Acid Sulphate Soils: Identification and Management in NZ's Largest Airport

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Introduction

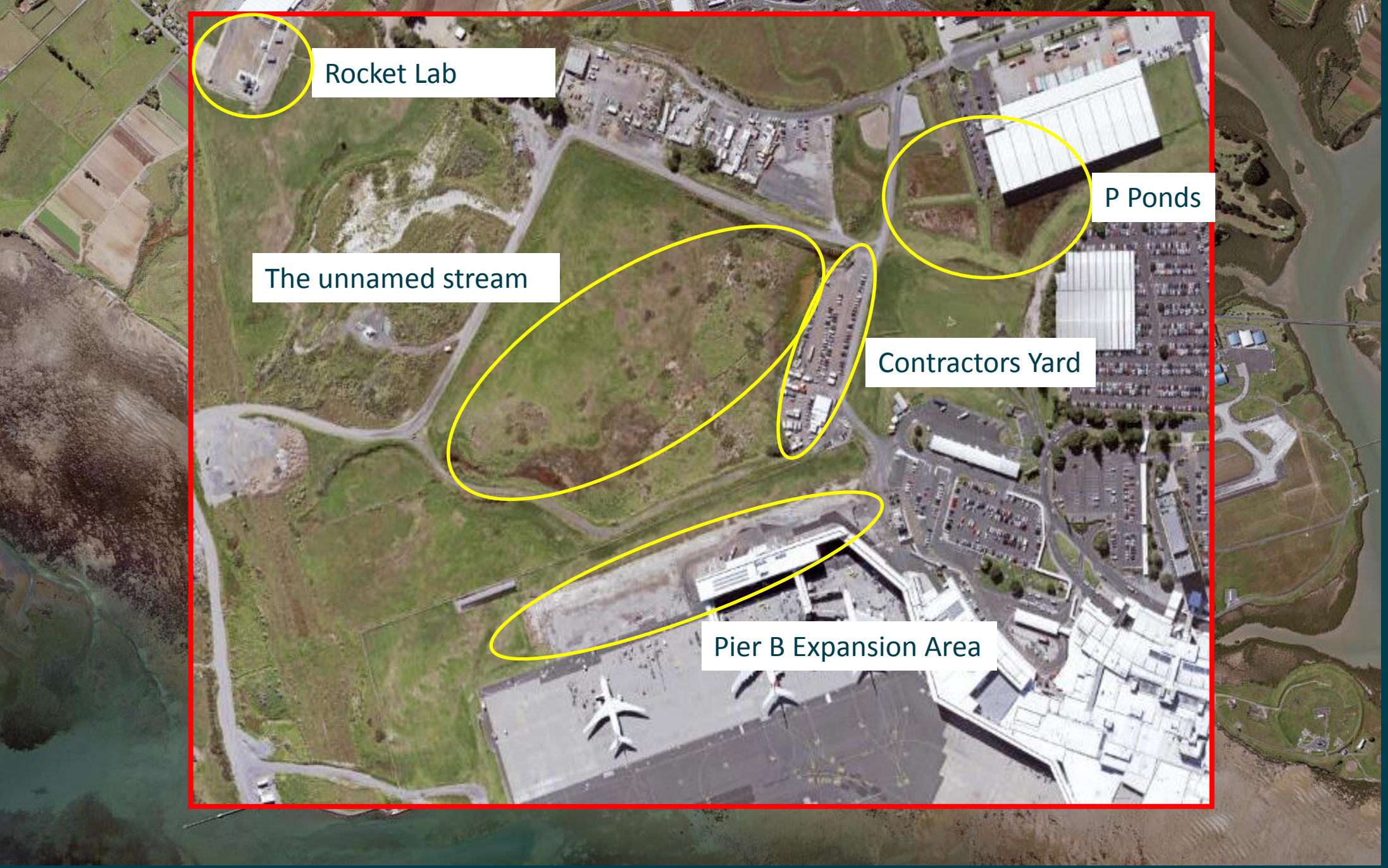
- What are acid sulphate soils?
- Auckland Airport timeline
- What have we done already and what further are we going to do about it?
- Summary

What are Acid Sulphate Soils?

- Natural forming soil, typically found near coastal areas.
- Conditions create pyrite (FeS_2) formations in the soil.
- As earthworks are carried out, groundwater elevations drop which allows oxygen to react with the pyrite.
- This reaction causes sulphuric acid and sulphates to form.
- Acid sulphate soils are typically in two distinct colours. Acid sulphate soils having had no exposure to oxygen are gleyed (grey) in colour, whilst soils that have been exposed to oxygen are typically orange, mottled, and can have a distinct rust staining to them.

What are Acid Sulphate Soils?

- Acid Sulphate Soils can have adverse effect to the environment and infrastructure.
- Possible Environmental Effects
  - Acidity Effects – when acid builds up in streams it can kill animals and plants. In low level acid conditions it can make plants and animals weak.
  - Iron Effects - Can smell bad and can cause the water to taste foul. Can lead to blooms of toxic algae in coastal environments.
- Possible Infrastructure Effects
  - Concrete and Steel damage – changes the minerals in concrete. This can make the concrete swell and loose strength. Steel will corrode over time.
  - Soil Strength - Once oxidised and dried, acid sulphate soils loose all structural strength.


Rocket Lab
P Ponds
The unnamed stream
Contractors Yard
Pier B Expansion Area

Auckland Airport Timeline

- PDP first notified of a potential spill event during August 2016. Site observations noted minor iron oxide precipitate and vegetation mortality within the unnamed stream and the P pond . Initially thought to be a spill from the contractors yard. pH concentrations were 4.6 pH units

- PDP called back by AIAL early November 2016 and found significant iron oxide accumulation within P Pond and the unnamed stream. Measured pH concentrations were 2.8 pH units in the unnamed stream. Water quality samples were collected, samples were analysed for iron, sulphate, pH (PDP had initial thoughts that effects may have been from acid sulphate soils). Results confirmed significantly elevated sulphate and iron concentrations.

- During mid-late November, PDP commenced first field assessments for acid sulphate soils. Confirmation of acid sulphate soil presence was made during these field assessments.

Auckland Airport Timeline

- Due to PDP and AIAL concerns of the pH 2.8 water entering into a significant stormwater reticulation network, discussions were had with Auckland Council regarding the use of lime to neutralise the stream water.

- Auckland Council gave verbal permission, with the premise to look into retrospective consent for the discharge at a latter date. This was then reconsidered and consenting was agreed to be unnecessary as works met the definition for emergency works.

- During November 2016, 8 tonne of lime was placed into the stream. This raised the pH from 2.8 to 6.3 pH units. Monitoring was carried out after the liming, after about one week the lime was consumed and pH began to drop again.

Auckland Airport Timeline

What's AIAL doing about it...

- Monitoring
  - Significant number of field assessments to identify the spatial scale and distribution of acid sulphate soils across the Airport precinct.
  - Installation of 11 groundwater monitoring bores. From this we can determine groundwater flow directions, groundwater chemistry, and soil chemistry.

- Information release
  - Have issued a 'no dig' notice to all AIAL project managers, unless soil tests have been conducted.
  - Prepared a Acid Sulphate Management Plan. This document provides guidance to land developers on how to identify and test for acid sulphate soils, options on how to manage acid sulphate soils, and how to monitor for ongoing effects caused by acid sulphate soils.

- Auckland Council Engagement and Consenting
  - Engaged with Auckland Council senior representatives to educate and discuss acid sulphate soil issues.
  - Currently preparing resource consent documentation to support the installation of acid sulphate soil management options, and any discharges that may occur.

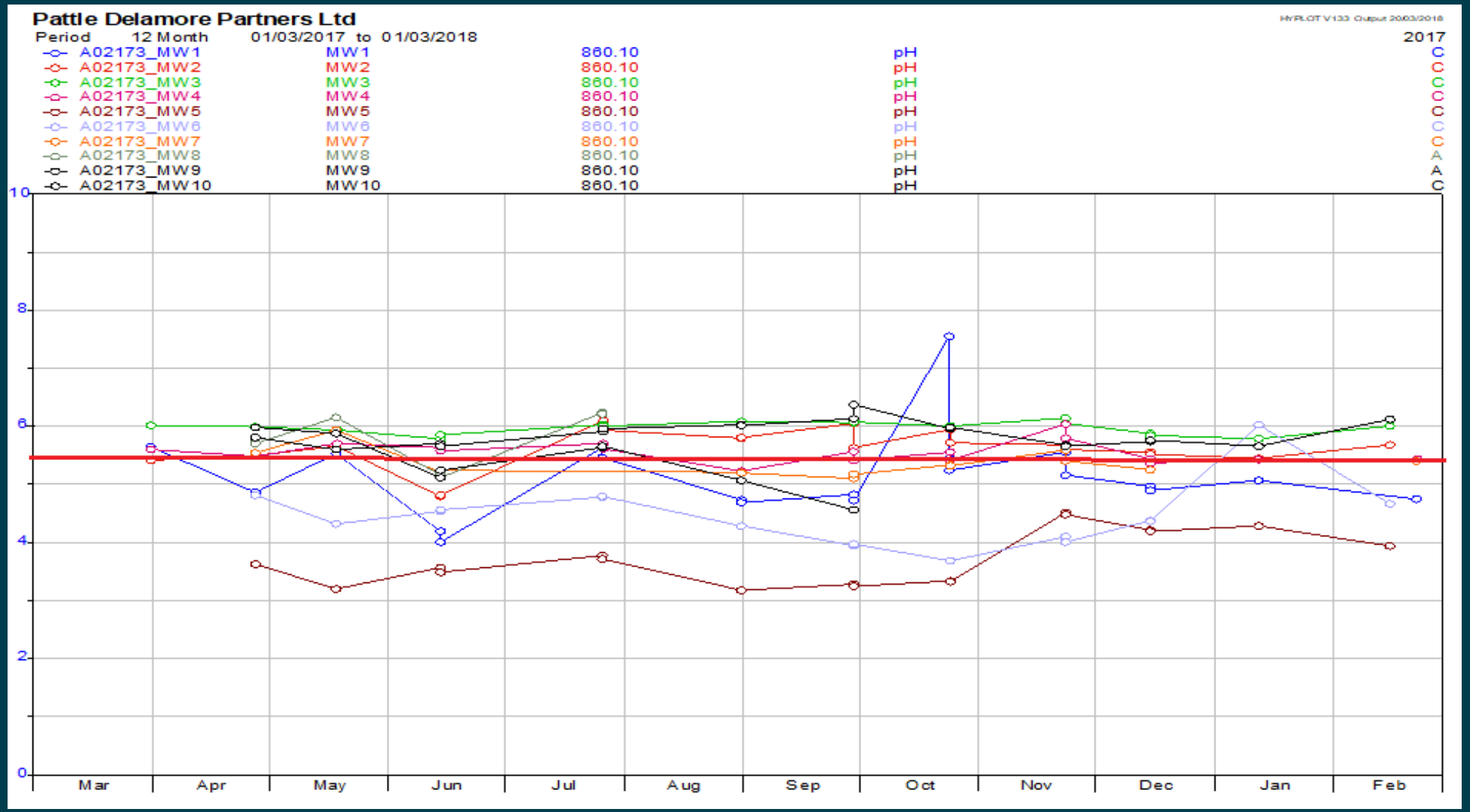
Auckland Airport Monitoring – GW Chemistry

Monthly Monitoring for:

- pH
- Sulphate
- Chloride
- Dissolved Oxygen
- Conductivity

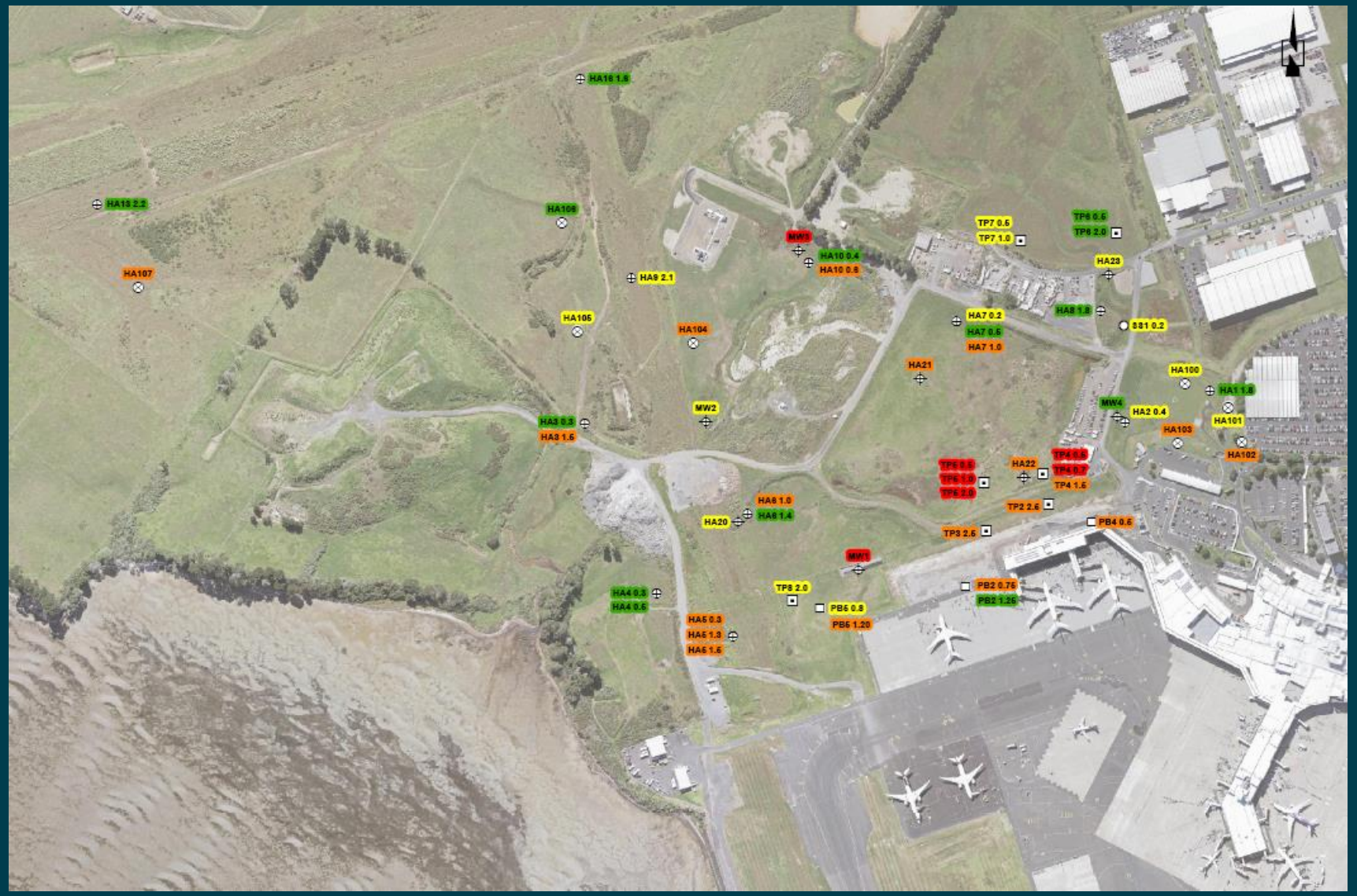
Auckland Airport Monitoring – GW Chemistry

Note: Presented results are with no management options implemented



Sulphate Concentrations (mg/L)
pH Measurements

Auckland Airport Monitoring – Soil Chemistry



- pHFOX result map (i.e. potential issues)

- Green – unsure to no
- Yellow – low risk
- Orange – moderate risk
- Red - high risk

- Again, further monitoring about to commence in the existing airport terminals

Acid Sulphate Management Plan

- Used by land development contractors.
- Provides the methodology for people to understand if they could be potentially working in acid sulphate soils.
- Provides an understanding of the issues and effects that can be caused by acid sulphate soils.
- Provides management options to ensure a consistent practice of acid sulphate management is carried out for all future land development activities within the Auckland Airport precinct.

Acid Sulphate Management Methods – Avoidance

- Relocate the development.

- Cover affected soils with cleanfill.

Due to the airport being well established and scale and spatial distribution of known acid sulphate soils these options are considered to be limited for the Airport.

Acid Sulphate Management Methods – Minimise Disturbance

- Low disturbance technologies

Acid Sulphate Management Methods – Prevent Soil Oxidisation

- Elevate groundwater table locally.

- Soakage practices:
  - Soakpits;
  - Infiltration swales;
  - Raingardens; and,
  - Filter strips.
- Groundwater Recharge - injection of water into the local groundwater table, i.e. via the use of raintanks. This increase in water volume causes the elevation of the groundwater table at the location of injection to rise.

Acid Sulphate Management Methods – Treatment or Acid Neutralisation

- Altering concrete/steel specifications. Concrete management can be achieved by changing binder content, increasing the concrete coverage, decreasing the water to cement ratio, and if required, adding supplementary cementitious materials (e.g. fly ash, slag, and amorphous silica). Alternatively, the thickness of the concrete/steel structure can be increased.

- Liming of soils. Mixing of granulated lime into the soils to neutralise the pH.

- Treatment of acidified surface waters. Addition of lime into water bodies/groundwater seepages

- Treatment of acidified groundwater: extracting groundwater from aquifer, treating with lime within storage tanks, then reinjecting back into the aquifer.

Acid Sulphate Management Methods – Offsite Soil Removal

- Involves stripping of the acid sulphate soil.

- Key issues with this method are:
  - No acceptance of this soil type in Auckland.
  - The depth of the soil.
  - The spatial extent of the soils.

This option is not practical for AIAL to implement.

Summary

- Areas of the Auckland International Airport have been built on acid sulphate soils.
- Acid sulphate soils are naturally occurring, but can lead to environmental and infrastructural effects.
- Effects are only observed once air and water gets into these soils.
- Monitoring, information dissemination and resource consenting has/is been undertaken to date.
- A acid sulphate soil management plan has been prepared to support S128 and new resource consent applications. This document provides a range of management options that can be considered to address the effects of acid sulphate soils.
- Monitoring will continue into future, to ensure management options are effective and effects of acid sulphate soils are managed appropriately.