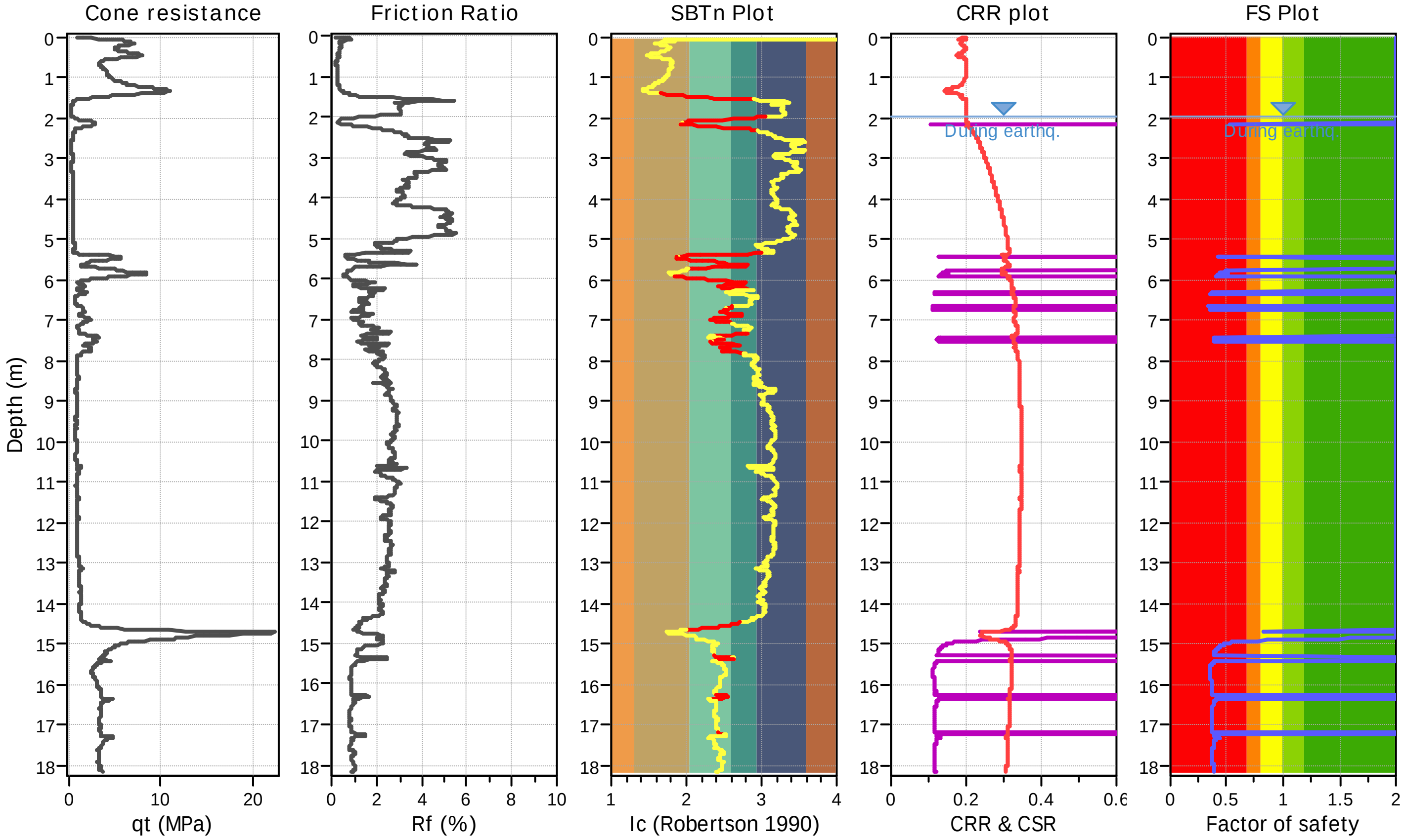
## LIQUEFACTION ANALYSIS REPORT

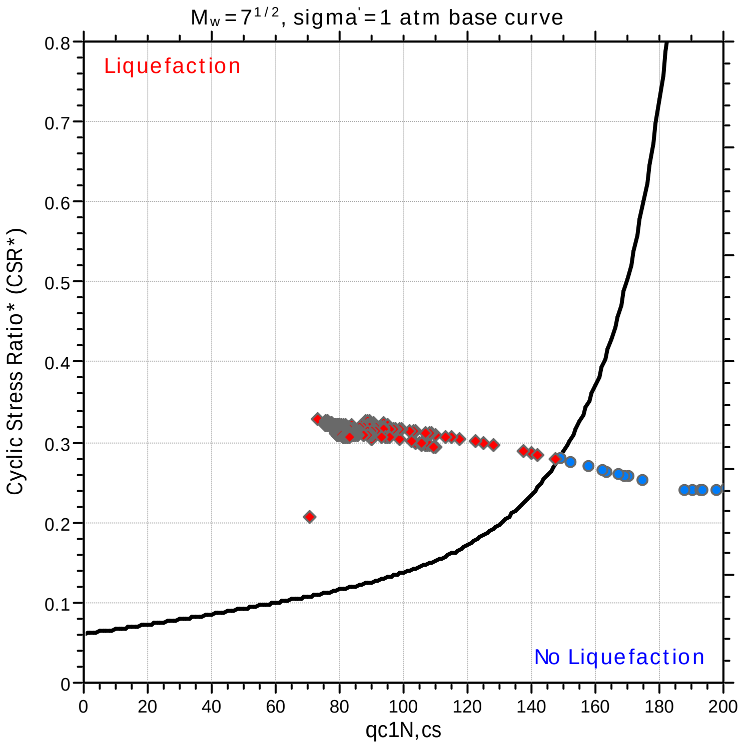
Project title : Liquefaction Assessment | Location : Wairoa Aerodrome

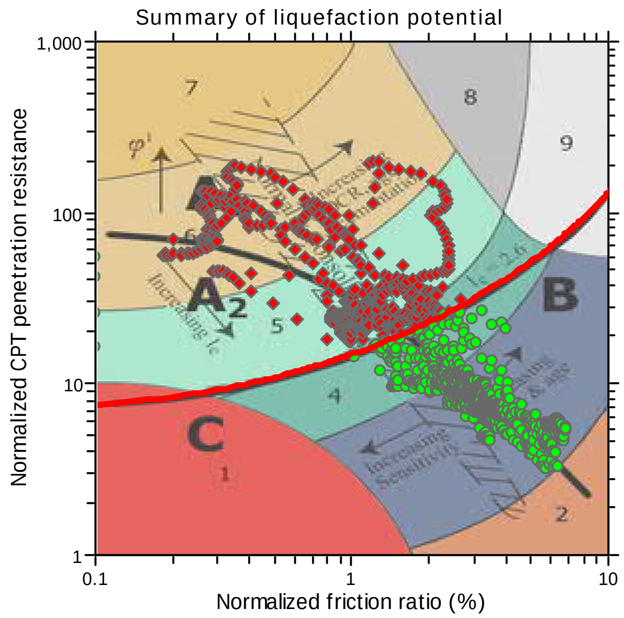
CPT file : CPT-2_ULS-L2_6.4M_0.36g

### Input parameters and analysis data

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | G.W.T. (in-situ): | 1.98 m | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | B&I (2014) | G.W.T. (earthq.): | 1.98 m | Fill height: | N/A | Limit depth applied: | No |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | N/A |
| Earthquake magnitude $M_w$: | 6.40 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method |
| Peak ground acceleration: | 0.36 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

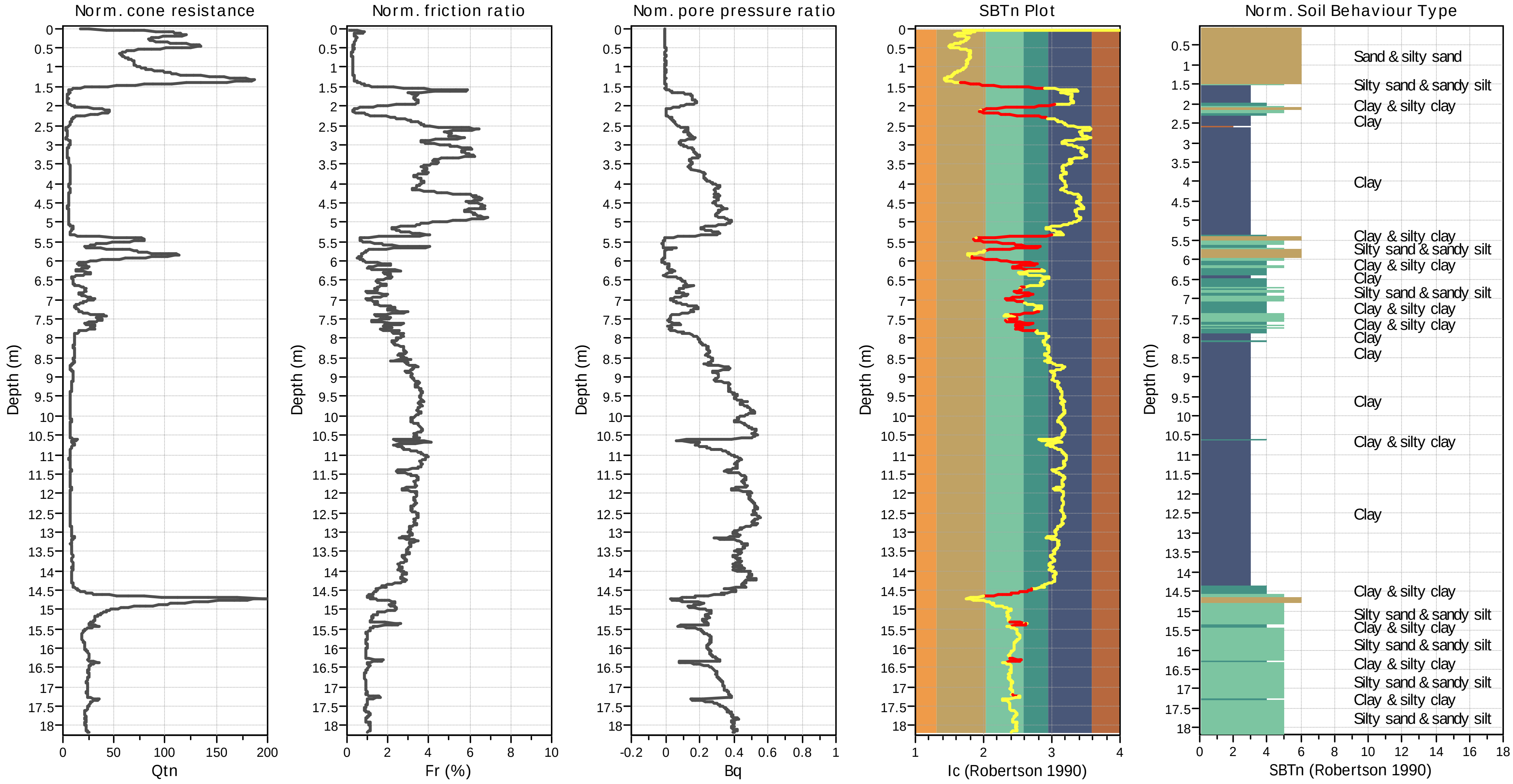



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

# CPT basic interpretation plots (normalized)



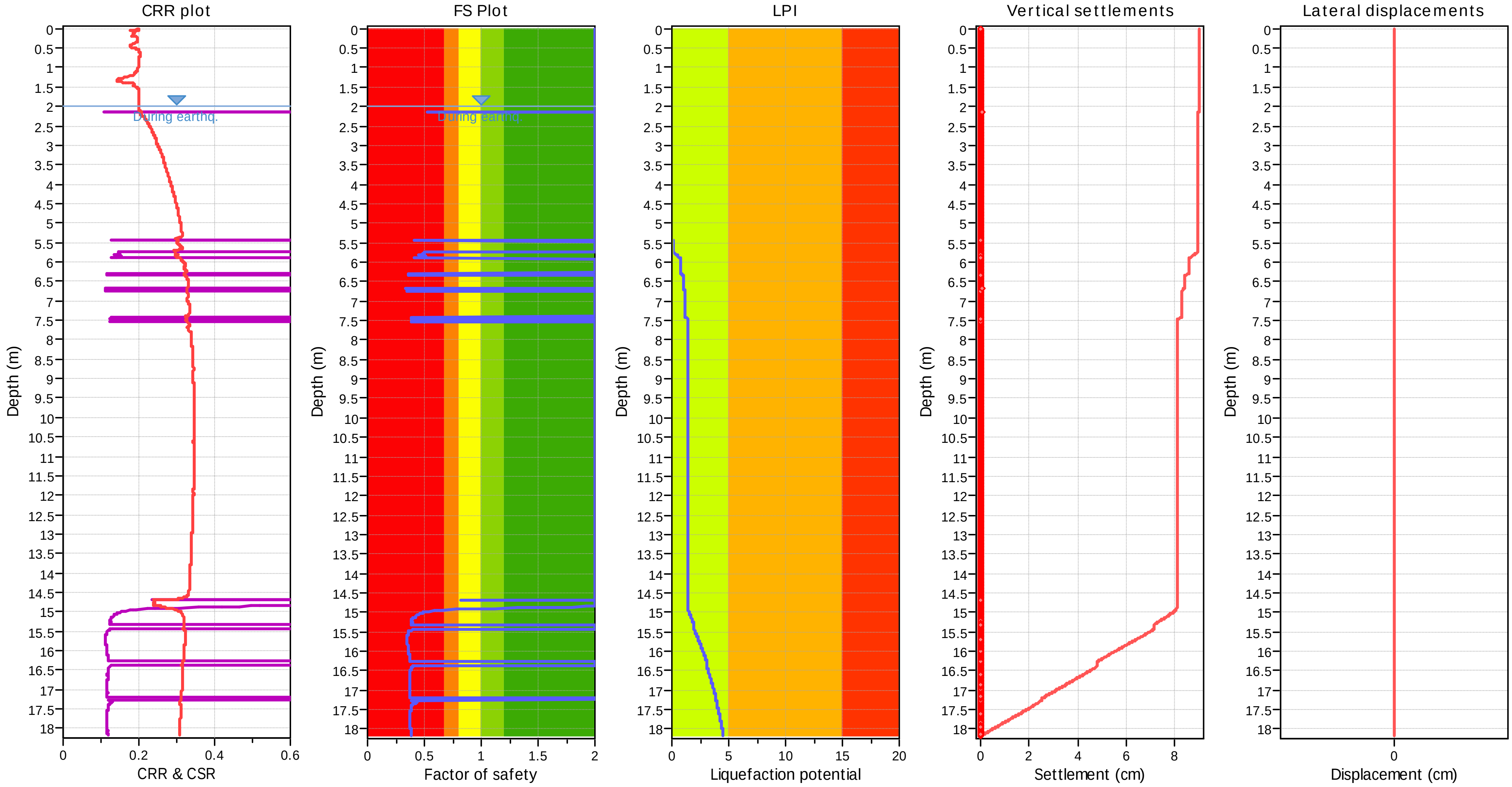

## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | Depth to GWT (erthq.): | 1.98 m | Fill weight: | N/A |
| Fines correction method: | B&I (2014) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.40 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.36 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.98 m | Fill height: | N/A | Limit depth: | N/A |

**SBTn legend**

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | Depth to GWT (erthq.): | 1.98 m | Fill weight: | N/A |
| Fines correction method: | B&I (2014) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.40 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.36 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.98 m | Fill height: | N/A | Limit depth: | N/A |

## F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

## LPI color scheme

- Very high risk
- High risk
- Low risk

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# LIQUEFACTION ANALYSIS REPORT

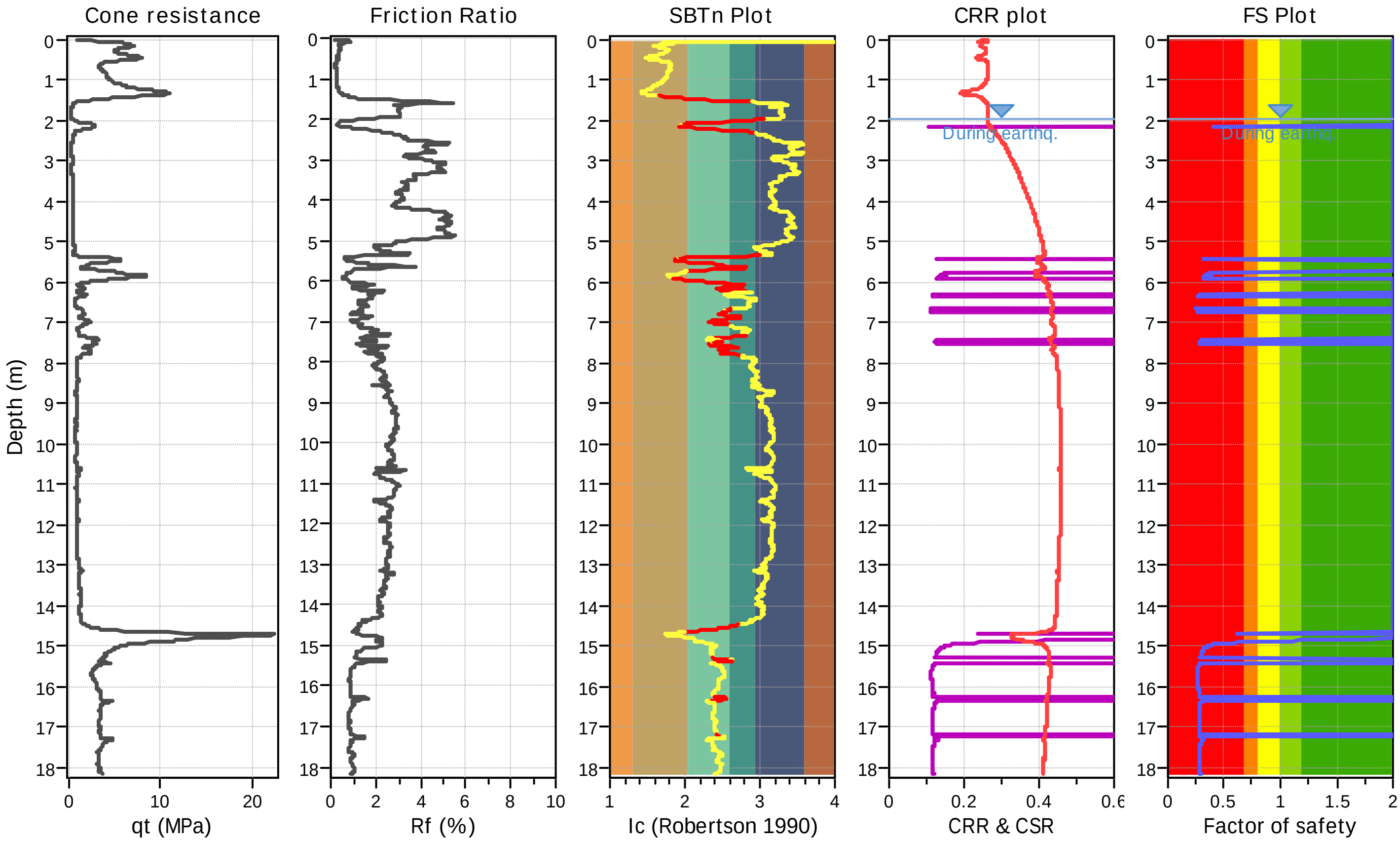
Project title : Liquefaction Assessment

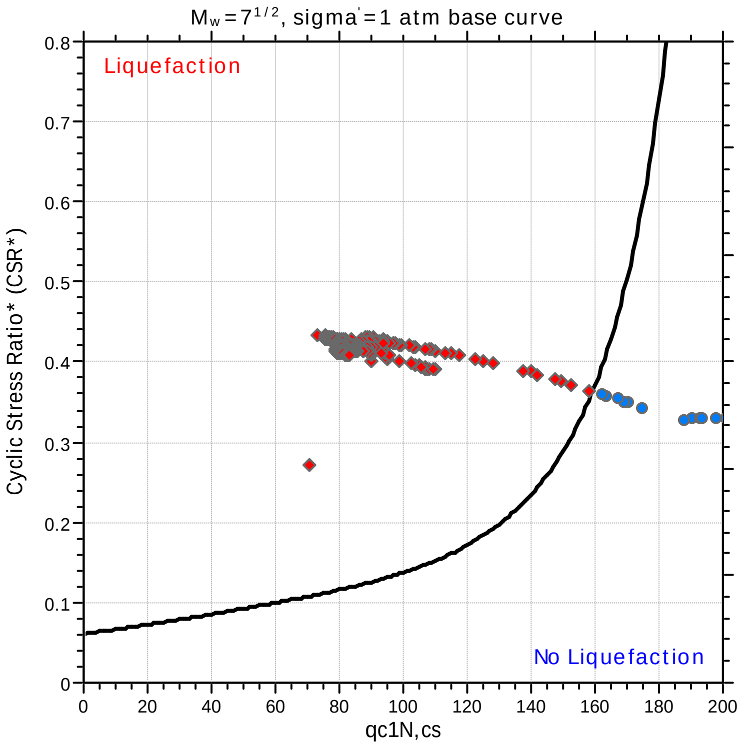
Location : Wairoa Aerodrome

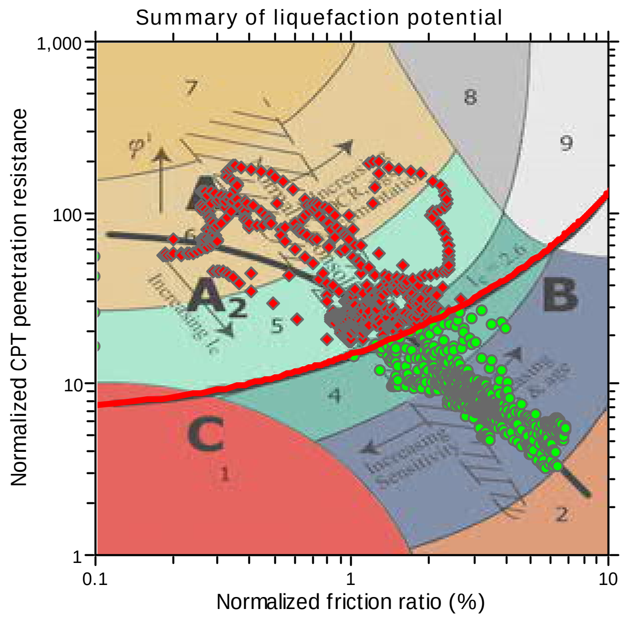
CPT file : CPT-2_ULS-L3_6.5M_0.47g

## Input parameters and analysis data

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | G.W.T. (in-situ): | 1.98 m | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | B&I (2014) | G.W.T. (earthq.): | 1.98 m | Fill height: | N/A | Limit depth applied: | No |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | N/A |
| Earthquake magnitude $M_w$: | 6.50 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method |
| Peak ground acceleration: | 0.47 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

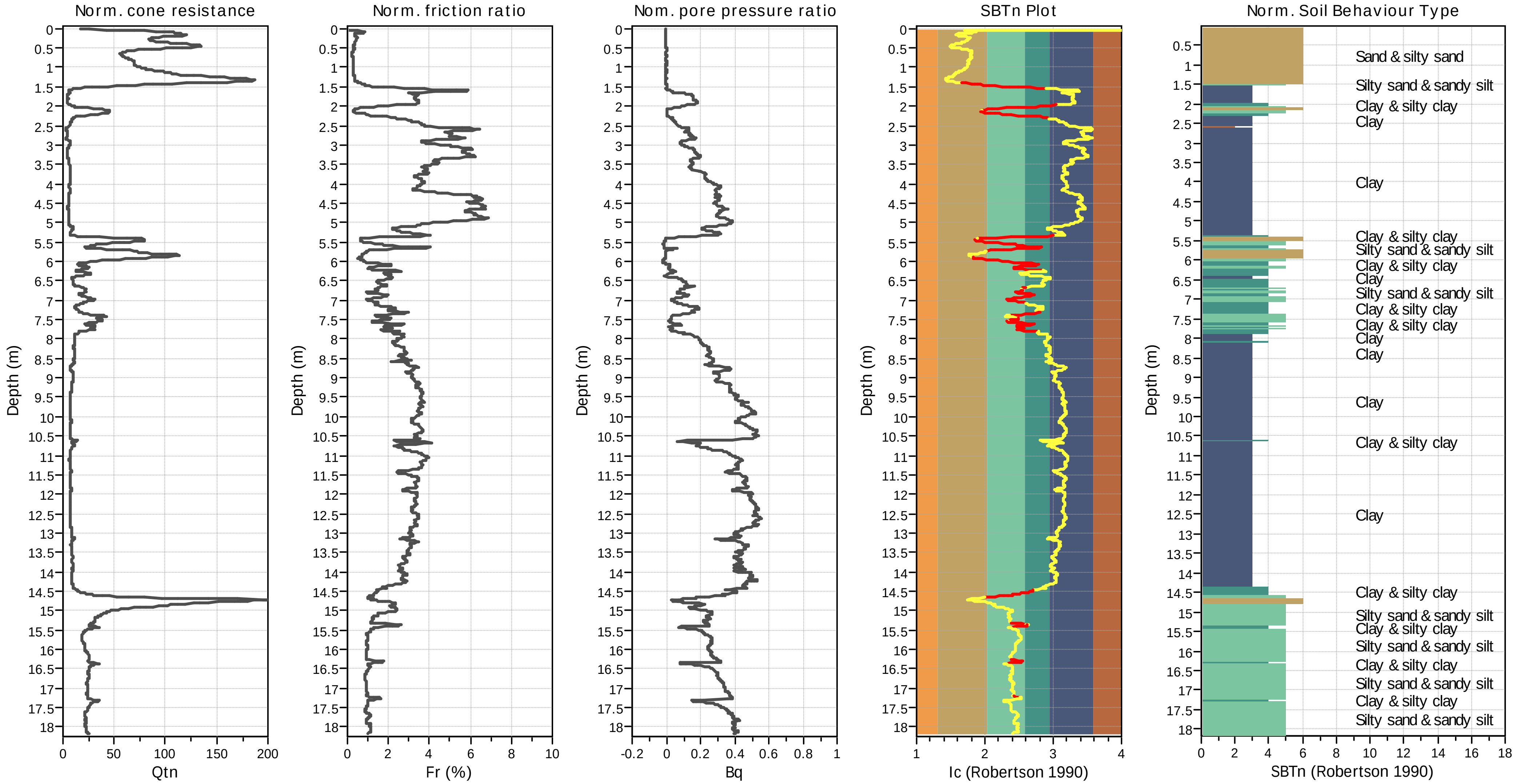



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

## CPT basic interpretation plots (normalized)



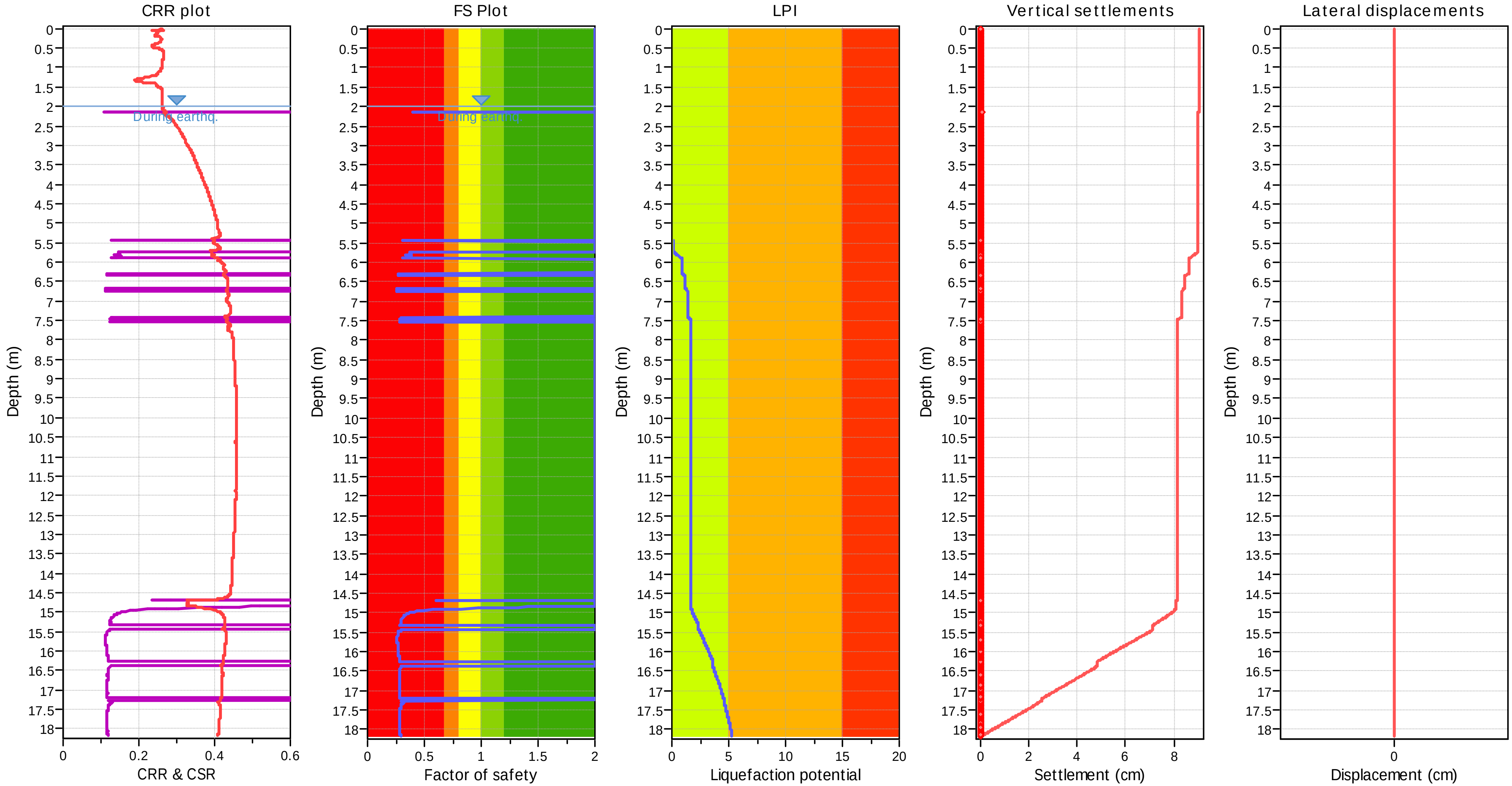

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | Depth to GWT (erthq.): | 1.98 m | Fill weight: | N/A |
| Fines correction method: | B&I (2014) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.47 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.98 m | Fill height: | N/A | Limit depth: | N/A |

### SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

## Liquefaction analysis overall plots




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | Depth to GWT (erthq.): | 1.98 m | Fill weight: | N/A |
| Fines correction method: | B&I (2014) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.47 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.98 m | Fill height: | N/A | Limit depth: | N/A |

### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

### LPI color scheme

- Very high risk
- High risk
- Low risk

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# LIQUEFACTION ANALYSIS REPORT

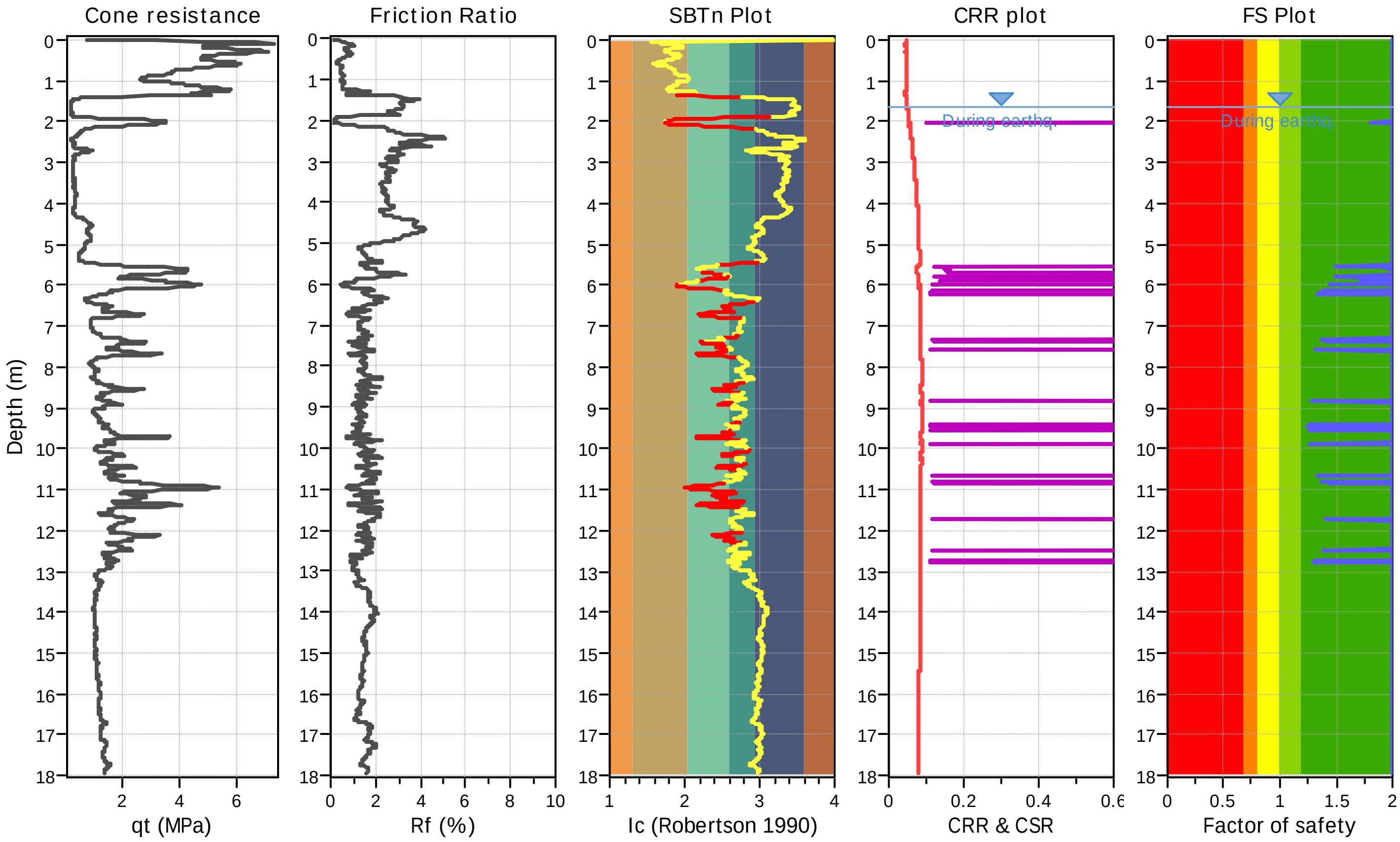
Project title : Liquefaction Analysis

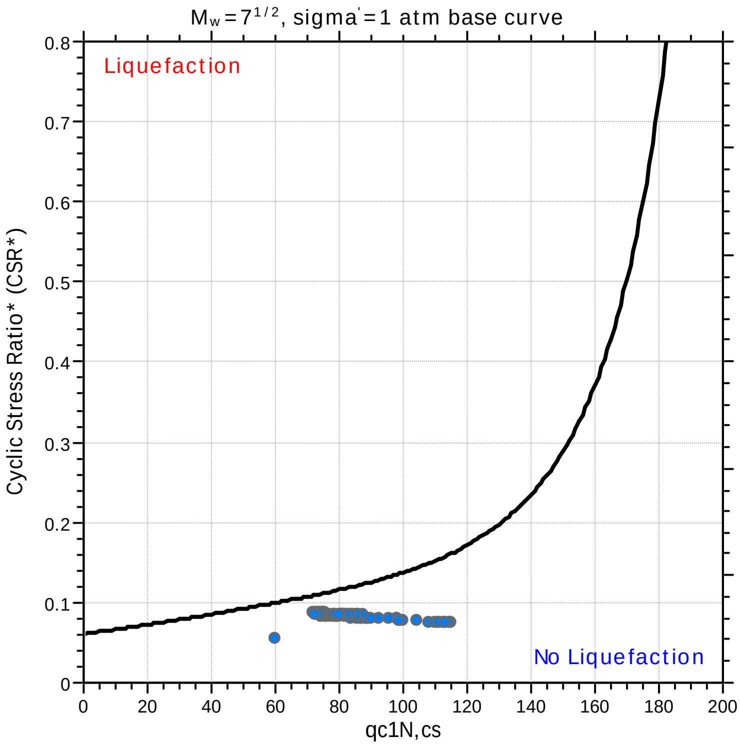
Location : Wairoa Aerodrome

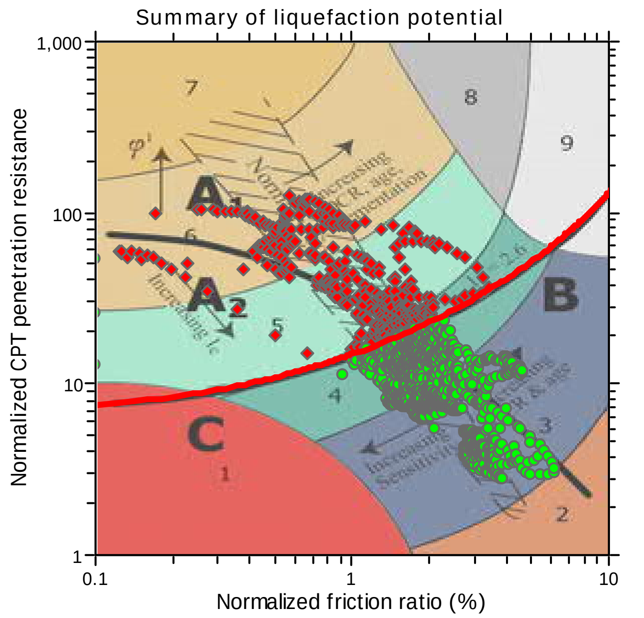
CPT file : CPT-3_SLS_6.2M_0.09g

## Input parameters and analysis data

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | G.W.T. (in-situ): | 1.66 m | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | B&I (2014) | G.W.T. (earthq.): | 1.66 m | Fill height: | N/A | Limit depth applied: | No |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | N/A |
| Earthquake magnitude $M_w$: | 6.20 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method |
| Peak ground acceleration: | 0.09 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

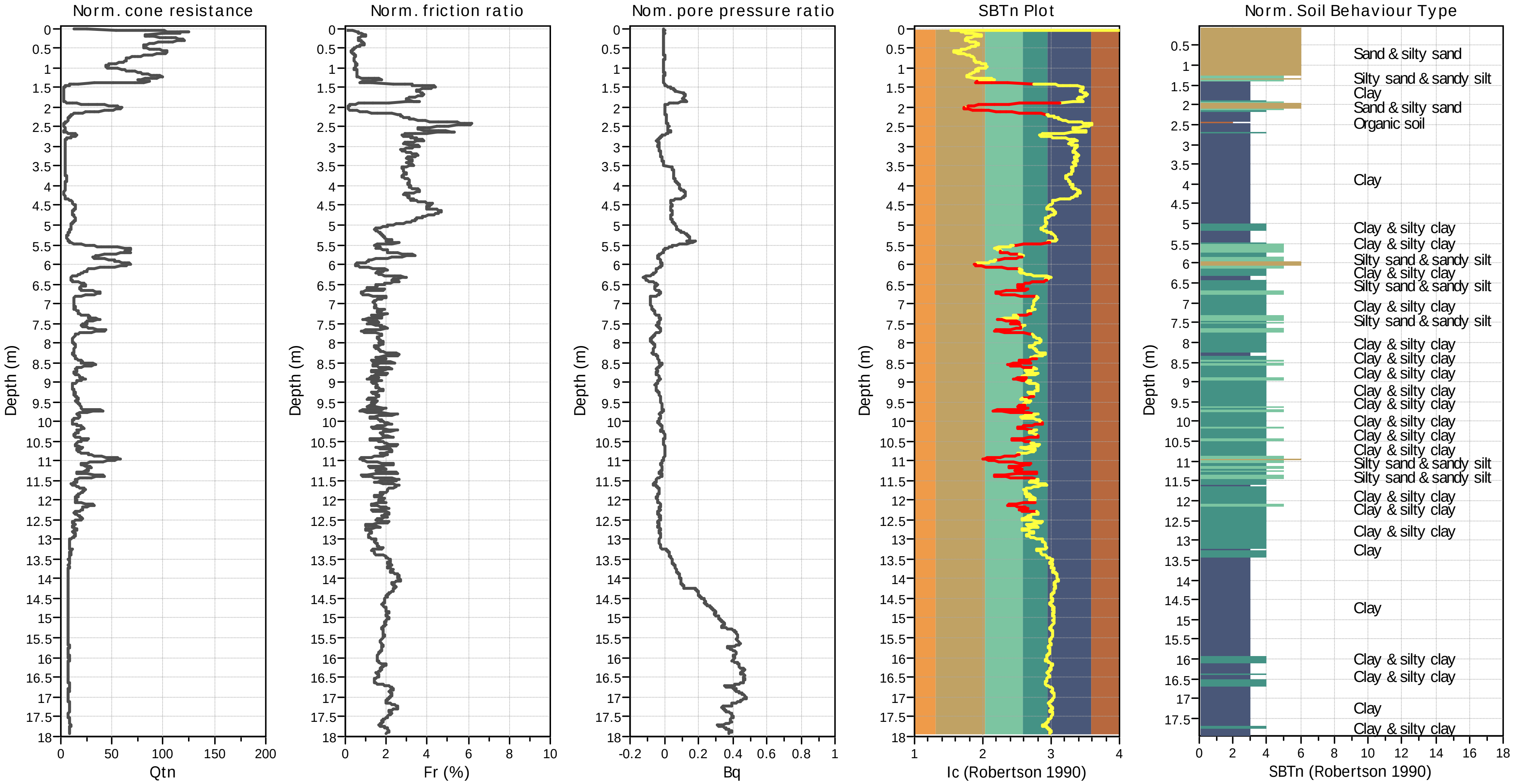



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

## CPT basic interpretation plots (normalized)



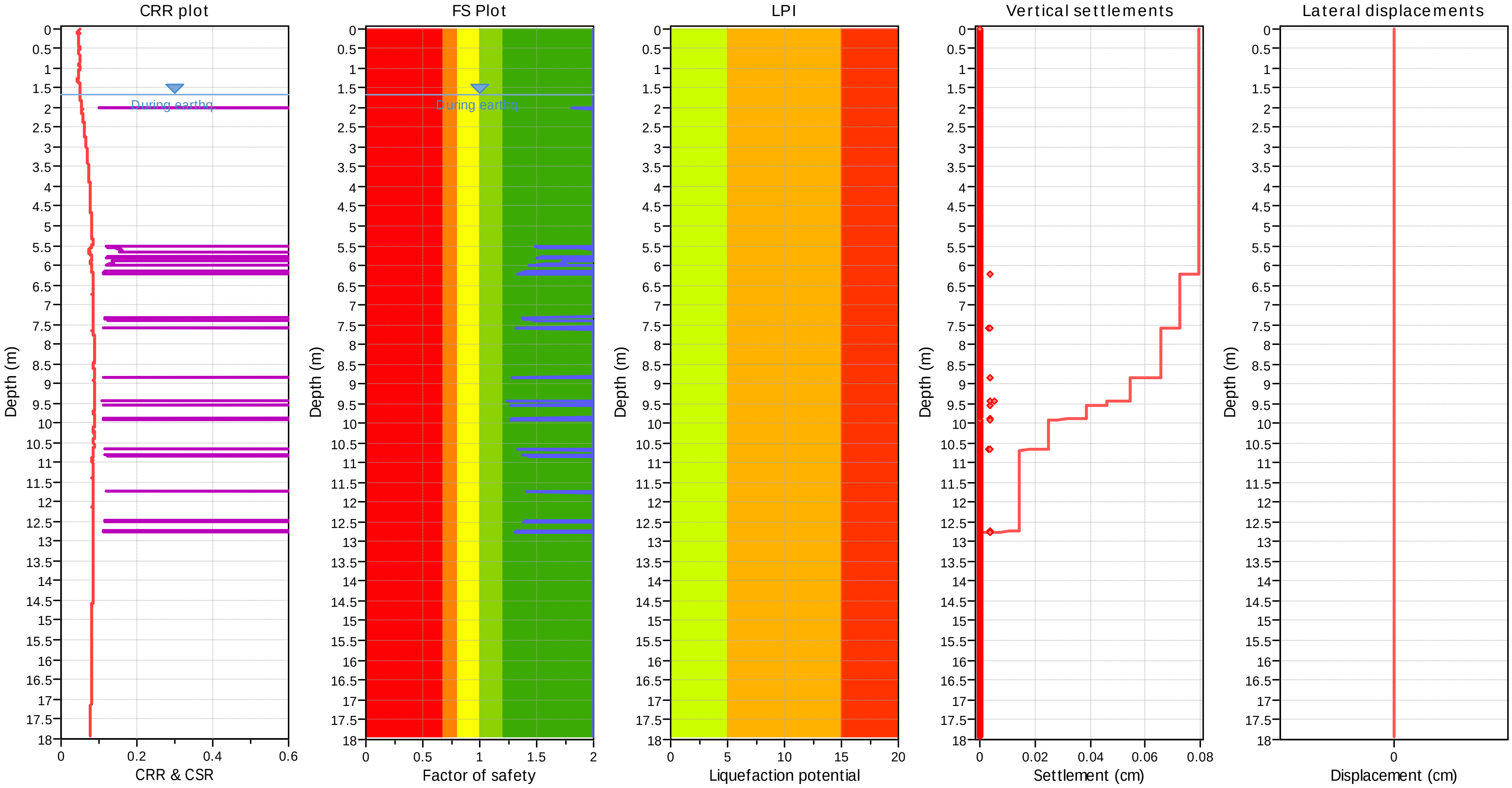

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | Depth to GWT (erthq.): | 1.66 m | Fill weight: | N/A |
| Fines correction method: | B&I (2014) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.20 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.09 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.66 m | Fill height: | N/A | Limit depth: | N/A |

### SBTn legend

| | | |
|---|---|---|
| 1. Sensitive fine grained | 4. Clayey silt to silty | 7. Gravely sand to sand |
| 2. Organic material | 5. Silty sand to sandy silt | 8. Very stiff sand to |
| 3. Clay to silty clay | 6. Clean sand to silty sand | 9. Very stiff fine grained |

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | Depth to GWT (erthq.): | 1.66 m | Fill weight: | N/A |
| Fines correction method: | B&I (2014) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.20 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.09 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.66 m | Fill height: | N/A | Limit depth: | N/A |

### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

### LPI color scheme

- Very high risk
- High risk
- Low risk

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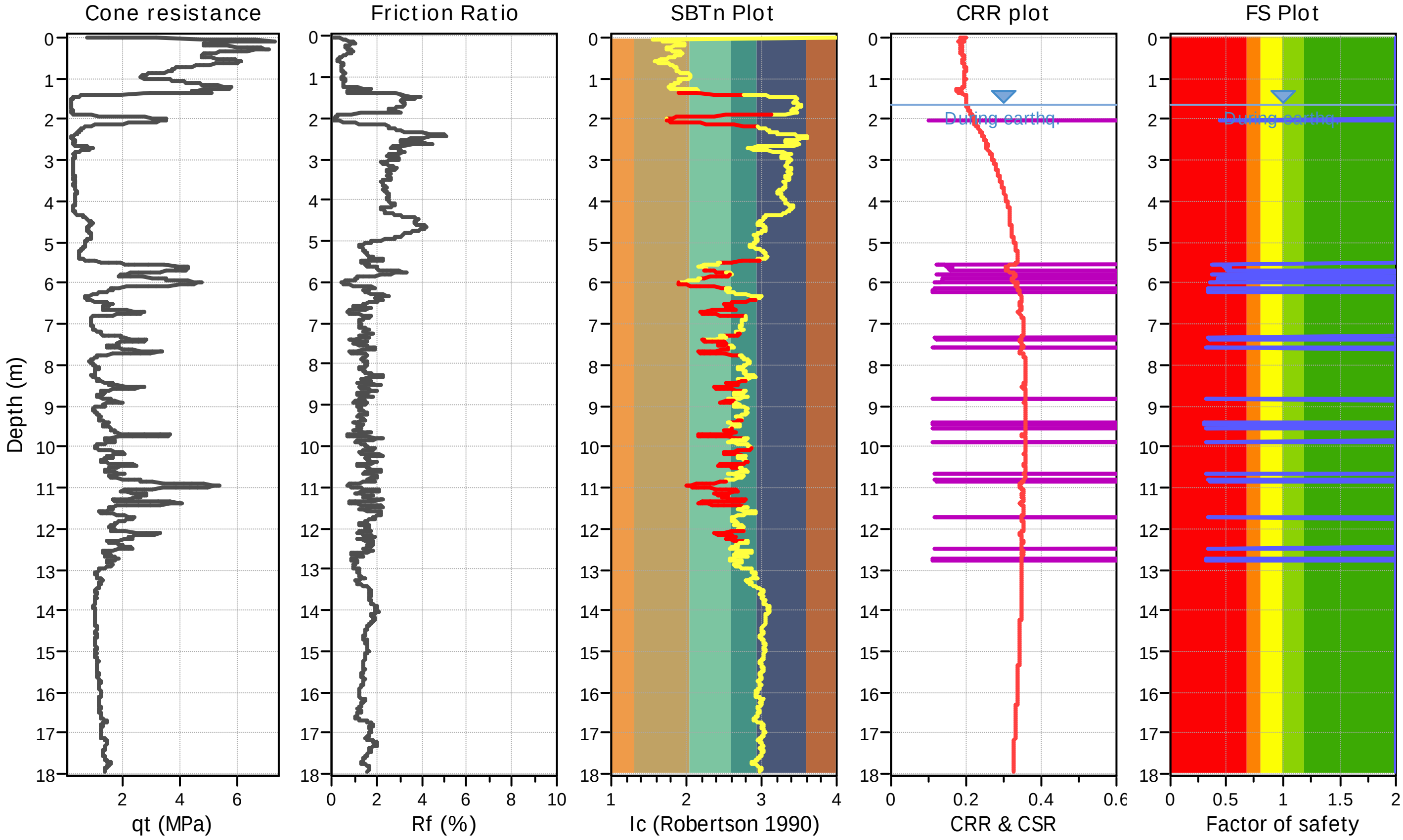
# LIQUEFACTION ANALYSIS REPORT

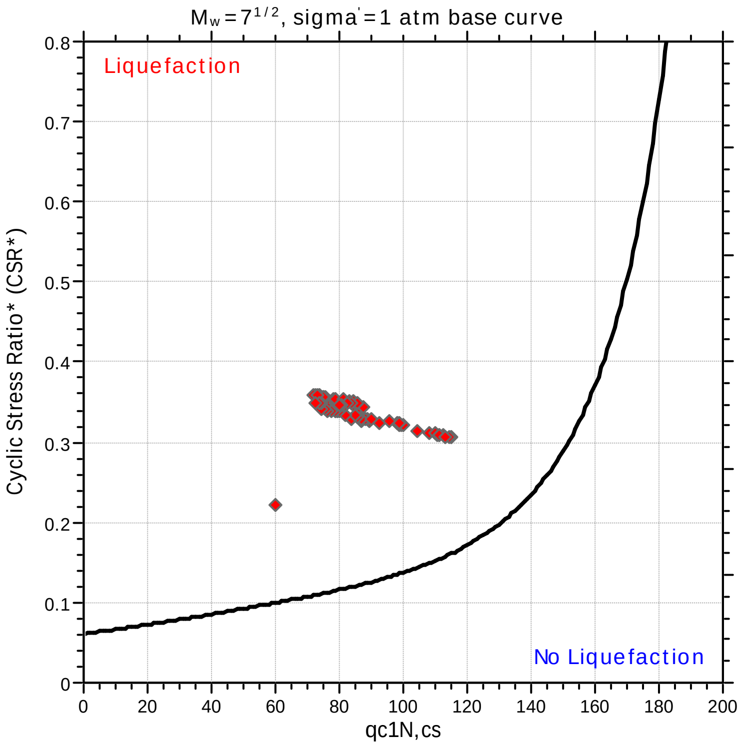
Project title : Liquefaction Analysis                Location : Wairoa Aerodrome

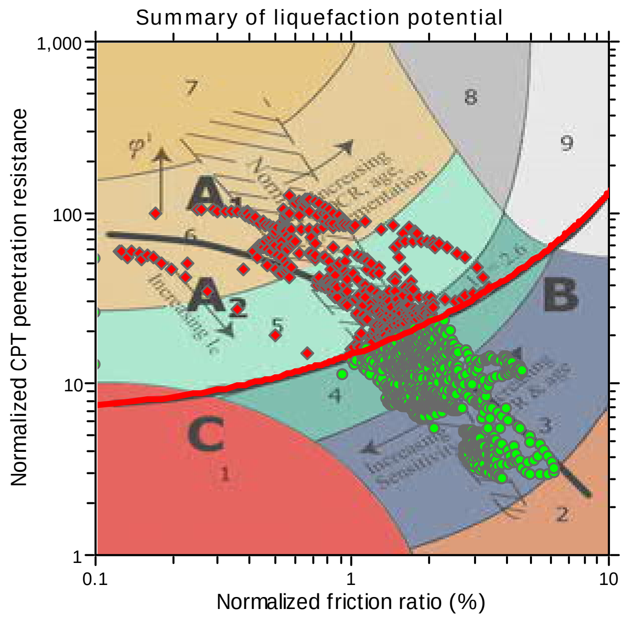
CPT file : CPT-3_ULS-L2_6.4M_0.36g

## Input parameters and analysis data

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | G.W.T. (in-situ): | 1.66 m | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | B&I (2014) | G.W.T. (earthq.): | 1.66 m | Fill height: | N/A | Limit depth applied: | No |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | N/A |
| Earthquake magnitude $M_w$: | 6.40 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method |
| Peak ground acceleration: | 0.36 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

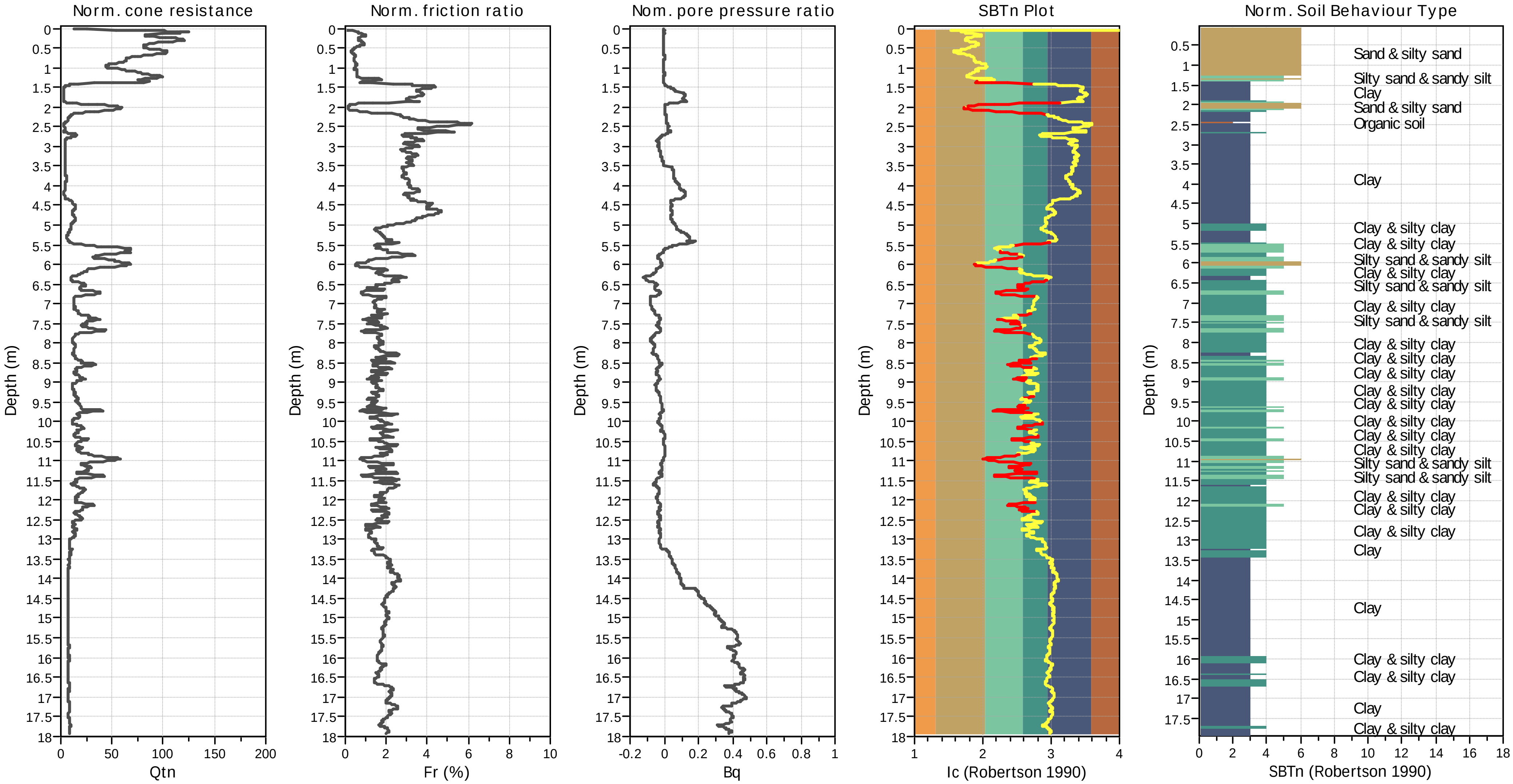



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

# CPT basic interpretation plots (normalized)



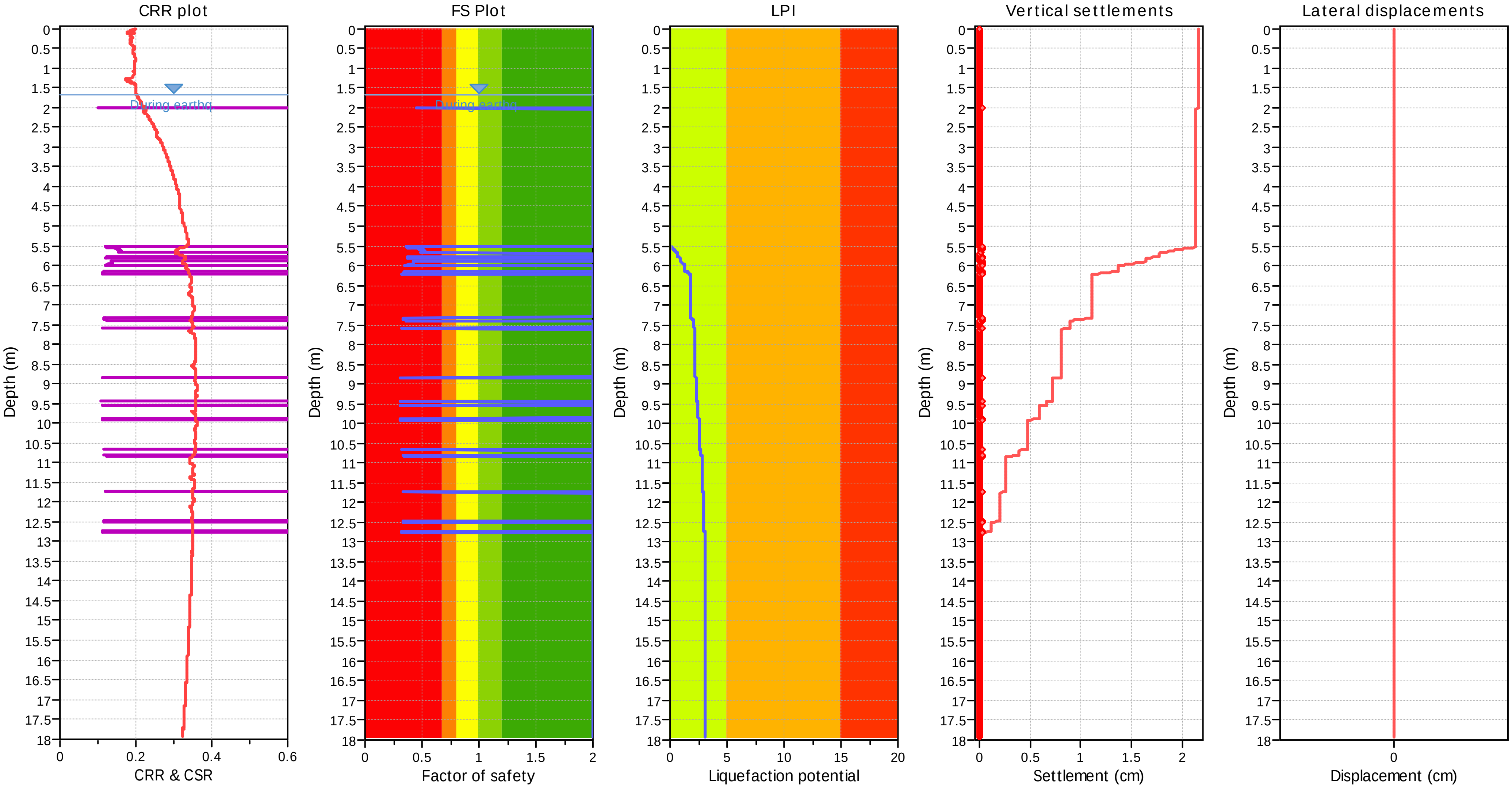

## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | Depth to GWT (erthq.): | 1.66 m | Fill weight: | N/A |
| Fines correction method: | B&I (2014) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.40 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.36 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.66 m | Fill height: | N/A | Limit depth: | N/A |

### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | Depth to GWT (erthq.): | 1.66 m | Fill weight: | N/A |
| Fines correction method: | B&I (2014) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.40 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.36 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.66 m | Fill height: | N/A | Limit depth: | N/A |

**F.S. color scheme**

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

**LPI color scheme**

- Very high risk
- High risk
- Low risk

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Napier 4110

# LIQUEFACTION ANALYSIS REPORT

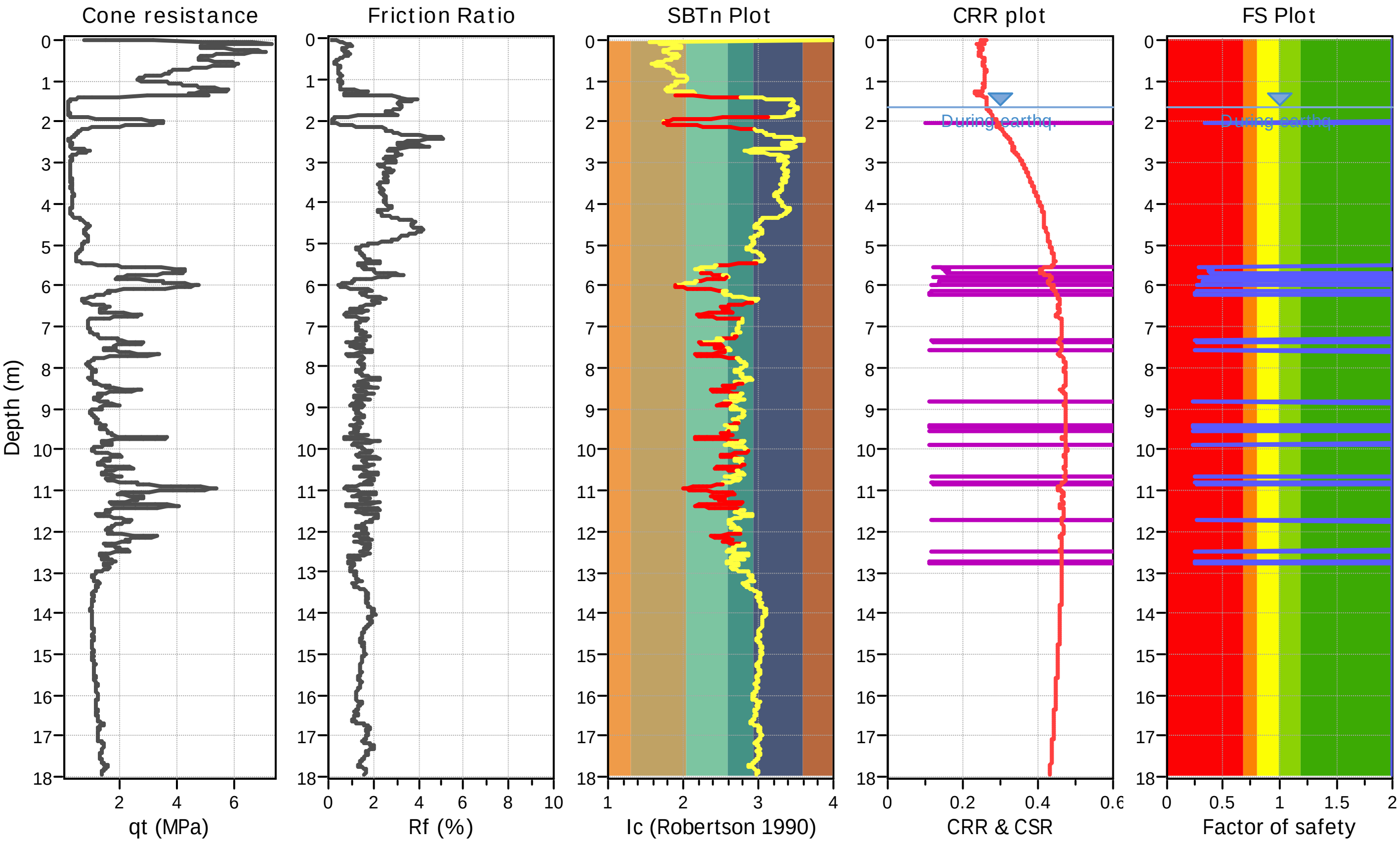
Project title : Liquefaction Analysis

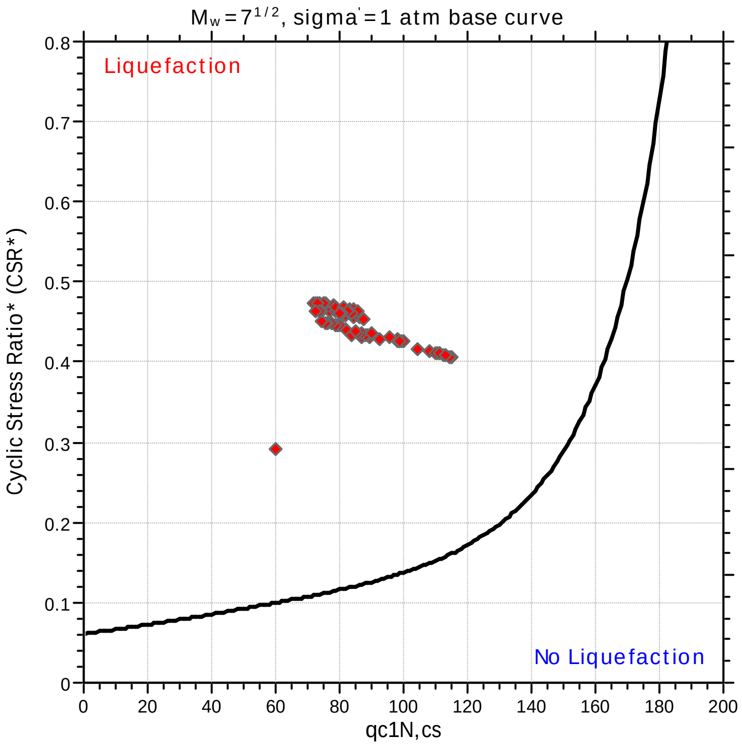
Location : Wairoa Aerodrome

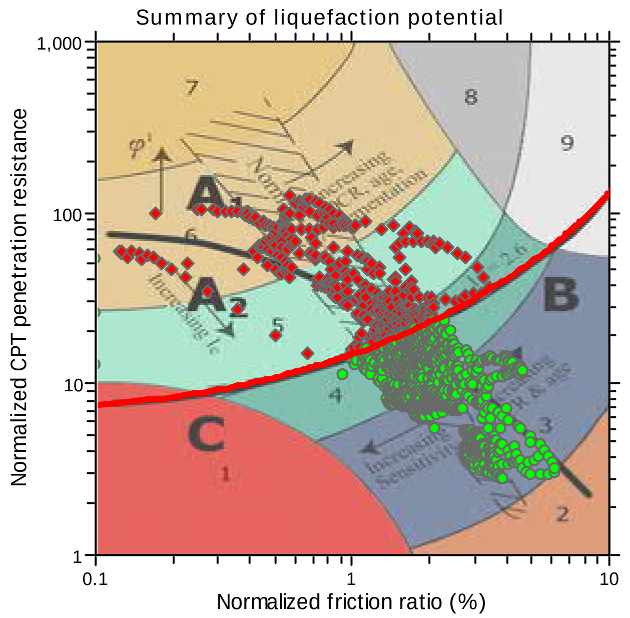
CPT file : CPT-3_ULS-L3_6.5M_0.47g

## Input parameters and analysis data

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | G.W.T. (in-situ): | 1.66 m | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | B&I (2014) | G.W.T. (earthq.): | 1.66 m | Fill height: | N/A | Limit depth applied: | No |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | N/A |
| Earthquake magnitude $M_w$: | 6.50 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method |
| Peak ground acceleration: | 0.47 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

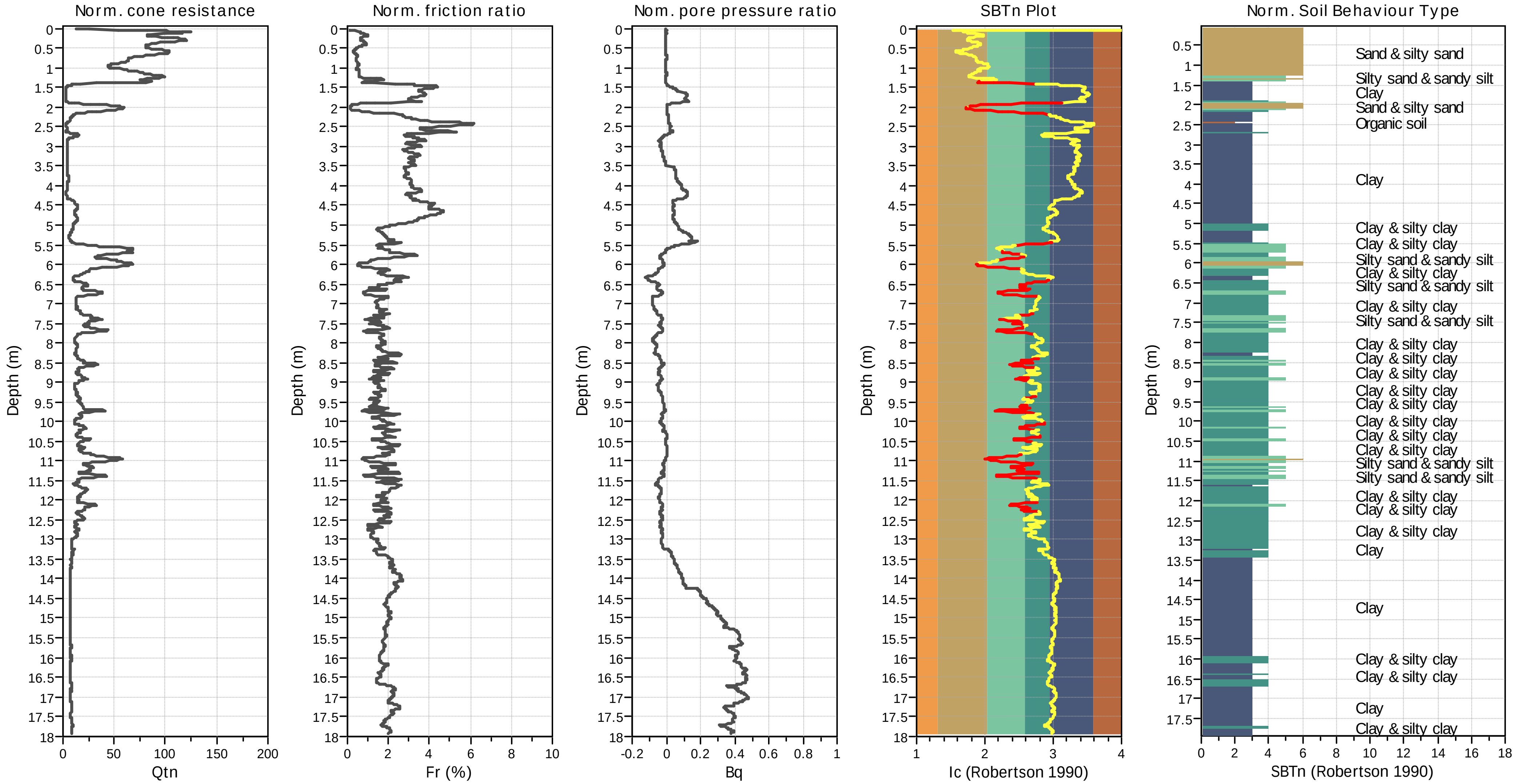



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

## CPT basic interpretation plots (normalized)



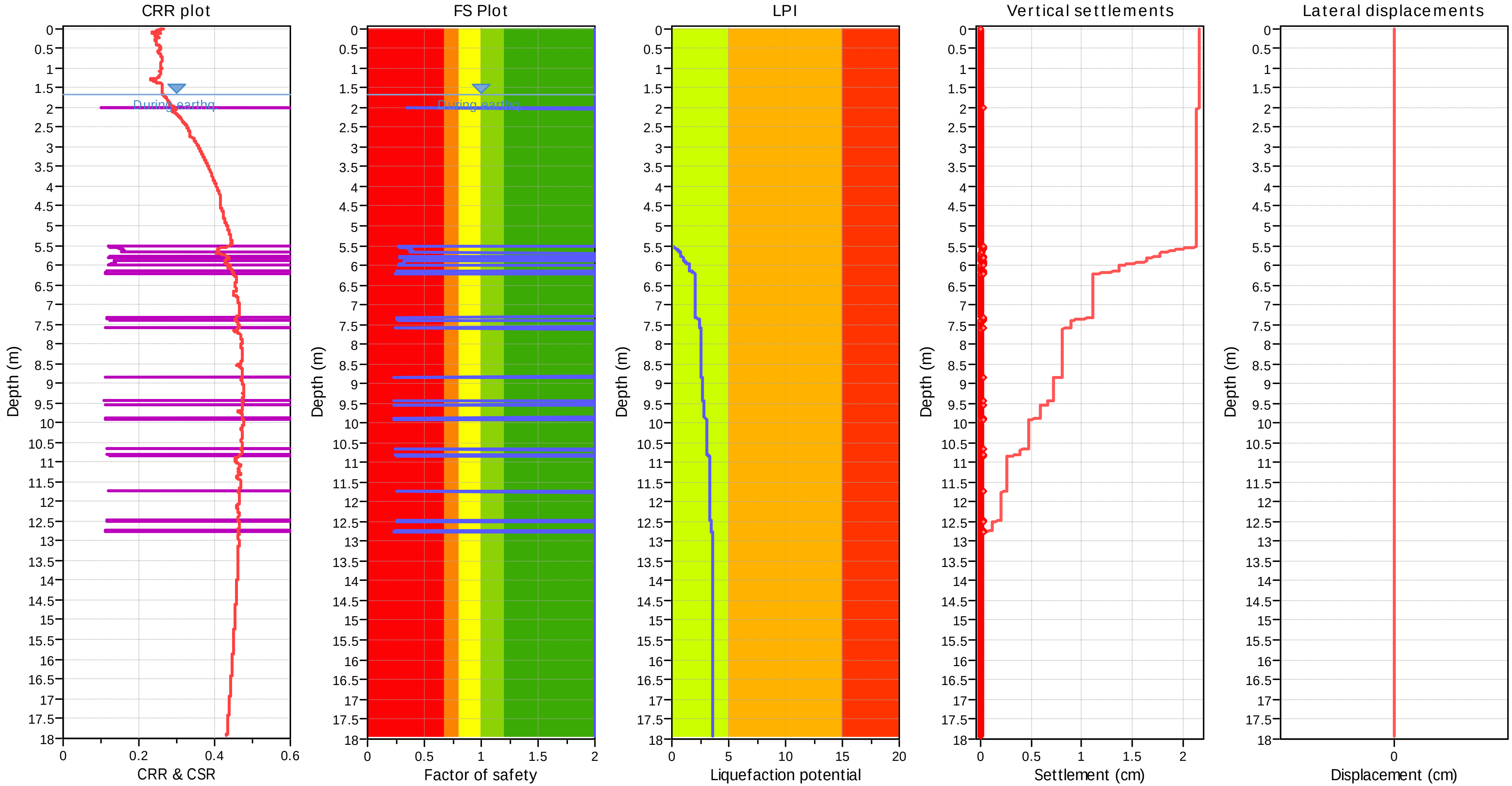

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | Depth to GWT (erthq.): | 1.66 m | Fill weight: | N/A |
| Fines correction method: | B&I (2014) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.47 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.66 m | Fill height: | N/A | Limit depth: | N/A |

### SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

## Liquefaction analysis overall plots




### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | B&I (2014) | Depth to GWT (erthq.): | 1.66 m | Fill weight: | N/A |
| Fines correction method: | B&I (2014) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.50 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.47 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.66 m | Fill height: | N/A | Limit depth: | N/A |

**F.S. color scheme**

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

**LPI color scheme**

- Very high risk
- High risk
- Low risk

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# LIQUEFACTION ANALYSIS REPORT

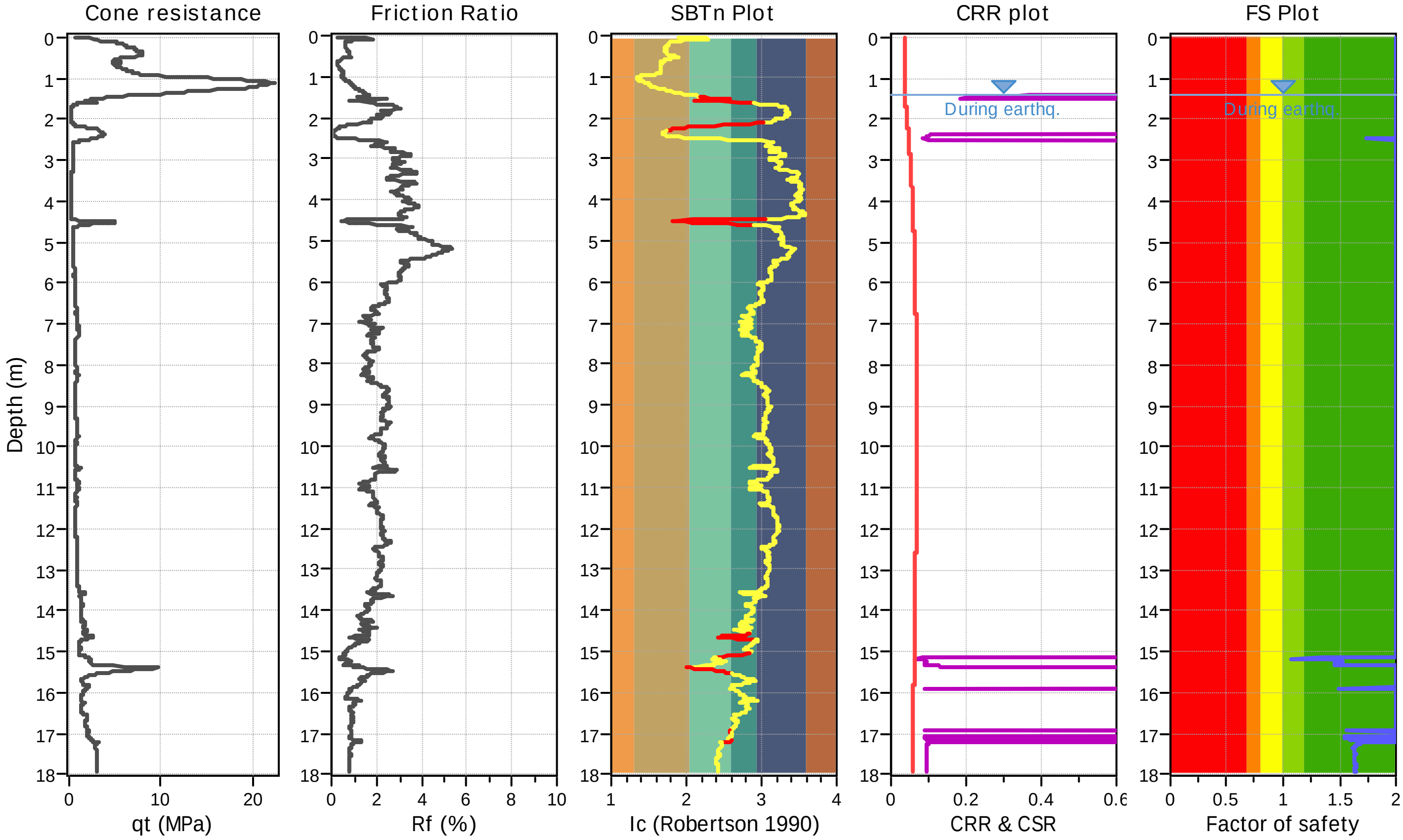
Project title : Liquefaction Analysis

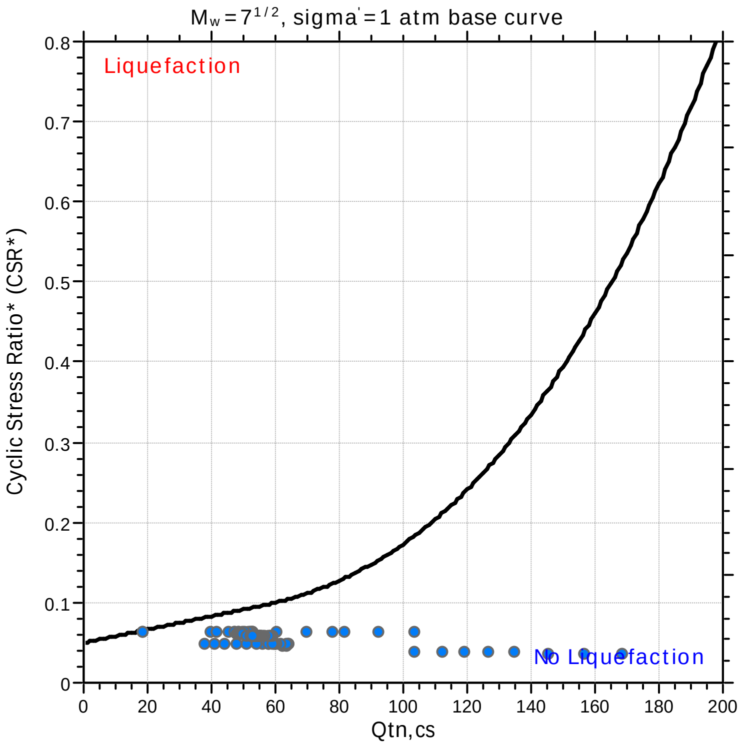
Location : Wairoa Aerodrome

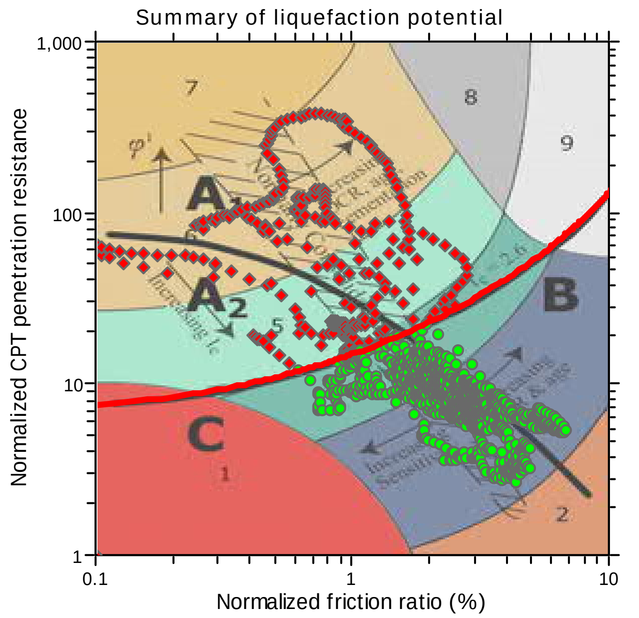
CPT file : CPT-4_SLS_6.2M_0.09g

## Input parameters and analysis data

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | G.W.T. (in-situ): | 1.40 m | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | NCEER (1998) | G.W.T. (earthq.): | 1.40 m | Fill height: | N/A | Limit depth applied: | No |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | N/A |
| Earthquake magnitude $M_w$: | 6.20 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.09 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

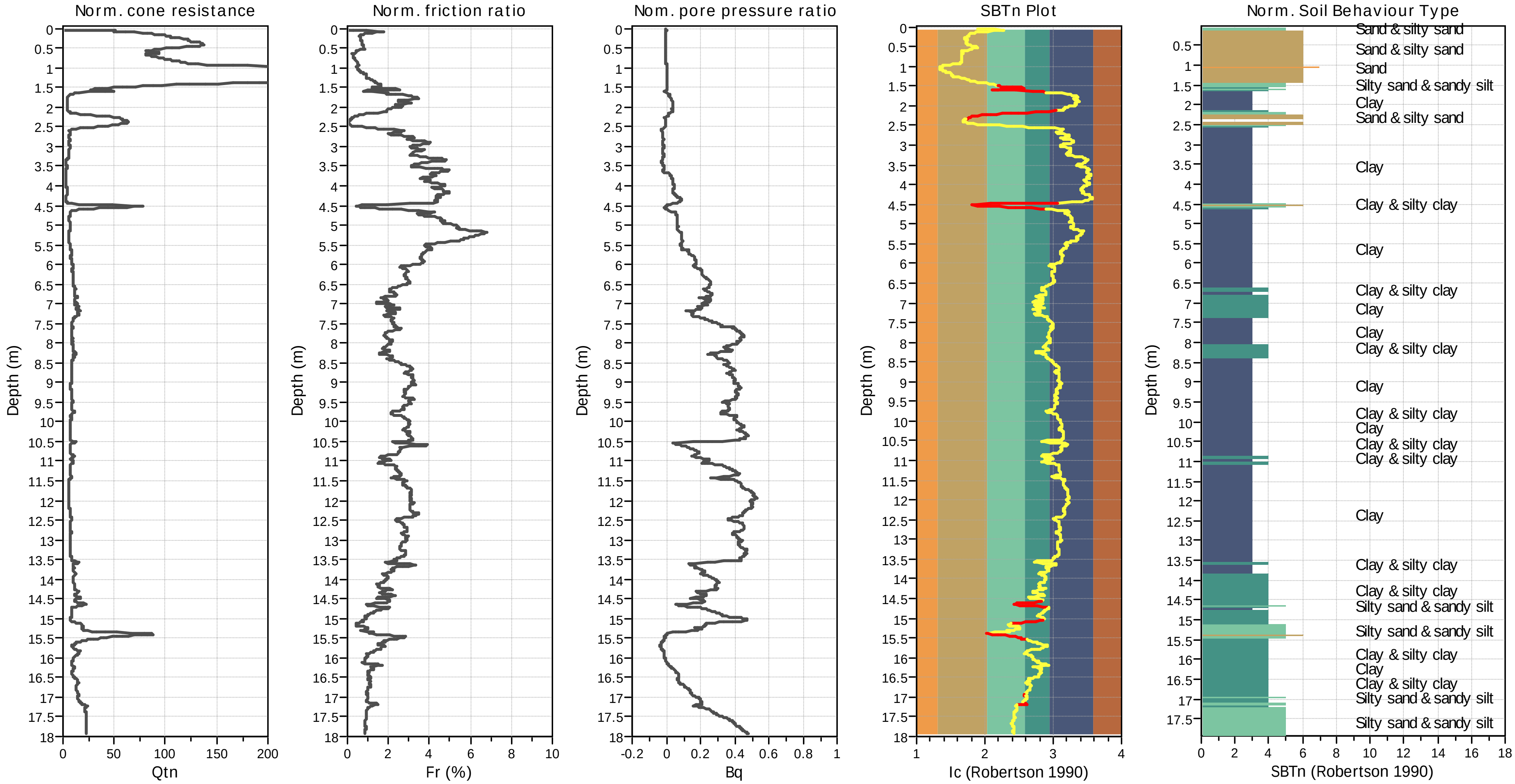



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

## CPT basic interpretation plots (normalized)



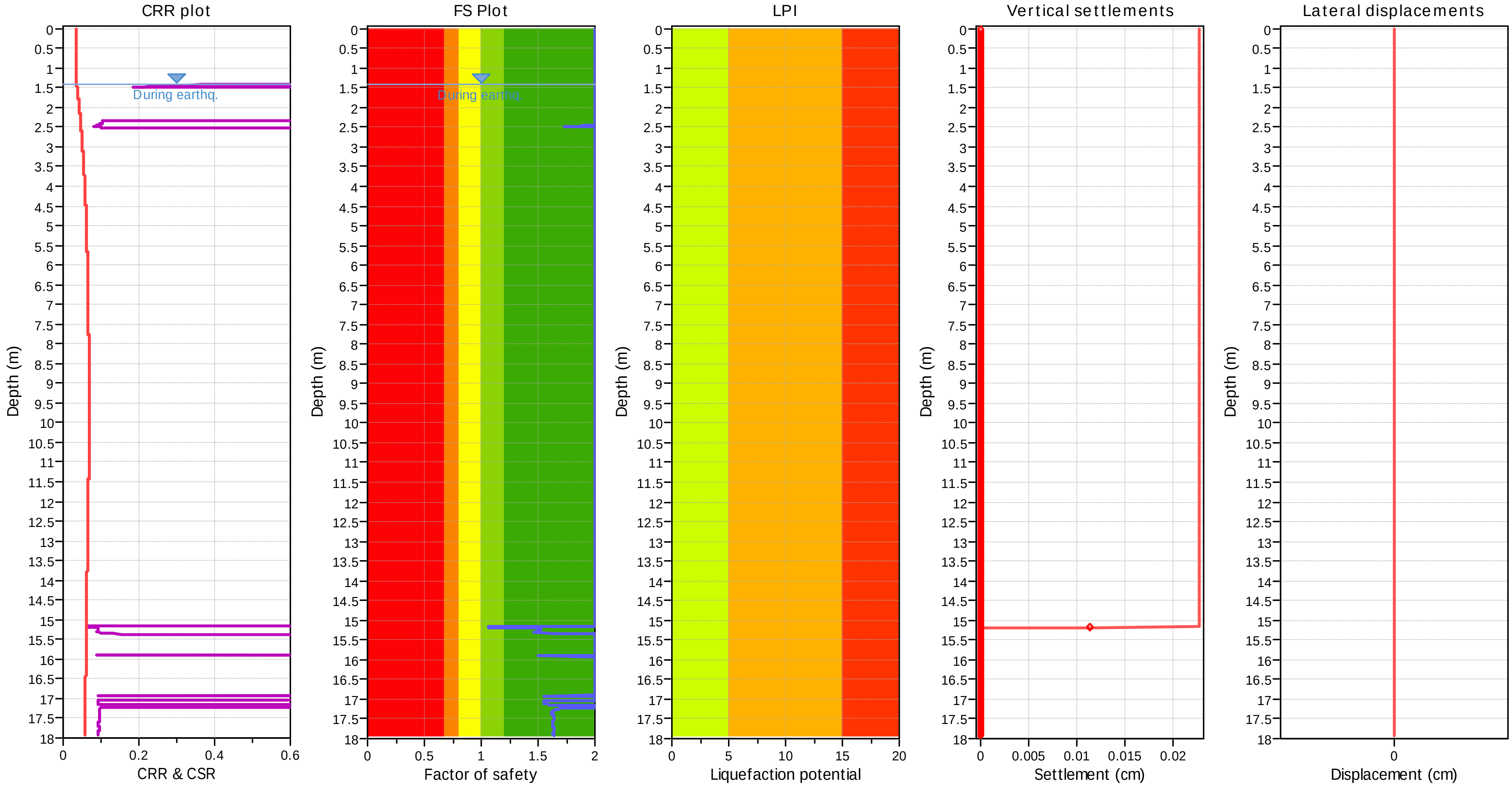

### Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 1.40 m | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.20 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.09 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.40 m | Fill height: | N/A | Limit depth: | N/A |

### SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

# Liquefaction analysis overall plots




## Input parameters and analysis data

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|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 1.40 m | Fill weight: | N/A |
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| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.20 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.09 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.40 m | Fill height: | N/A | Limit depth: | N/A |

### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

### LPI color scheme

- Very high risk
- High risk
- Low risk

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Opus House, 6 Ossian Street
Ahuriri
Napier 4110

# LIQUEFACTION ANALYSIS REPORT

Project title : Liquefaction Analysis

Location : Wairoa Aerodrome

CPT file : CPT-4_ULS-L2_6.4M_0.36g

## Input parameters and analysis data

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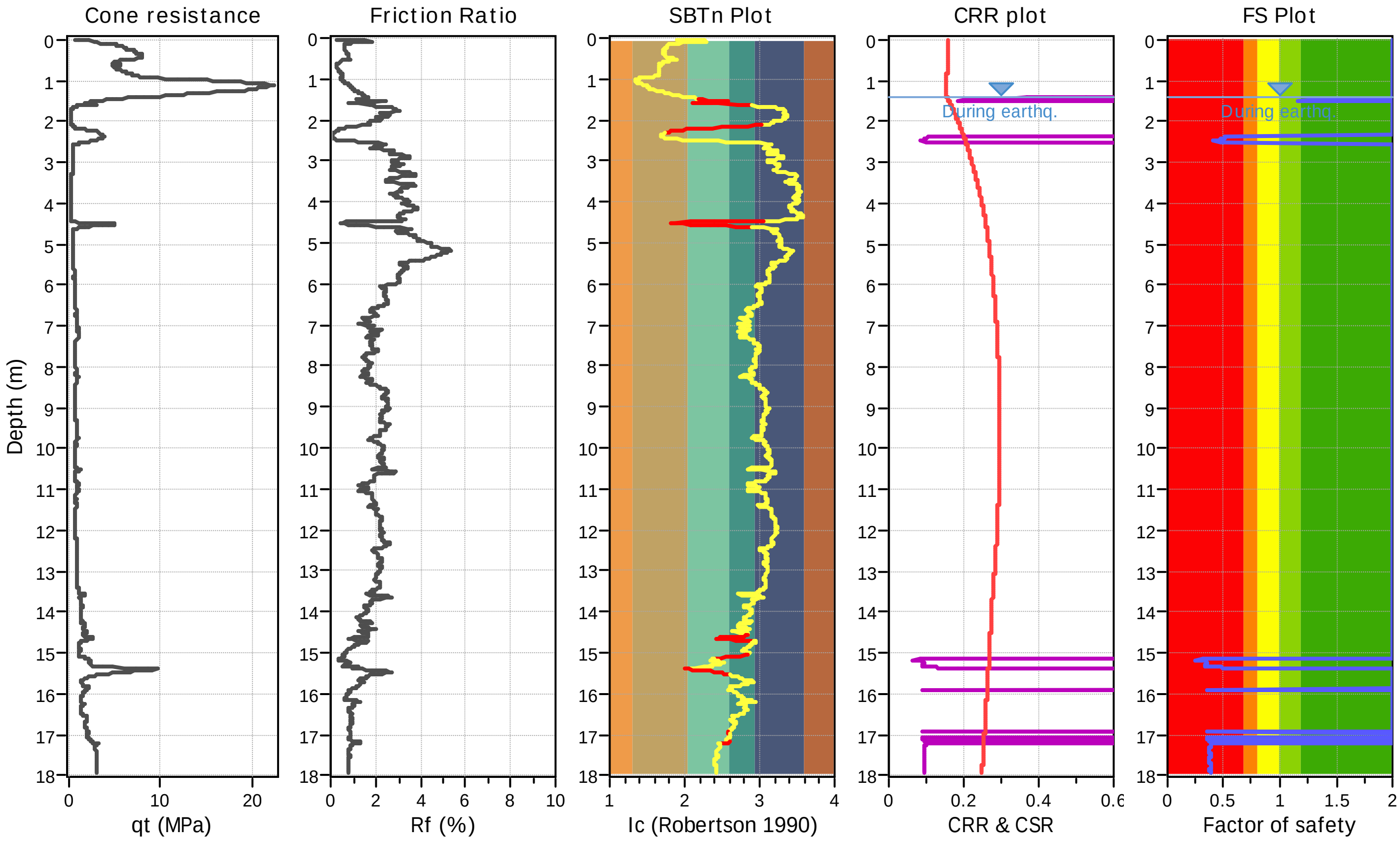
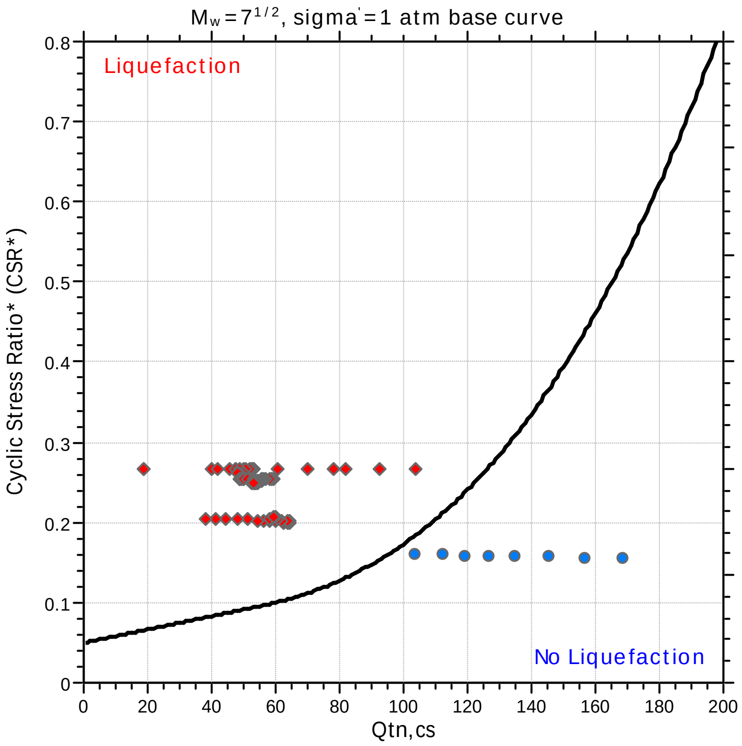
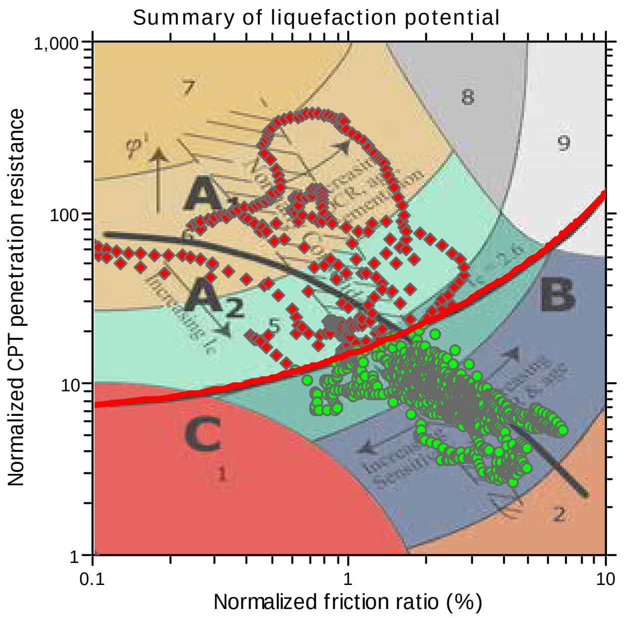
| Fines correction method: | NCEER (1998) | G.W.T. (earthq.): | 1.40 m | Fill height: | N/A | Limit depth applied: | No |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | N/A |
| Earthquake magnitude $M_w$: | 6.40 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.36 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |

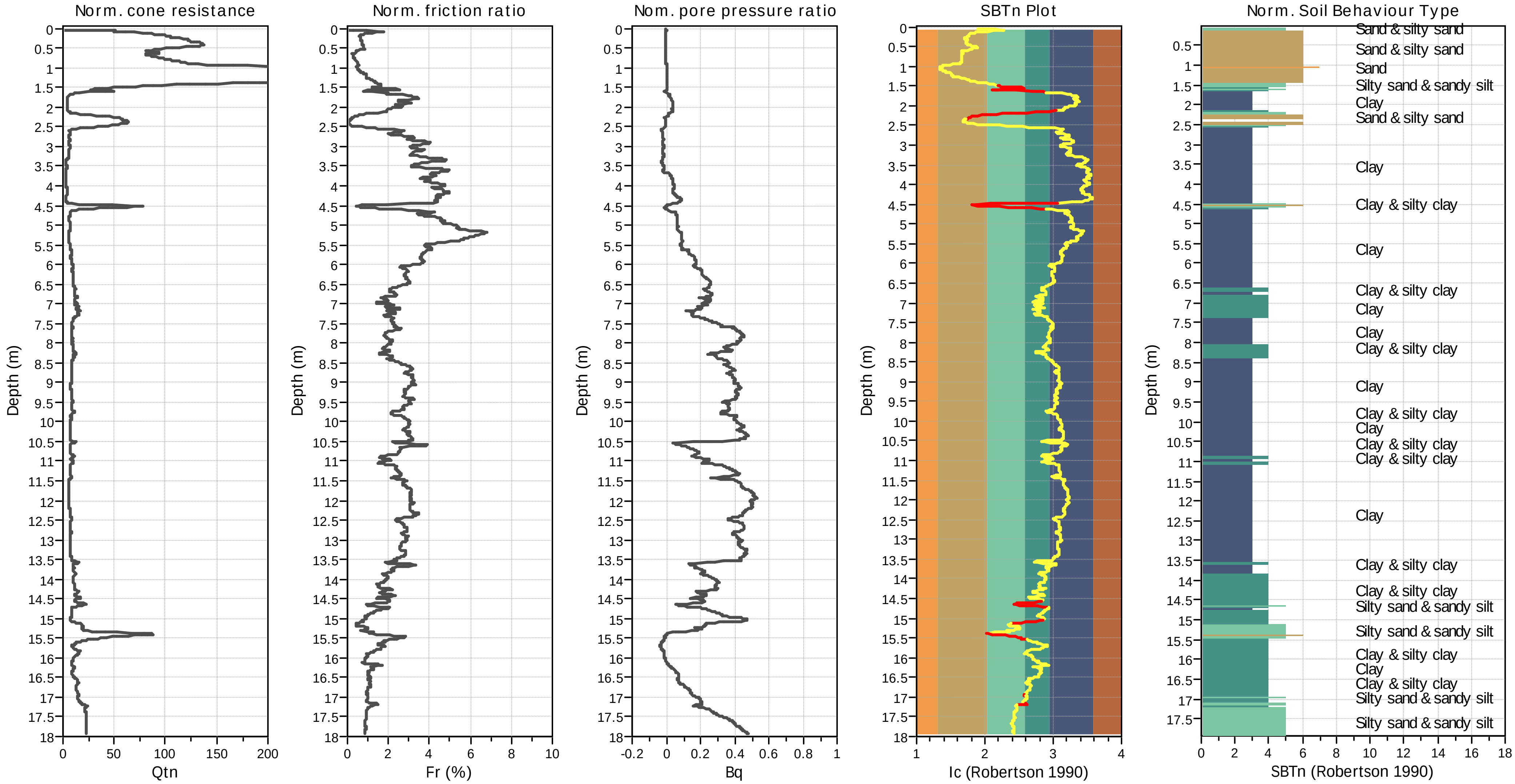



Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

# CPT basic interpretation plots (normalized)



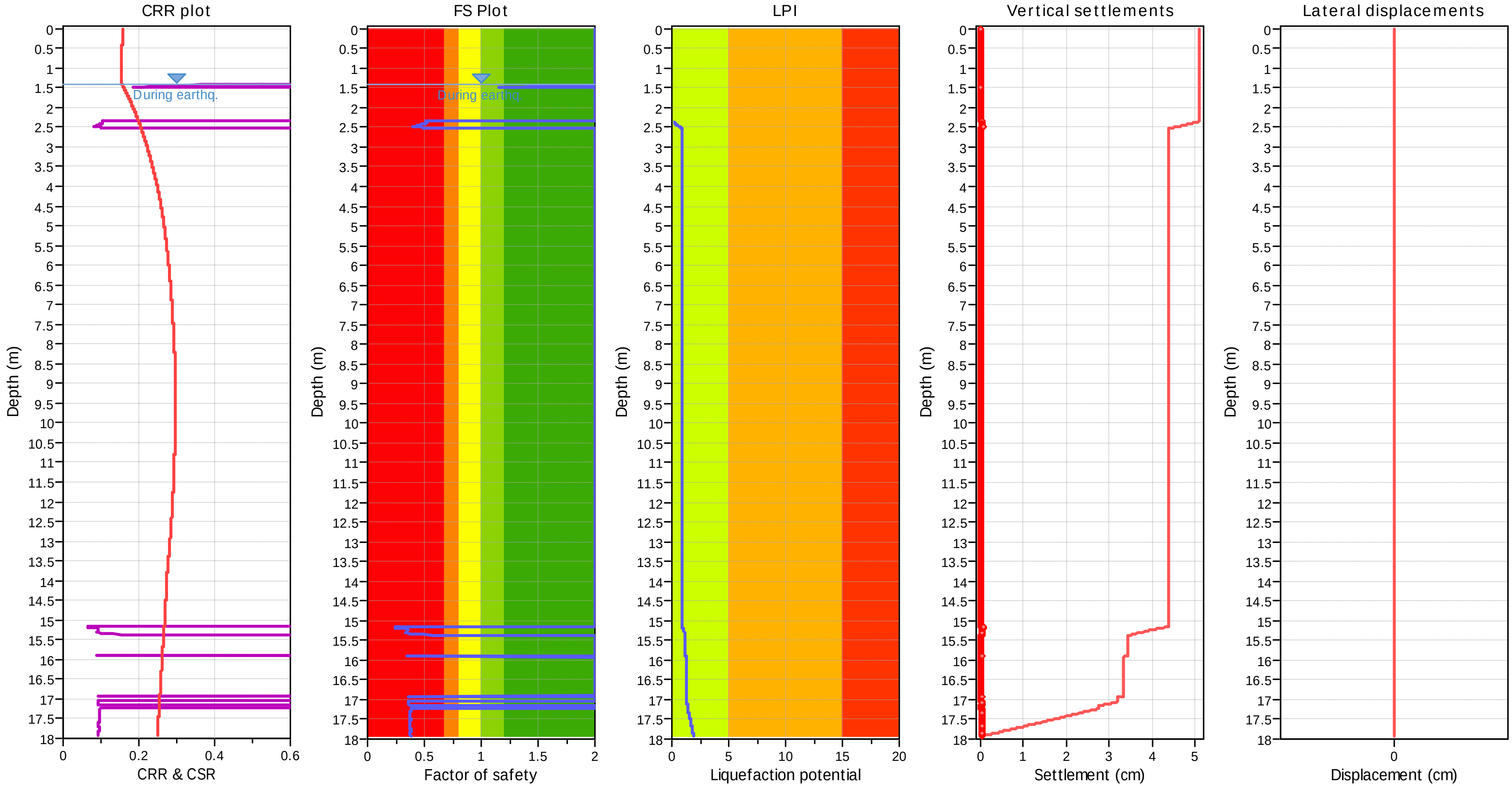

## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 1.40 m | Fill weight: | N/A |
| Fines correction method: | NCEER (1998) | Average results interval: | 3 | Transition detect. applied: | Yes |
| Points to test: | Based on Ic value | Ic cut-off value: | 2.60 | $K_\sigma$ applied: | Yes |
| Earthquake magnitude $M_w$: | 6.40 | Unit weight calculation: | Based on SBT | Clay like behavior applied: | Sands only |
| Peak ground acceleration: | 0.36 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.40 m | Fill height: | N/A | Limit depth: | N/A |

### SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

# Liquefaction analysis overall plots




## Input parameters and analysis data

| | | | | | |
|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 1.40 m | Fill weight: | N/A |
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| Peak ground acceleration: | 0.36 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.40 m | Fill height: | N/A | Limit depth: | N/A |

## F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

## LPI color scheme

- Very high risk
- High risk
- Low risk

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# LIQUEFACTION ANALYSIS REPORT

Project title : Liquefaction Analysis    Location : Wairoa Aerodrome

CPT file : CPT-4_ULS-L3_6.5M_0.47g

## Input parameters and analysis data

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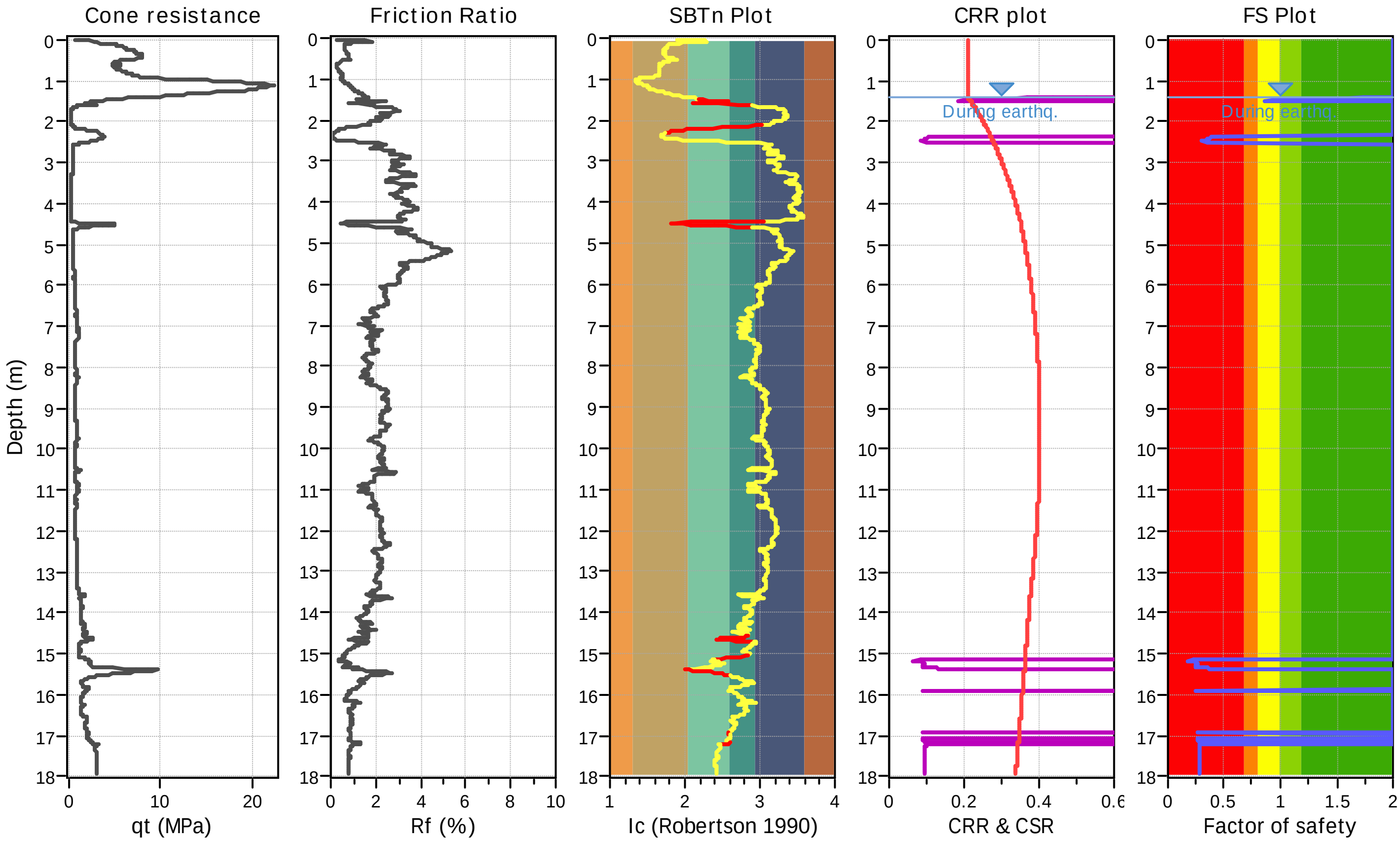
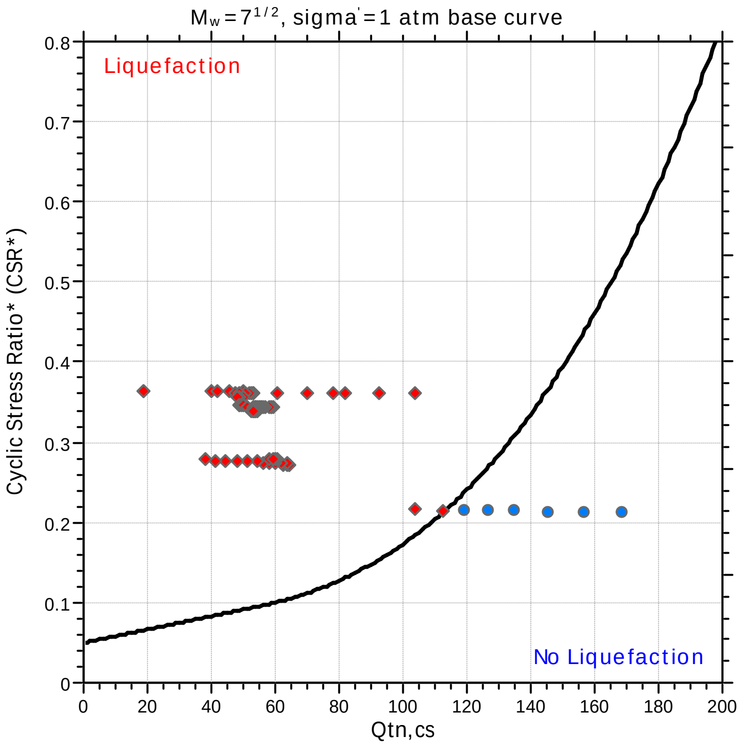
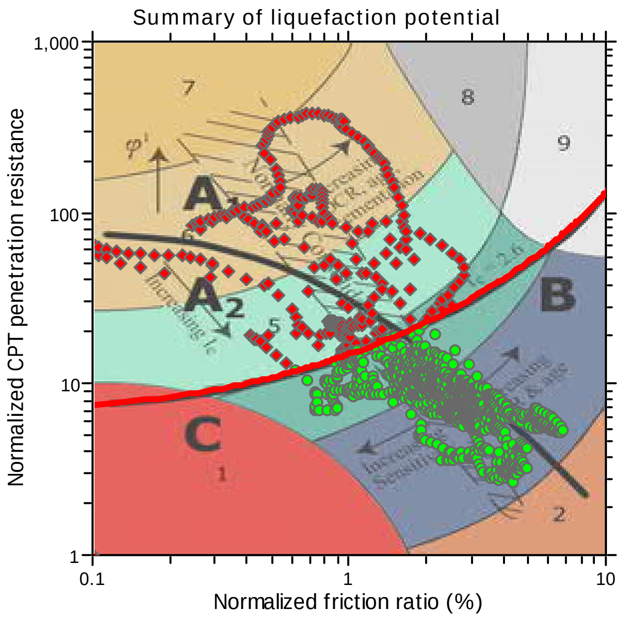
|---|---|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | G.W.T. (in-situ): | 1.40 m | Use fill: | No | Clay like behavior applied: | Sands only |
| Fines correction method: | NCEER (1998) | G.W.T. (earthq.): | 1.40 m | Fill height: | N/A | Limit depth applied: | No |
| Points to test: | Based on Ic value | Average results interval: | 3 | Fill weight: | N/A | Limit depth: | N/A |
| Earthquake magnitude $M_w$: | 6.50 | Ic cut-off value: | 2.60 | Trans. detect. applied: | Yes | MSF method: | Method based |
| Peak ground acceleration: | 0.47 | Unit weight calculation: | Based on SBT | $K_\sigma$ applied: | Yes | | |




Zone $A_1$: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone $A_2$: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
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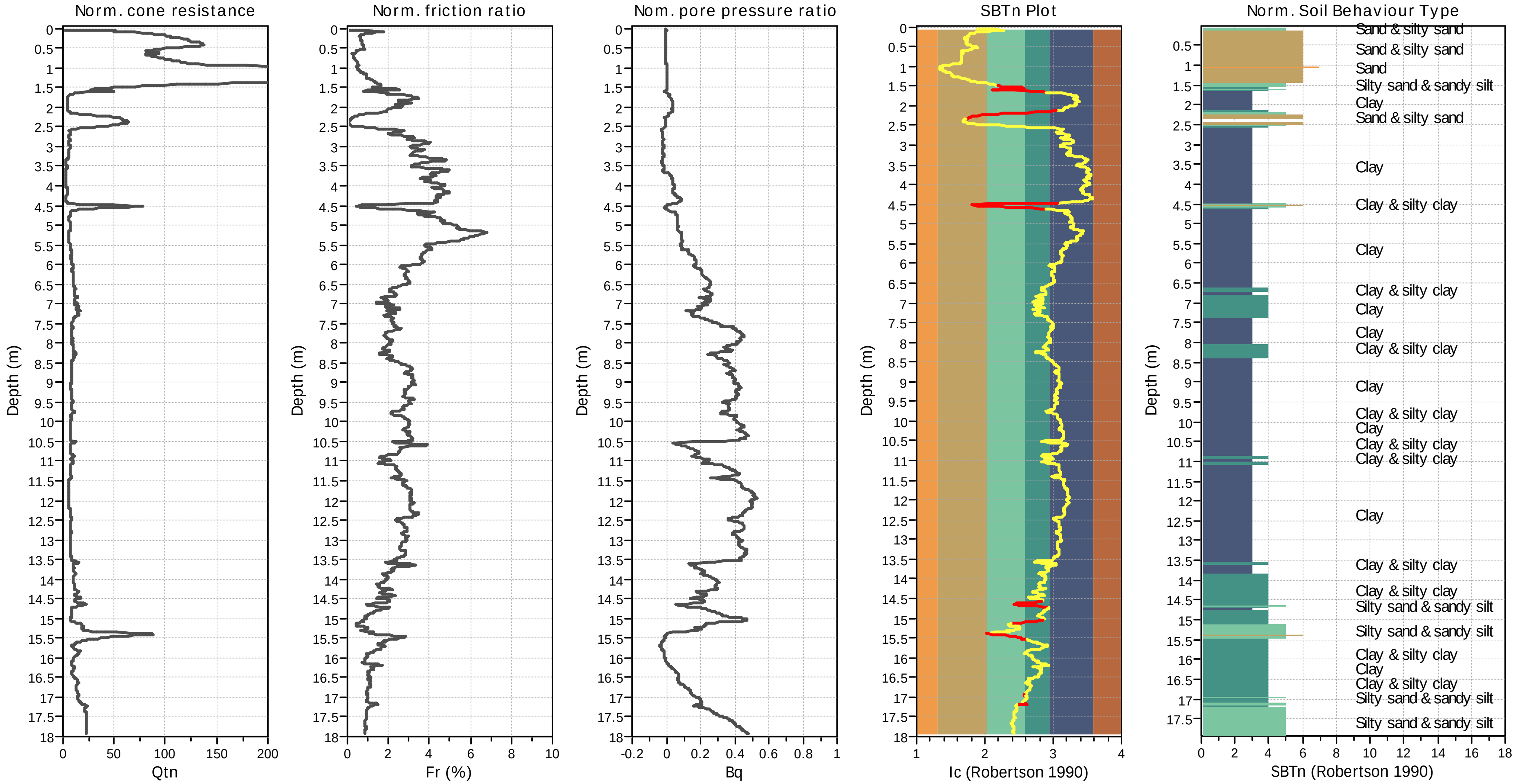


### Input parameters and analysis data

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|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 1.40 m | Fill weight: | N/A |
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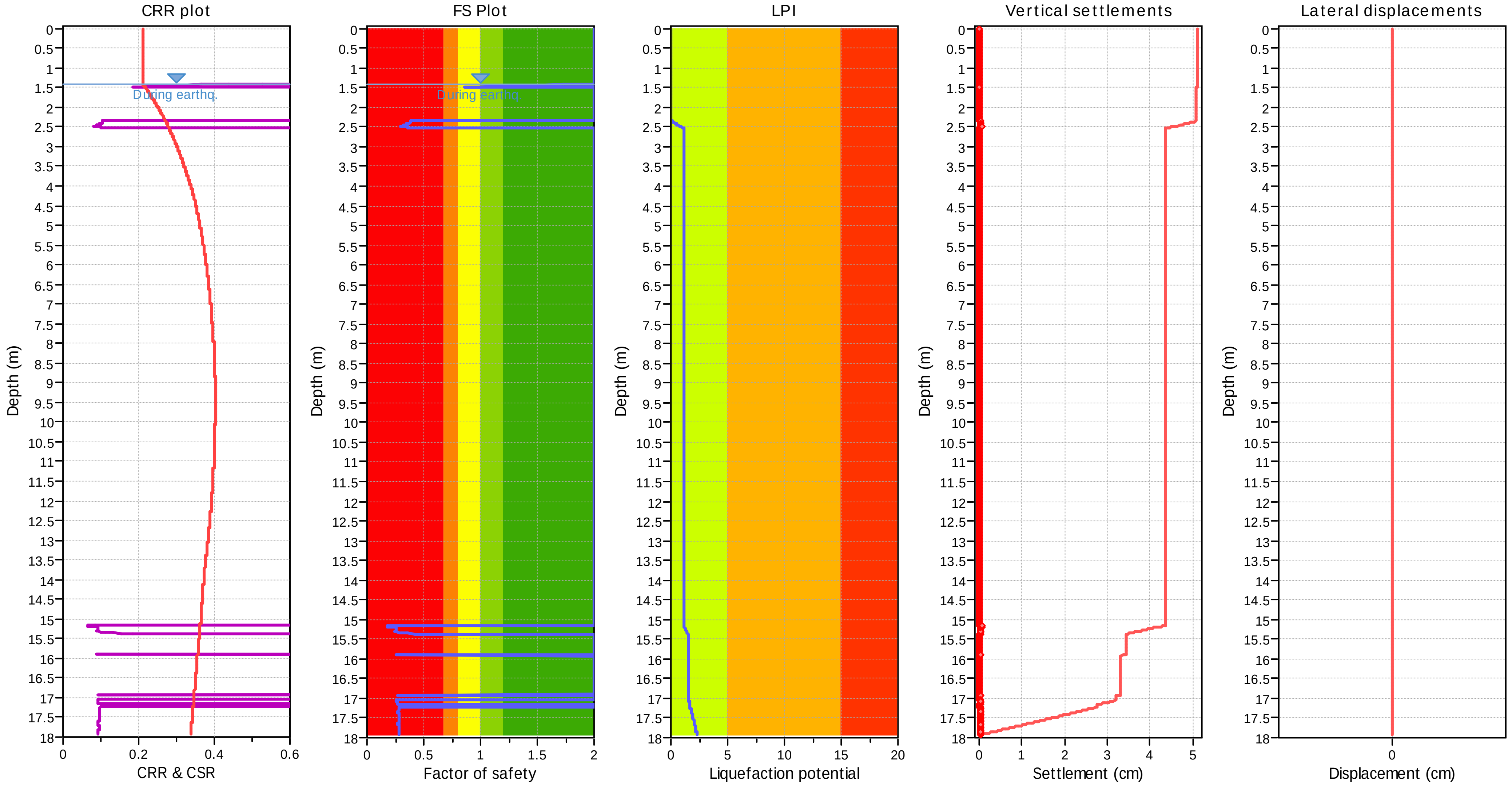
| Peak ground acceleration: | 0.47 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.40 m | Fill height: | N/A | Limit depth: | N/A |

### SBTn legend

| | | |
|---|---|---|
| 1. Sensitive fine grained | 4. Clayey silt to silty | 7. Gravely sand to sand |
| 2. Organic material | 5. Silty sand to sandy silt | 8. Very stiff sand to |
| 3. Clay to silty clay | 6. Clean sand to silty sand | 9. Very stiff fine grained |

# Liquefaction analysis overall plots




## Input parameters and analysis data

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|---|---|---|---|---|---|
| Analysis method: | NCEER (1998) | Depth to water table (erthq.): | 1.40 m | Fill weight: | N/A |
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| Peak ground acceleration: | 0.47 | Use fill: | No | Limit depth applied: | No |
| Depth to water table (insitu): | 1.40 m | Fill height: | N/A | Limit depth: | N/A |

F.S. color scheme

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- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

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w: www.opus.co.nz

# Appendix H

# Business Park Development Constraints

Mustang Jet type used by Skyline Air Ambulance

Top dressing aircraft used by Farmers Air

OPUS

# Memorandum

| | |
|---|---|
| **To** | Jamie Cox |
| **Copy** | |
| **From** | Andrew Sowersby (Principal Planner) |
| **Office** | Napier Office |
| **Date** | 16 March 2017 |
| **File** | 2-Y13000.DM |
| **Subject** | Business Park Constraints Investigations |

Opus have undertaken as review of the proposed Wairoa Airport Business Park to:

1. Identify the Resource Management Act 1991 requirements associated with the development of the business park
2. Ascertain whether the land has any archaeological sites of significance
3. Identify availability of power and computer media to the business park

The findings of our review are set out below:

### *1.1.1 Planning and the Resource Management Act 1991 (RMA)*

The airport is currently located entirely within Designation 64 on the Operative Wairoa District Council Planning Maps. This designation means that airport activities do not require resource consent under the Wairoa District Plan and may establish as a permitted activity (refer to Image 1 below).

The development of the business park for 'non-airport activities' will be a permitted activity (not requiring resource consent) under the District plan provided that the typical development standards in the plan are complied with.

The designation does not override the rules in the Hawkes Bay Regional Resource Management Plan related to the discharge of stormwater or contaminants. Stormwater discharge consent will be required from the Hawkes Bay Regional Council in the event that the airport is extended or the business park is developed. Discharge consent will also be required for the establishment of a new refuelling area. These consents are both likely to be granted with appropriate contaminant mitigation.

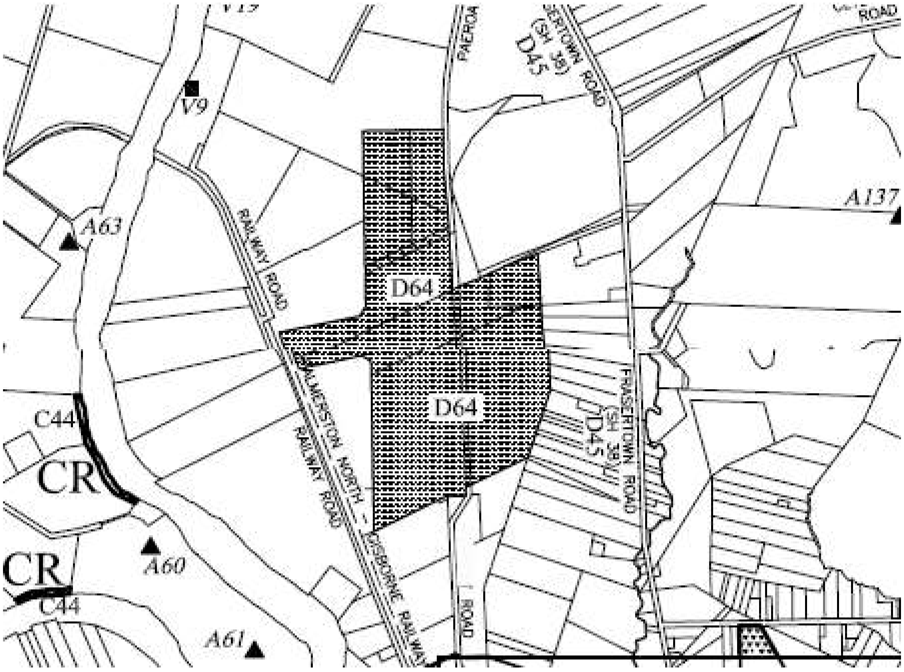



Image 1 – District Plan extract showing Designation 64

### *1.1.2 Archaeological and Cultural*

An 'ArchCheck' was undertaken by Opus International Consultants on 03/03/2017 within the extent of the proposed business park to the west of the paper road. There are no recorded archaeological sites within the immediate area of proposed work, nor are there any recorded archaeological sites within a 100 - 200m radius of the proposed work. However, there is a suggestion that there could be cultivation soils and other evidence of pre- European Māori horticulture and occupation across the wider area.

It is recommended that the geotechnical test-pitting is undertaken under an ADP (Accidental Discovery Protocol) in conjunction with an archaeological site visit (ArchCheck Stage 3) during excavations of building platforms or the runway extension.

### *1.1.3 Power and Telecommunications*

Chorus's website indicates that the airport has ADSL broadband availability at speeds greater than 1 Mbps. Speeds of greater than 5Mbps are available to the south of the airport. There is no fibre rollout currently planned for this area.

Vodafone have limited 3G coverage at the airport but 4G extended is available at the airport. Spark's network provides both good coverage for 3G and 4G extended.

Appendix I

# Preliminary Investigations for Upgrades and Improvements Report

Mustang Jet type used by Skyline Air Ambulance


Top dressing aircraft used by Farmers Air

*Wairoa District Council*

# Wairoa Airport

# Preliminary Investigations For Upgrade and Improvements

*Wairoa District Council*

# Wairoa Airport

# Preliminary Investigations For Upgrade and Improvements


Prepared By

Brendon Thomson
Civil Engineering Technician

Reviewed By

Andrew Sowersby
Principal Planner

Approved for Release By

Brian Jones
Asset Management Consultant

Opus International Consultants Ltd
Napier Office
Opus House, 6 Ossian Street
Private Bag 6019, Hawkes Bay Mail Centre,
Napier 4142
New Zealand

Telephone: +64 6 833 5100
Facsimile: +64 6 835 0881



Date: 04/04/2017
Reference: 2-Y1300.00
Status: FINAL

# Contents

# 1 Introduction

## 1.1 Background

Wairoa Airport is a Council owned asset, it is a non-certified airstrip, designated as a Public Airport by Air Transport, a division of the Ministry of Transport (NZ). The Airport is located approximately 3km NW of Wairoa Township. The existing 914m sealed length of the runway constrains its use to aircraft in the category of 5700kg Maximum Take-Off Weight (MTOW) or less. Normally, this means that the largest aircraft to use the Airport would be a light engine turboprop carrying up to 10 or 12 passengers. In order to accommodate the newly purchased Skyline jet air ambulance, and attract commercial operators to capitalise on the opportunities Rocket Lab brings to the region, Opus International Consultants (Opus) have been engaged by Wairoa District Council (WDC) to consult with stakeholders and users of the Airport, investigate improvements, and provide Rough Order Costings (ROC) for financial planning.

## 1.2 Airport Description

ICAO: NZWO

IATA: WIR

RUNWAY: 16/34 grass strip of 1371m in length containing an all-weather sealed strip of 914m on its southern two thirds.

RUNWAY STRENGTH ESWL: 9530

CIRCUIT FIXED WING: Left Hand for all runways

LIGHTING: Pilot controlled runway lighting

FUEL: Jet A1 available.

## 1.3 Pathway to CAA Certification

CAA Certification of the Airport is required for “an Airport serving an aeroplane having a certificated seating capacity of more than 30 passengers that is engaged in regular air transport operations for the carriage of passengers”. With certification comes greater responsibilities, and expenses, relating to management, safety, fire and/or rescue response, and wildlife management. A discussion with Nick Jackson of CAA, recommended 2 pathways to gaining ultimate certification of the Airport.

**Pathway 1:** Progressively upgrade the Airport over 5-10 years or as demand necessitates, then as aircraft operations approach the level required for certification, request a visit by CAA to advise on the process to be followed and how it can be achieved. The advantage of taking this path to certification is that the Airport can be steadily upgraded overtime and as funds become available.

**Pathway 2:** Ask CAA to visit and undertake an inspection and advise on what needs to be upgraded to meet certification standards. This results in CAA effectively driving the upgrades and making key points deliverable on a set time period.

# 2 Stakeholder Consultation

## 2.1 Stakeholders

As part of this investigation, stakeholders and users of the Wairoa Airport were contacted for their feedback on the current state of the Airport and what they would or would not like to see happen at the Airport. Stakeholders contacted in the course of this investigation were:

- Airways New Zealand (Dave Jordan/Richard Fry)
- Skyline Aviation (Alex McHardy)
- Air Napier (Gary Peacock)
- Civil Aviation Authority of New Zealand (Nick Jackson)
- Massey University School of Aviation (Andrew Vialoux)
- Hawke's Bay & East Coast Aero Club (and Air Hawke's Bay – wholly owned company of the Aero Club) )
- Ashworth Helicopters Ltd.
- Farmers Air Ltd (Andrew Hogarth)
- Wairoa Aero Club (Richard Tollison)

## 2.2 Stakeholder Feedback

The feedback/complaints received from stakeholders is as follows:

- There have been instances of stock incursions into the airport operational areas
- Failure of runway lighting in certain weather conditions.
- There have been instances where grass mowing tractors have not followed Notice to Airman requirements (NOTAM)
- Issues with night-time visibility
- Wairoa Lighthouse causing visual distraction to pilots on final approach
- Lack of information regarding weather conditions
- Lack of information for visitors and tourists
- Lack of shelter during inclement and hot weather
- Non-Aviation related vehicles using the apron and runway and causing damage to the surfacing
- Ashwortrh Helicopters report that since last sealing their hangar now floods during heavy rain events.
- Long grass on strip to the North of the runway
- Issue with loose chips on the runway and in particular apron/refuelling area

- Lack of runway visual markings
- Both Air Napier and Skyline have indicated that the runway length is an issue for several of their aircraft in certain weather conditions.
- Lack of Navigational Visual Aids to assist in making night time operations safer and easier including lack of GPS flightpath approach for runway-16
- Control of obstacles such as trees and power poles
- The Hawke's Bay and East Coast Aero Club (via Air Hawke's Bay) stated that the existing facilities on site are sufficient for their operations, and were concerned that lengthening the runway would result in increased landing charges with no benefit to them.
- Wairoa Aero Club have no planes at present but the current set is generally OK for their needs
- Farmers Air expressed concern at length of time taken to resolve permanent fuel storage application, lack off maintenance assistance regarding hardstand areas in front of leased hangar and super bins.

Appendix A has a table summarising the above feedback from stakeholders, the recommended actions, timeframes and rough order costs.

# 3 Recommended Actions

## 3.1 General Procedural Changes

As upgrades occur and air traffic increases, Wairoa District Airport needs to ensure it is compliant with Civil Aviation and Airways requirements relating to Airport operation. Particularly, the Council needs to ensure that maintenance contractors are contactable by Airways during maintenance operations. Also, should any works be undertaken within the airside apron and runway space, a NOTAM (Notice to Airmen) should be issued through Airways to notify pilots and air traffic control of potential hazards. Additionally, any works being carried out in the airside space should have a MOWP (method of works plan) as per CAA AC 139-5, to advise contractors and stakeholders of the impending works and to be aware of airside safety issues and activity limitations. This would include approved hours of work, clean up requirements and daily flight information etc.

## 3.2 Fencing – Airport Operational Zone

The existing post and wire perimeter fencing for the Airport currently ranges in condition, from very good to very poor condition. *(I.e. not stock proof)*. It is recommended that the entire perimeter fencing is checked and upgraded to ensure it is stock proof. It may be possible to install new posts and batons as required, while restraining the existing wire as a lower cost alternative. The northern 3rd of the runway appears to be partially buried as can be seen in the attached photo. *(Note: - extension of fence height using battens)*.

Should the runway be extend to accommodate larger aircraft then in keeping with CAA guidelines the width of the runway strip needs to be a minimum of 75m either side of the runway centreline *(Currently 55m either side of centreline)* and 240m off the end of the runway for Runway End

Safety Area (RESA) requirements. Therefore the existing runway perimeter fences will need to be removed and/or relocated.

Interim repairs to fences to make stock proof in particular northern fences (1.2km) = $15,000

Removal of existing fences (3.8km) = $19,000 - $25,000

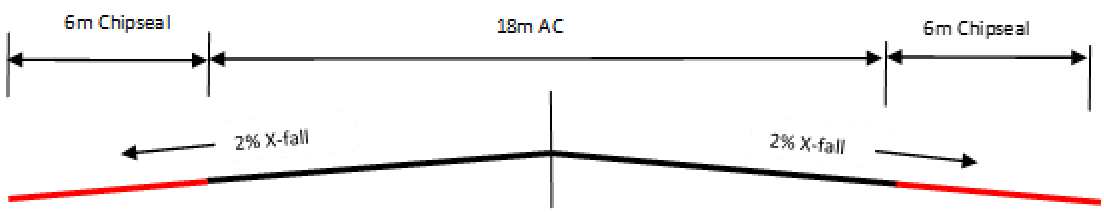
Option-1:- Renew fences around extremity of Extended Runway Strip (4.15km) = $62,000 - $83,000

Option-2:- Extend operational area out to utilise existing boundary fences (approximately another 15m wider either side. Construct new fences as required (2.25km) = $33,750 - $45,000

WDC has already indicated their intention to improve security and access onto the Airport by installing card activated security gates and fencing at the entrance = $50,000 - $70,000 budgeted

## 3.3 Existing Runway Resurfacing

The existing all weather runway is 914m long and 30m wide comprising 6m grade 3/5 chipseal, 18m asphaltic concrete (AC) and 6m grade 3/5 chipseal. The sides of the runway were sealed in 2014, but the age of the AC is approaching 30+ years and showing signs of fatigue with extensive cracking. Options for resurfacing the central runway and sides have been considered taking into account the likelihood of the runway being extended.




<u>Runway Typical X-Section</u>

Whilst the runway is not showing any signs of pavement failure it is recommended that either FWD testing or Benkelman Beam testing is carried out to help with determining the most appropriate resurfacing treatment. The various options are discussed below and summarised.

*Refer to Appendix – B for Cost Estimates, Seal Areas (Drawing – C01-B) and Research paper on Pavement Surfacing for Passenger Jet Aircraft.*

*Photo showing Grade 3/5 chipseal and AC surfacing*

### 3.3.1 Option-1:- Overlay existing AC (22m x 40mm) – $965,184 – 6m Chip seal sides to be resurfaced 2024/25

This option is the most expensive and provides for resurfacing of the fatigued and cracked AC with a PME membrane seal to help fill cracks and reduce reflective cracking prior to overlaying with 40mm of AC. The AC will need to be feathered out over 2m so that changes in x-fall grades are not too significant. Benefit is that the AC surface is more conducive to the operation of jet aircraft should the runway be extended in the future. Dis-benefit is that AC is expensive and additional width is required to accommodate grade change, edges of AC could look ragged and delaminate over time. Predicted life expectancy 18-25 years.

### 3.3.2 Option-2:- Mill off Existing AC and Replace (18m x 40mm) – $945,990 – 6m Chip seal sides to be resurfaced 2024/25

This option is the 2nd most expensive as the existing AC will need to be milled off prior to resurfacing with a membrane seal and 40mm of AC in order to maintain desired cross fall limits and tie-into sealed sides. Benefit is that the AC surface is more conducive to the operation of jet aircraft should the runway be extended in the future, less width of AC required. Dis-benefit is that AC is expensive. Predicted life expectancy 18-25 years.

### 3.3.3 Option-3:- Mill and Replace "Landing Zone" with AC (350m x 18m) and resurface remainder of Runway with a PMB grade 3 - Cape seal (564m x 18m) = $645,300 - 6m Chip seal sides to be resurfaced 2024/25

This option is the 3rd most expensive and provides for milling off the fatigued and cracked AC within the landing zone *(350m based on a mustang jet)* on the southern end of the existing runway-34 and 50m on the northern end runway-16 allowing for a future 300m extension. This area is recognised as being subjected to higher stresses due to wheel impact. The remainder of the runway to be resurfaced with a PMB grade-3 cape seal. Benefit is that the AC is more conducive to the operation of jet aircraft should the runway be extended in the future and this option is less expensive than the previous two options. Predicted life expectancy 18-25 years.

### 3.3.4 Option-4:- Overlay existing AC with PMB grade-3 fabric seal – Topped with Type III Slurry – $411,300 – 6m Chip seal sides to be resurfaced 2024/25

This option is the 4th most expensive and provides for resurfacing of the fatigued and cracked AC with a PMB grade 3 chip fabric seal topped with a type III slurry to provide a smoother surface similar to that of AC. The slurry surface should also be conducive to the operation of jet aircraft should the runway be extended in the future. The benefit is that the cost of resurfacing is approximately 50% less than AC. Dis-benefit is that the life expectancy is less than AC. Predicted life expectancy 12-18 years

### 3.3.5 Option-5 Fabric Chipseal Gr3/5/6 on AC – $320,814 – 6m Chip seal sides to be resurfaced 2024/25

This option is the 5th most expensive and provides for resurfacing of the fatigued and cracked AC with a PMB grade 3/5/6 chip fabric seal. The fabric will help to provide additional binder to bridge the cracks and reduce reflective cracking along with PMB. The grade 6 provides a smoother surface and less likely to fret loose chip once it has settled down and established. This treatment requires additional rolling in order to bed down the chip. Benefit is that the costs are extremely affordable. Dis-benefit is that periodic rolling and suction sweeping should be carried out on a regular basis and surfacing not totally conducive to the operation of jet aircraft due to threat of loose chip being sucked into engines causing damage. Predicted life expectancy 15-20 years

### 3.3.6 Option-6 Emulsion + Latex Chipseal on AC – $213,876 – 6m Chip seal sides to be resurfaced 2024/25

This option is the least expensive and provides for resurfacing of the fatigued and cracked AC with an Emulsion and Latex grade 3/5/6 chip seal. The emulsion will hopefully filter into the cracks and the latex will make the binder more durable. The grade 6 provides a smoother surface and less likely to fret loose chip once it has settled down and established. This treatment requires additional rolling in order to bed down the chip. Benefit is that the costs are extremely affordable. Dis-benefit is that periodic rolling and suction sweeping should be carried out on a regular basis and surfacing not totally conducive to the operation of jet aircraft due to threat of loose chip being sucked into engines causing damage. Predicted life expectancy 15-20 years

### 3.3.7 Summary – Existing Runway Resurfacing Options

| Option | Proposed Treatment | Estimated Cost | Life Expectancy |
|---|---|---|---|
| 1 | AC Overlay – Full length<br>*(914m long x 22m wide)* | $965,184 | 18 – 25yrs |
| 2 | AC Mill & Replace – Full length<br>*(914m long x 18m wide)* | $945,990 | 18 – 25yrs |
| 3 | AC Mill & Replace "Touch Down Zone" *(400m long x 18m wide)* Cape Seal – PMB Fabric - G3 + Slurry *(514m x 18m)* | $645,300 | 18 – 25yrs |
| 4 | Cape seal – PMB Fabric - G3 + Slurry<br>*(914m long x 18m wide)* | $411,300 | 12 – 18yrs |
| 5 | PMB Fabric seal – G3/5/6 chip<br>*(914m long x 18m wide)* | $320,814 | 15 – 20yrs |
| 6 | Emulsion + Latex - G3/5/6 chip | $213,876 | 15 – 20yrs |

With the likelihood of the runway being extended in the near future we would recommend option-3 as the preferred resurfacing treatment. The construction of AC in the touchdown zone allows for the inclusion of jet aircraft operations in the near future, whilst resurfacing the remaining runway with a Cape Seal makes the overall runway resurfacing more affordable.

## 3.4 Taxiways and Apron Resurfacing

The taxiway and apron were sealed in 2014 with a grade 3/5 chip which has lost chip in areas that haven't been trafficked sufficiently to imbed the chip and some areas where aircraft do power turns. There has been complaints / concern regarding this issue. Three options have been considered to remedy this problem.

### 3.4.1 Option-1 Resurface with a AC – Taxiways = $187,470 and Apron = $500,400

This option is the most expensive but provides a more homogenous surfacing throughout the Airport and is conducive with Jet aircraft operations. The surface is smooth providing for easier pedestrian and health care patience mobility and transfer and is less likely to have adverse effects from aircraft power turns. Predicted life expectancy 18-25 years

### 3.4.2 Option-2 Resurface with Slurry – Taxiways = $72,905 and Apron = $194,600

This option is the 2nd most expensive but provides a more reasonable alternative to AC. The surface is smoother than a chip seal providing for easier pedestrian and health care patience mobility and transfer and is reasonably conducive to jet aircraft operations. Predicted life expectancy 12-18 years

### 3.4.3 Option-3 Resurface with Emulsion + Latex G6 chipseal – Taxiways = $27,079 and Apron = $72,280

This option is the least expensive surfacing but provides an economic solution to minimising the chip loss and creating a smoother surface than existing still providing for easier pedestrian and health care patience mobility and transfer. Some maintenance texturizing of areas where chip has been lost maybe required prior to applying the grade 6 seal. Predicted life expectancy 10-15 years

*Photo showing chip loss on Taxiway*

### 3.4.4 Summary – Taxiway & Apron Resurfacing Options

| Option | Proposed Treatment | Estimated Cost Taxiway | Estimated Cost Apron | Life Expectancy |
|---|---|---|---|---|
| 1 | Resurface - AC | $187,470 | $500,400 | 18 – 25yrs |
| 2 | Resurface - Slurry | $72,905 | $194,600 | 12 – 18yrs |
| 3 | Resurface - Emulsion +Latex -G6 | $27,079 | $72,280 | 10 – 15yrs |

## 3.5 Resurface Taxiway to Super bins

The taxiway to and from the super bins needs to be resurfaced at some stage in the future. It is proposed that a 3/5/6 chipseal will be adequate for this purpose. During inspections it was noticed that sections of the taxiway are showing signs of deformation obviously due to loading operations and aircraft traffic. Estimated Cost = $24,180

## 3.6 Runway Marking

It is recommended that runway marking design is undertaken and implemented as per CAA AC139-6 with the use of aviation glass beads etc. for night time landings. We have consulted with Orsborn Road Markers Ltd as they currently mark Napier Airport. They have suggested that for the number of night time flights into Wairoa Airport that Highway glass beads could be used as latest Aviation beads are approximately 200% more expensive. There are only a couple of the major airports using them at present. *(Refer Appendix – C – Drawings C02-B & C03-B for required Markings and Estimate)*

Existing Runway Markings: - ROC = $24,480

Runway Extension Markings: - ROC = $42,620

## 3.7 Runway Lighting and Navigational Aids - Upgrade

Richard Fry of Airways New Zealand was contacted for his input on the Lighting of the Wairoa Airport, following his recent visit. Airways believe the issue with lights failing to activate in certain weather conditions is due to the proximity of the receiver to a power pole. Their recommendation is to move the receiver. He advised this would only require technicians for a couple of days, and some further trenching. A site inspection showed that many of the lights are damaged, and should be repaired or replaced as necessary. ROC = $15,000

Richard was asked for his comment on the adequacy of the current lighting system to cope with the proposed runway extension. His response was, "while the existing system could be used, if WDC are looking to attract commercial operators to the area, a new system may be a better option" This would also provide some assurance of reliability and safeguard against failure of an aging system.

It is recommended Richard and Airways New Zealand are consulted to provide detailed inputs for the lighting design of the runway extension. Richard indicated that in some cases Airways part fund/part own the lighting systems, in return for revenue from the airport operations, this may be an opportunity worth investigating to allow Wairoa District Council to upgrade while reducing the upfront capital investment.

The cost of a full upgrade of lighting inclusive of night time navigational aids such as PAPI's, VASIS and emergency power source has been based on the Westport Airport upgrade in 2008. Costs have been escalated to 2016 values. Tender schedule and plans attached for reference.
*(Refer Appendix – D)*

Existing Runway Upgrade ROC = $280,000

Runway Extension ROC = $95,000

## 3.8 Runway Extension

Both Air Napier and Skyline Aviation indicated that the existing runway length is inadequate for some of their aircraft in certain weather conditions. Lengthening the runway is also recommended to attract new commercial operators to the Airport and accommodate Skyline's jet Ambulance services for the region. Based on this, we have prepared an estimate to extend the runway to the North 300m. *(Refer Appendix – E – Drawings C04-B to C06-B)*

### 3.8.1 Pavement and Surfacing

Comparing recent LiDAR data to the original construction drawings, it appears the grass section of the runway has already been shaped as designed. This should mean, the extension will be a matter of constructing the pavement and surfacing. For the purposes of the preliminary pavement design, we have assumed the subgrade will have a CBR of 4 or better which will be confirmed when geotechnical investigations are undertaken as part of Phase 2 of this project and based on aircraft that are likely to use the Airport a pavement design will be confirmed. *(Since the initial draft report was done geotechnical investigations were carried out on Wednesday 19th January 2017. Unfortunately due to the extreme dry conditions it is inconclusive as to whether the subgrade CBR would be greater than 4 but from test pits dug for the development area our Geotechnical Engineer is reasonably confident that the CBR shouldn't be less than 4)*

It is therefore recommended that a test pit is dug within the existing runway to establish depths of the existing runway pavement and further scala testing is carried out in Autum to confirm subgrade CBR's. The results may allow a reduction in required pavement depths.

For the purpose of these ROC's the preliminary design consists of 200mm of Granular Subbase, 100mm of M4 Basecourse with Asphaltic Concrete (AC) surfacing. Alternative costing for surfacing with a Capeseal - Slurry has also been included.

We have included two cost estimates for construction of the extension, *(refer Appendix E)* one is "Conservative" utilising rates received for Mangahohi Bridge replacement SH38, the 2nd is "Best-Case" scenario based on a recent WDC urban contract.

### 3.8.2 Runway Extended Safety Area (RESA)

Should WDC look to gain certification of the Airport in the future, based on CAA Part-139.51 design requirements a Runway Extended Safety Area (RESA) will be necessary. As a minimum 90m is required but ideally this should be 240m. The existing distance to fence from end of proposed runway extension is 134m. The director of CAA will need to accept and agree any RESA less than 240m. Therefore land purchase for the additional length required has been allow for within the estimate. *(Refer to Appendix – E - plan C06-B and C07-B, and Loganstone report)*

### 3.8.3 Runway Drainage

The existing runway has slotted drainage along the outside edges of the sealed pavement for the latest extension of 400m but not for the original length of 490m. In discussion with colleagues the slotted drains are an ideal scenario but not totally necessary. We have allowed for the cost of a combination of subsoil drainage and surface water collection within our estimate.

### 3.8.4 Runway Lighting

As part of the runway extension the cost for lighting has been included. Two costs scenarios have been allowed for, extending the existing lighting system and constructing a new circuit for the entire runway. Refer to section 3.7 above regarding lighting upgrade.

### 3.8.5 Runway Markings

As part of the extension runway markings have been allowed for within the estimate. This includes removal of parts of the Threshold Markings and Designation number on end of existing runway and replacing with approach aiming markers along with centreline and threshold markings. *(Refer Appendix – E)*

### 3.8.6 Summary of Estimated Cost

| **Runway Extension - Summary of Estimated Costs** | | |
|---|---|---|
| Item | Description | Estimated Cost |
| 1 | Runway Construction | $696,600 |
| 2 | Runway Lighting and Navigational Aids *(Runway Extension Only)* | $95,000 |
| 3 | Runway Markings | $42,460 |
| 4 | Land Requisition for RESA | $47,360 |
| 5 | Remove and Relocate Fences – perimeter of runway strip | $69,700 |
| 6 | Preliminary & General Costs | $30,000 |
| 7 | Professional Services (4%) | $39,240 |
| 8 | Contingency (10%) | $102,040 |
| | **Total Estimated Cost** | **$1,122,400** |

## 3.9 Fuel Storage Resource Consent Requirements

From discussions with Farmers Air it is apparent that they would like to install a permanent fuel storage tank as soon as possible. Multiple fuel storage is common at other airports.

Whanganui have two suppliers: - Air BP and 'Z' Energy provide AVGAS 100 and Jet A1, with associated 'swipecard' service.

- Air BP is located adjacent to the main Terminal building. Their Jet A1 dispensers are located mid apron and at the eastern end, while the Avgas 100 dispenser is at the western end of the apron.
- 'Z' Energy dispensers are on the airfield near Aero Work towards the eastern end of the hangars

For the Wairoa Airport the ideal location for an additional fuel storage supply tank would be alongside the existing 'Z' Energy site provided future height limitations associated to the runway are not compromised.

Resource consent will be required from the HBRC for the establishment of the additional fuel supply.

# 4 Recommendations

## 4.1 Maintenance and Upgrades

Opus recommends Wairoa District Council convene a workshop to discuss the contents of this report and agree on options and timelines for the various components so that budgets and Forward Work Programmes (FWP) can be confirmed. Further consultation with stakeholders, Airways, CAA and Opus maybe required to discuss and analyse the pros and cons of a runway extension.

Upon completion of the upgrades and/or runway extension, should it become likely that CAA Certification is required, it is recommended that WDC consult with CAA to determine and confirm the requirements.

# Appendix A – Feedback Summary

**APPENDIX - A**

# Stake Holder Feedback - Summary

| Problem | Action | Target Completion Date | Estimated Cost | Comments |
|---|---|---|---|---|
| **Short term/Immediate tasks** | | | | |
| Incursions of stock in operational zone | Ensure Fences are secure and maintained to prevent stock incursions | Immediate/ASAP | $15,000 - Northern End of Runway is in the worsed state of disrepair - approx. 1.2km | Existing = 3.8km of fencing total. Need another 0.35km to extend out to 150m and include RESA = Total New = 4.15km<br>Fence cost $15-$20/m.<br>Cost to renew all Fences = $62,000-$83,000.<br>If runway extended - look at removal of existing fences ($20-25,000) and move operational area out to boundary fences another 30-35m wider than existing. Install new fences as required. (approximately 1.5km - $30,000) Note:- Extension will increase mowing requirements. |
| Grass Mowing Contractors randomly crossing the runway when aircraft are on their final approach to land (recent event) | Ensure mowing contractor is contactable during operations. Ensure correct procedures are in place for all works in apron/runway and that works have an approved method of works plan (as required by CAA). Consult with Airways NZ. | Immediate/ASAP | Nil - Procedural updates only | |
| Failure of lighting in certain weather conditions | Relocate reciever away from powerpole - replace/repair broken lights | Immediate/ASAP | $15,000 | Airways representative inspected in November 2016 |
| Night Time visibility issues | Upgrade runway and apron edge lighting and apron floodlighting and inclusion of PAPI's | Investigate costs | $280,000 | Full upgrade and installation of runway lights, taxiway lights, apron flood lights, controls, PAPI navigation aids, illuminated wind socks, and backup power supply. Cost based on Westport Airport |
| Wairoa Lighthouse causing visual distraction to pilots | Minimise light spill from Wairoa Lighthouse | ASAP - Investigate & Resolve | $7,500 | Maybe lighthouse can be controlled same as landing lights? |
| Lack of weather and landing conditions indicators | Install webcam (/weatherstation?) on terminal | As Nescessary/Mid 2017 | $15,000 | There is a metservice weather station at the aerodrome. Investaigate weather broadcast and linking data to a common website along with webcam |
| Lack of information for tourists and visitors | Establish airport webpage (perhaps incorporate with Wairoa i-site page?) | As Nescessary/2017/18 | $5,000 | WDC to investigate |

| Problem | Action | Target Completion Date | Estimated Cost | Comments |
|---|---|---|---|---|
| Lack of shelter during inclement and hot weather | Provide access to old airport lounge for pilots and passengers during inclement weather | As Nescessary/2017/18 | $15,000 - $20,000 | Nil - Utilise existing facilities. Funds could be allocated for upgrades |
| Non-Aviation related vehicles using the runway and damaging runway surface | Prohibit the use of non-aviation related vehicles on the runway and apron. | As Nescessary/2017/18 | $50,000 - $70,000 | Mostly procedural - but need security fencing / gates with swipe card access required |
| Long grass on the strip to the North of the runway | Ensure grass is mown on strip North of runway - update procedures so NOTAM is issued if not | Start Immediately/ASAP | Possible increase in maintenance costs. Unsure of existing arrangements. | Look at existing frequency of mowing - dicuss with Mtce contractor |
| Issue with loose chips/poor surfacing on runway, especially apron/refuelling area | Runway Resurfacing | Programme in stages starting 2017/18 | Refer Appendix B | Refer Appendix B |
| Lack of runway visual markings | Upgrade runway markings | 2017/2018 | $18,760 - Thresholds and Designation No. & Hold Bars, $4,060 - Centreline, $1,410 Taxiway centreline. Total = $24,230 | Minimum requirements - Threshold either end plus Runway designation numbers. Centreline Marking is optional |
| Pavement failure and potholes in area between Super Bins and taxiway - also pavement deformation noticed in taxiway | Carry out pavement repairs as required | 2017/2018 | $10,000 | WDC to investigate |
| **Medium Term Tasks** | | | | |
| Length of runway is too short for several aircraft in certain weather conditions (Air Napier & Skyline) | Lengthen Runway | 2018/2019 | Refer Appendix C - Runway Extension | |
| Lack of navigational aids to make night time operations safer and easier. | Install navigational aids. PAPI's, VASIS and REIL | 2019/2020 | Refer Appendix C - Runway Extension | |
| Control of obstacles such as tree and power poles | Undertake obstacle assessment, ROC and programme for removal | 2018/19 | $25,000 - $30,000 | Refer to Height Limitations Plan |
| **Long Term Tasks** | | | | |
| | Aerodrome certification | When required | | |

| | |
|---|---|
| $0,000 | Estimates to be confirmed |
| 2019 | Dates to be confirmed |

# Appendix B – Existing Runway Resurfacing

- **Existing Runway Resurfacing Options Costings**
- **Drawing - Seal Areas (C01-B)**
- **Resurfacing FWP**
- **Research Paper – Airport Seals**

## APPENDIX - B EXISTING RUNWAY - RESURFACING OPTIONS - COSTS

**Existing Runway Dimensions**

**914m** long **30m** wide = 6m chipseal + 18m AC + 6m chipseal

**Areas: =**

| | | |
|---|---|---|
| Chipseal sides - 12m | = | 10,968 m2 |
| Central Runway - 18m | = | 16,452 m2 |
| AC Overlay - 22m | = | 20,108 m2 |
| AC - 400m touch down | = | 7,200m2 |
| Capeseal - 514m | = | 9,252m2 |

**Central Runway**

| | Option-1- AC Overlay (22m) | Option-2 - Replace AC (18m) | Option-3 AC Touch Down Zone Cape seal Remainder | Option-4 - Capeseal PMB Fabric G3 + Slurry | Option-5 - PMB - Fabric Seal 3-5-6 Chipseal | Option-6 - Emulsion + Latex 3-5-6 Chipseal |
|---|---|---|---|---|---|---|
| Central Runway | $965,184 | $945,990 | $645,300 | $411,300 | $320,814 | $213,876 |
| **Runway Sides** | Grade 6<br>$47,528 | Grade 6<br>$71,292 | Grade 6<br>$71,292 | Grade 6<br>$71,292 | Grade 6<br>$71,292 | Grade 6<br>$71,292 |

**Existing Taxiways** **Area A** = 1,136 m2 **Area D** = 3,030 m2 **Area E** = 1,860 m2

| | Option-1 AC Overlay | Option-2 Slurry | Option-3 Gr 3/5/6 Chipseal |
|---|---|---|---|
| **Areas A & D** | $187,470 | $72,905 | $27,079 |
| **Area E - to Superbins** | | | $24,180 |

**Existing Aprons** **Area B** = 10,200 m2 **Area C** = 920 m2

| | Option-1 AC Overlay | Option-2 Slurry | Option-3 Gr 3/5/6 Chipseal |
|---|---|---|---|
| **Areas B & C** | $500,400 | $194,600 | $72,280 |

**Carpark and Entrance** **Area F** = 2,120 m2

| Option-1 AC Overlay | Option-2 Slurry | Option-3 Gr 6 Chipseal |
|---|---|---|
| $95,400 | $37,100 | $13,780 |


300 mm
200
100
50
10 mm
0

| Revision | Amendment | Approved | Revision Date |
|---|---|---|---|
| B | ISSUED FOR MASTERPLAN | BJ | 10/03/2017 |

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| | | |
|---|---|---|
| Designed: B. THOMSON | Approved: B. JONES | Approved Date: 11/01/2017 |
| Drawn: B. THOMSON | Scales: NOT TO SCALE | |

Project: WAIROA DISTRICT COUNCIL
WAIROA AERODROME
RUNWAY EXTENSION

Sheet: SEALED SURFACE AREAS

| Project No. | Sheet No. | Revision |
|---|---|---|
| 2-S5091.VT | C01 | B |

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## APPENDIX - B WAIROA AIRPORT - RESURFACING FORWARD WORKS PROGRAMME

**EXISTING RUNWAY**

(Highlighted) Actual age and dates unknown

| Start RP | End RP | Offset | Length | Width | Extra Area | Total Area m2 | Existing Surfacing | Date | Age | Condition | Remaining Usefull Life | Future Surfacing Date | Proposed Treatment | Predicted Life - Treatment | Rate $/m2 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 400 | C | 400 | 18 | 0 | 7,200 | AC | 1987 | 30 | Poor | 0 | 2018 | AC | 18-25 | $ 57.50 | | $ 414,000 | | | | | | | | |
| 400 | 914 | C | 514 | 18 | 0 | 9,252 | AC | 1987 | 30 | Poor | 0 | 2018 | Cape seal | 18-25 | $ 25.00 | | $ 231,300 | | | | | | | | |
| 0 | 914 | L | 914 | 6 | 0 | 5,484 | G3/5 | 2014 | 3 | Very Good | 7 | 2024 | G6 PME | 15-20 | $ 6.50 | | | | | | | | | $ 35,646 | |
| 0 | 914 | R | 914 | 6 | 0 | 5,484 | G3/5 | 2014 | 3 | Very Good | 7 | 2024 | G6 PME | 15-20 | $ 6.50 | | | | | | | | | $ 35,646 | |
| **Total** | | | | | | **27,420** | | | | | | | | | | **$ -** | **$ 645,300** | **$ -** | **$ -** | **$ -** | **$ -** | **$ -** | **$ -** | **$ 71,292** | **$ -** |

**TAXIWAYS**

| Start RP | End RP | Segment | Length | Width | Extra Area | Total Area m2 | Existing Surfacing | Date | Age | Condition | Remaining Usefull Life | Future Surfacing Date | Proposed Treatment | Predicted Life - Treatment | Rate $/m2 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 140 | A | 140 | 8 | 18 | 1,138 | G3/5-R | 2014 | 3 | Average | 7 | 2018 | Slurry | 12-15 | $ 17.50 | | | | 19915 | | | | | | |
| 0 | 190 | D | 215 | 12 | 450 | 3,030 | G3/5-R | 2014 | 3 | Average | 7 | 2018 | Slurry | 12-15 | $ 17.50 | | | | 53025 | | | | | | |
| 0 | 180 | E | 180 | 10 | 60 | 1,860 | G3/5-R | 2010 | 7 | Good | 5 | 2024 | G3/5/6 | 15-20 | $ 13.00 | | | | | | $ 24,180 | | | | |
| **Total** | | | | | | **6,028** | | | | | | | | | | | **$ -** | **$ -** | **$ 72,940** | **$ -** | **$ 24,180** | **$ -** | **$ -** | **$ -** | **$ -** |

**APRON**

| Start RP | End RP | Segment | Average Length | Average Width | Extra Area | Total Area m2 | Existing Surfacing | Date | Age | Condition | Remaining Usefull Life | Future Surfacing Date | Proposed Treatment | Predicted Life - Treatment | Rate $/m2 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 120 | B | 120 | 85 | 0 | 10,200 | G3/5-R | 2014 | 3 | Good | 7 | 2017 | AC | 18-25 | $ 45.00 | | | 459000 | | | | | | | |
| 0 | 35 | C | 35 | 20 | 220 | 920 | G3/5-R | 2014 | 3 | Good | 7 | 2017 | AC | 18-25 | $ 45.00 | | | 41400 | | | | | | | |
| **Total** | | | | | | **11,120** | | | | | | | | | | **$ -** | **$ -** | **$ 500,400** | **$ -** | **$ -** | **$ -** | **$ -** | **$ -** | **$ -** | **$ -** |

**Carpark & Entrance**

| Start RP | End RP | Segment | Average Length | Average Width | Extra Area | Total Area m2 | Existing Surfacing | Date | Age | Condition | Remaining Usefull Life | Future Surfacing Date | Proposed Treatment | Predicted Life - Treatment | Rate $/m2 | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | F | 0 | 0 | 2120 | 2,120 | G3/5-R | 2010 | 7 | Very Good | 7 | 2017 | G6 PME | 8-12 | $ 6.50 | | | | | | $ 13,780 | | | | |
| **Total** | | | | | | **2,120** | | | | | | | | | | | | | | | **$ 13,780** | | | | |

| | 2016/17 | 2017/18 | 2018/19 | 2019/20 | 2020/21 | 2021/22 | 2022/23 | 2023/24 | 2024/25 | 2025/26 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total Resurfacing Expenditure** | **$ -** | **$ 645,300** | **$ 500,400** | **$ 72,940** | **$ -** | **$ 37,960** | **$ -** | **$ -** | **$ 71,292** | **$ -** |

# USE OF SURFACE TREATMENTS ON PAVEMENTS FOR PASSENGER JET AIRCRAFT

By S. J. Emery[1] and M. W. Caplehorn[2]

## ABSTRACT

Asphalt is generally used as the surfacing for flexible airport pavements with airline passenger jet aircraft. In Australia and its neighbouring territories, surface treatments (seals) have been used for many years in remote areas, and for aircraft up to Boeing 767 in size. The suitability of surface treatments; their design, construction and maintenance; and their cost effectiveness are discussed within a framework of practical application.

## TERMINOLOGY

| **Bitumen terminology used in this paper** | **Terminology used in other countries** |
|---|---|
| Asphalt | Bitumen concrete, premix, hotmix |
| Cape Seal | A single seal overlain with a thin (5mm) slurry to form a relatively smooth surface texture |
| Cutter | Jet A1 or AVTUR or kerosine or paraffin |
| Double seal | Two engineered layers of stone and of bitumen |
| Fogspray | Enrichment coat |
| Flux | Diesel, flux oil |
| Modified bitumen | Bitumen with the addition of rubber or polymers |
| Surface treatment | Seal |
| Slurry | Cold microsurfacing, without polymer modification of the bitumen, and with a setting time of 10-24 hours |
| Stone | Aggregate, chip |
| Triple seal | Two engineered layers of stone and of bitumen, overlain with a third engineered layer of sand and of bitumen |

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## INTRODUCTION

For flexible pavements carrying airline passenger jet aircraft, the choice of surfacing is generally restricted to asphalt (for example: ICAO Aerodrome Design Manual, 1983). This type of treatment can be expensive to construct in areas which do not have ready access to an asphalt plant. In these areas, the alternative of a surface treatment (bitumen seal) can be technically and financially viable.

In Australia and its neighbouring territories, surface treatments have been used on flexible airport pavements for many years. The aircraft types using these pavements range from Fokker F28 to Boeing 767. Operations have also been reported in the South Pacific with DC10 and L1011 aircraft on surface treatments (McClung, 1992). The experiences built up have led to an understanding of the limitations and practicalities of surface treatments on these pavements.

In particular, this paper draws on experiences at 8 airports with surface treated pavements and served by airline passenger jet aircraft (Table 1). At these airports, the authors' have been variously involved with new surface treatments, reseals, pavement inspections and full-scale pavement investigations. This experience is combined with the results of recent research into bituminous surfacings for low volume roads in southern Africa by the Council for Scientific and Industrial Research (CSIR) and Southern African Bitumen and Tar Association (SABITA) (Emery et al., 1991).

The main advantage of surface treatments over asphalt is construction cost. Many areas do not have access to an asphalt plant, and the infrastructure to support a mobile asphalt plant in terms of materials sources is poor. If materials have to be transported significant distances, the volume of materials required for surface treatments is less than for a thin asphalt. Under these circumstances, a surface treatment can cost as little as half that of an asphalt.

Surface treatments should not be automatically substituted for asphalt, and the limitations to their use are discussed here. Experience in the use of surface treatments on airport pavements and roads has shown important differences between the two applications. These differences are discussed in terms of design, construction and maintenance. The cost effectiveness of surface treatments is compared to asphalt, and their increased maintenance costs and reduced lives are balanced against construction cost savings.

**TABLE 1 Airports with surface treatment pavements**

| Airport (1) | Main runway (2) | Largest aircraft (3) | Movements[a] (4) |
|---|---|---|---|
| Broome, WA | 2026m x 45m | F28/BAe146<br>Boeing 767 | 8 per day<br>1 per month |
| Carnarvon, WA | 1679m x 30m | F28 | 4 per day |
| Christmas Island, Indian Ocean | 2103m x 45m | Boeing 737 | 4 per week |
| Derby, WA | 1736m x 45m | F28/BAe146 | 4 per day[c] |
| Geraldton, WA | 1981m x 45m | F28/BAe146<br>DC9 | 4 per day<br>1 per month[b] |
| Kalgoorlie, WA | 1828m x 45m | F28/BAe146<br>Boeing 727 | 4 per day<br>1 per month[b] |
| Meekatharra, WA | 2181m x 45m | Boeing 727 | 1 per month[c] |
| Newman, WA | 2072m x 30m | F28/BAe146 | 6 per day |

Notes: a: varies with schedule; b: used or was used as an alternate and aircraft type may vary with fleet changes; c: no longer in use

## SUITABILITY OF FLEXIBLE AIRPORT PAVEMENTS FOR SURFACE TREATMENT

The suitability of flexible airport pavements for surface treatments varies, and surface treatments should not be considered to be a universal substitute for thin asphalt surfacings. Suitable applications are characterised by:

- Location : areas of lower shear stress,
- Traffic : occasional or infrequent trafficking,
- Design aircraft: lower tyre pressures, lighter aircraft.
- Foreign object damage (FOD) control.

<u>Location</u>

Surface treatments are better suited to the low stress locations. Although most of the runway and taxiway has low shear stress from aircraft traffic, the sections with higher shear stress on the surfacing are the runway turning nodes, runway ends (if these are used for $180^o$ turning), intersections, and (to a much lesser extent) the touchdown zone. These areas are less suited to surface treatments, and some special treatment may be necessary. It is very rare to see damage due to aircraft braking, and this is therefore not defined here as a high stress area. Aprons are generally medium stress areas, and parking bays are considered to be very high stress areas.

In the low stress areas, the double surface treatment (10-14mm stone on the lower layer and 5-7mm stone on the upper layer; plus a prime) has proved very successful for new construction. The single surface treatment has been used occasionally for general aviation aircraft <5700kg (such as Laverton, Western Australia), but extrapolating research into its performance on roads (Emery et al., 1991) confirms that it is not suitable for airline passenger jet aircraft.

In the high stress areas, the triple surface treatment (double surface treatment with a thin sand seal on top to fill the voids) or a Cape Seal (single surface treatment with a 13mm or a 19mm stone, and a thin slurry on top which almost fills the voids and creates a strong mosaic; TRH3, 1986) can be used. It may be desirable to use asphalt or concrete or concrete block paving in the high and very high stress areas; this has been done at Broome, for example, where the runway, taxiway and apron have a surface treatment and the parking area for 767 aircraft is concrete.

Traffic

The experience to date has been with airports with infrequent or occasional trafficking, and the suitability of surface treatments for intensive trafficking by airline passenger jet aircraft is not known. Surface treatments have been used on roads at traffic volumes more than 100,000 vehicles per day (Colwill, 1991). The materials requirements are more stringent at higher traffic volumes involving stone polishing/abrasion, and possibly modified bitumens. However with these requirements met, it should be possible to accept some increase in traffic volumes on airport pavements with surface treatments, although the contribution of asphalt to the pavement structural capacity would need to be balanced.

Design aircraft

The suitability of surface treatments decreases with increasing size of design aircraft. For the smallest airline jets (40 tonne class: F28 all variants, BAe146-200), surface treatments are generally suited to all pavements, and good success has been had with these at varying levels of traffic over many years. As the design aircraft size increases (and typically the tyre pressure increases), then surface treatments become less suitable and should be confined to progressively lower traffic frequencies. For the Boeing 767, they are suited only to occasional operations. For the Boeing 747, surface treatments are not recommended.

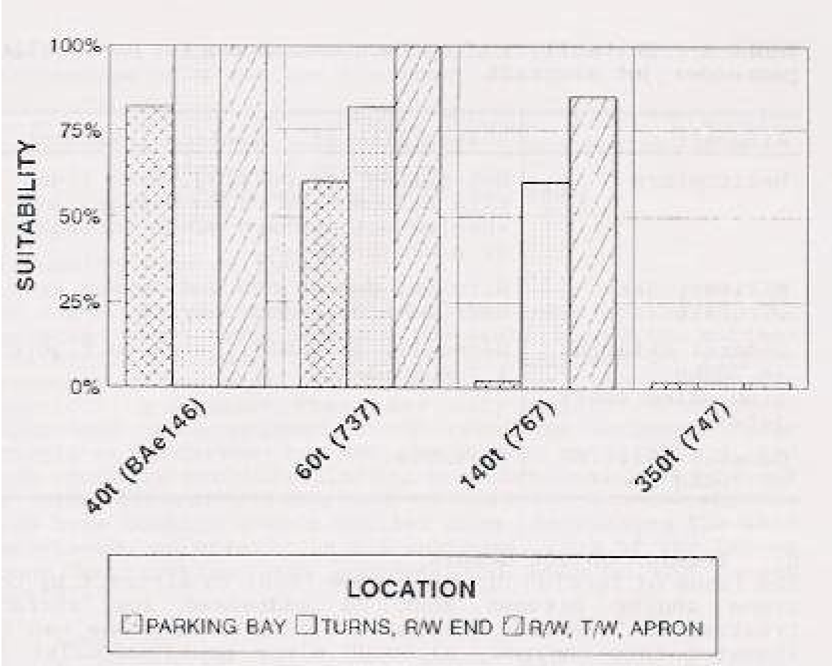


Figure 1. Suitability of surface treatments by aircraft type

The suggested suitability, based on the authors' experience, is shown in Figure 1. The range of design aircraft is 40 tonne, 60 tonne (Boeing 737-400, DC-9, Airbus 320), 140 tonne (Boeing 767-200, Airbus A300), and 350 tonne (Boeing 747). Although this paper addresses airline passenger jet aircraft, the suitability of surface treatments for other aircraft is noted briefly in Table 2.

**TABLE 2 Suitability of surface treatments for non-airline passenger jet aircraft**

| Aircraft | Suitability of a surface treatment |
|---|---|
| Helicopters | Not suited for parking. Even light skid helicopters cause damage, and wheeled helicopters punch through or pick up stones. |
| Military jet aircraft | Marginal due to FOD and damage from narrow high pressure tyres. |
| General aviation >5,700kg (including small jets) | Generally suitable; refer to Figure 1 for guidance. |
| General aviation <5,700kg | Suitable. |

Foreign object damage

The issue of foreign object damage (FOD) to aircraft by the stone and/or bitumen must be addressed for surface treatments. The main problem is that loose stone can be ingested into engines, although minor problems exist if bitumen or stone adhere to the wheels and are flung into the wheel wells or along the underside of the aircraft causing a cleaning problem.

FOD is obviously more of a potential problem with surface treatments than with asphalts, and a specific pavement maintenance programme is essential to deal with it, as discussed later under maintenance. However in over 15 years of airline jet operations on surface treatments, with suitable maintenance, the authors' have encountered no problems with FOD due to stone ingestion.

There have been occasional problems with bitumen in the wheel wells and on the aircraft in the first week after a new seal or reseal, usually when the work has been done in hot weather and the airport is opened to traffic within an hour of completing each stage. These have not caused operational or safety problems.

## DESIGN

The design of a surface treatment for an airport pavement is similar to that for a road. The performance of the pavement depends on the:

- characteristics of the stone and bitumen,
- rate of application of the stone and the bitumen,
- texture depth, development of good adhesion, and initial compaction at the construction stage to obtain a dense interlocking mosaic of stone,

and a number of other factors including the strength and flexural properties of pavement, climate, etc. which are common to roads and well documented (NAASRA, 1975). Only the design differences for airport pavements will be discussed here.

Stone

The suitability of the stone is a key issue in the performance of the surfacing. Experience has been that the testing and validation of stone supplies for airport surface treatments is a more extensive process compared to roads. The stone-related factors that affect the performance of a surface treatment are the:

- spread rate, shape, Average Least Dimension (ALD), Flakiness Index (FI) and nominal size,
- single-sized gradation,
- cleanness and dust content,
- strength, and
- adhesion.

All aggregates used in surface treatments, whether stone, crusher dust or natural sand, should conform to the specific quality recommendations on these factors from the various road or airport authorities.

The shape of the stone affects the interlocking of the compacted stone layer and thus the stability of the surface treatment, and this is especially important on airport pavements. The more angular the stone, the better the interlocking because there are many points of contact. Experience with rounded stone (such as screened river gravels at Carnarvon) has not always been satisfactory, and such stone is probably limited to occasional movements of 40 tonne aircraft. Stone not of uniform size results in firm tyre contact over a smaller area (decreasing the skid resistance, especially in wet weather), loss of the larger stone by plucking, and concentrated wear on the larger particles.

It is essential that the stone has good adhesion characteristics, and these should be retained throughout the life of the surface treatment in order to maintain a stable position under the action of aircraft. The presence of one per cent dust on the stone can result in a substantial loss of stone (TRH 3, 1986). Moist aggregate does not adhere well to bitumens (except bituminous emulsions) and if aircraft are allowed to use the surface treatment coat before adequate bonding has occurred, excessive whip-off can occur.

Precoating improves adhesion and obviates the problems associated with stone that is not free of dust and moisture. Generally speaking, it should be mandatory for airport surface treatments. Adhesion agents (generally of the amine type) are either mixed with the bitumen or applied in a dilutant to the aggregate. Laboratory precoating tests with the actual aggregate and various agents are essential to determine the correct agent and application rate. On occasions it has been necessary to use adhesion agents in both the bitumen and applied to the stone in the precoat (such as Broome with a high percentage of quartz).

Caution should be exercised with the application of diesel to the aggregate as part of a precoat. This acts as a fluxing agent, softening the bitumen for several months leading to a possible loss of stone. Precoating at 6-9 litres/$m^3$ with diesel is equivalent to a flux of 2-4% in the bitumen in the surface treatment.

The aggregate must be strong enough not to break excessively during rolling or under traffic, and this parameter is more critical for airport surface treatments than for roads because of the higher tyre pressures and wheel loads on airports. Recommended tests include the 10 per cent Fines Aggregate Crushing Test (FACT) or the Aggregate Crushing Value (ACV). The Los Angeles abrasion test is not especially applicable to airports since it is a wear test rather than a crushing test. Experience has been that a polished stone value requirement is not generally applicable due to the low traffic on an airport.

The stone must not weather during the life of the surface treatment. This property is more difficult to assess, but is generally specified by a minimum percentage ratio of soaked/dry 10 per cent FACT. In addition to this the stone should be inspected visually for the presence of inferior material, quartz (poor adhesion), and harmful minerals such as pyrite; a hand microscope is recommended.

Various test limits have been adapted from Australian and South African road and airport specifications to give a partial specification for stones for surface treatments on airports (Table 3). Other specifications such as grading can be taken directly from the road specifications.

**TABLE 3 Partial specification for airport sealing aggregates**

| TEST | FUNCTION | SUGGESTED LIMIT |
|---|---|---|
| 10% FACT dry | Aggregate crushing | ≥ 210 kN |
| Ratio soaked/dry 10% FACT | Weathering | ≥ 75% |
| ACV[a] | Aggregate crushing | ≤ 21 |
| Fines | Cleanliness | ≤ 0,5% passing 0,425mm sieve |
| Stripping test | Adhesion | Varies with test type |
| Flakiness Index | Shape | ≤ 30% |

However in some areas, stone which meets this specification is just not available economically, and a marginal stone must be used. In such cases, the use of a triple seal or Cape Seal will give additional support to the stone and ameliorate crushing to an extent.

Bitumen

Retention of the stone, the degree of stone whip-off, and durability are all related to the adhesive forces developed by the bitumen, and in turn depend on the type, grade and amount of bitumen applied. The bitumen must develop early adhesion and cohesive strength, and must be able to withstand "softening-up" under the normal temperature range encountered in service and to retain the stone under the action of moving wheel loads. Bitumen properties that affect the performance of a surface treatment are the:

- grade and type,
- spray rate, and
- durability.

Bitumen grade and type

The climatic conditions in the region where the surface treatment is to be laid affect the correct grade and type of bitumen to cater for. Extremely hot weather will reduce cohesion, and cold weather will result in a brittle, hard binder. Penetration grade bitumens, cut-back bitumens (i.e. bitumen with added cutter), and bitumen emulsions are used as binders for the construction of surface treatments on roads. However on airports penetration grade bitumens are preferable because of their rapid improvement in cohesive properties after spraying. The amount of cutter and flux depends on the climatic conditions. Experience has shown that the amount of cutter should be somewhat reduced on airports relative to roads, and the flux should be substantially reduced. If significant amounts of cutter are required (say > 8%), then the pavement should be kept closed for as long as possible before trafficking, or a specific anti-stripping design used such as a sand seal on top.

Good experience has been found in the warm to hot climate of Western Australia with medium class bitumens (such as Australian Class 160. Typically penetration at 25$^{o}$C/100g/5s,1/10mm of 80-100; viscosity at 60$^{o}$C, Pa.s of 60-130 ASTM D4402). Some work has been done with harder bitumens in warm climates (such as Australian Class 320. Typically penetration at 25$^{o}$C/100g/5s,1/10mm of 60-70; viscosity at 60$^{o}$C, Pa.s of 140-240 ASTM D4402), but no practical benefit could be identified despite the theoretical advantages. There may be a cost penalty with the harder bitumens, and at Broome in 1992 the tendered price was an extra $US0.20/l for the harder bitumen which is approximately $US60,000 for the entire runway.

The use of modified bitumens on roads has indicated properties which may be of benefit to airport surface treatments and where available are worth considering. Compared to penetration grade bitumens, they typically have improved toughness-tenacity properties and improved temperature sensitivity (Van Zyl, 1991). A higher application rate can be used resulting in a thicker bitumen film thickness and reduced voids, and bitumen rubber modified bitumens retain flexibility for longer than unmodified bitumen (Bergh and Thompson, 1991).

Spray rate

The bitumen spray rate (application rate) for airport surface treatments is higher than that for roads, partly because the lower traffic requires a higher design percentage voids filled and partly because bleeding is rarely an issue so the spray rate can go closer to the limit. A minimum spray rate is required to hold the stone firmly in place and bind it to the underlying surface. There is also a maximum spray rate, which, if exceeded, will overfill the voids in the compacted layer and result in low skid resistance, particularly in wet weather.

In Australia, typical spray rates are 1.35 $l/m^2$ cold with a 10mm stone (nominal size, not ALD) and 1.2 $l/m^2$ cold with a 5mm stone (Department of Transport, 1973). At Broome, for example, on a new double seal, the rates used were 1.45 $l/m^2$ cold with a 14mm stone and 1.2 $l/m^2$ cold with a small 7mm stone. It is possible to increase the spray rate on the runway outside the central 10 metres by 0.1-0.2 $l/m^2$ to improve the stone retention in untrafficked areas.

A "split application" of binder (defined below) for double surface treatments can be used to improve early stone retention and avoid any problems of fluxing from a diesel precoat on the top layer of stone, although it is less common now since it is preferred to precoat the top layer of stone instead. Split application and precoated top stone are not combined. The aim of the split application is to provide a fog spray with a hot application rate of 0,8 - 1,0 $l/m^2$ . This fogspray is subtracted from the total (both layers) calculated binder application rate. The remaining binder application rate is divided between the first and second layers in the ratio 60% for the first and 40% for the second (TRH 3, 1986). A disadvantage of the split application is that it closes the voids and a later fogspray (say at 80% life) is usually not possible.

Durability

The main cause of long term deterioration of surface treatments is the hardening of the bitumen. In Australia, this is primarily through a slow thermal reaction which causes oxidation hardening at high pavement temperatures (Dickenson, 1982). There is an Australian Road Research Board Durability Test for bitumen which has been adopted by most authorities in Australia and its use is recommended to ensure that the bitumen has good durability characteristics.

Texture depth, adhesion and compaction

The design of airport surface treatments should provide for mechanical interlock and support between the stones, and only slight protrusion of the stone above the bitumen. Stones which protrude far above the bitumen are likely to be plucked out by aircraft tyres, especially in turns. A low surface texture is therefore desirable. Experience has also shown that the stone on the upper layer should have a maximum nominal size of 7mm (maximum size - not average least dimension which is smaller). The use of larger stone leads to tyre shredding or excessive tyre wear on wheel spin-up in the touchdown zone.

In the early stages of introducing airline jets to runways with surface treatments, larger stones were experimented with. At Karratha Airport in the mid-1970s, a 10mm top stone gave a very high surface texture of 1.7-3.3mm, but caused unacceptable tyre wear in just four movements of a Gulfstream II (Tuisk, 1977). The runway was urgently rolled with a steel wheel roller and the touchdown area resealed with a smaller size aggregate. No data are available on the grading and ALD of the original stone, but from the unusually high rate of tyre wear, it is suspected that this was a particularly 'large and angular' 10mm stone.

Some texture depth is required to alleviate reverted rubber and viscous skidding problems. A limit of a minimum of 0.5mm and desirably 1mm has been used in Australia (Tuisk, 1977). There is no maximum value yet specified. Measurements at a number of airports across Australia gave general values in the range 1-2mm for surface treatments (isolated examples in the range 0.5-1.0mm), in the range of 0.25-1.00mm for ungrooved asphalts, and in the range 1.0-2.0mm for grooved asphalts; all using the grease patch method. The texture depth of a Cape Seal is usually low (it presents the appearance of an asphalt), and it is not recommended for use along an entire runway; however it is useful for runway ends and turning nodes.

The final control of texture depth on a new surface treatment or a reseal is best done at construction, and this is discussed below.

## CONSTRUCTION

Construction of surface treatments at airports is similar to that on roads. The main differences are rolling and control of texture depth. Rolling is more important on airport pavements than roads, because of their lack of subsequent trafficking. An Australian specification is 1 roller hour per 450 litres of bitumen sprayed for the first seal and again for the second seal (Department of Transport, 1973). This is at least twice the rolling applied on road construction, and close supervision of the contractor is needed to achieve it. Indeed practical experience is that the supervision of an airport surface treatment is very important, and it is somewhat unsatisfactory to leave the project to a supervisor experienced only in road construction.

The final control of texture depth is best done at construction. For runways where operations of medium to large airline jets are envisaged, a prudent construction method is to adjust the average texture of the pavement by applying steel rolling using static three point steel rollers.

At Broome on a new double seal for Boeing 767 aircraft, the high strength of the aggregate meant that static steel rolling did not significantly reduce the texture, and there was concern about stones being stripped during turns. Therefore at the runway ends, a large vibrating steel roller was used to crush the stone. It was observed during 767 operations that some minor stripping occurred while the aircraft was travelling in a straight line on the area just prior to the vibrating steel rolled area. This stripping ceased completely once the aircraft, still travelling in a straight line, reached the area where the surface texture had been reduced. Stripping still occurred where the aircraft was forced to do a minimum radius turn, though clearly the reduction of the surface texture in this area prevented major stripping.

## MAINTENANCE

Maintenance of a surface treatment on an airport comprises mainly patching, rolling, sweeping, fogsprays and reseals. Early and ongoing maintenance of an airport surface treatment is essential, and in countries which lack an institutional capability for maintenance, surface treatments are not recommended. Experience has shown that most surface treatments will be damaged by airline jet aircraft during the initial period of their life, particularly at turning areas and to a lesser extent at touchdown areas. It is common in Australia to issue a NOTAM during this initial period requesting "maximum radius turns at minimum speed". Even then, at the very least, there is rollover and stripping of stone at the inside wheels on turns and this has to be patched. The preferred patch method is to sweep the stone back in and then overlay with a thin sand-cement grout (mix of 1:4 cement to sand) and roll in.

One solution is to leave new work closed to aircraft for a month and only traffic it with a maintenance roller. This is not as impractical as it seems, particularly in the case of a surface treatment on a new pavement. Another solution is to use a triple seal or Cape Seal for the high stress areas.

### Rolling

Rolling can be an important component of maintenance in the first year or two after sealing or resealing, to compensate for the lack of trafficking. The pavement is rolled during warm weather (surface warm to touch) to knead the stones and bitumen and to push in loose stone. A suitable roller type is the pneumatic tyred roller, with 11 wheels, and an unballasted weight of 6 tonnes which can be ballasted to 12 tonnes. Tyre pressures should be about 600 kPa.

This type of maintenance rolling is negligible in structural terms. With a 12 tonne roller on a pavement designed for 40 tonne aircraft, and taking load equivalencies into account at an exponent of 4 (TRH 4, 1985), six months of maintenance rolling at 3 hours/day on a 2,000m x 45m pavement is structurally equivalent to one aircraft movement. However the effect of the roller on the surface treatment is much greater. It can be assumed that in terms of the trafficking effect on the surface treatment, 1 roller is equivalent to 15 light vehicles (TRH 3, 1986), and so the same six months maintenance rolling is equivalent to 1200 vehicles trafficking.

Practical experience with maintenance rolling has been good, although difficult to quantify. The need varies with each surface treatment. At Broome (new work, double seal), rolling was performed for 3 hours daily for a month after sealing. At Christmas Island (reseal), rolling was performed for 3 hours daily for the first few months. The positive effect in re-embedding loose aggregate can easily be observed. At Newman (reseal with a fogspray shortly afterwards to reduce the stripping), no rolling was needed after the fogspray, although the number of aircraft coverages at Newman is in the order of ten times higher than Christmas Island.

An example of contrary maintenance was observed at Christmas Island (Thomas, 1992), with excessive stripping, which was noted as a combination of failure to continue maintenance rolling, along with excess sweeping with mechanical brooms during warm weather (daily air temperature range 22-28$^{o}$C) on a surface treatment which was only a year old.

Brooming

Periodic brooming (or sweeping) of a surface treatment is required every month or two to remove loose stone, although it is noted that brooming of any surfacing type is needed periodically to maintain a clean runway from the FOD viewpoint. Brooming should be reserved for the cooler times of the day (surface cool to touch). The broom pressure should be adjusted so that it is not actually picking out stone.

Brooming is a low cost maintenance option. It is possible to reduce the frequency by applying a fogspray (provided there is adequate texture). However the cost of a fogspray is equivalent to five years of daily brooming in the cooler seasons, even before the need to broom for FOD containment, is considered.

Fogspray

A fogspray can be used to improve stone retention, particularly if the bitumen is oxidised and brittle. The application of a fogspray (usually of emulsion diluted 50% with water, and sprayed at 1 $l/m^2$) is usually triggered by an increase in the amount of loose stone. If the brooming frequency has to be increased to more than once a month, this is usually an indication of problems and a fogspray should be considered. The fogspray reduces the texture depth, and its use is therefore limited by considerations of skid resistance.

Sand seal

If stripping of stone from a surface treatment is noted in its early life, a sand seal may be useful on top to reduce texture depth, and improve stone retention in high stress areas.

Resealing

It is important for good performance that resealing of surface treatments be done before the integrity and impermeability of the surface treatment is lost. Reseal intervals range from 7 to 10 years, depending on climate (oxidation) and seal performance (stone loss). The two are inter-related, and experience is that a reseal is generally indicated by an increase in stone loss after several years of stable conditions. A fogspray can be used to extend the period before resealing. Interestingly, the higher binder application possible on an airport surface treatment with the subsequent increase in binder film thickness and increase in life seems to be countered by a reduction in life due to the low levels of trafficking on an airport.

## COSTS

The primary advantage of a surface treatment over asphalt is construction cost, and this is particularly important in outlying areas without a local asphalt plant, which is the case over large parts of Australia and Africa.

Experience has shown that in these outlying areas, the main cost variable is the supply of stone (the authors' experience includes stone hauls of 700 km by road at Meekatharra and 800 km by rail at Forrest). The cost to haul and spray bitumen in remote areas is in the same order of magnitude as non-remote areas.

To quantify the cost differential, a lifecycle cost analysis was performed for a new flexible pavement surfacing in a remote area for the range of surfacings shown in Table 4. The analysis was performed over a 30 year period, and lifecycle cost was calculated from construction and major maintenance costs, and expressed as present worth of costs, discounted at 8% real rate.

The construction cost included bitumen and stone buy, haul and apply, job establishment costs (also known as mobilisation, P&Gs, or set-up), camp and accommodation, site engineer's fee, profit, contingency, and basecourse sweeping. The cost of a prime was considered to be common to all new surfacings and was omitted. The construction costs were taken from a study which considered 27 combinations of size, location and cost in South Africa (Wright et. al., 1990), and were adjusted to 1993 costs and converted to $US. The costs used here were for a typical 90,000 $m^2$ project with a bitumen haul of 300km and a stone haul of 100km. These were then checked against recent tender prices at Australian airports and good agreement was found.

The cost of grooving was not included for asphalt, since its use is partially climate and traffic dependent. It would however add significantly to the cost of the asphalt and would increase the differential between asphalt and surface treatment. The routine maintenance cost of brooming, crack sealing and patching was assumed to be the same for all surfacings and not included. Even for brooming, this is considered reasonable because asphalt pavements need to be broomed at similar frequencies as pavements with surface treatments to remove foreign objects. The additional routine maintenance cost of rolling was added to the cost of surface treatments. Major maintenance costs such as overlays and reseals were included as noted in Table 4.

The lifecycle costs are shown in Figure 2. The lifecycle cost of surface treatments is less than that of the thinnest asphalt pavement, even though the lives are shorter. The "double seal and repairs" option was included to show the cost implications of problems with the surface treatment; this example required two fogsprays over the entire runway and a sand seal on the high stress areas. Even with the cost of the repairs, the lifecycle cost of the 25mm asphalt was 40.8% higher than this.

The cost analysis suggests that it is probably justified to vary the surface treatment for the low and the high stress areas from the start. The cost of the 'double/triple seal' option was only 7.7% higher than the 'double seal' alone; but the 'double seal & repairs' was 29.0% higher than the 'double seal' alone.

**TABLE 4 Surfacings analyzed by lifecycle cost in Figure 2**

| Surfacing | Construction cost | Pavement history |
|---|---|---|

| (1) | $US/sq.m.<br>(2) | (3) |
|---|---|---|
| Asphalt 25mm | $4.20 | Initial surfacing of 25mm asphalt; overlay every 16 years with 25mm asphalt |
| Asphalt 50mm | $6.35 | Initial surfacing of 50mm asphalt; overlay every 16 years with 25mm asphalt |
| Double seal | $2.23 | Initial surfacing of double seal; resealed every 10 years with single seal |
| Double/triple | varies | Initial surfacing of double seal in low stress areas and triple seal in high stress areas; resealed every 10 years with single seal |
| Triple seal | $3.04 | Initial surfacing of triple seal; resealed every 10 years with single seal |
| Double seal & repairs | varies | Initial surfacing of double seal which is unsuccessful; fogspray at years 1 and 8, sand seal in high stress areas at year 1; resealed every 10 years with single seal |

Sensitivity analysis

In the sensitivity analysis, a 25mm asphalt was compared with a double/triple seal. The four alternatives were:

- asphalt cost reduced by two-thirds,
- surface treatment cost increased by one-third,
- surface treatment life reduced to 7 years,
- asphalt life increased to 20 years.

The results are shown in Figure 3 and confirm that lifecycle cost differential between asphalt and surface treatments is robust.

Rapid assessment

To enable the lifecycle cost differential between a surface treatment and a 25mm asphalt to be rapidly assessed, Figure 4 was developed. This is used by entering the construction cost of each (the Figure is dimensionless so any currency can be used), and the surfacing choice can be quickly seen.

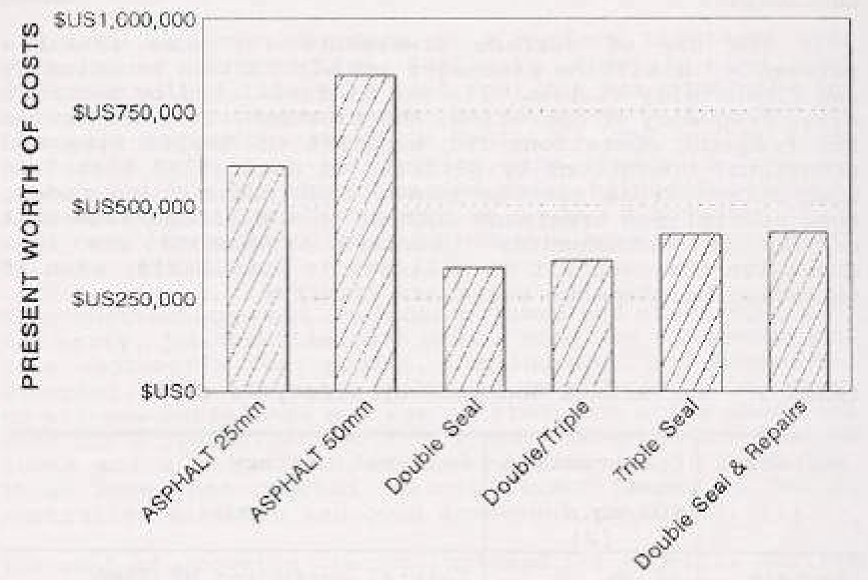


Figure 2. Lifecycle costs of various surfacings

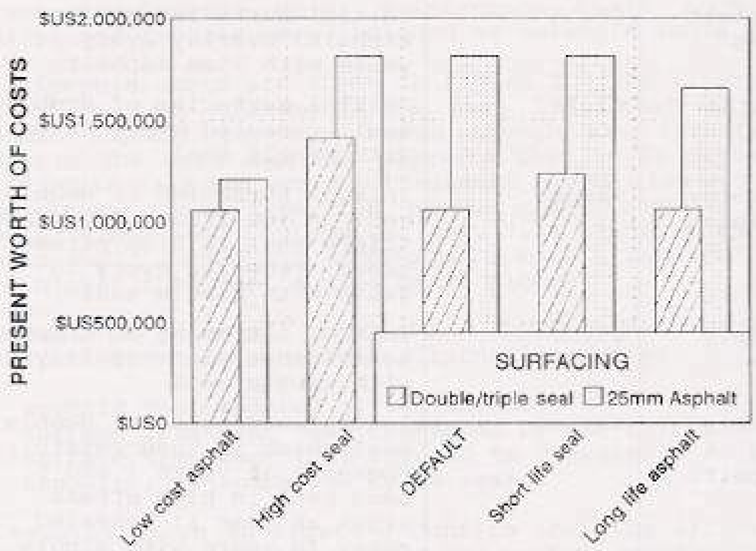


Figure 3. Sensitivity of lifecycle costs

## CONCLUSIONS

The use of surface treatments for some flexible pavements for airline passenger jet aircraft is technically and financially viable. Its use is restricted by aircraft size, frequency of operation, and location. They are suited for frequent operations for aircraft of BAe146 size and occasional operations by aircraft of

Boeing 767 size. In high stress areas such as runway ends and turning nodes, some specialised treatment such as an additional sand seal on top is recommended.

There are a number of differences between surface treatments on airports and on roads. In design for airports, they are characterised by small stone sizes, angular stone, mandatory precoating of stone, and higher bitumen application rates. In construction they are characterised by increased rolling and careful control of texture depth. In maintenance they are characterised by maintenance rolling, patching and brooming.

The lifecycle cost of various surface treatments and asphalts has been calculated on a present worth of costs basis over a 30 year analysis period. The surface treatments are less expensive than asphalt, even if excessive maintenance costs are incurred. A sensitivity analysis of construction cost and surfacing life confirm this.

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Wright, B., Emery, S., Wessels, M., Wolff, H. (1990). "Appropriate standards for effective bituminous seals: cost comparisons of paved and unpaved roads." Contract report 89/1 for SABITA, DRTT, CSIR, Pretoria.

**KEYWORDS**
AIRPORTS, ASPHALTS, BENEFIT COST ANALYSIS, BITUMEN, PAVEMENTS

# Appendix C – Runway Pavement Making

- **Estimate**
- **Drawings - 1200m Runway (C02-B)**
  **- 900m Runway (C03-B)**

## APPENDIX - C

## Runway Markings - Estimate

| | | Area (m2) | Rate $/m2 | Amount |
|---|---|---|---|---|
| **Existing Runway** | Runway Threshold (Both Ends) | 864 | 20 | $ 17,280 |
| | Runway Designation (16 & 34) | 54 | 20 | $ 1,080 |
| | Centreline Markings | 210 | 20 | $ 4,200 |
| | Taxiway Markings | 68 | 20 | $ 1,360 |
| | Hold Markers and Words | 28 | 20 | $ 560 |
| | **TOTAL** | **1224** | | **$ 24,480** |
| **Runway Extension** | Runway Threshold Northern End | 462 | 20 | $ 9,240 |
| | Runway Designation (16 ) | 27 | 20 | $ 540 |
| | Aiming Point Markers | 1440 | 20 | $ 28,800 |
| | Centreline Markings | 120 | 20 | $ 2,400 |
| | Taxiway Markings | 0 | 20 | $ - |
| | Hold Markers | 0 | 20 | $ - |
| | Removal of Threshold Markings | 164 | 10 | $ 1,640 |
| | **TOTAL** | **2213** | | **$ 42,620** |


| Revision | Amendment | Approved | Revision Date |
|---|---|---|---|
| B | ISSUED FOR MASTERPLAN | BJ | 10/03/2017 |

WAIROA DISTRICT COUNCIL

OPUS
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Private Bag 6019
Napier 4142
New Zealand

| Designed | Approved | Approved Date |
|---|---|---|
| B. THOMSON | B. JONES | 11/01/2017 |

| Drawn | Scales |
|---|---|
| B. THOMSON | NOT TO SCALE |

Project
WAIROA DISTRICT COUNCIL
WAIROA AERODROME
RUNWAY EXTENSION

Sheet
RUNWAY MARKINGS
900m RUNWAY

| Project No. | Sheet. No. | Revision |
|---|---|---|
| 2-S5091.VT | C02 | B |

Original Sheet Size A1 [841x594] Plot Date 2017-03-14 at 2:02:30 p.m. Path S:\Proj\NZ\2Y\2-Y1300.DM Wairoa DC TAM\Home\2_S51870.VT Wairoa Airport\Wairoa Airport.dwg C02 (B)


| Revision | Amendment | Approved | Revision Date |
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| B | ISSUED FOR MASTERPLAN | BJ | 10/03/2017 |

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Napier 4142
New Zealand

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|---|---|---|
| B. THOMSON | B. JONES | 11/01/2017 |

| Drawn | Scales |
|---|---|
| B. THOMSON | NOT TO SCALE |

Project
WAIROA DISTRICT COUNCIL
WAIROA AERODROME
RUNWAY EXTENSION

Sheet
RUNWAY MARKINGS
1200m RUNWAY

| Project No. | Sheet. No. | Revision |
|---|---|---|
| 2-S5091.VT | C03 | B |

Original Sheet Size A1 [841x594]   Plot Date 2017-03-14 at 2:02:04 p.m.   Path S:\Proj\NZ\2Y\2-Y1300.DM Wairoa DC TAM\Home\2_S51870.VT Wairoa Airport\Wairoa Airport.dwg C03 (B)

# Appendix D – Runway Lighting

- **Westport - Tender Schedule**
- **Westport - Estimate Schedule**
- **Westport - Lighting Layout Drawing**

# 1 Schedule of Quantities

| Schedule of Quantities: Contract 10925 | | | | | |
|---|---|---|---|---|---|
| **Item** | **Description** | **Unit** | **Qty** | **Rate** | **Amount** |
| **1.0** | **Construction Management** | | | | |
| 1.1 | Buller District Council Site Registration, Induction and Site Specific Management | LS | 1 | | 2200.00 |
| 1.2 | Construction Programme | LS | 1 | | 400.00 |
| 1.3 | Health and Safety Plan and Implementation | LS | 1 | | 500.00 |
| 1.4 | Quality Management Plan and Implementation | LS | 1 | | 600.00 |
| | | | | | |
| **2.0** | **Establishment** | | | | |
| 2.1 | General | LS | 1 | | 1225.00 |
| 2.2 | Liaison with Generator Supplier | LS | 1 | | 100.00 |
| 2.3 | Liaison with Airways Corporation for A-PAPI's and cable rerouting | LS | 1 | | 100.00 |
| 2.4 | Liaison with Buller Electricity for transformer upgrade | LS | 1 | | 200.00 |
| | | | | | |
| **3.0** | **Structure** | | | | |
| 3.1 | Foundation Structure | LS | 1 | | 17000.00 |
| 3.2 | Reinstatement of pavement/ground | LS | 1 | | 1207.00 |
| | | | | | |
| **4.0** | **Electrical Installation** | | | | |
| 4.1 | Supply and installation of the new mains cable from new 55kVA transformer to MSB in new generator building | LS | 1 | | 20500.00 |
| 4.2 | Supply and installation of sub mains from MSB to terminal building | LS | 1 | | 14955.00 |
| 4.3 | Supply and installation of Main Switchboard | LS | 1 | | 7980.00 |
| 4.4 | Rerouting of the cable from the old control tower towards the generator building | LS | 1 | | 2840.00 |
| 4.5 | Lighting and general purpose power in Generator building | LS | 1 | | 3970.00 |
| 4.6 | Supply and installation of control cables between Generator and changeover switchgear | LS | 1 | | 9540.00 |
| 4.7 | Installation of runway edge lights and cables | LS | 1 | | 48376.00 |
| 4.8 | Installation of turning bay edge lights and cables | LS | 1 | | 4476.00 |
| 4.9 | Installation of runway end / threshold lights and cables | LS | 1 | | 7452.00 |
| 4.10 | Installation of taxiway edge lights and cables | LS | 1 | | 12850.00 |
| 4.11 | Installation of visual approach slope indicator and cables on both end of runway | LS | 1 | | 11054.00 |
| 4.12 | Installation of windsock lighting and cables on both end of runway and in front of terminal. | LS | 1 | | 11804.00 |
| 4.13 | Installation of aerodrome beacon | LS | 1 | | 1532.00 |
| 4.14 | Installation of day / night mode lighting system | LS | 1 | | 500.00 |
| 4.15 | Installation of a pilot activation system | LS | 1 | | 500.00 |

| Schedule of Quantities: Contract 10925 | | | | | |
|---|---|---|---|---|---|
| **Item** | **Description** | **Unit** | **Qty** | **Rate** | **Amount** |
| 4.16 | Electrical testing and Commissioning | LS | 1 | | 4000.00 |
| 4.17 | Supply and installation of airfield lighting manual control cable between generator building and terminal | LS | 1 | | 12470.00 |
| 4.18 | Supply and installation of airfield lighting manual control panel inside the terminal | LS | 1 | | 1000.00 |
| | | | | | |
| **5.0** | **Generator Positioning and connecting** | | | | |
| 5.1 | Generator uplift and placement in new building | LS | 1 | | 480.00 |
| 5.2 | Installation of Vent ducting | LS | 1 | | 1500.00 |
| 5.3 | Generator testing and commissioning | LS | 1 | | 500.00 |
| | | | | | |
| **6.0** | **As-Built Drawings and Documentation** | LS | 1 | | 4000.00 |
| | | | | | |
| **7.0** | **Dayworks** | | | | |
| 7.1 | Labour | hr | 20 | | 1000.00 |
| 7.2 | Digger | hr | 20 | | 1600.00 |
| 7.3 | Truck | hr | 20 | | 1600.00 |
| 7.4 | Loader | hr | 20 | | 1600.00 |
| 7.5 | Excavate to Waste | $m^3$ | 20 | | 400.00 |
| 7.8 | Other Materials | % | $1000 | | 1150.00 |
| | | | | | |
| **8.0** | **Provisional Sum** | | | | |
| | Relocation of existing underground services if necessary | PS | 1 | $3000.00 | $3000.00 |
| | | | | | |
| **Schedule Total (Excl. GST)** | | | | | **216161.00** |
| | | | | | |

Tenderer's Name Kevin E. Jackson

Address: 63 Palmerston Street, Westport

Signature: K. E. Jackson

Date: 21/01/2008

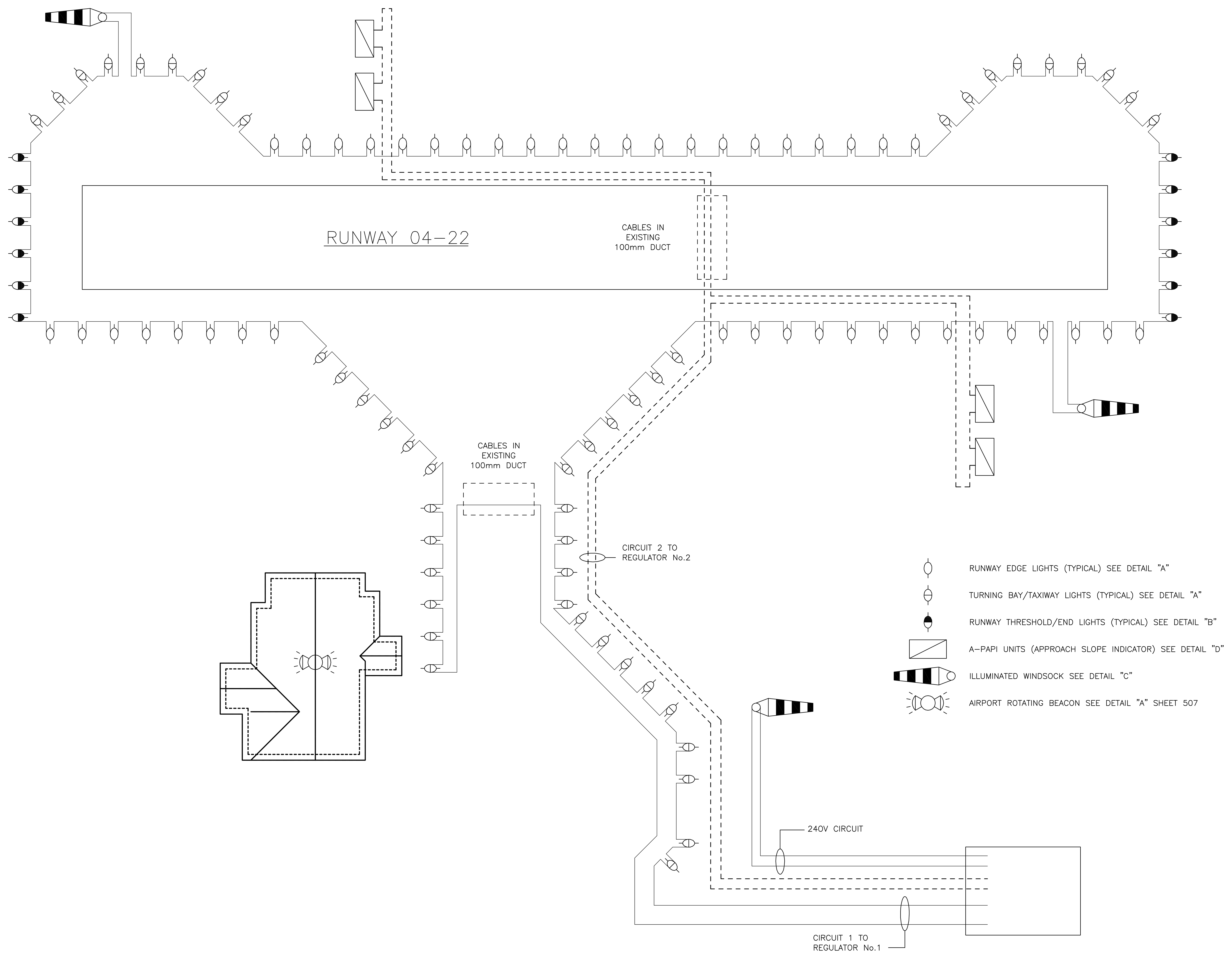
Telephone No: 03 789 7662

Facsimile No:

## Schedule of Quantities: Contract 10925 Westport Airport Lighting Upgrade 21-11-2007

| Description | Unit | Qty | Rate | Amount | Estimate |
|---|---|---|---|---|---|
| **Construction Management** | | | | | |
| Buller District Council Site Registration, Induction and Site Specific Management | LS | 1 | | | $500.00 |
| Construction Programme | LS | 1 | | | $500.00 |
| Health and Safety Plan and Implementation | LS | 1 | | | $500.00 |
| Quality Management Plan and Implementation | LS | 1 | | | $500.00 |
| | | | | | |
| **Establishment** | | | | | |
| General | LS | 1 | | | |
| Liaison with Generator Supplier | LS | 1 | | | $500.00 |
| Liaison with Airways Corporation for A-PAPI's and cable rerouting | LS | 1 | | | $1,000.00 |
| Liaison with Buller Electricity for transformer upgrade | LS | 1 | | | $500.00 |
| | | | | | |
| **Structure** | | | | | |
| Foundation Structure and Genereator building assembly | LS | 1 | | | $8,000.00 |
| Reinstatement of pavement/ground | LS | 1 | | | $3,000.00 |
| | | | | | |
| **Electrical Installation** | | | | | |
| Supply and installation of the new mains cable from new 55kVA transformer to MSB in new generator building | LS | 1 | | | $13,300.00 |
| Supply and installation of sub mains from MSB to terminal building | LS | 1 | | | $14,000.00 |
| Supply and installation of Main Switchboard | LS | 1 | | | $4,500.00 |
| Rerouting of the cable from the old control tower towards the generator building | LS | 1 | | | $500.00 |
| Lighting and general purpose power in Generator building | LS | 1 | | | $850.00 |
| Supply and installation of control cables between Generator and changeover switchgear | LS | 1 | | | $1,500.00 |
| Installation of runway edge lights and cables | LS | 1 | | | $36,500.00 |
| Installation of turning bay edge lights and cables | LS | 1 | | | $7,250.00 |
| Installation of runway end / threshold lights and cables | LS | 1 | | | $4,500.00 |
| Installation of taxiway edge lights and cables | LS | 1 | | | $14,750.00 |
| Installation of visual approach slope indicator and cables on both end of runway | LS | 1 | | | $22,500.00 |
| Installation of windsock lighting and cables on both end of runway and in front of terminal. | LS | 1 | | | $3,000.00 |
| Installation of aerodrome beacon | LS | 1 | | | $600.00 |
| Installation of day / night mode lighting system | LS | 1 | | | $700.00 |
| Installation of a pilot activation system | LS | 1 | | | $700.00 |
| Electrical testing and Commissioning | LS | 1 | | | $2,000.00 |
| Supply and installation of airfield lighting manual control cable between generator building and terminal | LS | 1 | | | $2,000.00 |
| Supply and installation of airfield lighting manual control panel inside the terminal | LS | 1 | | | $1,000.00 |
| | | | | | |
| **Generator Positioning and connecting** | | | | | |
| Generator uplift and placement in new building | LS | 1 | | | $3,000.00 |
| Installation of Vent ducting and building sound proofing | LS | 1 | | | $20,000.00 |
| Generator testing and commissioning | LS | 1 | | | $2,500.00 |
| | | | | | |
| **As-Built Drawings and Documentation** | LS | 1 | | | $500.00 |
| | | | | | |
| **Daywork excluded from estimate - Included in pricing schedule to establish contractor rates for for variations if required.** | | | | | |
| | | | | | |
| **Provisional Sum** | | | | | |
| Relocation of existing underground services if necessary | PS | 1 | $3,000.00 | $3,000.00 | $3,000.00 |
| | | | | | |
| Contingency (10%) | | | | | $17,415.00 |
| | | | | | |
| | | | | | |
| **Additional Cost** | | | | | |
| Supply of Airfield Lighting Equipment | PS | 1 | | | $132,567.75 |
| Generator Set | PS | 1 | | | $23,900.00 |
| OPUS International Consultant fees | PS | 1 | | | $27,380.00 |

**Grand Total** **$375,412.75**




PRIMARY CIRCUIT DIAGRAM
NOT TO SCALE

07/08/2009 7:48

GRAPHIC SCALES: 0, 10 mm, 50, 100, 200, 300 mm

**AS BUILT**
CERTIFIED TRUE
AS BUILT RECORD
*Contractor:* Buller Refrigeration and Electrical
*Signed:*..............................
*Date:* 06/08/2009

| AMENDMENT | APP'D | DATE |
|---|---|---|
| RAB – AS BUILT | JEB | 08/09 |

| | BY | CHECKED | DATE |
|---|---|---|---|
| DESIGN | RSD | PJD | 08/07 |
| DRAWN | RSD | JEB | 08/07 |
| APPROVED | | | |



BULLER DISTRICT COUNCIL

OPUS
*Christchurch*
***Mechanical & Electrical***
*PO Box 1482*
*Christchurch, New Zealand*
*Tel: +64 3 363 5400*
*Fax: +64 3 365 7858*

*TITLE*
WESTPORT AIRPORT
Buller District Council
Brougham Street, PO Box 21
Westport 7825

RUNWAY EDGE LIGHTING
CIRCUIT DIAGRAM

| STATUS | AS BUILT | | |
|---|---|---|---|
| SCALE: N.T.S. | PLOT DATE: 06/08/09 @ 08:32 | | |
| FILE: 1–42151.00 | | | |
| FEATURE IDENTIFIER: 6/398/24 | CODE: 7603 | SHEET: 506 | REVISION: RAB |

g:\projects\local authorities\1–42151.00 westport airport\10 cad drawings\500 electrical\6–398–24–7603–506_rab.dwg – 506 *ORIGINAL SHEET SIZE A1 [840x594]*

# Appendix E – Runway Extension

- **Estimate**
- **Drawings - Runway Extension (C04-B – C07-B)**
- **Loganstone – WDC Airport – Land Feasibility Report**

## APPENDIX - E

## RUNWAY EXTENSION - ROUGH ORDER COST ESTIMATE

**"CONSERVATIVE"**

**300m long x 30m wide**

| Item | Unit | Quantity | Rate | Cost | Assume CBR>4 |
|---|---|---|---|---|---|
| AC surfacing (18m wide + Turn around) | m2 | 5760 | $48.00 | $276,480.00 | 50AC |
| Chipseal runway sides - G3/5/6 | m2 | 3240 | $13.00 | $42,120.00 | G3/5/6 |
| 100mm Basecourse | m3 | 900 | $120.00 | $108,000.00 | 100BC |
| 200mm Subbase | m3 | 1800 | $85.00 | $153,000.00 | 200SB |
| Cut to waste 300mm | m3 | 3150 | $20.00 | $63,000.00 | |
| Subsoil / SWC Drains | m | 600 | $90.00 | $54,000.00 | |
| Runway Lighting (Extension Only) | LS | 100% | $95,000.00 | $95,000.00 | |
| Runway Marking (Extension Only) | LS | 100% | $42,460.00 | $42,460.00 | |
| Land required for RESA | Ha | 2.56 | $18,500.00 | $47,360.00 | $15k - $22K/Ha |
| Removal of Existing Fences | Km | 3.80 | $6,500.00 | $24,700.00 | $7.5 - $10/m |
| Construction of New Fences | Km | 2.25 | $20,000.00 | $45,000.00 | $15 - $20/m |
| P&G | LS | 100% | $30,000.00 | $30,000.00 | |
| Proff. services | LS | 4% | $981,120.00 | $39,244.80 | |
| Contingency | LS | 10% | $1,020,364.80 | $102,036.48 | |

**TOTAL** **$1,122,401.28**

**"BEST CASE SCENARIO"**

| Item | Unit | Quantity | Rate | Cost | Assume CBR>4 |
|---|---|---|---|---|---|
| AC surfacing (18m wide + Turn around) | m2 | 5760 | $42.00 | $241,920.00 | 50AC |
| Chipseal runway sides - G3/5/6 | m2 | 3240 | $12.50 | $40,500.00 | G3/5/6 |
| 100mm Basecourse | m3 | 900 | $95.00 | $85,500.00 | 100BC |
| 200mm Subbase | m3 | 1800 | $75.00 | $135,000.00 | 200SB |
| Cut to waste 300mm | m3 | 3150 | $20.00 | $63,000.00 | |
| Subsoil / SWC Drains | m | 600 | $75.00 | $45,000.00 | |
| Runway Lighting (Extension Only) | LS | 100% | $75,000.00 | $75,000.00 | |
| Runway Marking (extn) | LS | 100% | $42,460.00 | $42,460.00 | |
| Land required for RESA | Ha | 2.56 | $15,000.00 | $38,400.00 | $15k - $22K/Ha |
| Removal of Existing Fences | Km | 3.80 | $5,000.00 | $19,000.00 | $7.5 - $10/m |
| Construction of New Fences | Km | 2.25 | $15,000.00 | $33,750.00 | $15 - $20/m |
| P&G | LS | 100% | $30,000.00 | $30,000.00 | |
| Proff. services | LS | 4% | $849,530.00 | $33,981.20 | |
| Contingency | LS | 10% | $883,511.20 | $88,351.12 | |

**TOTAL** **$971,862.32**

**"Cost of Alternative Surfacing"**

| Item | Unit | Quantity | Rate | Cost |
|---|---|---|---|---|
| Capeseal/Slurry surfacing (18m wide + Turn around) | m2 | 5760 | $17.50 | $100,800.00 |


FOR DISCUSSION

| Revision | Amendment | Approved | Revision Date |
|---|---|---|---|
| B | ISSUED FOR MASTERPLAN | BJ | 10/03/2017 |

WAIROA DISTRICT COUNCIL

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Private Bag 6019
Napier 4142
New Zealand

| Designed | Approved | Approved Date |
|---|---|---|
| B. THOMSON | B. JONES | 11/01/2017 |

| Drawn | Scales |
|---|---|
| B. THOMSON | 1:2000 [A1] 1:4000 [A3] |

Project
WAIROA DISTRICT COUNCIL
WAIROA AERODROME
RUNWAY EXTENSION

Sheet
PLAN VIEW

| Project No. | Sheet. No. | Revision |
|---|---|---|
| 2-S5091.VT | C04 | B |

1:2000 @ A1
1:4000 @ A3
0 20 40 60 80 100 120 140 160 180 200 m

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CONTOUR DATA SOURCED FROM HAWKE'S BAY REGIONAL COUNCIL LiDAR DATA

1:2000 @ A1
1:4000 @ A3
0 20 40 60 80 100 120 140 160 180 200 m

| Revision | Amendment | Approved | Revision Date |
|---|---|---|---|
| B | ISSUED FOR MASTERPLAN | BJ | 10/03/2017 |
| | | | |

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| Designed | Approved | Approved Date |
|---|---|---|
| B. THOMSON | B. JONES | 11/01/2017 |
| **Drawn** | **Scales** | |
| B. THOMSON | 1:2000 [A1] 1:4000 [A3] | |

Project
WAIROA DISTRICT COUNCIL
WAIROA AERODROME
RUNWAY EXTENSION

Sheet
LiDAR CONTOURS

| Project No. | Sheet. No. | Revision |
|---|---|---|
| 2-S5091.VT | C05 | B |

Original Sheet Size A1 [841x594] Plot Date 2017-03-14 at 11:10:49 a.m. Path S:\Proj\NZ\2Y\2-Y1300.DM Wairoa DC TAM\Home\2_S51870.VT Wairoa Airport\Wairoa Airport.dwg C05 (B)


LEGEND

LAND TO BE PURCHASED

| Revision | Amendment | Approved | Revision Date |
|---|---|---|---|
| B | ISSUED FOR MASTERPLAN | BJ | 10/03/2017 |
| C | AREA C ADDED | BJ | 22/03/2017 |

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Private Bag 6019
Napier 4142
New Zealand

| Designed | Approved | Approved Date |
|---|---|---|
| B. THOMSON | B. JONES | 11/01/2017 |

| Drawn | Scales |
|---|---|
| B. THOMSON | NOT TO SCALE |

Project
WAIROA DISTRICT COUNCIL
WAIROA AERODROME
RUNWAY EXTENSION

Sheet
## LAND REQUIREMENT PLAN

| Project No. | Sheet. No. | Revision |
|---|---|---|
| 2-S5091.VT | C06 | C |

Original Sheet Size A1 [841x594] Plot Date 2017-04-03 at 2:36:42 p.m. Path S:\Proj\NZ\2Y\2-Y1300.DM Wairoa DC TAM\Home\2_S51870.VT Wairoa Airport\Wairoa Airport.dwg C06 (C)


300 mm
200
100
50
10 mm
0

| Revision | Amendment | Approved | Revision Date |
|---|---|---|---|
| B | ISSUED FOR MASTERPLAN | BJ | 10/03/2017 |

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New Zealand

| Designed | Approved | Approved Date |
|---|---|---|
| B. THOMSON | B. JONES | 11/01/2017 |

| Drawn | Scales |
|---|---|
| B. THOMSON | NOT TO SCALE |

Project
WAIROA DISTRICT COUNCIL
WAIROA AERODROME
RUNWAY EXTENSION

Sheet
PROPERTY DETAILS
CT AND OWNER

| Project No. | Sheet. No. | Revision |
|---|---|---|
| 2-S5091.VT | C07 | B |

Original Sheet Size A1 [841x594]    Plot Date 2017-04-03 at 2:37:35 p.m.    Path S:\Proj\NZ\2Y\2-Y1300.DM Wairoa DC TAM\Home\2_S51870.VT Wairoa Airport\Wairoa Airport.dwg C07 (B)

File Ref: 5295

26 January 2017

Wairoa District Council
C/- OPUS International Consultants Ltd
Private Bag 6019
Hawke's Bay Mail Centre
**NAPIER 4142**

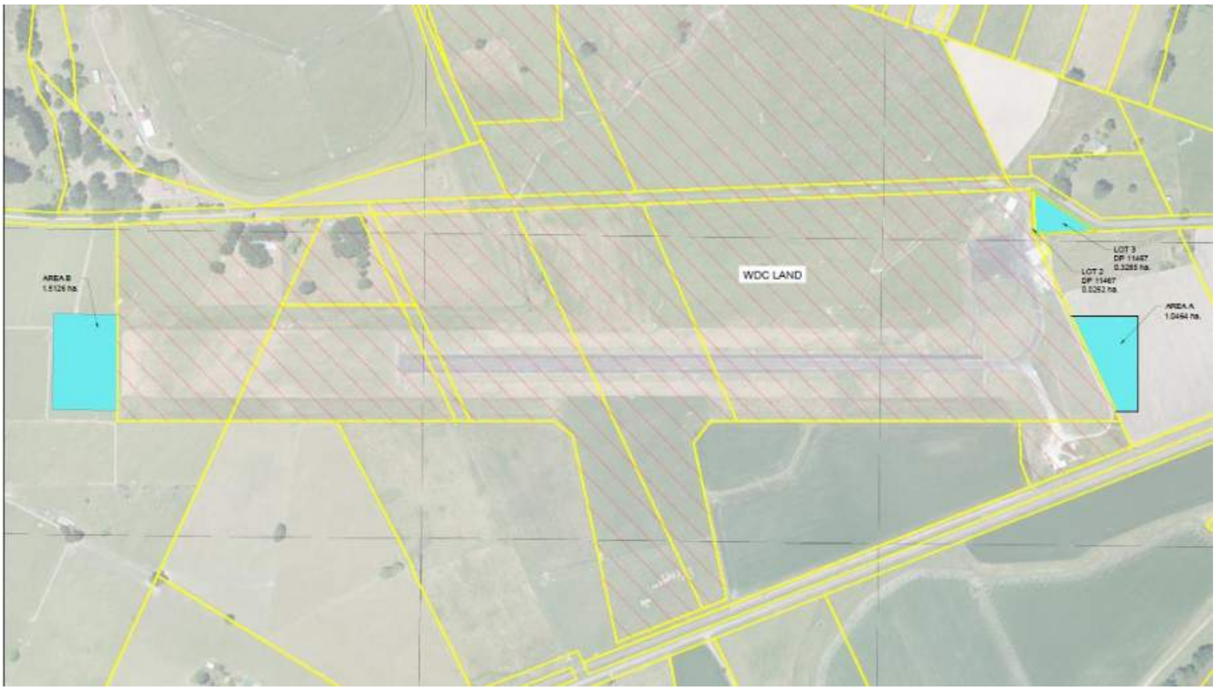
**Attention: Andrew Sowersby**
**andrew.sowersby@opus.co.nz**

**RE: Wairoa Aerodrome – Feasibility Assessment**
**Airport Road, Wairoa**

1.0.1 Further to instructions from Andrew Sowersby OPUS International Consultants Ltd we inspected the above properties on 20 January 2017 in order to provide a short report commentary on the general Wairoa market including breakdown of land values per hectare for varying land classes. This report is also to highlight key issues affecting the properties from which the land is to be acquired. We note this report does not constitute a full compensation assessment, and should only be relied upon for feasibility purposes.

1.0.2 The valuation has been completed in accordance with the International Valuation Standard framework. International Valuation Standards IVS 101 – Scope of Work, International Valuation Standard IVS 102 – Implementation, International Valuation Standard IVS 103 – Reporting, Property Institute of New Zealand Valuation Guidance Note 1 – Valuation Procedures for Real Property and Guidance Note 10 – Valuation of Agricultural Properties. The only deviation is a full report was not required as per client's instructions and therefore this letter does not meet IVS or PINZ Reporting Standards

1.0.3 The feasibility study relates to the taking of three parcels of land as outlined in the map and table below.




| Area | Land Required (ha) | Owner | Current Utilisation |
|---|---|---|---|
| A | 1.0464 | Clark | Cropping |
| B | 1.5126 | Hayward, Standring & Thomas | Dairy |
| C | 0.3537 | Ashworth Helicopters Ltd | Grazing and Access |

1.0.4 We have been asked to provide commentary on the general Wairoa rural land market and breakdown of land values per hectare for varying land classes. In determining this we have analysed a number of recent sales within the Wairoa District in order to determine appropriate land value rates for different land classes.

1.0.5 The majority of flat land on the Plains surrounding Wairoa is utilised for cropping, or pastoral finishing purposes with a small number of dairy farms. The land rates per hectare vary depending on the soils, contour, drainage and location. Sale volumes of this type of land are generally small in number, however well located high productivity blocks are generally met with good interest from existing land owners.

1.0.6 There has also been a small amount of interest from out of town purchasers seeking blocks to develop for horticulture. A number of these discussions are still in a feasibility stage and are reliant on suitable water volumes for horticulture being available. These operators are also seeking to lease properties long term rather than purchase. This interest is therefore yet to flow through to sales or value levels. Values are therefore generally consistent as seen from the sales analysed.

| Address | Sale Date | Title Area | Net Sale Price | Imp. $/ha | Site Value | Prod Land Value/eff ha |
|---|---|---|---|---|---|---|
| 101 RUATANIWHA RD | Nov-16 | 2.16 | 247,000 | 85,648 | 30,000 | 19,277 |
| KAIMOANA ST | Sep-16 | 0.19 | 20,000 | 54,048 | 9,920 | |
| 14 KITCHENER ST | Aug-16 | 3.37 | 120,000 | | 70,000 | 17,437 |
| 118 SH 38 | May-16 | 20.27 | 474,000 | 13,709 | 30,000 | 8,404 |
| OHUIA RD | Apr-16 | 8.99 | 100,000 | 1,113 | 20,000 | 8,248 |
| 2 RUATANIWHA RD | Apr-16 | 1.03 | 117,000 | 76,162 | 38,500 | |
| 220 RUATANIWHA RD | Apr-16 | 25.30 | 1,042,000 | 17,710 | 40,000 | 21,985 |
| 442 AWAMATE RD | Mar-16 | 8.59 | 417,000 | 28,686 | 60,000 | 18,986 |
| 251 TE RATO RD | Feb-16 | 0.25 | 29,000 | 35,957 | 20,000 | |
| 78 CLYDEBANK RD | Dec-15 | 7.47 | 354,000 | 28,462 | 52,000 | 13,162 |
| 370 STATE HIGHWAY 38 | Dec-15 | 38.85 | 793,000 | 7,069 | 45,000 | 12,490 |
| 104 HURUMUA RD | Oct-15 | 22.59 | 795,000 | 12,000 | 45,000 | 21,968 |
| MILL RD | Jul-15 | 23.22 | 484,000 | 7,752 | 40,000 | 11,579 |
| 36 HURUMUA RD | May-15 | 35.74 | 975,000 | 7,055 | 30,000 | 19,278 |
| 50 BELL RD | May-15 | 92.21 | 2,542,000 | 4,917 | 20,000 | 22,559 |
| Average of above data | | 19.35 | 567,267 | 27,163 | 36,695 | 16,281 |

1.0.7 When analysing the above sales we have broken out the site value or lifestyle component of the land, and the productive land value. From the above sales information we are the able to extrapolate the following land rate per hectare for the following land classes. A description of the land classes are shown below, along with the value range per hectare.

| Unit | Description | Derived from | Erosion | | Gradient Range | Land Value Range $/ha |
|---|---|---|---|---|---|---|
| | | | Present | Potential* | | |
| Ic1 | Recent river terraces with soils of high fertility. | Alluvium from sedimentary rocks | Nil | Nil | 0 - 3° | $20,000-$24,000 |
| IIIw1 | Low river terraces subject to surface flooding, and having clay subsoils and a moderately high water table. | Alluvium from sedimentary rocks | Nil | Nil | 0 - 3° | $12,000-$22,000 |
| IIIw2 | Low, poorly drained river terraces subject to surface flooding. Soils have a poor structure and low organic matter levels. | Alluvium from sedimentary rocks | Nil | Slight to moderate deposition | 0 - 3° | $19,000-$21,000 |
| IIw1 | Low river terraces with a slight wetness limitation due to moderately slow subsoil drainage. | Alluvium from sedimentary rocks | Nil | Nil | 0 - 3° | $11,500-$20,000 |
| IVe2 | Rolling to strongly rolling downlands with a mantle of recent rhyolitic tephra. | Taupo tephras on Quaternary and Tertiary sediments. | Nil | Severe sheet and rill, and slight gully when cultivated. Slight tunnel gully. | Predominantly 8 - 15° with pockets of 16 - 20° | $10,000-$12,000 |
| IVw1 | Former swamps and present swamp margins where high water table levels make drainage difficult. | Peat and alluvium. | Nil | Nil | 0 - 3° | $7,000-$9,000 |
| VIe1 | Strongly rolling to moderately steep hills, with a mantle of recent rhyolitic tephra on Tertiary and Quaternary rocks. | Taupo tephras on mudstones, sandstones, siltstones. | Nil to slight soil slip. Nil to slight tunnel gully. | Slight soil slip. Nil to slight tunnel gully. | Predominantly 16 - 20° with pockets of 21 - 25° | $7,000-$12,500 |

| Unit | Description | Derived from | Erosion Present | Erosion Potential* | Gradient Range | Land Value Range $/ha |
|---|---|---|---|---|---|---|
| VIe7 | Moderately steep to steep, fertile hills of soft siltstone, subject to severe soil slip erosion | Soft siltstones and silty sandstones. (Taupo tephra in places). | Moderate to severe soil slip. Slight sheet. | Severe soil slip. Slight sheet. | Predominantly 21 - 25° with pockets of 26 - 35° | $5,000-$11,000 |

* Assessed as under actual or assumed grassland cover with average management and no soil conservation measures applied.

1.0.8 All of the areas proposed to be acquired are contained within Land Use Classification IIw1.

1.0.9 The below commentary relates to the specific land areas to be acquired, and potential value impacts.

1.0.10 Area A – This area was planted in maize at inspection and was utilised in conjunction with surrounding land blocks. The taking of this land would include the physical loss from a productive perspective along with impacting on the overall workability of the block from a cropping perspective. The land take will make the residual area an irregular shape which will be difficult to effectively crop. There would therefore be some injurious affect to the shape of this block, and the impact on the value of land on either side of the land take would need to be determined. This land is contained within Land Classification IIw1 so the physical loss would be reflective of the upper end of the productive land value range shown above, plus the allowance for injurious affect given the impact on the shape of the property from a productive perspective. This injurious affect amount would need to be determined using before and after compensation methodology. Improvements impacted would need to be reinstated as part of the works.

1.0.11 The access to the southern end of the runway also appears to currently run over the Clark's land, with no easement apparent. We would recommend that this be addressed as part of the proposed land takes. This area is shown in the aerial below. (Source: Property-guru).

1.0.12 Area B – This area is contained at the northern of the runway, and is presently utilised for pastoral grazing as part of a larger dairy unit. This area could also be potentially cropped. The impact on this area will be similar to that of Area B, and would include the physical land take plus some Injurious Affect given the impact on shape and workability. This land is also contained within Land Classification IIw1 so the physical loss would be reflective of the upper end of the productive land value range shown above, plus an allowance for injurious affect given the impact on the shape of the property from a productive perspective. This injurious affect amount would need to be determined using before and after compensation methodology. Any impact on improvements would need to be reinstated as part of the works.

1.0.13 There may be some opportunity to offset the above land take by completing a land swap with other WDC land found on the eastern side of the runway. This would however need to be negotiated between parties, and approved by WDC.

1.0.14 Area C – This area comprises a triangular shaped paddock being utilised for limited pastoral grazing purposes, along with sealed yard and entrance area. This area is contained in two Computer Freehold Registers (CFR's). The sealed access is presently utilised to access a storage shed, and is also used as a secondary access to the main airport, however there appears to be no right of way easement for this access. Power is reticulated by way of overhead power lines along the western boundary, with water being provided by town supply. The pastoral component would have limited appeal from a grazing perspective given its size, with the lifestyle appeal of this area also likely to be low given the proximity to the airport. The land may have some commercial appeal given the proximity to the airport, but potential purchasers would be small in number.

1.0.15 The value of the land would likely therefore be at the mid to lower end of the site factors determined within the sales analysis given the properties proximity to the airport. The taking of the land will however have an impact on the ability to access the current storage shed found on the land. Access would therefore need to be provided over the airport land to ensure that this shed can be effectively utilised by the current land owners.

1.0.16 Improvements contained on the land that would be impacted by the land take would include approximately 220$m^2$ of sealed yard. This would need to be compensated for. The impact on any other improvements would need to be reinstated as part of the works. Easements may also need to be registered for services to be provided to the shed.

1.0.17 We have been advised that the above land parcels are required as part of a run way extension, and allocation for land for business and car parking. The runway extension may allow larger aircrafts to fly from the airport. This may increase noise and disturbance to the surrounding properties. We would expect any impact on these properties to be minimal given the current productive land uses, and limited lifestyle appeal. We would therefore expect limited injurious affect from increased noise and disturbance.

1.0.18 A summary of the above is provided below.

| Area | Land Required (ha) | Land Value Range | Improvements | Injurious Affect |
|---|---|---|---|---|
| A | 1.0464 | $15,000-$22,000/ha | Reinstated if impacted | Yes - shape |
| B | 1.5126 | $15,000-$22,000/ha | Reinstated if impacted | Yes - shape |
| C | 0.3537 | $10,000-$35,000 total | Impact on sealed yard area, other improvements to be reinstated if impacted | Yes - access |

1.0.19 The values of areas A and B would be plus GST if any, with Area C being inclusive of GST if any. The impact on improvements and any injurious affect would need to be added to the value of the land taken.

1.0.20 The above information is to be used for feasibility purposes only. In order to quantify the full impacts to each property before and after scenarios would need to be undertaken, along with discussions with land owners.

**DISCLAIMER**

**Logan Stone Ltd** prohibits the publication of this report in whole or in part, or any reference thereto, or to the valuation figures contained therein, or to the names and professional affiliations of the valuer, without the written approval of the valuer as to the form and context in which it is to appear.

Our valuation has been completed in compliance with International Valuation Standard framework. International Valuation Standards IVS 101 – *Scope of Work,* International Valuation Standard IVS 102 – *Implementation*, International Valuation Standard IVS 103 – *Reporting*. We confirm that:

- The statements of fact presented in the report are correct to the best of the Valuer's knowledge;
- The analysis and conclusions are limited only by the reported assumptions and conditions;
- The Valuer has no interest in the subject property;
- The Valuer's fee is not contingent upon any aspect of this report;
- The valuation was performed in accordance with an ethical code and performance standards;
- The Valuer has satisfied professional educational requirements;
- The Valuer has experience in the location and category of the property being valued;
- The Valuer has made a personal inspection of the property;
- The Valuer has an Annual Practicing Certificate; and
- No one except those specified in the report, has provide professional assistance in preparing the report.

1.0.21 The report has been internally Peer Reviewed as part of the Logan Stone Limited internal review process. This review considers all aspects of the report, unless specifically instructed or stated otherwise.

1.0.22 Should you require any further advice, do not hesitate to contact us.

Yours faithfully
**LOGAN STONE LIMITED**

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**STATEMENT OF GENERAL VALUATION POLICIES**

1. Our responsibility in connection with this valuation report is limited to the person to whom the report is addressed and we disclaim all responsibility to any other party without reference to us.

2. This report may not be reproduced, in whole or in part, without our prior written approval.

3. This report has been prepared for the purpose stated in the report and may be relied upon for that purpose only. Assumptions made in the preparation of the report are as expressly stated in the report or set out below.

4. Where it is stated in the report that information has been supplied to us by another party, this information is believed to be reliable but we cannot accept responsibility if this should prove not to be so. Where information is given without being attributed directly to another party, this information has been obtained by our search of records and examination of documents or by enquiry from Government or other appropriate departments.

5. We have made no survey of the property and unless otherwise stated assume that all improvements lie within the Computer Freehold Register boundaries. No guarantee is given that the land is not subject to statutory rights not recorded on the relevant Computer Freehold Register and not apparent from normal inspection of the property. We assume no responsibility in connection with such foregoing matters.

6. We do not carry out investigations on site in order to determine the suitability of ground conditions and services, nor do we undertake environmental or geotechnical surveys. Unless notified to the contrary, our valuations are on the basis that these aspects are satisfactory and also that the site is clear of underground mineral or other workings, methane gas or other noxious substances.

7. Unless otherwise stated our report is subject to there being no detrimental registration(s) affecting the land other than those appearing on the Computer Freehold Register(s) valued in this report. Such registrations may include Wahi Tapu registrations and Historic Places Trust registrations.

8. We have not obtained from the territorial authority a Land Information Memorandum. Our valuation has been made on the basis that such Memorandum if obtained would not have disclosed information which would have affected adversely our opinion of the market value of the property.

9. No environmental audit has been undertaken, although contaminants present on the site and obvious to us on inspection may have been noted in the report. No warrant is given, or is to be implied, in this report that the property is free from contaminants.

10. While in the course of inspection due care is taken to note building defects, no structural survey has been made and no undertaking is given about the absence of rot, termite or pest infestation, deleterious substances such as asbestos or calcium chloride or other hidden defects. We can give no guarantee as to outstanding requisitions in respect to the subject building.

11. In preparing the valuation it has been assumed hot and cold water systems, electrical systems and other devices, fittings and conveniences as are in the building to be in proper working order and functioning for the purpose for which they were designed.

12. Where a property is leased, this report records the nature of the information supplied. That information has been accepted and relied upon at face value. It has been assumed that the information supplied is complete and accurate, and that the lease is fully enforceable.

13. Unless otherwise stated in our report our valuation is on the basis that the property complies with the Building Act 1991, Health and Safety in Employment Act 1992, Evacuation of Buildings Regulations 1992 and Disabled Persons Community Welfare Act 1975 or that the legislation has no significant impact on the value of the property.

14. We certify that Logan Stone Limited holds professional indemnity insurance.

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