# Merrifield North Employment Precinct - Sodic and Acid Sulfate Soil Assessment

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Victorian Planning Authority

Merrifield North Land Capability and Sodic Soils Assessment
24 October 2023

# Merrifield North Employment Precinct - Sodic and Acid Sulfate Soil Assessment

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| | | Project manager: | Michelle Castro |
| Version: | Final | Prepared by: | Peter Sandercock, Christian Bannan, Nicolaas Unland, Giulia Zanotta, Graeme Jardine, Craig Clifton, Adam Hall and William Rodger |
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Jacobs Australia Pty Limited

Floor 13, 452 Flinders Street
Melbourne, VIC 3000
PO Box 312, Flinders Lane
Melbourne, VIC 8009
Australia

T +61 3 8668 3000
F +61 3 8668 3001
www.jacobs.com

# Executive summary


Jacobs was engaged by the Victorian Planning Authority (VPA) to provide an assessment of the distribution of sodic and acid sulfate soils, erosion and environmental risks and consider their implications for future planned development in the Merrifield North Employment Precinct.

The soils of the Merrifield North Employment Precinct that were assessed in this investigation are classified as Sodosols and Vertosols. Across the site, the investigation identified that most of the soils are sodic, with highly dispersive subsoils. Acid sulfate soils were identified in the majority of topsoil samples analysed at the site and in isolated subsoil samples, located in the north and south east of the site.

A vulnerability assessment approach was used to assess the implications of sodic and acid sulfate soils for the construction phase of the precinct and for the future developed land use.

Vulnerability (V) = Exposure (E) + Sensitivity (S)

Exposure (E): refers to attributes of soils that determine their sodicity, acidity and propensity to erosion. Exposure criteria included sodicity and acidity of topsoil and subsoil, dispersion scores for topsoil and subsoil, A horizon depth, organic carbon in topsoil, slope and flooding.

Sensitivity (S): refers to attributes of the land or activities that influence the extent to which the land and urban developments may be disrupted or detrimentally affected by sodic and acid sulfate soils (ASS). Sensitivity criteria included potential disturbance associated with construction activity for different land use types and water balance change expected for future land use.

During construction, areas identified with a high vulnerability to soil erosion are the open space (drainage/wetlands, conservation) and flood prone areas. Activities that expose these soils to rainfall and associated runoff will present significant construction challenges and need to be managed carefully. These activities also expose potential ASS to oxidising conditions.

Water balance changes resulting from future developed land use and associated impervious areas will generate high volumes of runoff which will drain into open space (drainage/wetlands, conservation) and flood prone areas. Further increases in runoff could accelerate erosion of bed and bank materials and oxidise potential ASS.

Recommended treatments for areas identified as having high vulnerability to sodic and acid sulfate soils:

- Conservation area and existing wetland - Ideally these areas should be reserved as green spaces to maintain their ecological values and functions. The incoming catchments that contribute runoff to the conservation area and existing wetland also need to be carefully managed as urbanisation will result in increased runoff to these areas. Consideration should be given to the design and layout of the drainage network, so that the volume of runoff is limited or redirected to other locations (i.e. redirect stormwater to constructed wetlands in Kalkallo Retarding Basin). Surface ground cover measures, specifically managing organic matter including ground cover, plant growth and roots are critical for protecting the soils against dispersion and erosion.
- Constructed waterway/drainage assets - The drainage schemes will need to be designed with specific consideration given to the erosion risks associated with sodic and dispersive soils (and acid sulfate soils). A high level of engineering will be required to create waterway/drainage assets that are stable and can withstand the volume of water that will be generated from the developed areas (i.e. appropriate channel linings and/or armouring to provide protection for dispersive subsoils). Where possible, it is recommended that the waterway/drainage corridors include wetland and swales, to assist with attenuation and treatment of stormwater runoff.

It is recommended that detailed sodic and dispersive soils management plans are developed for managing sodic and dispersive soil-related erosion risks in high vulnerability areas identified in this investigation.

It is recommended that acid sulfate soil management plans are developed for managing acid sulfate soils. This will primarily be required for managing topsoils and given the limited occurrence of sulfides, management would likely take the form of minimising and avoiding disturbance where possible, and applying lime to top soils (either *in situ* or in stockpiles) where disturbance is unavoidable.

# Important note about your report

The purpose of this report and the associated services performed by Jacobs is to provide an assessment of the distribution of sodic soil and acid sulfate soils, erosion and environmental risks that relate to the characteristics of these soils, their position in the landscape and the implications of this for future planned development within the Merrifield North Employment Precinct. Advice is also provided on the range of treatment options that are available to manage identified soils and risks. The work has been conducted in accordance with the scope of services set out in the contract between Jacobs (Australia) and Victorian Planning Authority.

In preparing this report, Jacobs has relied upon, and presumed accurate information provided by Victorian Planning Authority and/or other sources as referenced in the report. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete, the observations and conclusions in this report may change.

The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession following applicable standards, guidelines, procedures and practices at the date of issue of this report. No other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This assessment has been prepared with reference to a Future Urban Structure (FUS) dataset provided by Victorian Planning Authority. Should the FUS structure change materially (as precinct development is refined), this could affect the distribution of erosion and environmental vulnerability.

This report should be used in full, and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Victorian Planning Authority subject to, and issued in accordance with, the provisions of the contract between Jacobs and Victorian Planning Authority.

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# 1. Introduction

## 1.1 Background

Jacobs was engaged by the Victorian Planning Authority (VPA) to map sodic and acid sulfate soils, erosion and environmental risks and provide advice on treatment options in light of future planned development in Merrifield North Employment Precinct (the Precinct).

## 1.2 Scope

This report provides an assessment of the distribution of sodic and acid sulfate soils, erosion and environmental risks and considers their implications for future planned development in the Precinct. The assessment forms part of the pre-commencement phase for the Merrifield North Employment Precinct Structure Plan (PSP).

The Precinct covers an area of approximately 988 ha with its location to be 35 km north of Melbourne's Central Business District (CBD) and is found immediately to the north of the emerging Merrifield Town Centre. The Precinct straddles both the Mitchell Shire and Hume City local government areas. It is identified in the North Growth Corridor Plan (NGCP) which provides a high-level vision for the northern growth corridor. The Precinct is to be developed for employment land uses, as well as open space, conservation, and water retardation.

Figure 1-1 shows a preliminary Future Urban Structure for the Precinct that was developed as part of the Merrifield North Threshold Assessment Project. It represents the direction for the PSP and key elements that the PSP project should contain. It should be noted that this is a preliminary plan that shows the range of future potential land uses, however the specifics of future land uses and their layout could still be subject to significant changes (i.e. siting of roads, extent of retarding basin, waterbodies and open space) and additions (i.e. further provisions of waterway/drainage reserves for Kalkallo Creek and trubutaries).

Vulnerability assessment was used to explore the implications of sodic and acid sulfate soils for future planned urban development. This assessment was completed for two scenarios, the precinct construction phase and the future developed land use. Advice is provided on the range of treatment options that are available to manage identified sodic and acid sulfate soils, environmental and erosion risks.

## 1.3 Report structure

This report has been structured as follows:

- Section 2 provides a brief background of sodic and acid sulfate soils definitions and terms used in this report, Victorian context regarding the distribution of sodic and acid sulfate soils and their implications for urban development.
- Section 3 describes our approach to mapping sodic and acid sulfate soils, erosion and environmental risks.
- Section 4 presents the results of the assessment.
- Section 5 provides discussion and recommendations on options to manage identified erosion and environmental risks, including potential planning control measures.
- Section 6 documents gaps in knowledge/requirements for further soil investigations and further work to validate the predictions of the distribution of sodic and acid sulfate soils, erosion and environmental risks.

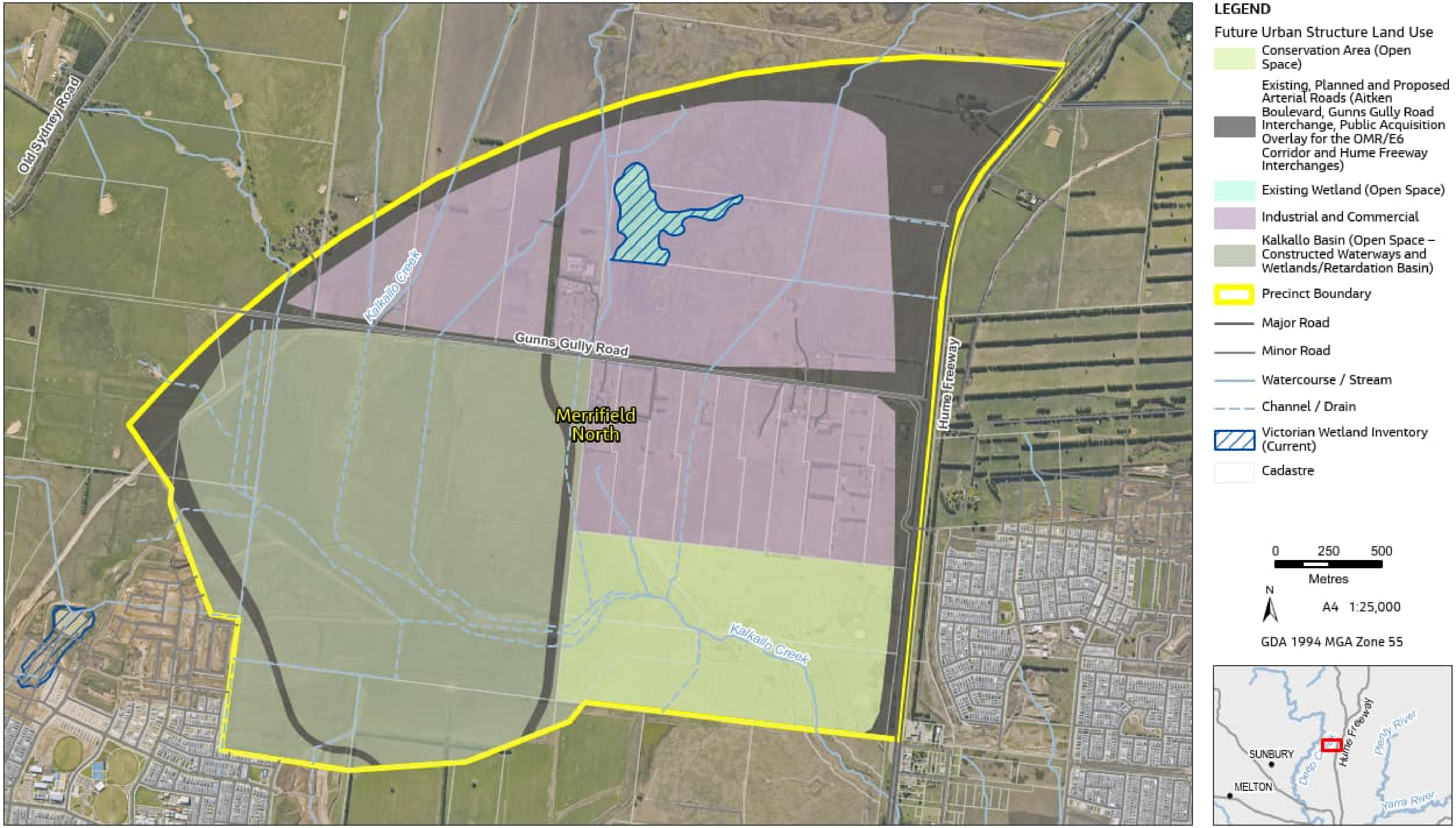



Figure 1-1. Preliminary Merrifield North Future Urban Structure Land Use (Source: Merrifield North Threshold Assessment Project).

# 2. Sodic and Acid Sulfate Soils

## 2.1 Sodic soils

### 2.1.1 Sodic soil definitions and terms used in this report

Sodic soils are defined in Australia as those with an exchangeable sodium percentage (ESP) of 6% or greater (Northcote and Skene 1972). An ESP of 6% is considered to be the threshold where the cation sodium in soil has an adverse impact on soil structure when in contact with fresh water, causing clay dispersion (Northcote and Skene 1972). Soils may also reveal dispersive behaviour under the influence of elevated exchangeable potassium (K) and magnesium (Mg) (Marchuk and Rengasamy 2012, Dang et al. 2018). These considerations are necessary in the evaluation of sodic and dispersive soils where dispersion is evident when ESP levels are below 6%. Figure 2.1 provides examples of the Emerson Aggregate Test where varying levels of dispersion are recorded (Armstrong 2019).

Wetting of sodic and dispersive soils may lead to soil structural decline, crusting, waterlogging, low rates of hydraulic conductivity, excessive runoff, erosion and poor agricultural performance. Sheet, rill, gully and tunnel erosion may all be observed in areas with sodic and dispersive soils. Erosion is exacerbated when sodic soils are disturbed or groundcover is removed or absent. Figure 2-2 shows photographs of erosion that has developed in sodic and dispersive soils, elevated turbidity and sedimentation in waterways. Charman and Murphy (2007) provide further details of the impact of sodic and dispersive soils in an Australian context.

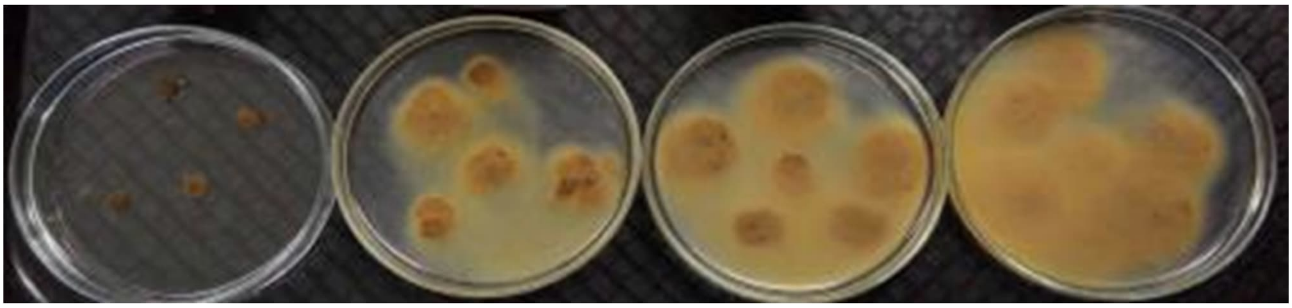


Figure 2-1. Examples of soil aggregates subject to the Emerson Aggregate Test, showing nil dispersion on the left with increasing levels of dispersion to the right (Armstrong 2019).

Figure 2-2. Example of erosion of sodic and dispersive soils which can result in elevated turbidity and sedimentation in waterways.

The Australian Soil Classification (Isbell and NCST 2021) outlines 14 soil orders, several of these contain soil materials that are sodic and dispersive. The soil order 'Sodosol' is a specific class that has strong texture contrast between the A horizon and sodic B horizon, with the latter characteristically being dispersive. This report seeks to identify 'Sodosols' and other soil orders across the Precinct. Soil orders other than Sodosols can be identified with sodic and dispersive properties.

### 2.1.2 Sodic soil distribution across Victoria

The distribution of sodic soils across Victoria is well known and documented by Ford et al. (1993) with further mapping by others, including Agriculture Victoria (2020), as shown in Figure 2-3. Sodic soils are common across large expanses of land used for agriculture and urban development. Sodicity and dispersion characteristics vary depending on parent material, geomorphic processes, particle size distribution, rainfall and leaching. In most cases, soils with sodic horizons are texture contrast soils with a clear or abrupt A horizon topsoil layer overlying a finer textured, clay-dominant B horizon subsoil with lower permeability and a high propensity to adsorb cations including sodium.

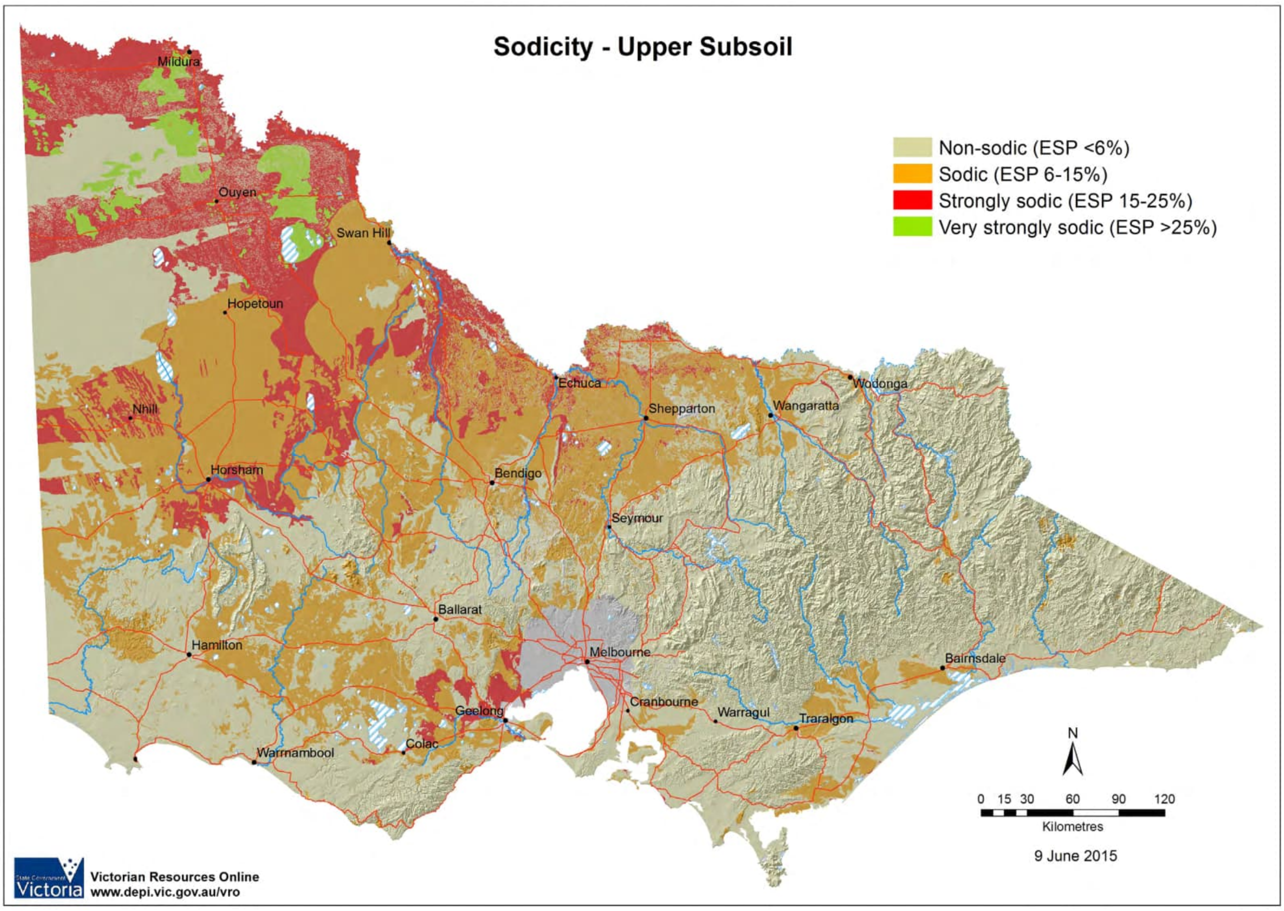



Figure 2-3. Distribution of soils in Victoria with elevated sodicity in the upper subsoil (Agriculture Victoria 2020).

### 2.1.3 Sodic soil implications for urban development

Urban development and site construction has the potential to cause significant ground disturbance, eliminate vegetative ground cover and expose sodic soils to erosion. Erosion risks are directly influenced by sodic soil exposure and changes in landscape hydrology. Changes to hydrology, including the concentration of flow in culverts and channels, runoff from impervious areas and ponding of rainfall contribute to increased erosion risk.

Development on sodic and dispersive soils may have on and off-site impacts, for example:

- Dispersion of topsoil and subsoil.
- Loss of topsoil and subsoil with overland and subsurface flow (sheet, rill, tunnel and gully erosion).
- Poor infiltration and increased volumes of stormwater runoff.
- Water ponding in hollows, break of slope areas or depressions.
- Poor ability to establish vegetation due to adverse soil chemical conditions.
- Lack of trafficability.
- Increased turbidity and sediment load in waterways in response to runoff from development areas. This results in deterioration in water quality and degradation of aquatic flora and fauna habitat with effects on populations.

## 2.2 Acid Sulfate soils

### 2.2.1 Acid sulfate soil definitions and terms used in the report

The term acid sulfate soil (ASS) refers to soils that contain elevated concentrations of sulfides (normally pyrite – $FeS_2$) or their oxidation products. The key difference between oxidised acid sulfate soils and many other naturally occurring acidic soils is that the former contains the products of sulfide oxidation (i.e. sulfuric acid) which acts as a strong acid which is hazardous, while the latter is usually domionated by organic acids which are weaker and hence, less hazardous.

Acid sulfate soils form under reducing conditions in the presence of dissolved iron, sulfate and sulfate reducing bacteria. Such conditions are commonly found in waterlogged environments such as low-lying coastal areas and inland wetlands; however, they have been identified in a wide range of environmental settings.

These soils are often naturally occurring and if they remain in a waterlogged, anoxic state, they are somewhat benign and do not pose a significant hazard to human health or the natural/built environment. However, if they are disturbed and exposed to oxygen, the sulfides can oxidise and release sulfuric acid and iron hydroxides via equation (1) below:

$$4FeS_2 + 15O_2 + 14H_2O \Leftrightarrow 16H^+ + 8SO_4^{2-} + 4Fe(OH)_3 \qquad (1)$$

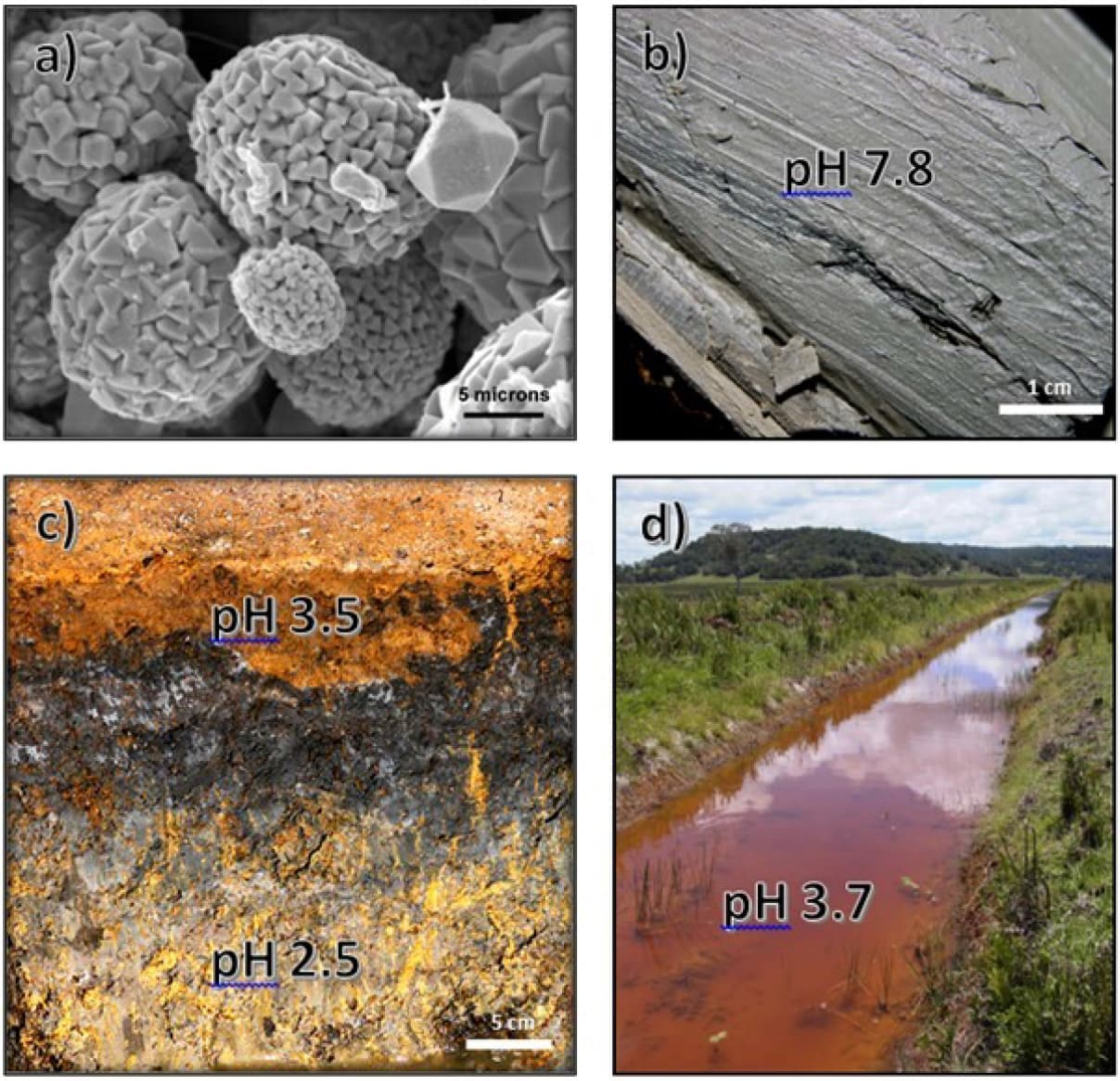
This may result in a wide range of environmental hazards, including the:

- acidification of soil and drainage waters
- mobilisation of metals, nutrients and rare earth elements
- deoxygenation of water bodies

In turn, this may cause fish kills, loss of biodiversity in wetlands and waterways, contamination of groundwater resources, loss of agricultural productivity, and corrosion of concrete and steel infrastructure.

Acid sulfate soils can be broadly classified into two different categories. This includes actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS). The term AASS refers to those soils which have already been subject to oxidation and have become acidic, with a pH of less than 4. The term PASS refers to those soils that are not currently acidic, with a pH of greater than 4, but have the potential to become acidic via sulfide oxidation if they are disturbed.

Some examples of ASS and their potential impacts in different environments have been illustrated in Figure 2-4.




Note: a) PASS containing framboidal pyrite ($FeS_2$) crystals. b) Blue-greenish grey PASS. c) AASS profile showing surficial iron oxide and yellow jarosite segregations. d) Iron staining (by schwertmannite and goethite) of a drain in an ASS landscape. Source: Photographs from LA Sullivan.

Figure 2-4 Examples of ASS and their potential environmental effects (Sullivan et al. 2018).

### 2.2.2 Acid sulfate distribution across Victoria

The probability and confidence of ASS occurrence across Victoria is illustrated in Figure 2-5, with red areas indicating a higher probability of occurrence, yellow indicating a low probability of occurrence and green areas indicating a very low probability of occurrence. Darker shading indicates a higher degree of confidence in the probability ranking.

Accordingly, the figure indicates a higher probability of ASS occurring along the coastline. This is because highly favourable conditions for ASS accumulation were widespread following the last major sea level rise, and resulted in the accumulation of extensive deposits of Holocene age (less than 10 000 years BP) ASS materials in coastal floodplains and inter-tidal swamps worldwide (Dent 1986).

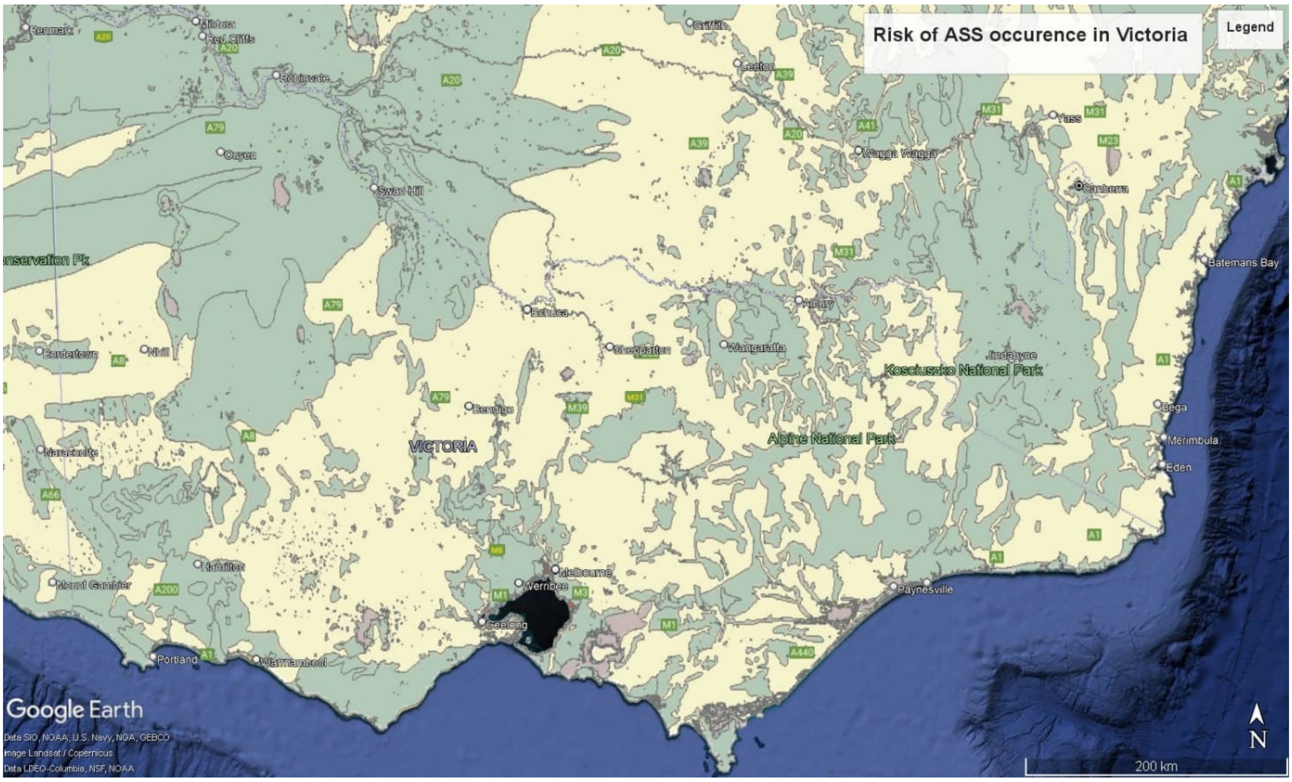



Figure 2-5 Risk of ASS occurrence across Victoria (CSIRO 2008).

While this may be the case, ASS can occur in any environment in which organic matter, dissolved iron, dissolved sulfate and reducing conditions persist. Such conditions occur in a variety of settings including:

- shallow tidal flats or tidal lakes,
- shallow estuarine, or shallow marine deposits,
- stranded beach ridges and adjacent swales,
- interdune swales or coastal sand dunes,
- coastal alluvial valleys,
- wetlands (groundwater dependant and perched),
- floodplains,
- waterlogged areas,
- scalded areas,
- sump land,
- marshes, and
- swamps

### 2.2.3 Acid sulfate implications for urban development

The following activities are identified as having the potential to create disturbance in acid sulfate soil and sediments:

- excavation of land
- lowering the groundwater table
- filling land or stockpiling soil over in situ PASS – more than 100 $m^3$ of fill or stockpiling soil with an average depth of 0.5 m or greater. These activities can force the underlying ASS above the water table at the margins of the added soil or fill.
- planting vegetation or crops that may lower the water table
- coastal or inshore dredging (EPA 2009)

The disturbance of ASS and associated exposure to oxidising conditions has the potential to result in a variety of impacts to infrastructure and the surrounding environment. Such impacts have been summarised in Figure

2-6. The most significant and common of these tend to include impacts to receiving waterways, vegetation dieback, loss of agricultural productivity and corrosion of concrete and steel infrastructure.


Figure 2-6 Potential impacts related to ASS disturbance (Sullivan et al. 2018).

While such impacts have the potential to manifest in ASS environments, it is important to recognise that in almost all situations, such impacts can be mitigated if the disturbance of ASS is well characterised and planned for. The level of management of ASS tends to scale with the concentration of acidity, the magnitude of the planned disturbance and the sensitivity of potential receptors. For example, the development of parklands and sporting fields on low concentration acid sulfate soils may simply require the application of agricultural lime to improve the growth of vegetation during seeding. Conversely, significant excavation of high concentration acid sulfate soils for major infrastructure near a waterway may require the use of corrosion resistant concrete and a carefully detailed acid sulfate soil management plan, with robust on site monitoring and liming of soil stockpiles prior to disposal at a licenced facility.

# 3. Method

## 3.1 Spatial Logic Assessment Framework

Jacobs' Spatial Logic Assessment Framework was used in the delivery of this project (Figure 3-1). Spatial Logic is an approach that brings together source information, with the data used to represent criteria that reflect exposure or sensitivity. An assessment was made of potential sodic/dispersible and acid sulfate soils' extent and their level of vulnerability to proposed future land uses.

Spatial Logic has 5 key stages (Figure 3-1):

- Define – Define the soil/landscape profile relationships, scenarios for assessment and data sources.
- Collate and integrate – Collate source data and document for transparency, collate any accessible literature that supports soil studies in the area of interest that will inform or be the basis of the assessment. Integrate by converting source data into documented criteria in a single spatial data set.
- Assess – With reference to landscape profile criteria, undertake an assessment of potential sodic/dispersible and acid sulfate soil extent, severity and/or risk. The assessment indicates where sodic/dispersible and acid sulfate soils may occur and their level of risk, based on available evidence.
- Communicate – Provide a report on the study area, the project evidence base, assessment of findings and the information package.

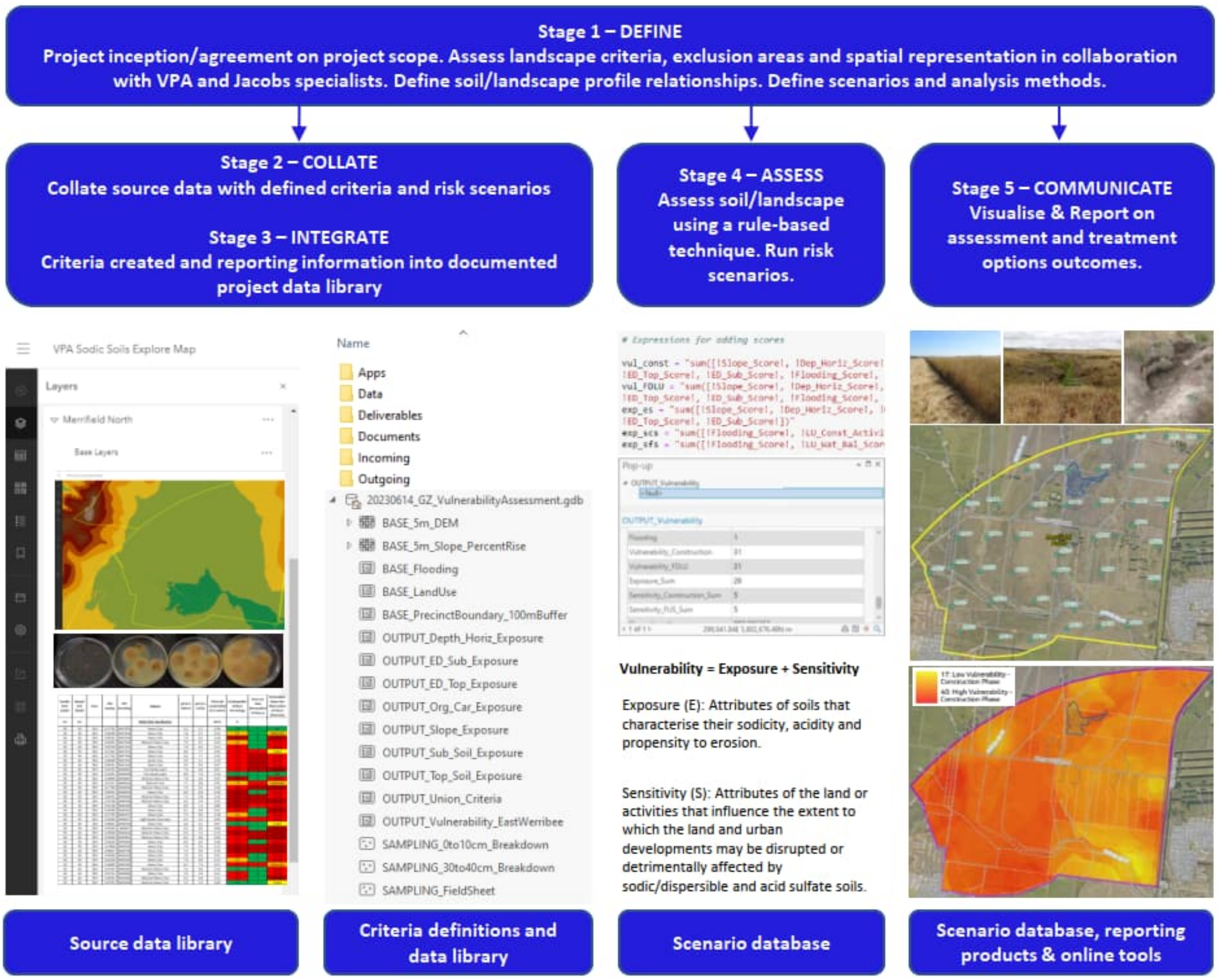



Figure 3-1. The Spatial Logic Assessment Framework.

## 3.2 Vulnerability Assessment

The principles of the Vulnerability Assessment approach and how they are applied to this assessment are outlined in this section. Vulnerability is defined for the purposes of this assessment as:

Vulnerability (V) = Exposure (E) + Sensitivity (S)[1]

Where:

Exposure (E): Attributes of soils that characterise their sodicity, acidity and propensity to erosion.

Sensitivity (S): Attributes of the land or activities that influence the extent to which the land and urban developments may be disrupted or detrimentally affected by sodic and acid sulfate soils.

### 3.2.1 Exposure criteria

Attributes of soils that were used to characterise their sodicity, acidity and exposure to erosion are:

- Sodicity of topsoil (0-10 cm) - Exchangeable Sodium Percentage (ESP) values. This soil layer is also referred to as the A horizon topsoil throughout the report.
- Sodicity of subsoil (30-40 cm) – ESP. In most cases this layer is B horizon subsoil clay, but can include A horizon topsoil where topsoils were deeper than 40cm.
- Net Acidity of topsoil (0-10cm) – Net acidity (NA) values. The potential of topsoil to act as an acid sulfate soil is represented by its NA value.
- Net Acidity of subsoil (30-40cm) – As above, but for subsoil.
- Emerson Dispersion Observations Topsoil (Remoulded 20 hr) - Level of dispersion of remoulded topsoil aggregates as a score from 1-5 (1-Nil, 5-complete) after 20 hours of immersing in deionised water. Use of a dispersion score allows for greater accuracy in understanding the dispersiveness of soils and considers all factors that influence soil dispersion, such as high exchangeable potassium and conductivity levels, especially where soils are dispersive but non-sodic.
- Emerson Dispersion Subsoil (Remoulded 20 hr) – As above, but for subsoil aggregates.
- A horizon depth – subsoil exposure/erosion risk decreases with depth.
- Organic Carbon in topsoil (0-10 cm) – Organic Carbon (OC) values. Soil exposure/erosion risk increases with low organic carbon content.
- Slope – erosion risk increases with slope (which, for this assessment, was derived using 50cm contours).
- Flooding - Based on 1 in 100 Year Flood Extents. Waterway and flood prone areas are points of convergence for runoff and flows which makes these areas more sensitive to erosion.

These attributes form the exposure criteria, with criteria values ranked according to the scoring system outlined in Table 3-1.

Table 3-2, Table 3-3 and Table 3-4 provide a description of the Exchangeable Sodium Percentage (ESP), Organic Carbon (OC) and Net Acidity (NA) values used to define the respective exposure criteria.

[1] Vulnerability is typically expressed as Exposure (E) + Sensitivity (S) – Adaptive Capacity (AC). In this case we have not included Adaptive capacity (AC) in the assessment. The Vulnerability assessment is essentially an assessment of potential impacts. Adaptive capacity is included in the discussion when considering aspects of urban development that can be managed to mitigate risks.

Table 3-1. Exposure criteria and scores. For further descriptions of ESP, organic carbon and acidity values/scores, refer to Table 3-2, Table 3-3 and Table 3-4.

| Criteria | Score | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Sodicity of Topsoil (ESP) | <5% | 5 to <7% | 7 to <10% | 10 to <15% | >15% |
| Sodicity of Subsoil (ESP) | <5% | 5 to <7% | 7 to <10% | 10 to <15% | >15% |
| Acidity of Topsoil (mole $H^+$/tonne) | <18 | >18 to <90 | >90 to <180 | >180 to <540 | >540 |
| Acidity of Subsoil (mole $H^+$/tonne) | <18 | >18 to <90 | >90 to <180 | >180 to <540 | >540 |
| Emerson Dispersion Observations Topsoil (Remoulded 20 hr) | Nil | Slight | Moderate | Strong | Complete |
| Emerson Dispersion Observations Subsoil (Remoulded 20 hr) | Nil | Slight | Moderate | Strong | Complete |
| A horizon depth | >40cm | 30-40cm | 20-30cm | 10-20cm | <10cm |
| Topsoil Organic Carbon (%) | >4.0 | 3.0-<4 | 2.0-<3 | 1.0-<2 | <1.0 |
| Slope | 0-1 % | 1-5% | 5 to 10% | 10 to 20% | >20% |
| Flooding (based on 1 in 100 Year Flood Extent) | No | - | - | - | Yes |

Table 3-2. Exchangeable Sodium Percentage (ESP) values used to define Sodicity exposure criteria.

| Score | ESP Range | Description |
|---|---|---|
| 1 | <5% | Non-sodic, unlikely to reveal dispersion when in contact with fresh rainfall or runoff. |
| 2 | 5 to <7% | Transition between non-sodic and sodic soil (sodic soil of 6%). Clay fraction within samples likely to evince dispersion when in contact with fresh rainfall or runoff. |
| 3 | 7 to <10% | Moderate to high sodicity. Dispersion likely to occur when in exposed to fresh rainfall or runoff. |
| 4 | 10 to <15% | High to very high sodicity. Dispersion likely. Significant erosion risk when exposed to fresh rainfall or runoff. |
| 5 | >15% | Very high to extreme sodicity. Significant erosion risk when exposed to fresh rainfall or runoff. |

Table 3-3. Organic Carbon (OC) values used to define exposure criteria for Topsoil.

| Score | OC Range | Description |
|---|---|---|
| 1 | >4.0% | Optimal to high. Aggregate stability likely. |
| 2 | 3.0 to <4% | Optimal. Water stable aggregates expected. |
| 3 | 2.0 to <3% | Acceptable. Variable water stability expected. |
| 4 | 1.0 to <2% | Slightly low. Aggregates expected to be unstable, or partially stable. |
| 5 | <1.0% | Low to deficient. Low or poor aggregate stability expected. |

Table 3-4. Net Acidity (NA) values used to define Acidity exposure criteria.

| Score | Net Acidity Range (mole $H^+$/tonne) | Description |
|---|---|---|
| 1 | <18 | Non ASS. Don't need an Acid Sulfate Soil Management Plan (ASSMP) |
| 2 | >18 to <90 | Low capacity ASS. 1-5 times criteria, often effects not manifest, usually easily to manage under an ASSMP |
| 3 | >90 to <180 | Moderate capacity ASS. 5-10 times criteria, not uncommon but need robust management under an ASSMP |
| 4 | >180 to <540 | Moderate to high capacity ASS. 10-30 times criteria, less common and potentially problematic, need very careful management under ASSMP |
| 5 | >540 | High capacity ASS. >30 times criteria, often hard to manage even under a robust ASSMP, evaluate other alternatives |

### 3.2.2 Sensitivity criteria

Attributes of the land or activities that influence sensitivity to sodic and acid sulfate soils are:

- Construction activity – Potential disturbance of construction for future land use sub types mapped in Preliminary FUS Dataset. Sensitivity to sodic and acid sulfate soils increases with clearing of landscape and earthworks.
- Water balance change – Potential for change in water balance due to future land use (based on FUS classes)[2]. This considers potential for increases in overland flow from impervious surfaces and stormwater pipes in proposed developments. Sensitivity to sodic and acid sulfate soils is heightened as a result of increases in runoff and changes to groundwater tables (lowering of groundwater tables and fluctuations in wetting/drying provides opportunities for oxidation). Wetlands also have the potential to accumulate the products of sulfide oxidation in areas sensitive to their impact

These attributes form the Sensitivity criteria, with criteria values ranked according to the scoring system outlined in Table 3-5. Table 3-6 and Table 3-7 provides a description of scorings used for Construction Activity and Water Balance Change criteria.

Table 3-5. Sensitivity criteria and scores. For further description of Construction Activity and Water Balance Change values/scores, refer to Table 3-6 and Table 3-7.

| Criteria | Score | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| Construction activity | Minimal disturbance | | | | High level of disturbance |
| Water balance change | Low (stay the same, infiltration) | | | | High (generate runoff) |

Table 3-6. Descriptions of scorings for Construction Activity ranked by level of disturbance expected for Land Use Classes mapped in the Future Urban Structure (FUS).

| Score | Level of Disturbance | Land Use Class |
|---|---|---|
| 1 | Minimal disturbance | Conservation Area (Open Space), Existing Wetland (Open Space) |
| 2 | | *(No land use classes fall in this category)* |
| 3 | | *(No land use classes fall in this category)* |
| 4 | | Industrial and Commercial; Existing, Planned and Proposed Arterial Roads (Aitken Boulevard, Gunns Gully Road Interchange, Public Acquisition Overlay for the OMR/E6 Corridor and Hume Freeway Interchanges) |
| 5 | High level of disturbance | Kalkallo Basin (Open Space – Constructed Waterways and Wetlands/Retardation Basin) |

Table 3-7. Description of scorings for Water Balance Change expected for Land Use Classes mapped in the Future Urban Structure (FUS).

| Score | Water Balance Change | Land Use Class |
|---|---|---|
| 1 | Low (stay the same, infiltration) | *(No land use classes fall in this category)* |
| 2 | | *(No land use classes fall in this category)* |
| 3 | | *(No land use classes fall in this category)* |
| 4 | | Industrial and Commercial; Existing, Planned and Proposed Arterial Roads (Aitken Boulevard, Gunns Gully Road Interchange, Public Acquisition Overlay for the OMR/E6 Corridor and Hume Freeway Interchanges) |
| 5 | High (generate runoff) | Conservation Area (Open Space), Existing Wetland (Open Space), Kalkallo Basin (Open Space – Constructed Waterways and Wetlands/Retardation Basin) |

[2] This is an assessment of where in the PSP landscape the water balance is likely to change the most due to development. Note that waterways within the PSP may experience additional impacts caused by changed hydrology outside of the PSP, this potential has not been considered by this high-level assessment.

### 3.2.3 Risk scenarios

The distribution of erosion risk associated with sodic and acid sulfate soils was modelled using the collated datasets. This assessment was undertaken using Jacobs' Vulnerability Assessment Engine (VAE) - a tool that assists in assembling and analysing spatial data sets.

The VAE was used to assess the risks associated with sodic and acid sulfate soils for the following two scenarios:

- Construction phase, where the Vulnerability of land and urban development to sodic and acid sulfate soil erosion risks during the construction phase is a function of the following Exposure and Sensitivity criteria:
  - Exposure (E) – Sodicity topsoil, Sodicity subsoil, Acidity topsoil, Acidity subsoil, Emerson Dispersion Topsoil (Remoulded 20 hr), Emerson Dispersion Subsoil (Remoulded 20 hr), A horizon Depth, Organic Carbon topsoil, Slope, Flooding.
  - Sensitivity (S) - Construction Activity
- Future developed land use, where the Vulnerability of land and urban development to sodic soil and acid sulfate erosion risks in the future land use is a function of the following Exposure and Sensitivity criteria:
  - Exposure (E) - Sodicity topsoil, Sodicity subsoil, Acidity topsoil, Acidity subsoil, Emerson Dispersion Topsoil (Remoulded 20 hr), Emerson Dispersion Subsoil (Remoulded 20 hr), A horizon Depth, Organic Carbon topsoil, Slope, Flooding.
  - Sensitivity (S) - Water Balance Change

Exposure and Sensitivity criteria scores are summed to calculate Vulnerability. The decision was made to apply an equal weighting of scores to each of the Exposure and Sensitivity criteria, as they are all considered to be similarly important. The spatial distribution and range of Vulnerability scores informs an assessment of the potential impact of land and urban developments have on sodic and acid sulfate soil erosion risks.

### 3.2.4 FUS Dataset Limitations

The FUS dataset that has been used for the purposes of this assessment as agreed with Victorian Planning Authority is a preliminary plan that shows the range of future potential land uses, however the specifics of future land uses and their layout could still be subject to significant changes (i.e. siting of roads, extent of retarding basin, waterbodies and open space) and additions (i.e. further provisions of waterway/drainage reserves for Kalkallo Creek and trubutaries).

Notably absent from the FUS dataset is provision for waterway/drainage reserves for Kalkallo Creek and tributaries through areas that are currently zoned as Industrial and Commercial (Figure 1-1). By not including these in the FUS dataset, this gives the perception that these waterways are to be piped (to maximise developable land). This however is not correct and it should be acknowledged that the current version of the Kalkallo Creek Drainage Services Scheme (DSS) indicates that the Kalkallo Creek and its tributaries (drains) are to be retained as natural waterways (Figure 5-1). The area is also prone to significant flooding, and as such this will need to be taken into consideration when developing waterway/drainage corridor widths for the future developed precinct area.

It is expected that Melbourne Water as the responsible authority for the development of the DSS will work in collaboration with Victorian Planning Authority to establish appropriate waterway/drainage corridor widths. The corridor widths and any stormwater conveyance and treatment assets must be designed to avoid or mitigate the risks of erosion from sodic and/or dispersive soils (and also acid sufate soils). This is consistent with expectations outlined in planning requirements and guidelines documented in the Beveridge North West PSP that relate to Inegrated Water Management (Table 5-1).

# 4. Results

## 4.1 Sodicity and acidity of soils and their exposure to erosion

A total of 40 sites were assessed across the Merrifield North Employment Precinct (Figure 4-1), with samples collected at two depth ranges within each profile (0-10cm and 30-40cm). Of these sites, 29 were collected at depths of 80-150cm, with the deeper samples not collected where soils were hand augured.

Physical and chemical assessment confirms that soils are classified as follows:

- Sodosols, identified at 15 sites, or 37.5% of sample points. Sodosols are defined as *'soils which display a clear or abrupt textural B horizon in which the major part of the upper B2 horizon is sodic and not strongly acid'* (Isbell and NCST 2021). This also includes soils which record sodic conditions in the A horizon (topsoil).
- Vertosols, identified at 25 sites or 62% of sample points. Vertosols are defined as *'clay soils with shrink-swell properties that exhibit strong cracking when dry and at depth have slickensides or lenticular peds'* (Isbell and NCST 2021), with additional summarised definitions:
  - A clay field texture or 35% or more clay throughout the solum,
  - When dry, open cracks occur at some time in most years, and
  - Slickensides and/or lenticular peds occur at some depth in the solum.

Soil profile observations are consistent with the mapping of surface geology (Refer to Section A.3.1, Figure A-2). Newer volcanics (Neo, Neo2) are found in the eastern part and also wrap around the southern extreme. Quaternary alluvial deposits (Qa2) are found within the flow path and floodplain of the Kalkallo Creek, which runs south and turns eastward. There is a transitional zone on newer volcanics covering the break of slope where alkaline clays with calcium carbonate are identified, reflecting lava flows and aeolian deposits. Geology is broadly summarised into two units, 'volcanics' and 'alluvials', with soil physical and chemical conditions listed as follows:

- Volcanics: Rising to gently undulating land containing variable topsoils overlying heavy clay subsoils. Volcanics are broken into two divisions based on geology mapping and field condition:
  - Volcanic Rises: Volcanic soils located on higher land with unimpeded surface drainage. Soils are variable, dominated by duplex loams over clay subsoil, or gradational clay-loam topsoils over clay subsoil.
  - Transitional volcanics: Land on lower slope and gently undulating areas with basalt exposed in some areas. These soils occur within a transition zone between volcanic rises and alluvial soils. Soils are gradational to uniform, clay-loam or light-medium clay topsoils over heavy clay subsoils. Many sites in this group recorded sampling refusal on basalt rock at between 100-150cm.
- Alluvials: Soils formed from alluvial floodplain deposits from the Kalkallo Creek, consisting of fine sand, silt and clay, also exhibiting calcium carbonate at depth indicating that clays may also be aeolian. Differing groups of alluvial soils are separated mainly by their surface textures, which include:
  - Gradational to uniform soils, with the dominant group containing light clay, light-medium clay or medium clay topsoil over heavy clay subsoil. Some contain clay-loam surface textures.
  - Duplex soils, containing sandy loam, light sandy clay-loam and sandy clay-loam topsoil over heavy clay subsoil. This also includes one waterway sample (MN38), recording loam to 40cm, with sampling depth limited from hand auguring.

There is a strong correlation between ESP (sodicity) and dispersion observations on remoulded samples at 20 hours across the 0-10cm and 30-40cm soil depths. Results confirm that when exposed to fresh rainfall, dispersion is likely to occur within both soil depths, with the 30-40cm soil depth of higher risk of erosion.

There is no clear pattern of variation between volcanics and alluvials when comparing results, even though surface textures vary significantly from loam to medium clay.

The presence of highly sodic and dispersive conditions throughout the 30-40cm range indicates that soils are likely to evince poor profile drainage. Physical assessment has revealed medium to heavy clay as the dominant subsoil textures, which further confirm that profile drainage is likely to be poor. Waterlogging is expected during winter months or whenever seasonally wet conditions prevail.

The occurrence and distribution of acid sulfate soils was estimated using the co-variance between chromium reducible sulfur suite results (24 tests) and screen test results (109 tests) across the 40 sample sites. In general, the majority of soils (65%) exhibited concentrations of net acidity greater than18 mole $H^+$/tonne and were more prevalent in topsoils. Net acidity was primarily present as actual acidity, however the acidity appears to be related to the presence of sulfides, which were detected in 92% of samples analysed. More specifically:

- Within topsoils (0-10cm depth), the majority (77.5%) exhibited concentrations of net acidity greater than18 mole $H^+$/tonne and require management under an Acid Sulfate Soil Management Plan (ASSMP). However, the majority (67.5%) exhibited concentrations ranging between 1 and 5 times the action criteria (18-90 mole $H^+$/tonne) and are likely to be easily managed under an ASSMP. Only 4 locations in the northeast of the project area (Figure 4-5) exhibited concentrations between 5 and 10 times the action criteria (90-180 mole $H^+$/tonne) and may need more robust management under an ASSMP.
- Within subsoils (30-40cm depth), the majority (82.5%) exhibited concentrations of net acidity less than 18 mole $H^+$/tonne and do not require management under an ASSMP. A total of 7 locations exhibited net acidity concentrations ranging between 1 and 5 times the action criteria (18-90 mole $H^+$/tonne) and are likely to be easily managed under an ASSMP. These occurred in the north and southeast of the project area (Figure 4-6).

Based on screen test results for deeper soil samples (80-150cm range) the occurrence of AASS and PASS soils below the upper most subsoil profile is atypical. All of these deeper samples were assessed as having a low risk of being an AASS. All but one sample was identified as a low risk of being PASS. Further descriptions of soil characteristics and detailed tables of soil test results are included in Appendix A.

Some photographs of the field area showing ground cover are shown in Figure 4-2. A reasonable cover of grass pasture was present across most of the area at the time of sampling, apart from cropping lands on Volcanic Rises and Transitional Volcanics to the north of Gunns Gully road. The dominant pasture species is Phalaris (*Phalaris aquatic*), a perennial which has thrived following wet seasonal conditions throughout the past 3 years. This is particularly dominant across non-cropping areas. Most areas showed little sign of grazing apart from one property on the western end of Gunns Lane. In general, organic carbon levels averaging 3.0-3.3% across the volcanics and alluvials respectively reflect optimal groundcover and improved stability. Organic matter from plant biomass and plant roots is vital for preventing erosion where sodic soil conditions exist.

Disturbances to topsoil and construction of roads and drains can impact surface groundcover, increasing risks of erosion of sodic soil. Currently most undisturbed areas present a low or negligible erosion risk. Undisturbed topsoils appear relatively stable in their current condition. Exposed subsoils at 30-40cm are a high risk of erosion. Risks also remain high for exposed subsoils > 40cm depth. These soils were found to be moderately to very strongly sodic (Average ESP 28.5%, refer to Table A-15) though most samples were observed as having low dispersion. Other factors including elevated EC are likely to be reducing or inhibiting dispersion and therefore improving stability, even though ESP levels are very high. If salts are permitted to leach from deeper material which is stockpiled as loose fill, dispersion will become evident. Protection measures are required to manage risks and minimise impacts on surrounding waterways.

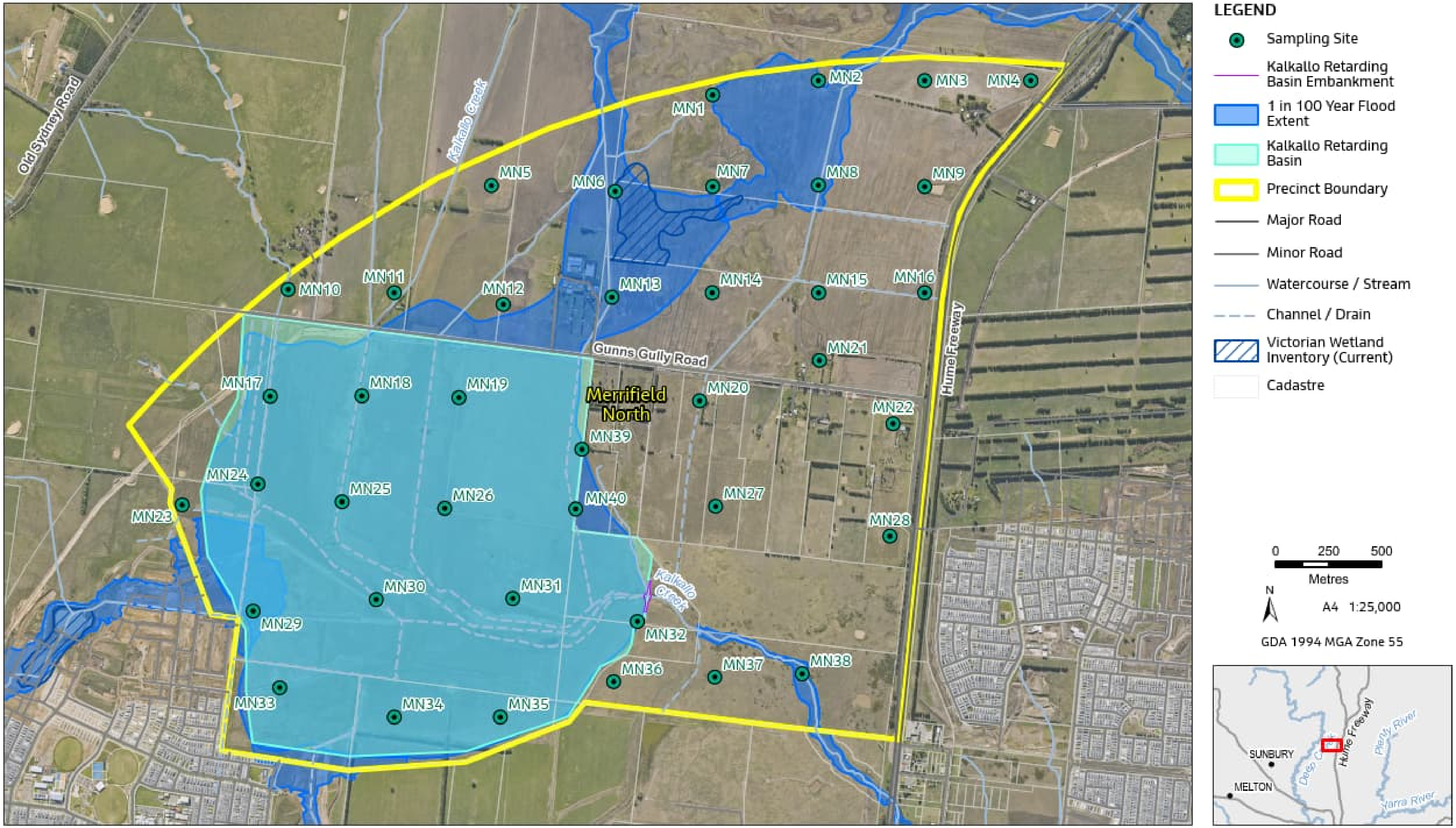



Figure 4-1. Merrifield North Employment Precinct: Key landscape features and soil sample sites.

Figure 4-2. Selected photos of Merrifield North Employment Precinct: Phalaris grass and recently slashed track that forms a thick organic matt across surface in the Kalkallo Retarding Basin (top left), Looking upstream at Kalkallo Creek/Drains from embankment of Retardation Basin (top right), paddock that has been recently cropped with areas of bare ground (bottom left) and erosion of soil along drainage channel (bottom right).

An inverse distance weighted (IDW) interpolation was used to estimate values of soil sodicity (topsoil and subsoil), net acidity (topsoil and subsoil), Emerson Dispersion (topsoil and subsoil) A horizon depths and Organic Carbon (topsoil) at unsampled locations across the Precinct. IDW interpolation is a standard method that is used for spatial interpolation and development of soil maps (Mueller et al. 2004).

Maps showing the spatial distribution of these eight exposure criteria are presented on the following pages (Topsoil Sodicity - Figure 4-3, Subsoil Sodicity - Figure 4-4; Topsoil Net Acidity - Figure 4-5; Subsoil Net Acidity - Figure 4-6; Topsoil Emerson Dispersion - Figure 4-7, Subsoil Emerson Dispersion - Figure 4-8, A horizon depth - Figure 4-9, Topsoil Organic Carbon - Figure 4-10).

The final exposure criteria is slope and flooding, with classes shown in Figure 4-11 and Figure 4-12. The area is relatively flat and is prone to flooding, with drainage provided by Kalkallo Creek and its network of tributaries which function as drainage channels. The area of flooding is extended a result of the attenuation and storage of stormwater in Kalkallo Retarding Basin.

Figure 4-13 presents the sum of the ten exposure criteria (Topsoil sodicity, Subsoil sodicity, Topsoil net acidity, Subsoil net acidity, Topsoil Emerson Dispersion, Subsoil Emerson Dispersion, A horizon depth, Topsoil Organic Carbon, slope and flooding). Soils that have higher ESP values, recorded strong or complete dispersion, lower A horizon depths are a greater erosion risk. Flooding also influences exposure to erosion.

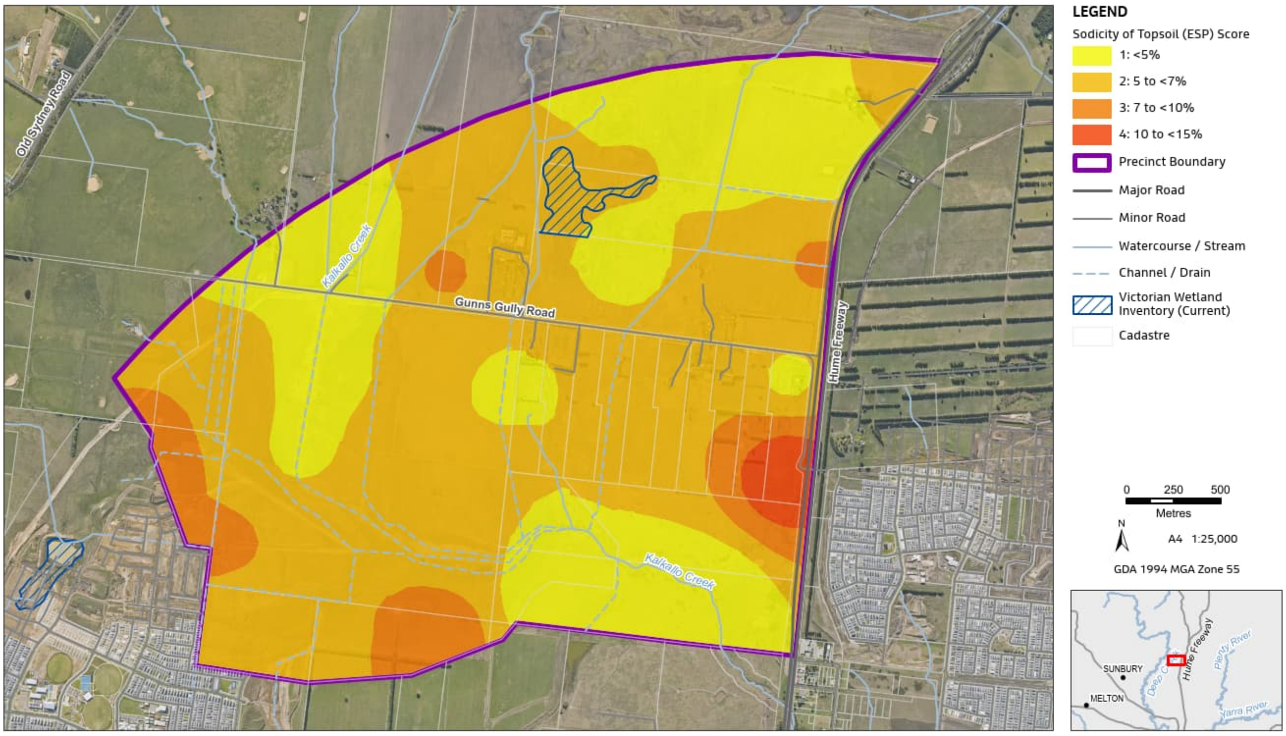



Figure 4-3. Sodicity of topsoil.

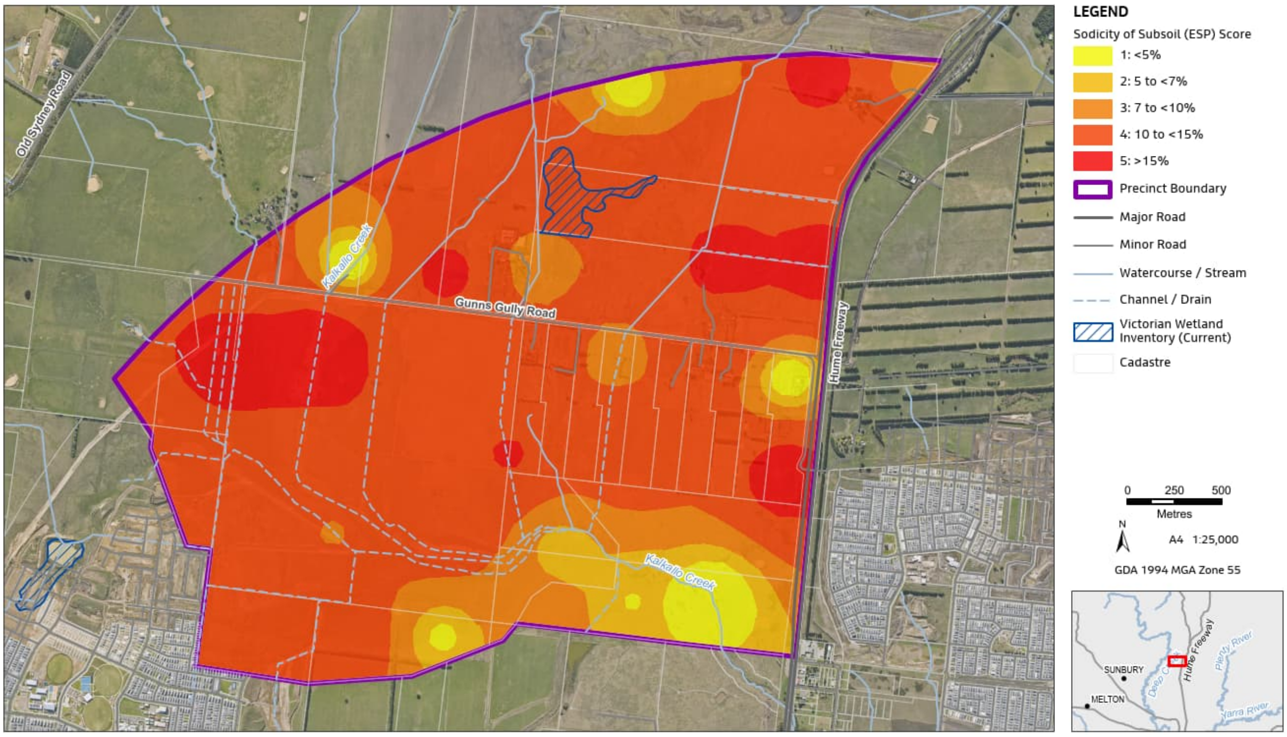



Figure 4-4. Sodicity of subsoil.


Figure 4-5. Net acidity of topsoil.

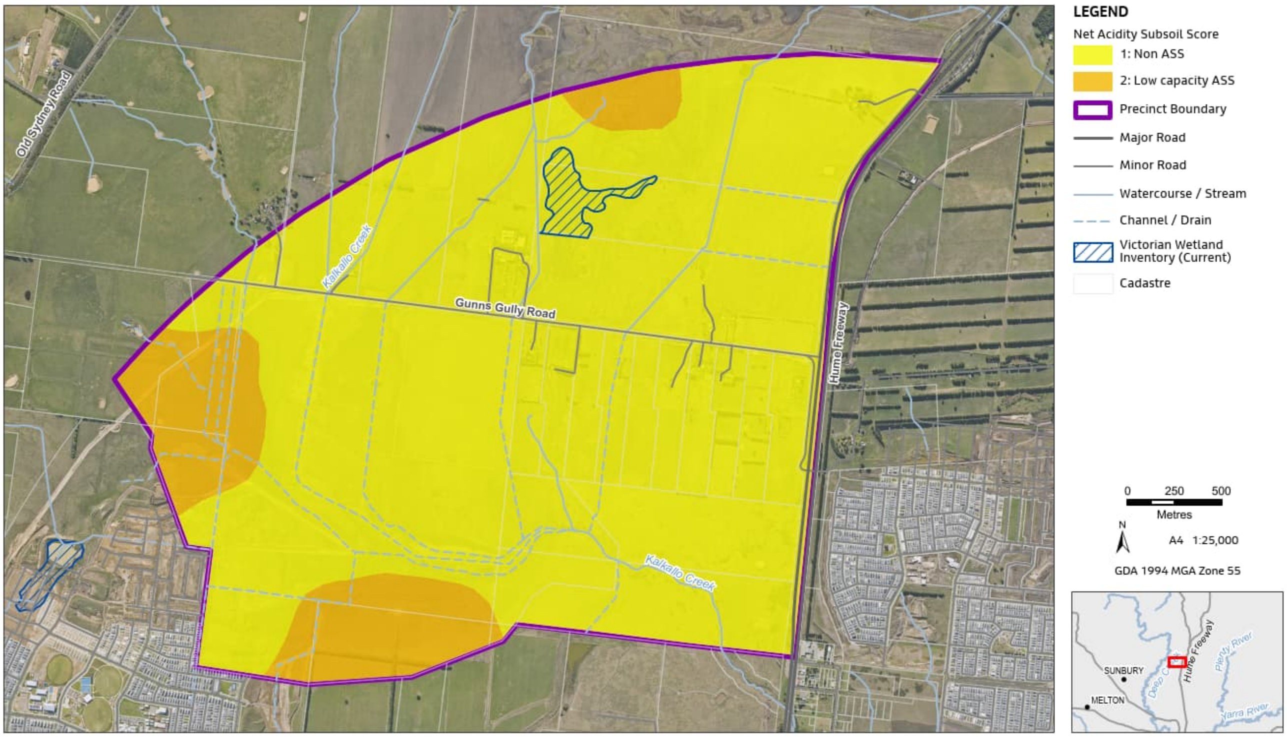



Figure 4-6. Net acidity of subsoil.


Figure 4-7. Emerson Dispersion Topsoil (Remoulded 20 hours).

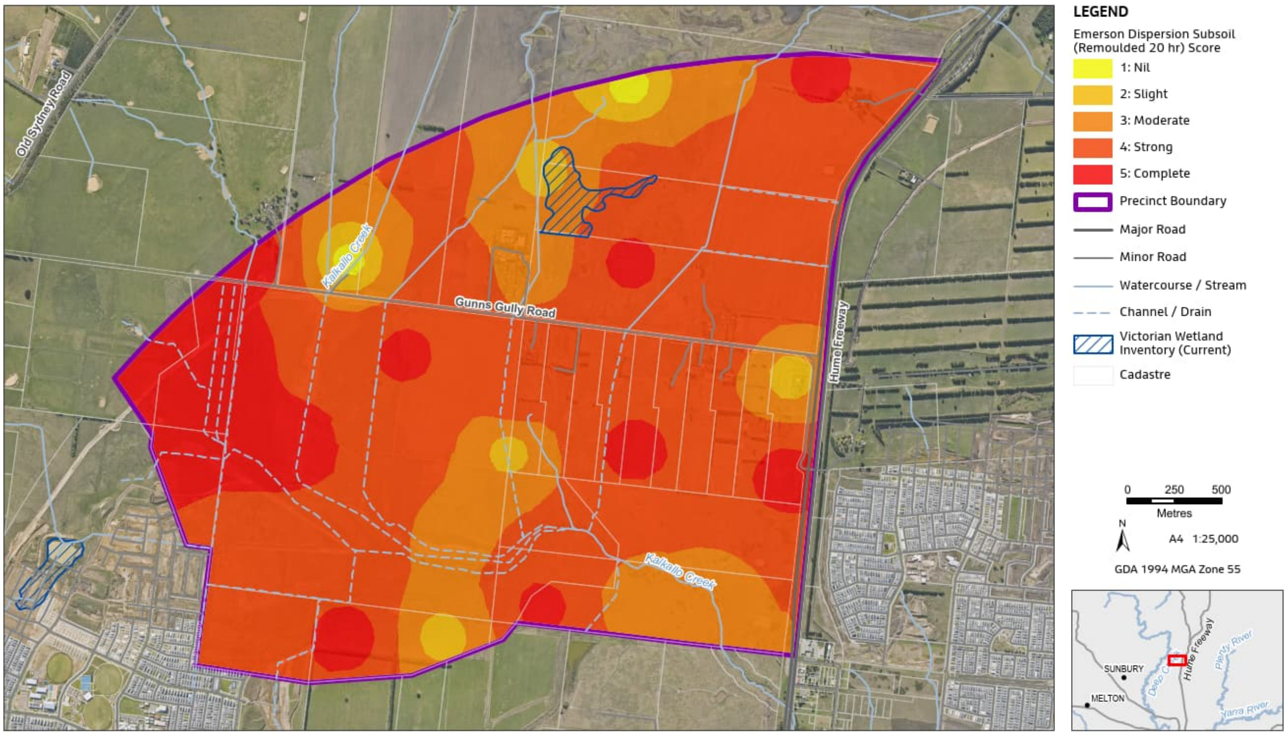



Figure 4-8. Emerson Dispersion Subsoil (Remoulded 20 hours).

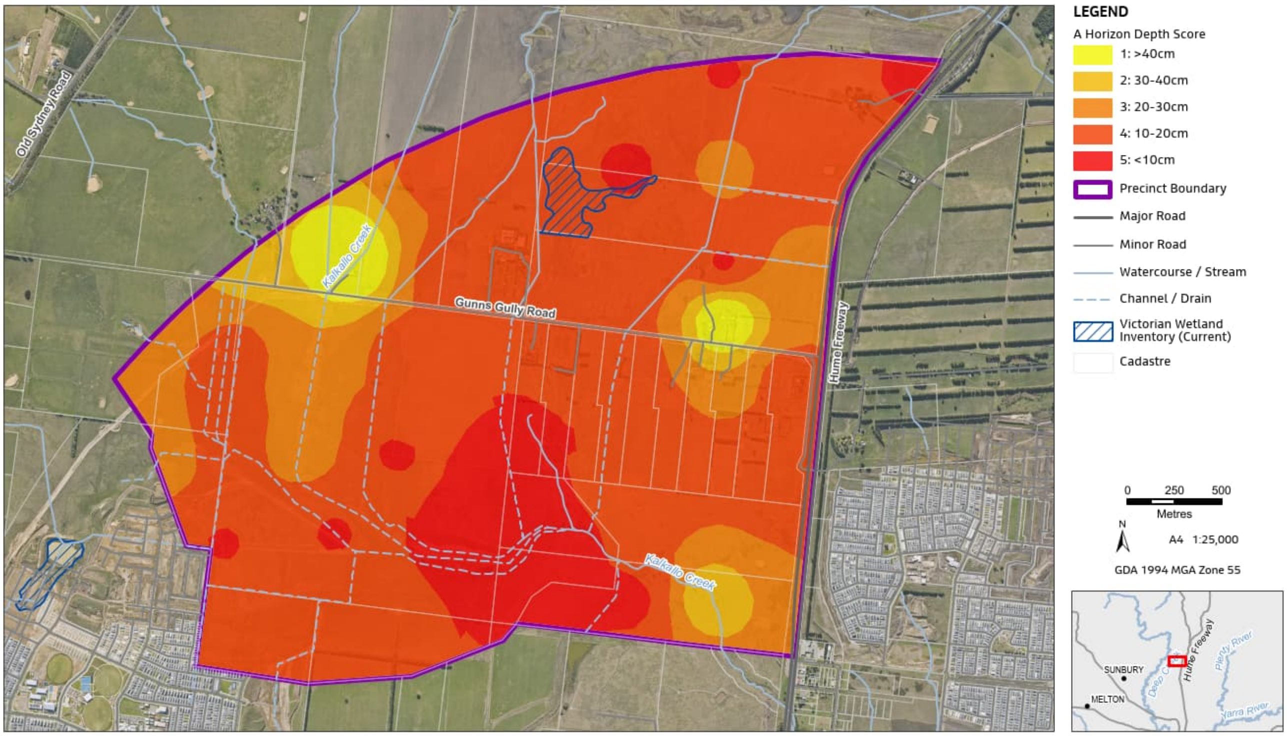



Figure 4-9. A horizon depth.


Figure 4-10. Topsoil Organic Carbon.

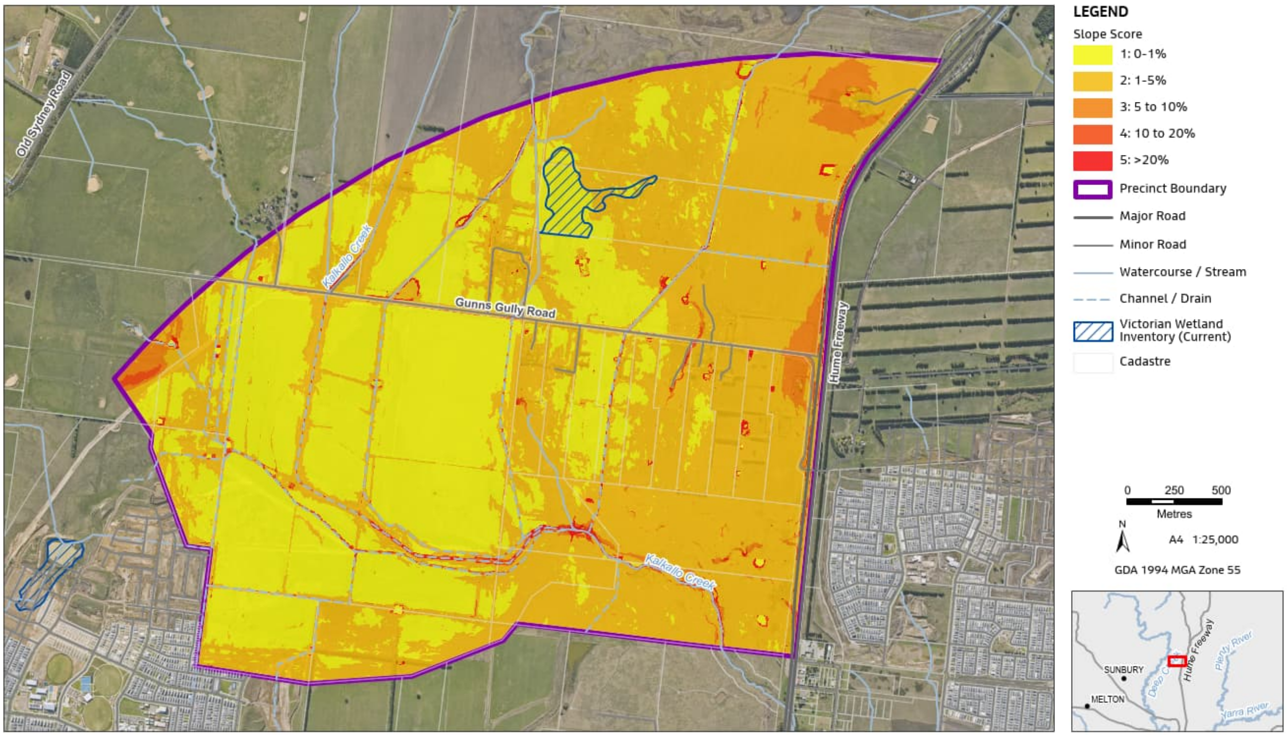



Figure 4-11. Slope.

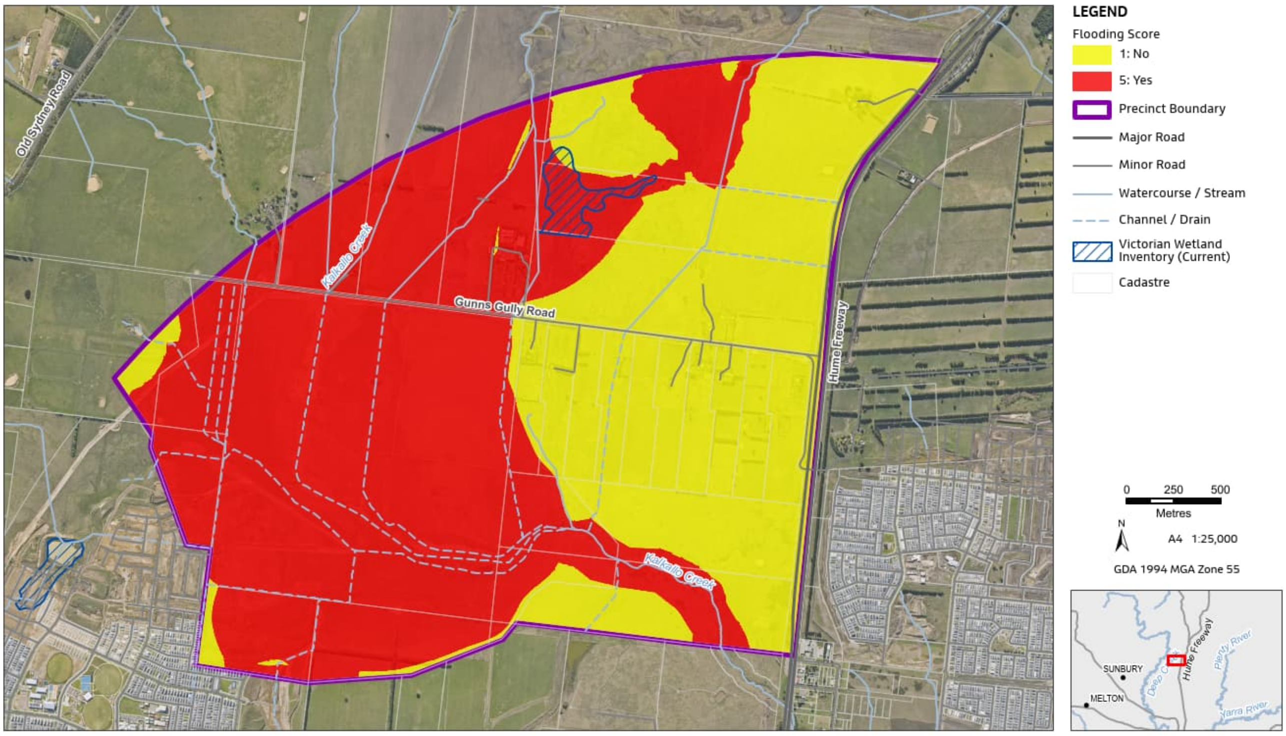



Figure 4-12. Flooding.

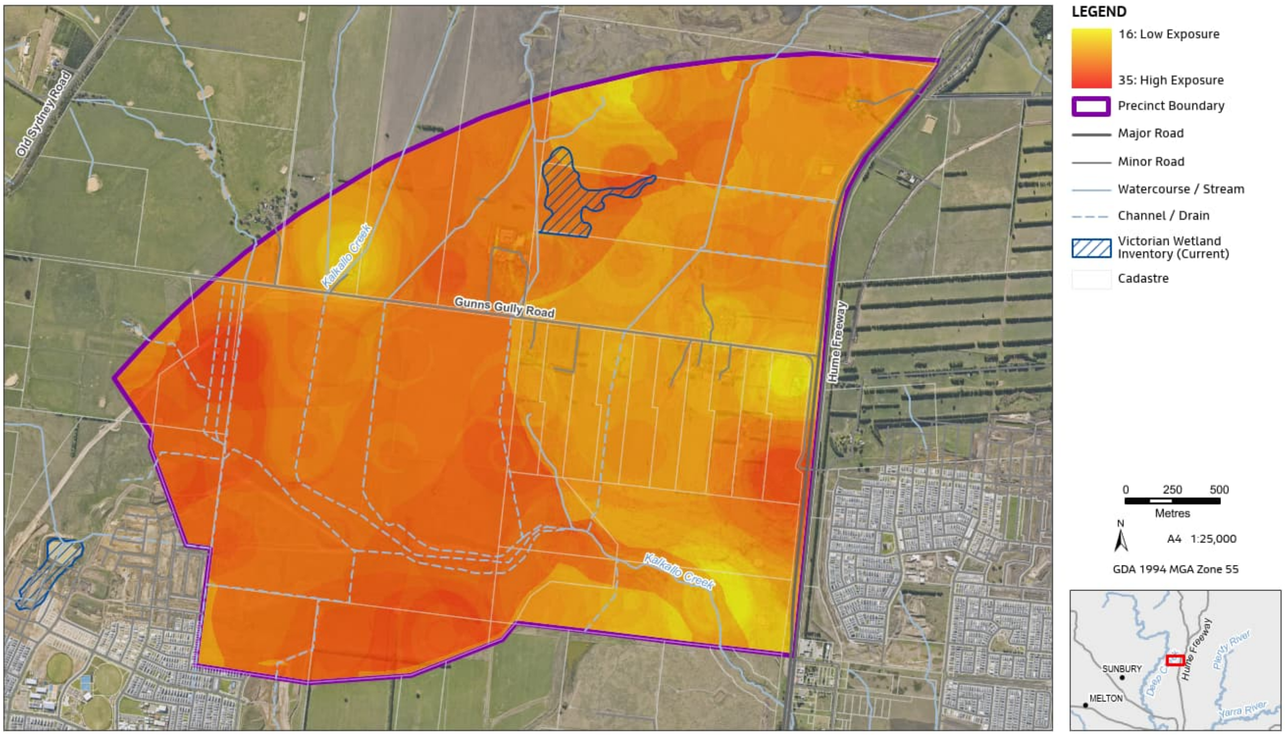



Figure 4-13. Sum of exposure criteria.

## 4.2 Sensitivity of land and urban development to sodic and acid sulfate soils

The Future Urban Structure (FUS) dataset with its preliminary layout of future land uses has been used as the basis for defining the sensitivity of land and urban development to sodic and acid sulfate soils (ASS). Figure 4-14 and Figure 4-15 present the spatial distribution of sensitivity scores as applied to the FUS dataset for construction activity and water balance change.

Construction activities in different land use types are ranked on a scale for sensitivity from minimal disturbance (low sensitivity) to high levels of disturbance (high sensitivity). Areas that are set aside as open space (Conservation Area, Existing Wetland) have low levels of development and are scored as minimal disturbance (1), with the level of disturbance increasing with the intensity of development. The majority of the land use sub types are given a score of 4, with the Kalkallo Basin experiencing the highest level of disturbance (5). This high scoring for the Kalkallo Basin is due to the extent of excavations that are expected to occur within the basin during the formation of constructed waterways and wetlands (refer to Figure 5-2).

Sensitivity to sodic and acid sulfate soils increases with clearing of landscape and earthworks. Construction activites will expose sodic and dispersive soils to erosion from runoff. These activities also have the potential to expose potential ASS to oxidising conditions.

In scoring water balance change, all of the open space areas (Conservation Area, Existing Wetland, Kalkallo Basin) are expected to experience the highest levels of water balance change (5). Increasing development of land use, will result in development of impervious areas that generate runoff and therefore have the potential to result in high levels of water balance change to the Conservation Area, Existing Wetland and Kalkallo Basin.

Sensitivity to sodic and ASS is heightened as a result of increases in runoff and changes to groundwater tables (lowering of groundwater tables and fluctuations in wetting/drying provides opportunities for oxidation). Wetlands also have the potential to accumulate the products of sulfide oxidation in areas sensitive to their impact.


Figure 4-14. Construction activity.


Figure 4-15. Water balance change.

## 4.3 Vulnerability Assessment

The outcomes of the vulnerability assessment for the construction phase and future developed land use scenarios are presented in Figure 4-16 and Figure 4-17. The vulnerability assessment provides similar results for the two phases of development.

During construction, areas identified with a high vulnerability to soil erosion are the open space (drainage/wetlands, conservation) and flood prone areas (Figure 4-16). Activities that expose these soils to rainfall and associated runoff will present significant construction challenges and need to be managed carefully. These activities also have the potential to expose ASS to oxidising conditions.

For future developed land use, open space (drainage/wetlands, conservation) and flood prone areas are identified with a high vulnerability to soil erosion (Figure 4-17). Water balance changes resulting from future developed land use and associated impervious areas will generate high volumes of runoff, which will drain into these areas. Further increases in flows have the potential to accelerate erosion of bed and bank materials and the activation of potential ASS.

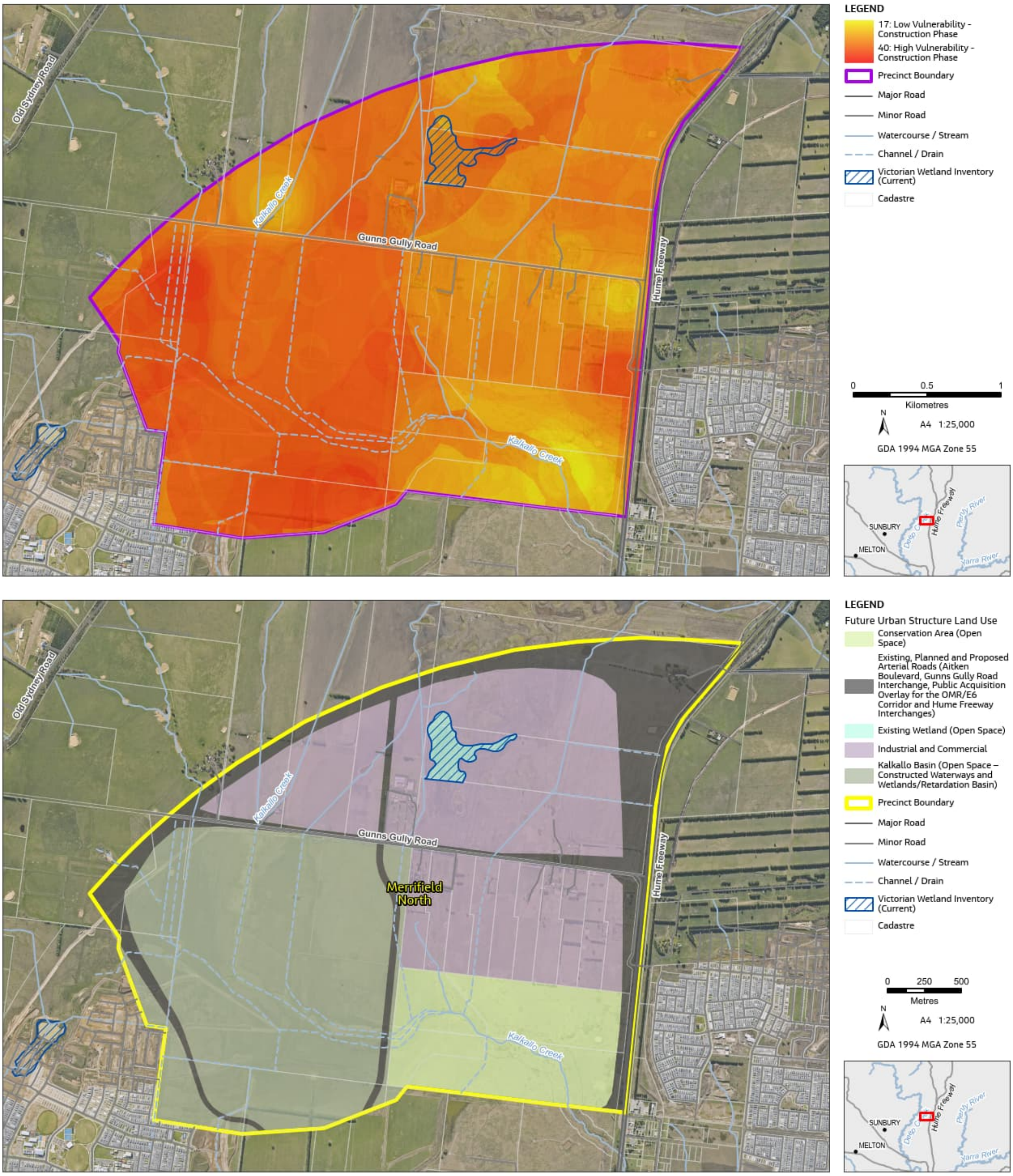
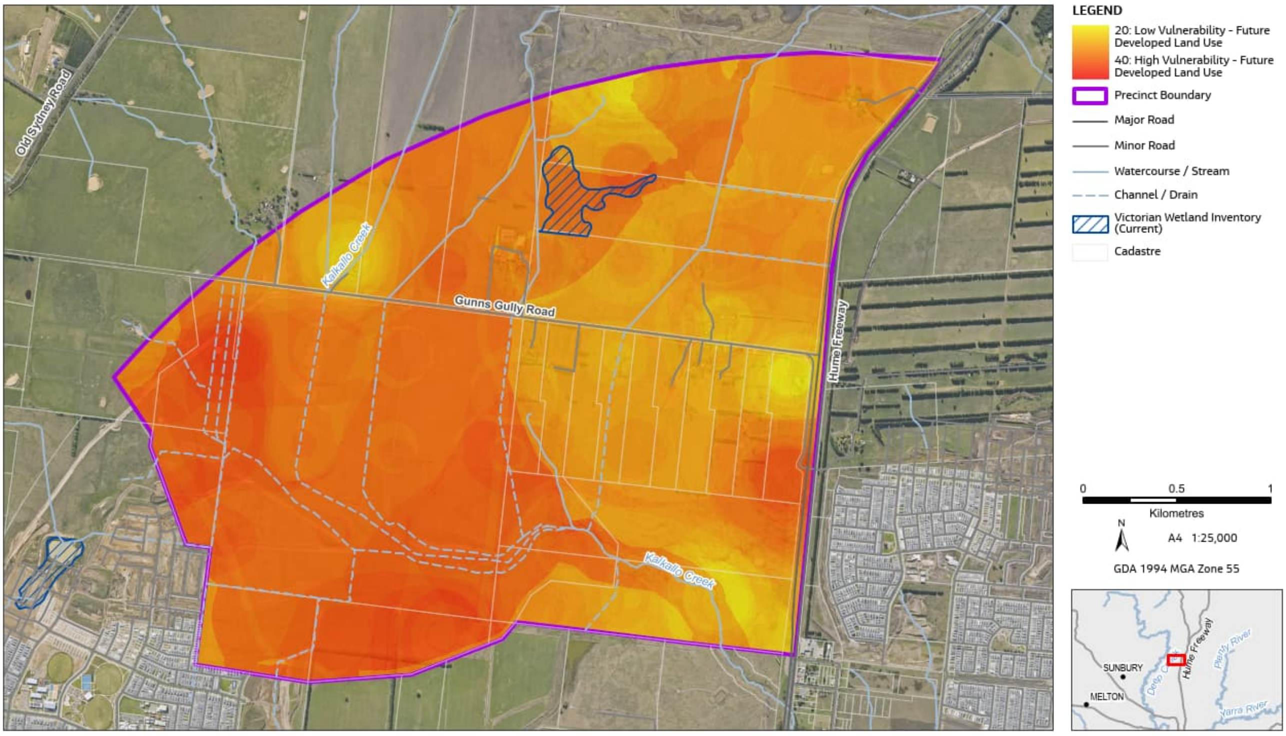



Figure 4-16. Vulnerability Construction Phase (upper). Map of Future Land Use Types (below).



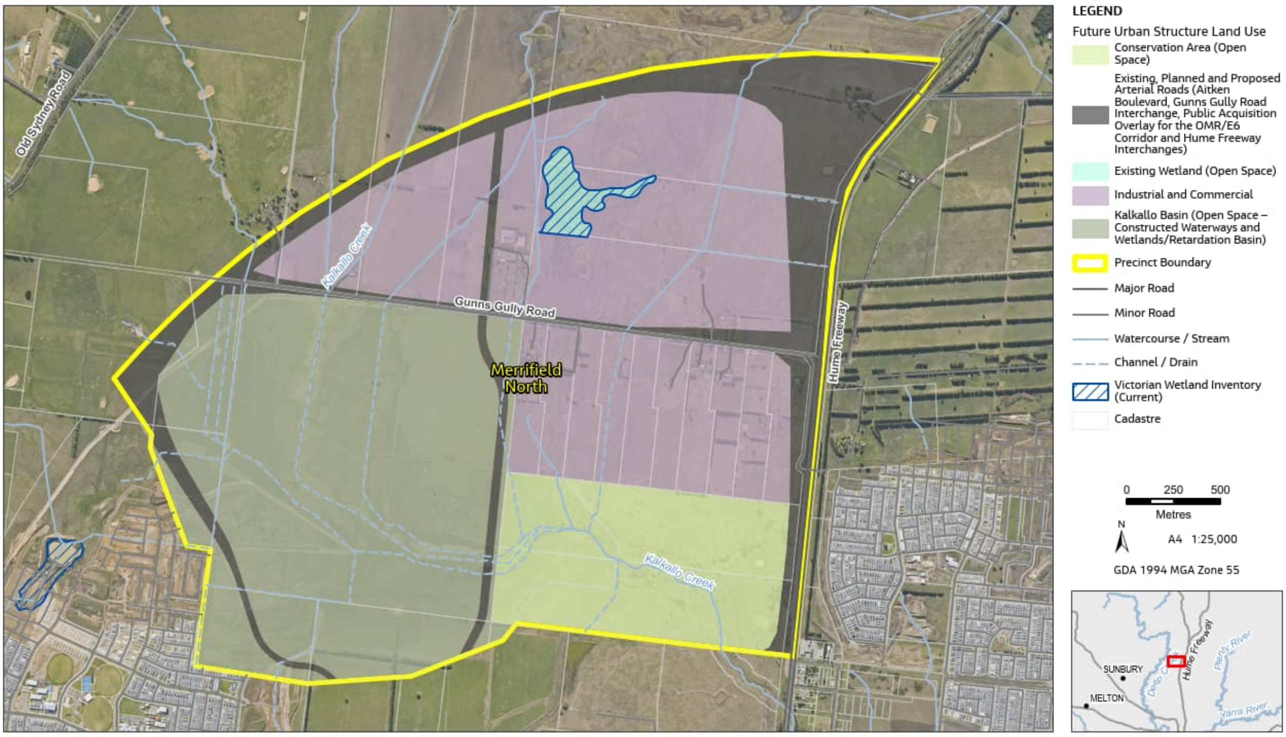




Figure 4-17. Vulnerability Future Developed Land Use (upper). Map of Future Land Use Sub Types (below).

# 5. Discussion and recommendations

## 5.1 Erosion and environmental risks

Erosion and environmental risks are directly influenced by soil exposure and changes in landscape hydrology. Examples of activities that may potentially expose sodic and acid sulfate soils include disturbance to vegetation and groundcover, removal of topsoil, subsoil excavations (cut and fill), supply of services by trenches and construction of roads and culverts. Changes to hydrology, such as the concentration of flow in culverts, runoff from impervious areas and ponding of rainfall can lead to concentrated, elevated velocity water flow and may also increase erosion risk. These activites and changes to hydrology also may lead to the activatation of potential ASS and mobilisation of their products.

Clay-loam surface soil textures were dominant across the precinct area, with clay-dominant subsoils most common. Soils with these characteristics evince rapid to moderate infiltration on the surface which is reduced under sodic and dispersive conditions. Subsoil permeability will be poor. Consequently, when rainfall intensity exceeds the soils' capacity to infiltrate water, or when profiles are at field capacity overland flows are generated. Overland flows will entrain sand, silt and clay particles when they are loose and disturbed, when velocity or shear stress of flows exceed thresholds for particle entrainment or where dispersive conditions lead to a deterioration in soil structure, breaking down aggregates and soil particles leaving them liable to erosion. Fresh rainfall contact with clay exhibiting sodic and dispersive characteristics may induce sheet or rill erosion on exposed surfaces. These processes are a threat to the quality of stormwater, with high turbidity expected across untreated earthworks areas. Turbid water will pond in localised depressions, or enter drainage lines and result in increased turbidity in connecting waterways off-site.

Erosion issues are also expected to arise along drainage depressions and waterways and may be compounded by historical changes to the physical form of the waterway, such as the removal of vegetation from the landscape and the formation of artificial drains. Initiation of scour in drainage depressions arising from increased runoff, exposure of subsoils and the dispersive nature of these soils require specific management. Future urban development, with clearing and removal of topsoils, trenching and changes to drainage patterns increases the erosion risk. Sand and silt particles are heavier than suspended clay particles. All will migrate downslope with the flow of water, however sand and silt are likely to fall out of suspension in low-energy detention points, or where erosion control measures are installed. There are high prospects for the capture of sand and silt particles with erosion control measures proposed but not suspended clay particles.

The following areas are identified as areas of high erosion and environmental risk:

- Conservation area and existing wetlands - Further increases in runoff into the conservation area and existing wetlands from an urbanised catchment and modifications to drainage have the potential to degrade the ecological values and functions of these areas. Changes in runoff that follow urbanisation can cause bed and bank erosion and the activation of potential ASS as well as the assumuation of their products.
- Constructed waterway/drainage assets - The landscape in its existing condition is relatively flat, has poor drainage and is prone to flooding. With future urban development, there will be a need to provide drainage and treatment of stormwater runoff. A new constructed drainage network with wetland treatments will need to be established.

## 5.2 Planning measures

Erosion risks associated with sodic and dispersive soils can partly be managed by appropriate planning. This report concurs with the planning requirements and guidelines documented in the Beveridge North West PSP that relate to Integrated Water Management (Victorian Planning Authority 2021). These have been specifically developed with consideration of the risks of erosion from sodic and/or dispersive soils. These are reproduced in Table 5-1. For Merrifield North it is recommended that these requirements and guidelines are updated to explicitly include reference to acid sulfate soils and the development of an Acid Sulfate Management Plan (refer to Section 5.5).

Table 5-1. Integrated Water Management Requirements and Guidelines (Victorian Planning Authority 2021).

| Requirements |
|---|
| Development must give effect to the relevant policies and strategies being implemented by the responsible authority, Melbourne Water and Yarra Valley Water*, including any approved integrated water management plan. |
| Stormwater conveyance and treatment must be designed to avoid or mitigate the risk of erosion from sodic and/or dispersive soils to the satisfaction of Melbourne Water and the responsible authority. |
| Final designs and boundaries of wetlands, retarding basins, stormwater quality treatment infrastructure, and associated paths, boardwalks, bridges, and planting, must include appropriate treatments to provide protection for dispersive soils where these are present and be designed to the satisfaction of both the responsible authority and Melbourne Water. |
| Development staging must provide for the delivery of ultimate waterway and drainage infrastructure, including stormwater quality treatment, and consider opportunities for early establishment of waterways. Where this is not possible, development proposals must demonstrate how any interim solution adequately manages and treats stormwater generated from the development and how this will enable delivery of an ultimate drainage solution, to the satisfaction of Melbourne Water and the responsible authority. Development staging and interim solutions must avoid or mitigate the risk of erosion from sodic and/or dispersive soils. |
| Stormwater runoff from the development must meet the performance objectives of the CSIRO Best Practice Environmental Management Guidelines for Urban Stormwater prior to discharge to receiving waterways, unless otherwise approved by Melbourne Water and the responsible authority. |
| Applications must demonstrate how:<br>▪ Waterways and integrated water management design enable land to be used for multiple recreation and environmental purposes.<br>▪ Overland flow paths and piping within road reserves will be connected and integrated across property/parcel boundaries.<br>▪ Melbourne Water and the responsible authority freeboard requirements for overland flow paths will be adequately contained within the road reserves.<br>▪ Relevant Integrated Water Management (IWM) requirements of this PSP will be achieved to the satisfaction of the retail water authority, including the supply of recycled water where required by the relevant water authority. |
| **Guidelines** |
| Subdivision and development in areas identified as being affected by sodic and/or dispersive soils should be managed to avoid or mitigate the potential risk of erosion, both in the master planned design response to the subdivision, during construction phase, and on an ongoing basis. |
| Stormwater runoff in areas identified as being affected by sodic and/or dispersive soils should be designed to manage the potential risk of erosion.<br>Potential management methods may include but is not limited to:<br>▪ Widening the buffer distances between the core riparian zone and the outside vegetated buffers that allows sufficient tolerances for channel migration.<br>▪ Diversion of water away from sodic and/or dispersive materials<br>▪ Minimising potential convergence and/or ponding of surface flows<br>▪ Compacting to reduce pore spaces and minimise water movement through material<br>▪ Physical and chemical soil ameliorants.<br>▪ Maintenance of topsoil across undisturbed land, preferably with grasses to provide surface soil stability and root anchorage.<br>▪ Minimise the amount of time land is exposed (e.g. by staging development).<br>▪ Ensure that culverts and drains excavated into dispersive subsoils are capped with non-dispersive topsoil, gypsum stabilised and vegetated. |
| The design and layout of roads, road reserves, and public open space should optimise water use efficiency and long-term viability of vegetation and public uses through the use of overland flow paths, Water Sensitive Urban Design initiatives such as street swales, rain gardens and/or locally treated storm water for irrigation to contribute to a sustainable and green urban environment. |
| Where practical, and where primary waterway or conservation functions are not adversely affected, land required for integrated water management initiatives should be integrated with the precinct open space and recreation system. |

* For Merrifield North Employment PSP Melbourne Water, Mitchell Shire Council, Hume City Council, Yarra Valley Water and Office of Living Victoria are the responsible Water Authorities.

The Melbourne Water Developer Services Scheme (DSS) outlines the catchment-based drainage strategy and the functional designs of relevant infrastructure required to service urban growth. The Kalkallo Creek DSS is shown in Figure 5-1.

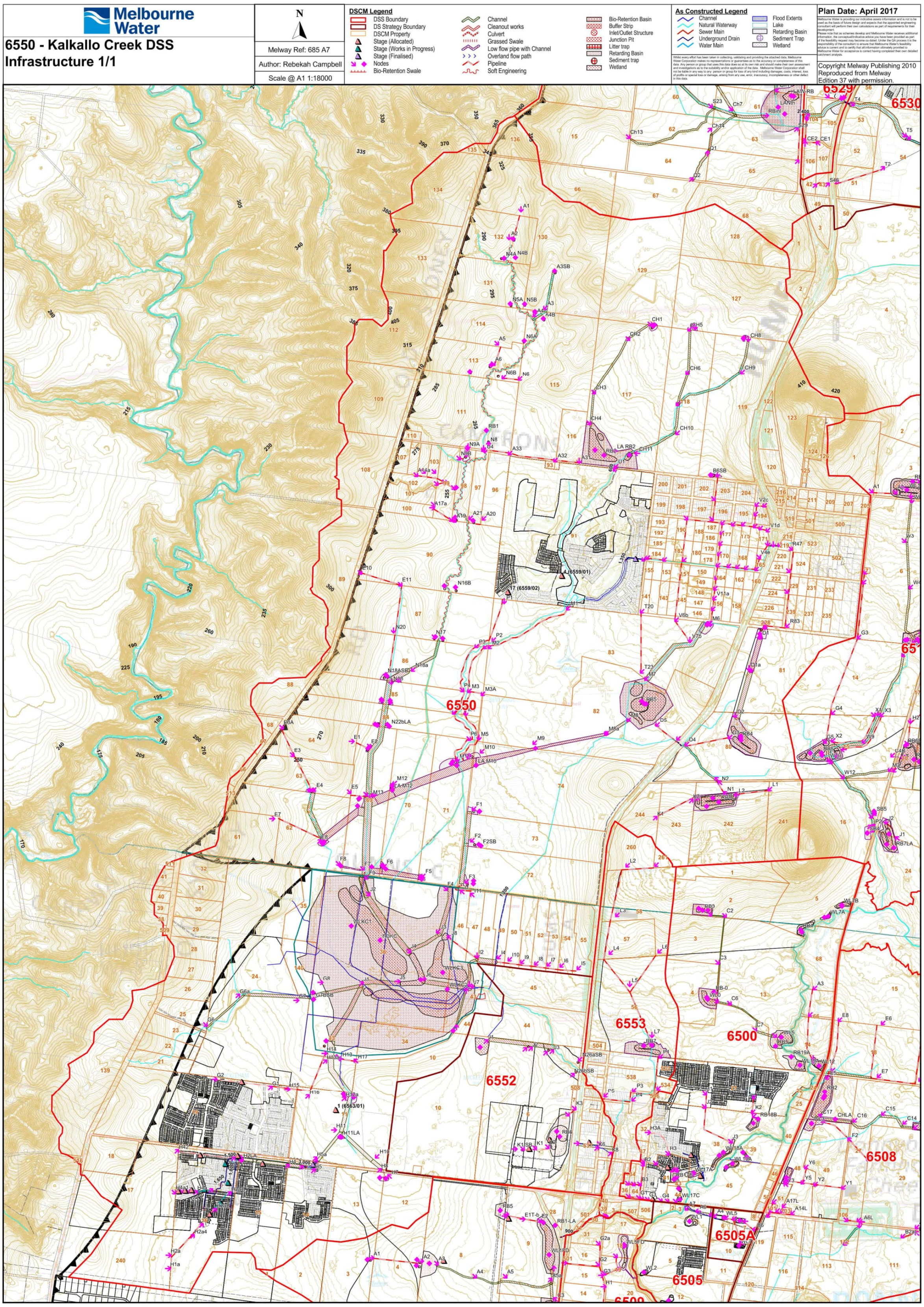



Figure 5-1. Kalkallo Creek Developer Services Scheme (Melbourne Water 2017).

The Kalkallo Creek DSS is currently under review and may change from that depicted in Figure 5-1. In the interim, Melbourne Water has prepared a concept design for the Kalkallo Retarding Basin - the *Kalkallo Basin Concept Design Analysis* (Jacobs 2022). This report assesses several different visions for the Kalkallo Retarding Basin, required as part of the current review of the Kalkallo DSS. The scope of the project was to provide a more detailed assessment of the retarding basin in meeting water quality, flood conveyance and retardation objectives. The developed concept design places particular emphasis on minimising disruption to the sodic soils that were identified within the retarding basin, and minimising velocities within the conveyance waterways inside the retarding basin.

The recommended option was detailed within the Concept Design Report (Figure 5-2), and includes:

- Targeted level of excavation required to obtain sufficient increases in storage from constructed waterways and wetland cells to meet additional flows from developed catchments in adjoining PSPs.
- Configuration of wetland cells (size and orientation) required to meet water quality objectives, in particular nitrogen and phosphorus removal.
- Identification or areas for future development.
- 1% AEP and 10% AEP extents of inundation.

The Concept Design Report also outlines a risk minimisation approach to excavation, through minimising the volume required and appropriate construction methods.

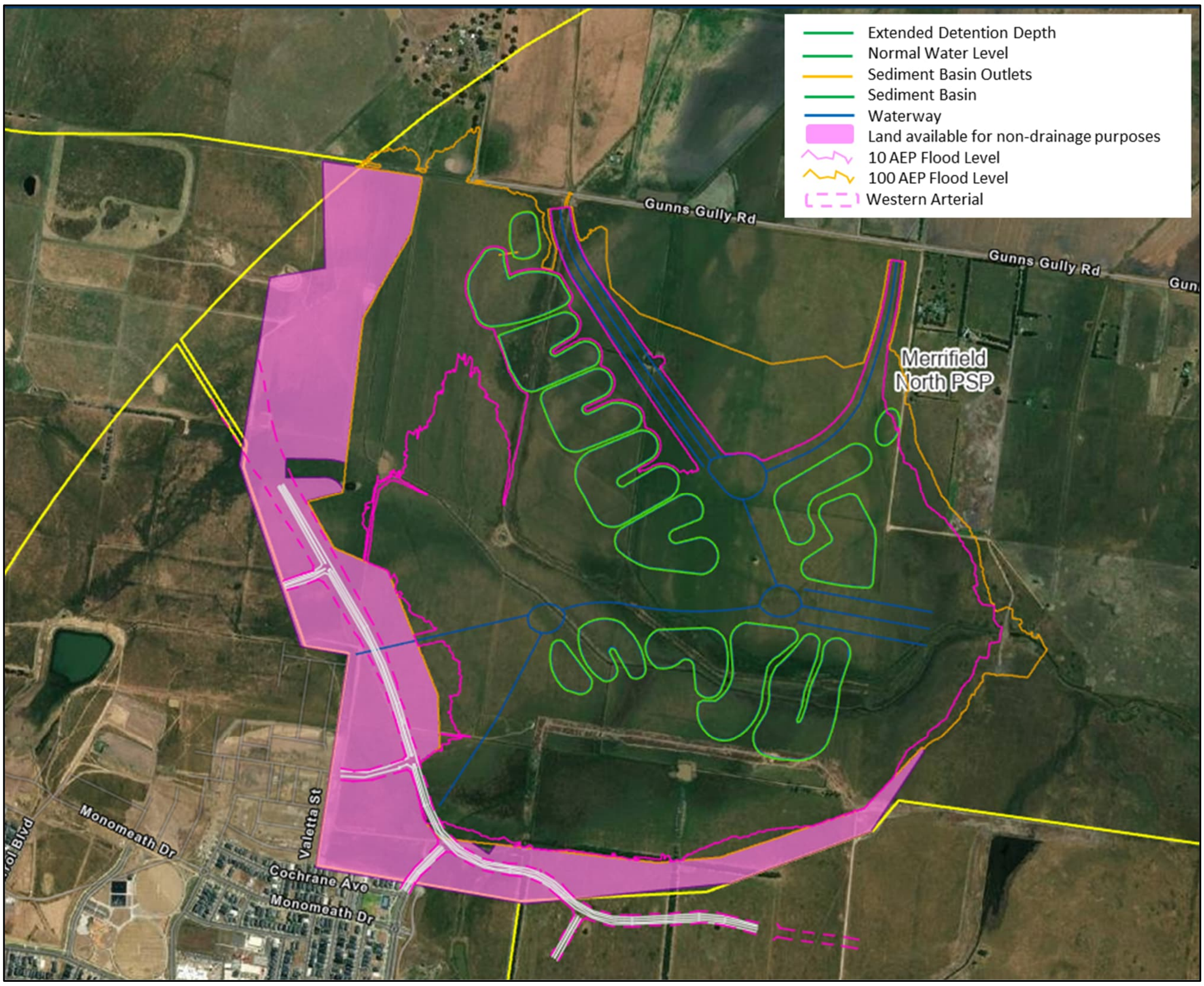



Figure 5-2. Kalkallo Basin Concept Design (Jacobs 2022).

## 5.3 Treatment options

### 5.3.1 Areas with high vulnerability to sodic and acid sulfate soils

For areas identified with a high vulnerability to sodic and acid sulfate soils, treatment options include:

- Conservation area and existing wetland - Ideally these areas should be reserved as green spaces to maintain their ecological values and functions. The incoming catchments that contribute runoff to the conservation area and existing wetland also need to be carefully managed as urbanisation will result in increased runoff to these areas. Consideration should be given to the design and layout of the drainage network, so that the volume of runoff is limited or redirected to other locations (i.e. redirect stormwater to constructed wetlands in Kalkallo Retarding Basin). Surface ground cover measures, specifically managing organic matter including ground cover, plant growth and roots are critical for protecting the soils against dispersion and erosion.
- Constructed waterway/drainage assets – The drainage schemes will need to be designed with specific consideration given to the erosion risks associated with sodic and dispersive soils (and also acid sulfate soils). A high level of engineering will be required to create waterway/drainage assets that are stable and can withstand the volume of water that will be generated from the developed areas (i.e. appropriate channel linings and/or armouring to provide protection for dispersive subsoils). Where possible, it is recommended that the waterway/drainage corridors include wetland and swales, to assist with attenuation and treatment of stormwater runoff.

### 5.3.2 Design and planning for construction of future drainage schemes

The drainage schemes for waterway/drainage assets need to be designed with specific consideration given to the erosion risks associated with sodic and dispersive soils (and also acid sulfate soils). A high level of engineering will be required to create waterway/drainage corridors that are stable and can withstand the volume of water that will be generated from the developed areas. It is expected that all waterway/drainage corridors will need to have a constructed form, with appropriate channel linings and/or armouring to provide protection for dispersive subsoils. Where possible, it is recommended that the waterway/drainage corridors include wetland and swales, to assist with attenuation and treatment of stormwater runoff.

It is recommended that further consideration is given to staging construction works, to manage erosion risks. In principle, it is better to work from top of catchment/higher areas in the landscape first and then progressively work downstream, but this may not be practical. The development sequence should allow the installation of temporary drainage and erosion control measures, and preferably permanent stormwater drainage system as soon as practicable. As waterways are a high risk, if possible, it makes sense to start on these first and construct the drainage schemes and get the waterway corridors ready for the future developed land use.

The stormwater drainage requirements of a site to be developed within the Precinct Area also needs to be appropriately incorporated into all stages of construction. This will require the development of temporary drainage control measures, separate to the sites' permanent drainage system. This will need to recognise the requirements and provide an appropriate drainage design for the diversion of up-slope "clean" water as opposed to the delivery of sediment-laden water generated within the construction site to sedimentation ponds. Appropriate hydrologic and hydraulic design is needed to size the drainage control measures for both the temporary and permanent drainage system (IECA 2008).

Runoff from construction sites should be managed by temporary drainage and sedimentation ponds, with the aim that it does not enter the waterway corridor until development is near completion. Harvesting of stormwater in appropriately designed sedimentation ponds within each development area, then dosing these with flocculants to drop out clay and improve water clarity before releasing downstream is recommended. Runoff dams can be designed and managed to capture runoff events, with immediate dosing and release in the days following collection. Consideration should also be given to the use of cyclones and appropriately designed sedimentation ponds and/or cascading v-notch weir type arrangement from inlets to outfalls so that clays and fine sediments are caught. These would require maintenance to remove captured sediments.

### 5.3.3 Management options during construction

A range of technical guidelines and manuals are available which provide advice on options for reducing the risk of soil erosion during construction arising from development works on dispersive soils (SCA 1979, DPIW 2008, Witheridge 2012, ICC 2016). Management options start with preservation and treatment of topsoil, with options variable depending on the level of disturbance (Table 5-2). For further advice on management options for reducing environmental risks associated with acid sulfate soils, refer to EPA (2009), DSE (2010) and Section 5.5 of this report.

Table 5-2. Management options for reducing risk of erosion during construction for sodic and dispersive soils.

| Management options | |
|---|---|
| Preservation and treatment of topsoil | ▪ Preservation of A-horizon topsoil should be used to shroud sodic and dispersive subsoil in all areas across the precinct.<br>▪ Topsoils of a lighter texture such as loams are preferred for erosion protection as opposed to clay-loams or other materials with a higher clay content. They are of a lower ESP and require lesser treatment to ameliorate by comparison with finer textured materials.<br>▪ Gypsum treatment of all topsoils to minimise dispersion of any clay within topsoil or subsoil. Gypsum treatment of topsoil is a simple, fast and cost-effective solution that can be applied without use of specialised equipment.<br>▪ Mixing the acid sulfate soil with lime or another neutralising agent, at predetermined rates. The rate of lime application must be managed carefully to avoid mobilisation of other compounds in soil such as nutrients and metals. |
| Undisturbed sites | ▪ Maintenance of topsoil across undisturbed land, preferably with grasses to provide surface soil stability and root anchorage.<br>▪ Maintenance of tree cover where trees exist.<br>▪ Groundcover including a mix of perennial grasses and larger shrubs and overstory vegetation is critical for slowing down overland flow and providing root anchorage of soil. |
| Disturbed sites – large scale surface disturbance | ▪ Minimise the amount of time land is exposed (e.g. by staging development).<br>▪ Apply gypsum and lime to all topsoils for improved stability (either in situ or stockpiles).<br>▪ Avoiding removal or disturbance to topsoil or vegetation until absolutely necessary.<br>▪ Covering dispersive subsoils with a shroud of stabilised topsoil (100-150mm), should works cease for any period of time or prolonged rainfall is forecast.<br>▪ Consider using appropriately specified geotextile barriers and other engineering measures to protect disturbed areas particularly where there is minimal topsoil, or where steep slopes occur.<br>▪ Re-vegetate exposed areas immediately after completion of earthworks, with specific emphasis on steep slopes (Gyasi-Agyei et al. 2007).<br>▪ Avoid construction techniques that result in exposure of dispersive subsoils.<br>▪ Use alternatives to 'cut and fill' construction such as pier and pile foundations.<br>▪ Use of interception trenches stabilised with topsoil to catch runoff in a controlled fashion and divert flow to sedimentation ponds to capture sediments.<br>▪ Use of organic materials on finished surfaces to soften the impact of rainfall, filter runoff and aid the germination of seed or growth of turf.<br>▪ Use of agricultural fertilisers at sound agronomic rates to expedite the process of vegetation establishment. |
| Disturbed sites – Trenching, culverts and drains | ▪ Where possible avoid the use of trenches for the construction of services i.e. water & power.<br>▪ Limit extents of trench open at any one time. Material stockpiles from trenching, particularly dispersive soils, to be covered temporarily as required.<br>▪ Ensure that trench backfill is properly compacted, treat with hydrated lime (subsurface treatment) and gypsum (topsoils) to limit dispersion and erosion. |

| | |
|---|---|
| | ▪ Consider alternative trenching techniques that do not expose dispersive subsoils. i.e. use of trenchless technology installations of utilities/services such as horizontal directional drilling.<br>▪ Ensure runoff from hardstand areas is not discharged into areas with dispersive soils.<br>▪ If necessary, create safe areas for discharge of runoff.<br>▪ If possible do not excavate culverts and drains in dispersive soils.<br>▪ Following engineered design, consider placement of non-sodic soil to create appropriate road surfaces and drains without the need for excavation.<br>▪ Ensure that culverts and drains excavated into dispersive subsoils are capped with non-dispersive topsoil, gypsum stabilised and vegetated. |

The management of water flows over and through dispersive soils is key in the control of detrimental effects. Approaches may include:

- Diversion of water flows away from sodic and dispersive materials, particularly exposed subsoils. This is not always possible due to the extensive distribution of these dispersive soils.
- Minimising potential convergence and/or ponding of surface flows, particularly on disturbed soils;
- Development of appropriate cover/protection of dispersive soils (i.e. creation of stable linings that a resistant to rainfall and runoff);
- Compacting to reduce pore spaces and minimise water movement through the material. This will reduce the potential for soil dispersion and piping developing, however it will promote overland flow. For road formation levels and any other areas stripped or in shallow excavations (culverts, utility ducts) consideration should be given to running plant over the surface a number of times or placing engineered fill. In the case of utility trenches, backfill material should be at least the same density as the material surrounding to minimise ponding, infiltration, leaching within the trench and around the ducting/piping;
- The use of concave batter slopes without benching or contour banks has been shown to reduce the potential for convergence of water flows and to minimise flow velocities leading to gullying. However, it should be borne in mind that building extensive bank systems on dispersive soils can be problematic due to their surface erosion and tunnelling/piping potential; and
- Reducing the potential for undercut and piping failures for proposed road formations by excavating interception trenches below and parallel with both sides of the formations. If these trenches are to carry large flows, then the use of agricultural pipes with appropriate granular backfill would be appropriate, and where low flows are anticipated then the use of use appropriate granular porous backfill to the trench may be relevant. It may also be appropriate to line the trenches with impervious materials.

Soil chemical ameliorants are recommended for short-term stabilisation of sodic/dispersive and acid sulfate soils on construction sites. Three primary soil chemical ameliorants and their uses for stabilising sodic/dispersive and acid sulfate soils on construction sites are:

- Gypsum ($CaSO_4$), primarily for stabilising dispersive topsoil or subsoil not intended for construction or geotechnical use. Gypsum flocculates soil and increases soil permeability, rendering materials less favourable for compaction and geotechnical use. Gypsum significantly reduces dispersion of clay and turbidity of runoff.
- Hydrated Lime ($Ca(OH)_2$). When slaked in water, hydrated lime stabilises soil cations by supply of calcium (reducing or eliminating dispersion and sodicity) and increases soil strength. Hydrated lime is the favoured soil chemical ameliorant for stabilisation of soils in civil and geotechnical works such as around pipes, structures, roads, trenches and any works requiring compaction upon reinstatement.
- Agricultural Lime ($CaCO_3$). Standard agricultural lime will provide minor soil stability however the solubility is low and immediate response is poor. Where topsoils are acidic (pH water <6.5) agricultural lime could be used to support improving plant growing conditions by adjustment of soil pH. However, the effect on soil stability is expected to be low or negligible in the short term. Agricultural lime will be a critical ameliorant in the reuse of topsoil across recreational and environmental areas upon completion of

works, where soils are acidic and an improvement in soil health and plant growth is sought with the application of agricultural lime.

Where strongly duplex soils exist, management and amelioration of lighter-textured topsoil is normally favoured as it provides a source of cover and protection of dispersive subsoil. Lighter textured topsoils are also easier to ameliorate than clay subsoils. As organic matter plays a significant role in maintaining soil structure and providing some resilience to dispersion and erosion, careful management of any available topsoil is imperative. Staging of earthworks to minimise disturbance of soils and immediate gypsum and lime treatment (or other neutralising agent) is recommended to reduce potential dispersion of clay following rainfall and runoff.

Table 5-3 provides calculated rates of gypsum to minimise or eliminate dispersion based on the analysis of soils across the precinct. These rates are averages of each data set and should be used as a guide only. Rates can be further refined at a site-specific level with the development of sodic and dispersive soils management plans for separate subdivisions and land uses.

Table 5-3. Calculated rates of gypsum to minimise or eliminate dispersion of soils in the Merrifield North Employment Precinct (t/Ha/100mm thick soil layer).

| Gypsum treatment | Topsoil (0-10cm) | Subsoil (30-40cm) | Deeper subsoil (80-150cm) |
|---|---|---|---|
| Full gypsum rate to displace exc. Na, Mg and K to optimum levels | 11.83 | 25.04 | 45.52 |
| Gypsum rate to displace exc. Na to below 5% | 0.31 | 3.57 | 13.36 |
| Gypsum rate to displace exc. Mg to below 15% | 11.33 | 21.44 | 32.59 |
| Gypsum rate to displace exc. K to below 5% | 0.19 | 0.03 | 0.00 |

Soil physical ameliorants are recommended for long-term structural stability of soils. Their effectiveness varies, depending on the nature of the ameliorant and how effective it is for protecting dispersive soils from direct contact with fresh water and erosion, or slowing down water flow. Examples of soil physical ameliorants and options include:

- Geotextile fabrics and mattings that provide short term sodic soil protection, shrouding and assist with plant establishment.
- Organic matter. Used as a protective shroud on topsoils, improving soil physical structure and biological condition. Hydro-mulching is a form of stabilisation using organic matter. Organic matter is not suitable for stabilisation of soils for civil or geotechnical works unless it is a final layer of protection used for shrouding.
- Direct seeding of sites to fast-growing species by seed drills, spreader trucks or aerial seeding. This option will not necessarily reduce sodicity and dispersion.
- Physical and chemical treatment of seeds to accelerate germination.

## 5.4 Sodic and Dispersive Soils Management Plan

In areas where sodic and/or dispersive soils have been identified it is recommended that a sodic and dispersive soils management plan are developed according to the requirements as outlined in the Whittlesea planning scheme (Schedule 7 to Clause 37.07 Urban Growth Zone[3]).

An application to subdivide land or undertake bulk earthworks *(including any excavations for utilities)* must be accompanied by a sodic and dispersive soils management plan, prepared by a suitably qualified professional, that includes:

[3] https://planning-schemes.app.planning.vic.gov.au/Whittlesea/ordinance/37.07-s7

- The existing site conditions, including:
  - extent of sodic and dispersive soils based on topsoil and subsoil samples in the works area
  - land gradient
  - erosion risk mapping
  - the extent of any existing erosion, landslip or other land degradation;
- Soils investigation, undertaken by a soil scientist;
- The extent of any proposed earthworks;
- Recommendations for soil management practices (including fill) with consideration of anticipated sodic and dispersive soil exposure;
- The management of drainage during all stages of development (including run-off);
- The staging of development;
- Any training and supervisions processes proposed for construction contractors to ensure compliance with the sodic and dispersive soils management plan;
- Any treatment of soil proposed to be removed from the site;
- Any post-construction monitoring and/or management requirements; and
- Recommendations that inform a site management plan including:
  - The management, volume and location of any stockpiles
  - Vehicle access and movement within the site area
  - Any treatment to manage the soil while works are undertaken
  - Treatment to rehabilitate areas that are distributed during site works
  - Any soil treatment to manage the soil to reduce risk to existing or current infrastructure and dwellings.

## 5.5 Acid Sulfate Soil Management Plan

For those areas identified with net acidity concentrations exceeding 18 mole $H^+$/tonne, an acid sulfate soils management plan would need to be developed in accordance with Publication 655.1[4] (EPA 2009). Accordingly, the hierarchy for managing acid sulfate soils includes:

- Avoid disturbance - Select areas onsite or alternative sites which do not contain acid sulfate soils.
- Minimise disturbance - Project works can be designed to minimise the need for excavation or disturbance of acid sulfate soils.
- Prevent oxidation - This may include placing PASS into an anaerobic environment, usually below the water table. However, AASS must not be disposed of below the water table without prior neutralisation or implemented control measures.
- Treat to reduce or neutralise acidity - Typically, this would involve mixing the acid sulfate soil with lime or another neutralising agent, at predetermined rates. The rate of lime application must be managed carefully to avoid mobilisation of other compounds in soil such as ammonia. Verification testing should be carried out following treatment to confirm an acceptable rate of neutralisation.

[4] https://www.epa.vic.gov.au/about-epa/publications/655-1

- Offsite reuse or disposal - Acid sulfate material may be removed offsite and reused or disposed of in accordance with the requirements of the *Industrial Waste Management Policy (Waste Acid Sulfate Soils) 1999*.

Given the nature of the site, and that concentrations of sulfides are typically low (~7 mole H+/tonne on average), management of ASS would likely take the form of minimising and avoiding disturbance where possible, and applying lime to topsoils (either in situ or in stockpiles) where disturbance is unavoidable.

Specific liming rates for ASS treatment would need to be developed as part of the ASS management plan (ASSMP) according to localised acidity concentratiions and the proposed disturbance, which would require further sampling and analysis at the requisite sample density in accordance with Sullivan et al. (2018). However, based on the results from this program, treatment rates are likely to be modest and restricted to topsoils.

Indicative liming rates for ASS have been provided in Table 5-4 below assuming a neautralising value of 98% for aglime, a soil bulk density of 1.3 kg/tonne and a safety factor of 1.5. Accordingly, based on the net acidity concentrations estimated across the site by extrapolating CRS results, the average liming rate for topsoils is estimated to be 3.5 kg $CaCO_3/m^3$, while a conservative liming rate (based on the 80$^{th}$ percentile net acidity value) is 5.6 kg $CaCO_3/m^3$. Liming rates have not been provided for subsoils as neither the mean nor 80$^{th}$ percentile net acidity concentration exceedes the criteria required for management of acid sulfate soils.

Table 5-4. Indicative liming rates for treating ASS.

| ASS treatment | Topsoil (0-10cm) | Subsoil (30-40cm) | Deeper subsoil (80-150cm) |
|---|---|---|---|
| Average liming rate (kg $CaCO_3$/t) | 3.5 | N/A | N/A |
| Conservative liming rate (kg $CaCO_3$/t) | 5.6 | N/A | N/A |

# 6. Knowledge gaps and recommendations for further investigations

## 6.1 Knowledge gaps

This assessment has focused on sodic/dispersive and acid sulfate characteristic of soils as they relate to erosion and environmental risks. Some of the soils assessed may experience significant shrinking and swelling, associated with from drying and wetting. This often results in the development of features such as surface cracking, heaving and gilgai formation. These features are of significance for engineering purposes and controls against the adverse impacts of these soils character will be important if the development proceeds (pavement, shallow foundations, subsurface utilities etc). The controls to manage the effects of reactive soils may differ to those applicable to sodic, erosive soils. This assessment should be undertaken prior to planning and design at the site level to inform engineering controls. As for sodicity and acidity, it is recommended that the potential adverse effects of soils on proposed developments should also be considered as early as possible in the planning stages to assess their associated risks, avoidance/elimination or the scope and cost of appropriate preventative measures.

## 6.2 Recommendations for further investigations

It is recommended that detailed Site Environment Management Plans (SEMPs) and Erosion and Sediment Control Plans (ESCPs) are developed for managing sodic and dispersive soil related erosion risks. These plans would be developed during the planning of building and construction projects within the Precinct. This should include consideration of staging of development from initial bulk earthworks down to the construction of individual lots. It is expected that further sampling of soils, testing and analysis of the sodicity of soils, dispersion and erosion potential will be required at a higher resolution to inform construction techniques and management of erosion risks.

It is recommended at a minimum that sodic and dispersive soils management plans are a requirement at a subdivision / zone level, and at the individual block level. The subdivision level needs to be a detailed investigation with a report that covers all aspects of the subdivision, works to occur and management techniques to manage sodic and dispersive soil and erosion. The individual block level could simply be a set of requirements set by local government that ensure good soil management practices are mandated and sodic soil exposure and disturbances are minimised, with disturbed areas treated or shrouded where possible.

It is recommended that acid sulfate soil management plans are developed for managing acid sulfate soils. This will primarily be required for managing topsoils and given the limited occurrence of sulfides, management would likely take the form of minimising and avoiding disturbance where possible, and applying lime to top soils (either in situ or in stockpiles) where disturbance is unavoidable.

In line with the earlier comments on the potential impacts of reactive soils on the future development of the Precinct, it is recommended that any future ground investigation campaign should include the appropriate sampling and associated laboratory testing to ascertain the shrink-swell potential of soils, in particular residual basaltic soils.

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# Appendix A. Soil Sampling and Analysis

## A.1 Project scope

Jacobs and project partners South East Soil and Water (SESW) were engaged by Victorian Planning Authority to complete soil sampling and analysis so as to obtain data on the sodic/dispersive and acid sulfate characteristics of soils in the Merrifield North Employment Precinct. The sodic/dispersive soil sampling and analysis methodology is similar to that which has been undertaken for other precinct Sodic Soil Investigations (Jacobs 2020a, Jacobs 2020b, Jacobs 2021b, Jacobs 2021a, Jacobs 2023). The acid sulfate soil sampling analysis methodology is an additional component that was included in our investigation.

An initial inspection of the Merrifield North Employment precinct was undertaken by Peter Sandercock of Jacobs and Christian Bannan of South East Soil and Water on the 12 October 2022. Observations were made to support planning for fieldwork. Fieldwork was carried out by on 6, 7 and 13 February 2023. Initially a grid pattern was selected across the Precinct with approximately one sampling set for one site per 25-hectares of land. Following a review of property access, landowner permission and further discussions with the project stakeholders, the sampling pattern was adjusted to those sites available. The revised sampling plan ensured a suitable representation of the range of geological conditions were maintained for use in interpolating data and providing an indication of variability of soil characteristics across the Precinct.

The total number of sites inspected in Merrifield North was 40 with the total number of samples collected recorded at 109. A Garmin 76CX handheld GPS was used to locate sites in the field. Figure A-1 provides an overview of the sampling sites. The breakdown of samples comprised of:

- 0-10cm samples: 40
- 30-40cm samples: 40
- 80-150 cm samples: 29

## A.2 Soil sampling and laboratory analysis

At each location, a basic visual and textural classification was undertaken of the soil profile. The following parameters were recorded:

- depth of A horizon topsoil.
- hand texture of the A and B horizons
- visual colour and Munsell colour of the A and B horizons
- other notes on soil physical characteristics defined by the assessor, in particular the depth of soil over impenetrable rock
- photograph of the sample collected.

Samples were collected from three depths, A horizon topsoil (0-10cm) and B horizon subsoil (30-40cm) and a deep sample from 80-150cm.

Soil samples were dispatched to Nutrient Advantage (NA) Laboratories, Werribee, Victoria on 15 February 2023. Results were received on 3 March 2023. NA are an ASPAC and NATA accredited laboratory. The following laboratory analysis were undertaken of the soil samples:

- Soil pH (water)
- Soil pH (CaCl2)
- Electrical Conductivity (1:5 soil water) (uS/cm and dS/m)

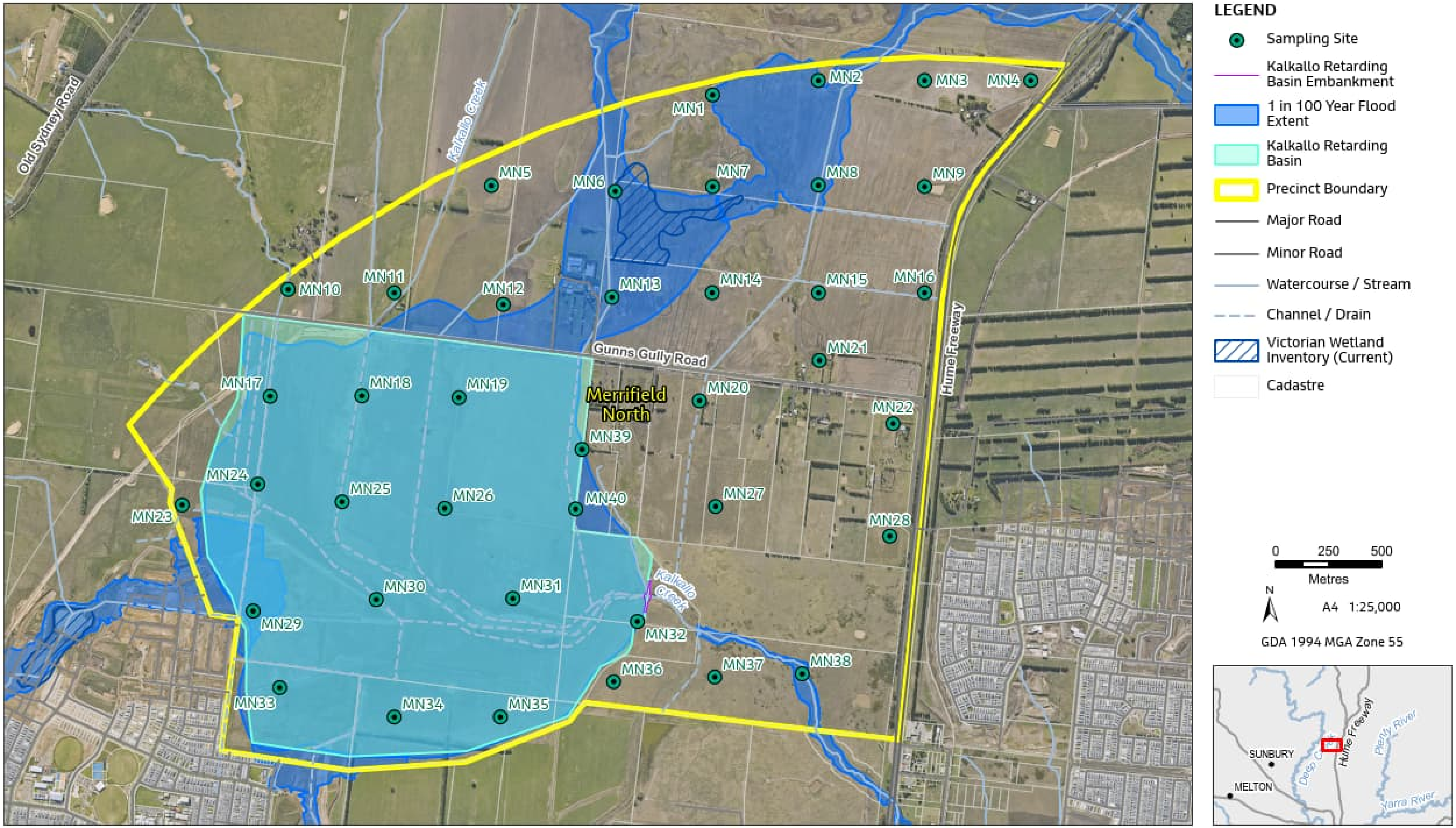


Figure A-1. Merrifield North Employment Precinct Sample Sites.

- Exchangeable Cations, including calcium, magnesium, potassium, sodium and aluminium (cmol/kg and base saturation percentage)
- Emerson Dispersion Class
- Loveday & Pyle Dispersion Score
- Calculated ESP and exchangeable cation levels

Organic Carbon analysis was also undertaken for all samples to gain an understanding of the influence of soil organic carbon levels on soil behaviour. In addition to receival of laboratory results, calculations were carried out on all samples to calculate cation levels in mg/kg. Indicative gypsum calculations were carried out by SESW and results are provided in this report as a guide to gypsum requirements for minimising soil dispersion.

ALS were used for testing of acid sulfate soils. ALS are a NATA accredited laboratory. The following laboratory analysis were undertaken of the soil samples:

- Acid Sulfate Soil (ASS) Field Screening Analysis - pHF, pHFOX, Delta pH, reaction rate (NSM-1.1 and NSM-1.2)
- Detailed analysis of ASS for 20% subset of all samples (be selected following review of ASS Field Screening Analysis) - Chromium reducible sulfur suite including: Chromium Reducible Sulfur (SCR; NLM-2.1); KCl Extractable pH (pHKCl; NLM-3.1); Titratable Actual Acidity (TAA; NLM-3.2); Net Acid Soluble Sulfur (SNAS; NLM-4.1) and Acid neutralising capacity via back-titration (ANCBT; NLM-5.2).

## A.3 Summary

### A.3.1 Geology, Geomorphology and Soils

The Merrifield North Precinct site is classified as part of the Mickleham Land System (Jeffrey 1981). The Mickleham Land System is listed as Pleistocene basalt, while surface geology is mapped as newer volcanics, alluvium and pockets of siltstone and sandstone on rising land parallel to the Hume Freeway. A map showing local geology for the project area is shown in Figure A-2.

Newer volcanics (Neo, Neo2) are found in the eastern part and also wrap around the southern extreme. Quaternary alluvial deposits (Qa2) are found within the flow path and floodplain of the Kalkallo Creek, which runs south and turns eastward. There is a transitional zone on newer volcanics covering the break of slope where alkaline clays with calcium carbonate are identified, reflecting lava flows and aeolian deposits.

Jeffrey (1981) mapped six separate land system components on the Mickleham Land System, which include; long gentle slope; stony rise; depression; steep slope (sometimes rocky); drainage line and cone. Soil profiles vary in physical and chemical properties across each geology type, broadly defined as ‘volcanics’ and ‘alluvials’, summarised as follows:

- Volcanics: Rising to gently undulating land containing variable topsoils overlying heavy clay subsoils. Volcanics are broken into two divisions based on geology mapping and field condition:
  - Volcanic Rises: Volcanic soils located on higher land with unimpeded surface drainage. Soils are variable, dominated by duplex loams over clay subsoil, or gradational clay-loam topsoils over clay subsoil.
  - Transitional volcanics: Land on lower slope and gently undulating areas with basalt exposed in some areas. These soils occur within a transition zone between volcanic rises and alluvial soils. Soils are gradational to uniform, clay-loam or light-medium clay topsoils over heavy clay subsoils. Many sites in this group recorded sampling refusal on basalt rock at between 100-150cm.

- Alluvials: Soils formed from alluvial floodplain deposits from the Kalkallo Creek, consisting of fine sand, silt and clay, also exhibiting calcium carbonate at depth indicating that clays may also be aeolian. Differing groups of alluvial soils are separated mainly by their surface textures, which include:
  - Gradational to uniform soils, with the dominant group containing light clay, light-medium clay or medium clay topsoil over heavy clay subsoil. Some contain clay-loam surface textures.
  - Duplex soils, containing sandy loam, light sandy clay-loam and sandy clay-loam topsoil over heavy clay subsoil. This also includes one waterway sample (MN38), recording loam to 40cm, with sampling depth limited from hand auguring.

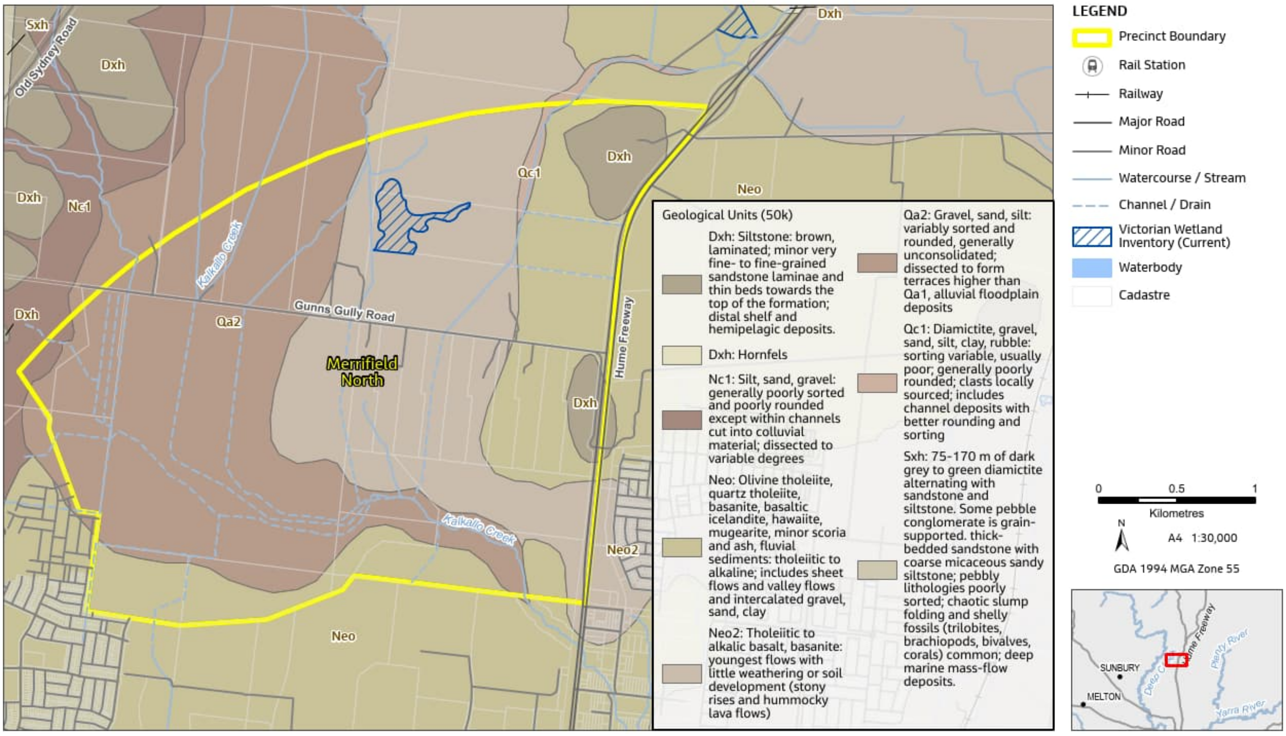


Figure A-2. Local geology.

Land levels are sloping on rises with good drainage. Across the Transitional Volcanics zone, land levels are variable with poor to imperfect drainage. Across the alluvial zone, levels are flat to very gently undulating and drainage is poor. Despite the variation in surface drainage patterns, profile drainage is poor based on the common presence of medium or heavy clay subsoil which dominated by dispersive and sodic conditions.

## A.3.2 Soil Classification

In accordance with Isbell and NCST (2021), soils across the Precinct are broadly classified into the following soil orders:

- Sodosols, identified at 15 sites, or 37.5% of sample points. Sodosols are defined as: *'Soils which display a clear or abrupt textural B horizon in which the major part of the upper B2 horizon is sodic and not strongly acid'*. This also includes soils which record sodic conditions in the A horizon (topsoil). The definition of a sodic soil is outlined in Section 2.
- Vertosols, identified at 25 sites or 62% of sample points. Vertosols are defined as *'clay soils with shrink-swell properties that exhibit strong cracking when dry and at depth have slickensides or lenticular peds'*, with additional summarised definitions:
  - A clay field texture or 35% or more clay throughout the solum, and
  - When dry, open cracks occur at some time in most years, and

- Slickensides and/or lenticular peds occur at some depth in the solum.

Across the Precinct, Exchangeable Sodium Percentages (ESP) levels in the 0-10cm range (topsoil) were deemed sodic at 16 of the 40 sampled sites. In the 30-40cm range, 33 of 40 sites were sodic. Almost all sites which were sampled in the deeper range from 80-150cm were sodic. There is no clear change in sodicity (ESP) between alluvial and volcanic soils within subsoils. Consequently, soils are sodosols, or where clay-dominant they are classified broadly as sodic Vertosols, commonly across areas of volcanic geology in Victoria. Of the land system components identified by Jeffrey (1981), several of these were identified as containing sodic soil conditions.

### A.3.3 Soil Sodicity and Dispersion

Jacobs has adopted an Exchangeable Sodium Percentage (ESP), or 'sodicity' value of 6.0% as the trigger level for a sodic soil consistent with literature and field practice in Australia (Ford et al. 1993, Isbell and NCST 2021). Exchangeable Sodium Percentage (ESP) is the most common analytical technique used to identify sodic or potentially dispersive soils in Australia and there are general trends showing this correlation (DPIW 2008). A graph showing all ESP results is shown in Figure A-3.

In addition to sole reliance on sodicity testing, the presence of dispersive soils has been defined by obtaining dispersion observations from the laboratory, which are also included as a data layer within the vulnerability assessment. This is opposed to use of the Emerson Class itself. The level of dispersion of remoulded aggregates after 20 hours of immersing in deionised water are scored from 0 (nil) to 5 (complete) by the laboratory, with these scores adopted in the same order of ranking to define dispersive soil exposure risk. Results below are discussed with respect to their ESP values and dispersion observations.

Sodicity results and dispersion observations are summarised as follows:

- 0-10cm topsoils: Across the data set, 16 of the 40 sites (40%) of topsoil samples tested as sodic, with the average ESP across all data recorded at 5.5%. The breakdown in ESP across the two geomorphic groups is:
  - Volcanics: Average ESP level of 5.9%, borderline sodic. Of these, dispersion observations on dry aggregates were almost nil (some slight) at 2 and 20 hours, while remoulded aggregates recorded mostly slight dispersion at these times.
  - Alluvials: Average ESP level of 5.9%, borderline sodic. Of these, dispersion observations on dry aggregates were almost nil at 2 and 20 hours, while remoulded aggregates recorded mostly slight dispersion at these times, with few recording moderate or strong.
- 30-40cm subsoils: Across the data set, 33 sites (82.5%) of samples tested as sodic, with the average ESP across all data recorded at 11.5%. The breakdown in ESP across the geological groups is:
  - Volcanics: Average ESP level of 12.2%, moderate to strongly sodic. Of these, dispersion observations on dry aggregates and remoulded aggregates were mostly strong and complete at 2 and 20 hours respectively.
  - Alluvials: Average ESP level of 11.1%, moderate to strongly sodic. Of these, dispersion observations on dry aggregates were almost nil at 2 and 20 hours, while remoulded aggregates recorded mostly slight dispersion at these times, with few recording moderate or strong.
- 80-150cm samples: Across the data set of 29 samples collected, 28 were sodic recording an average ESP of 20.3%, strongly sodic. There is no clear pattern of sodicity between the two geology groups. Furthermore, there is no clear difference in dispersion observations between dry and remoulded aggregates at 2 and 20 hours. Nil dispersion was most common, which is most likely contributed to elevated salinity causing flocculation, inhibiting dispersion. The average electrical conductivity (salinity) level is 1.1 dS/m, or an EC Saturated Extract value of approximately 6.6 dS/m for heavy clay. Flocculation is imminent at EC Saturated Extract level above 3.0 dS/m.

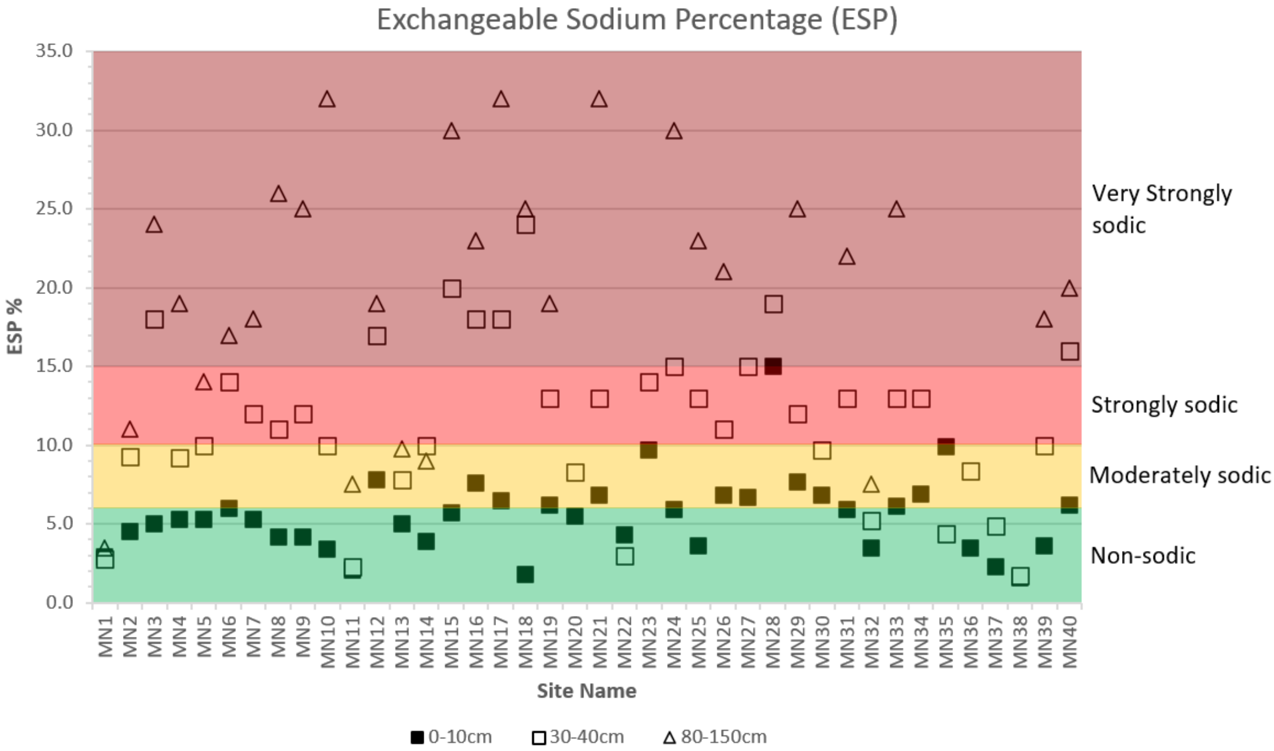


Figure A-3. Exchangeable Sodium Percentage (ESP) values across all samples and depths.

Table A-1. Exchangeable Sodium Percentage (ESP) values and their description.

| ESP Range | Description |
|---|---|
| <6% | Non-sodic, unlikely to reveal dispersion when in contact with fresh rainfall or runoff. |
| 6.1 to 10% | Moderately sodic. Dispersion likely to occur when exposed to fresh rainfall or runoff. |
| 10.1 to 15% | Strongly sodic. Dispersion likely. Significant erosion risk when exposed to fresh rainfall or runoff. |
| >15% | Very strongly sodic. Significant erosion risk when exposed to fresh rainfall or runoff. |

There is a strong correlation between ESP (sodicity) and dispersion observations on remoulded samples at 20 hours across the 0-10cm and 30-40cm data sets. Results confirm that when exposed to fresh rainfall, dispersion is likely to occur within both materials, with the 30-40cm zone of higher risk of erosion. These risks also appear consistent within the vulnerability assessment in both construction and future developed phases of precinct development. Protection measures are required to manage risks and minimise impacts on surrounding waterways. Risks also remain high for deeper material being highly sodic, even though dispersion was minimal. If salts are permitted to leach from deeper material which is stockpiled as loose fill, dispersion will become evident.

The presence of highly sodic and dispersive conditions throughout the 30-40cm range indicates that soils are likely to evince poor profile drainage. Physical assessment has revealed medium to heavy clay as the dominant subsoil textures, which further confirm that profile drainage is likely to be poor. Waterlogging is expected during winter months or whenever seasonally wet conditions prevail.

Sodicity and dispersion results are further reinforced by the Loveday and Pyle Dispersion Index, which is a comprehensive indicator of soil stability. These combined measurements allow for greater accuracy in understanding the dispersiveness of a soil, considering all factors that influence soil dispersion. These include high exchangeable potassium and electrical conductivity (EC), or salinity levels as discussed in the previous section. This is particularly important where soils are dispersive but non-sodic (observed in the 100-150cm data set), or non-sodic but dispersive (observed in the 0-10cm data set). Furthermore, understanding changes in dispersion with testing of dry and remoulded aggregates provides some context around soil behaviour following disturbances including earthworks. A graph showing all Dispersion Index results is shown in Figure A-4.

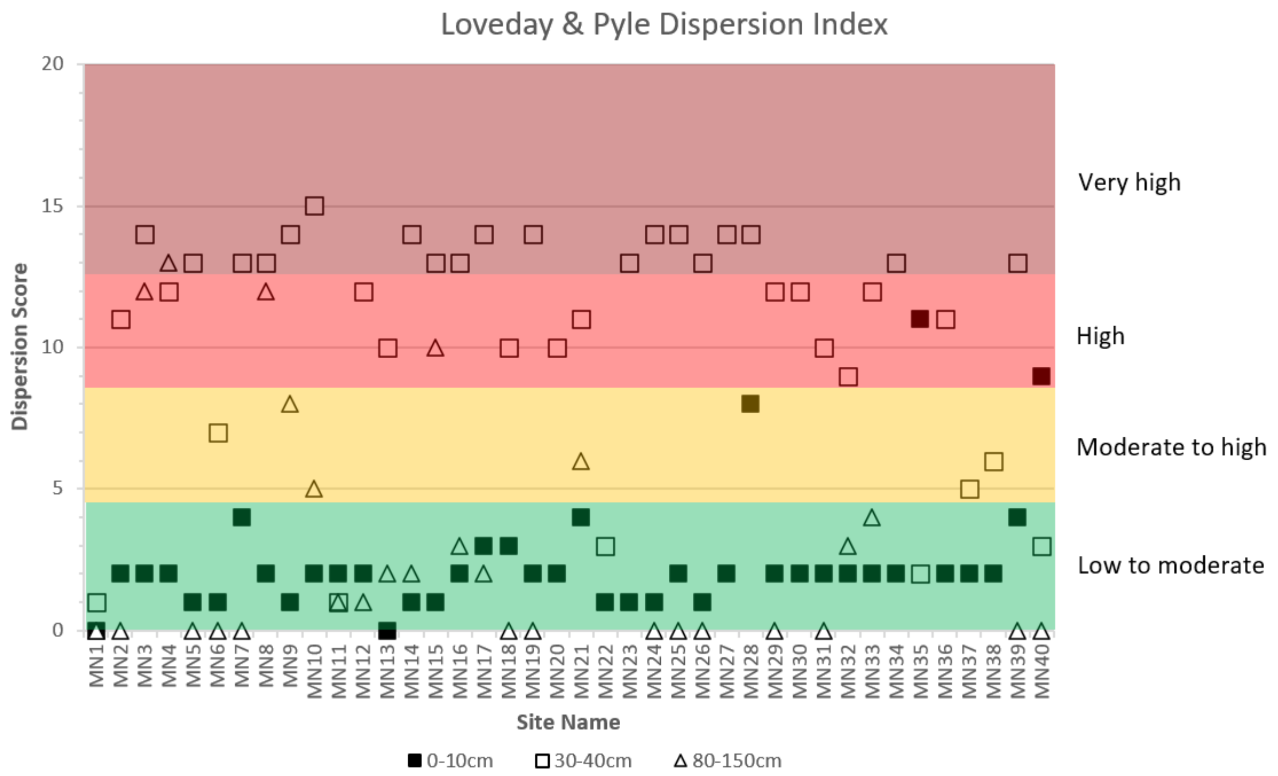


Figure A-4. Loveday & Pyle Dispersion Index results across all samples and depths.

Table A-2. Loveday & Pyle Dispersion Index values and their description.

| L&P Score | Description |
|---|---|
| 0, 1, 2, 3, 4 | Low to moderate. Nil to slight gypsum response expected where dispersive. |
| 5, 6, 7, 8 | Moderate to high. Gypsum response expected to control dispersion. |
| 9, 10, 11, 12 | High. Gypsum response expected to control dispersion. High rates required. |
| 13, 14, 15, 16 | Very high. Very high rates required to control dispersion. |

Dispersion index observations within Figure A-4 reveal clear patterns, listed as follows:

- 0-10cm topsoils:
  - Volcanics: Results are generally low to moderate, with most results recorded at score 4 or less. Results correspond with non-sodic conditions. Low to moderate stability is expected within most areas across the precinct. Sites MN25, 38 and 40 were all high however these are not connected by geology or topography.
  - Alluvials: Results are all low, recorded at score 3 or less. Results reflect soils of slight stability but evincing slight dispersion. This group is of higher stability than the volcanic group of samples.
- 30-40cm subsoils: Across both geological groups the results are variable, with some non-sodic or low sodicity samples recording low to moderate levels (<4). Most results were recorded ranging from score 9 (high) to 14 (very high). Results correspond with mostly sodic conditions. Low soil stability is expected within this group, confirming that almost all soils are highly unstable when wetted and dispersion will be evident unless treated.
- 80-150cm samples: Most samples are low, ranging from 0 to 4, reflecting the presence of nil dispersion. There are few samples (7 of 29), which recorded levels ranging from 5 to 13. In accordance with

dispersion observations, there are factors including elevated EC which are likely to be reducing or inhibiting dispersion and therefore improving stability, even though ESP levels are very high.

Organic carbon was tested in all 0-10cm samples to gain an understanding of its influence on soil condition and surface soil stability. Organic carbon levels average 3.0% across volcanics areas and 3.3% across alluvial soils. These are corresponding organic matter levels of 5.1% and 5.6% respectively. Levels are deemed acceptable for long term pastures and reflect soils subject to agricultural grazing with some historical pasture improvement. It is likely that organic matter may be reducing the propensity for 0-10cm topsoils to disperse. Where earthworks disturbances occur, soil with organic matter will be more stable by comparison with a soil which is deficient.

Based on comparison with other sodic soil investigations in this region by Jacobs, there is a consistency in the results obtained covering areas of volcanics and alluvials. Most are sodic, with highly dispersive conditions evident in the 30-40cm range.

### A.3.4 Gypsum stabilisation rates

Table A-3 provides calculated rates of gypsum to reduce or minimise or eliminate dispersion, to be used as a guide during earthworks. Table A-4 provides these as a percentage weight to volume calculation. Calculations adopt the following criteria:

- Reduce ESP to below 5%
- Reduce exchangeable magnesium to below 15%
- Reduce exchangeable potassium to below 5%
- Recommendations based on averages of each data set (0-10cm, 30-40cm, 80-150cm)

Table A-3. Calculated rates of gypsum to minimise or eliminate dispersion (t/Ha/100mm thick soil layer).

| Gypsum treatment | Topsoil (0-10cm) | Subsoil (30-40cm) | Deeper subsoil (80-150cm) |
|---|---|---|---|
| Full gypsum rate to displace exc. Na, Mg and K to optimum levels | 11.83 | 25.04 | 45.52 |
| Gypsum rate to displace exc. Na to below 5% | 0.31 | 3.57 | 13.36 |
| Gypsum rate to displace exc. Mg to below 15% | 11.33 | 21.44 | 32.59 |
| Gypsum rate to displace exc. K to below 5% | 0.19 | 0.03 | 0.00 |

Table A-4. Calculated rates of gypsum to minimise or eliminate dispersion (% weight to volume).

| Gypsum treatment | Topsoil (0-10cm) | Subsoil (30-40cm) | Deeper subsoil (80-150cm) |
|---|---|---|---|
| Full gypsum rate to displace exc. Na, Mg and K to optimum levels (% weight to volume) | 1.18% | 2.50% | 4.55% |
| Gypsum rate to displace exc. Na to below 5% (% weight to volume) | 0.03% | 0.36% | 1.34% |
| Gypsum rate to displace exc. Mg to below 15% (% weight to volume) | 1.13% | 2.14% | 3.26% |
| Gypsum rate to displace exc. K to below 5% (% weight to volume) | 0.02% | 0.00% | 0.00% |

### A.3.5 Acid sulfate soils

Two sets of laboratory analysis were undertaken on soil samples including ASS screen tests and the chromium reducible sulfur (CRS) suite.

Screen tests were undertaken on all samples collected, totalling 109 samples. These analyses include measuring the current pH of the soil ($pH_F$) and the pH of the soil following the addition of peroxide ($pH_{FOX}$). The former provides an indication of the current acidity of the soil, with a $pH_F$ of less than four indicating the occurrence of actual acid sulfate soils. The latter provides an indication of whether the soil may become acidic under oxidising conditions. The change in pH and reactivity of the soil during peroxide addition can also be used to indicate whether sulfides are present.

While screen tests are useful in assessing the likelihood of whether AASS or PASS are present, the results are considered indicative, as (1) peroxide is a much stronger oxidant than oxygen which may lead to greater pyrite oxidation than would occur under natural conditions and (2) organic carbon can be oxidised by peroxide and release humic and fulvic acids, resulting in a lower pH than would occur naturally. As such, the CRS suite provides a more accurate and definitive characterisation of the ASS potential by measuring the soils current acidity (TAA), its potential acidity (CRS) and its neutralising capacity (ANC). The potential of a soil to act as an acid sulfate soil is represented by its net acidity (NA), which is the sum of its current acidity (TAA) and potential acidity (CRS), less its neutralising capacity (ANC). A sub set of samples (24) were thus subject to more detailed ASS analysis based on the screen test results.

Screen test results have been assessed in accordance with guidance from Sullivan et al. (2018), Department of Environment Regulation (2015) and EPA (2009), which describe an increasing risk of AASS as $pH_F$ declines, an increasing risk of PASS as $pH_{FOX}$ declines and an increasing risk of reduced inorganic sulfur (RIS) as the difference between the two (ΔpH) increases. For the purposes of the assessment, Table A-5 below details the screening criteria adopted for the preliminary assessment of soils.

Table A-5. Screen test risk criteria.

| $pH_F$ | AASS risk | $pH_{FOX}$ | PASS Risk | ΔpH | RIS Risk |
|---|---|---|---|---|---|
| <4 | High | <3 | High | >2 | High |
| 4-5 | Medium | 3-5 | Medium | 1-2 | Medium |
| >5 | Low | >5 | Low | <1 | Low |

Of the 109 samples collected, none exhibited a $pH_F$ of <4, indicating the absence of soils with a high risk of being AASS. A total of 14 samples exhibited a pH of 4-5 (most of these occurred in surface samples collected in the upper 10 cm of the soil profile) and a medium risk of being an AASS, while the remining 95 samples exhibited a pH of >5 and a low risk of being an AASS.

Figure A-5 below summarises the $pH_{FOX}$ and ΔpH results of the soil samples collected. Accordingly, 32 samples exhibited a $pH_{FOX}$ of <3 and a high risk of being PASS, 37 samples exhibited a $pH_{FOX}$ of 3-5 and a medium risk of being PASS while 40 samples exhibited a $pH_{FOX}$ of >5 and a low risk of being PASS. In addition, 63 samples exhibited a ΔpH of >2 and a high risk of containing RIS, 20 samples exhibited a ΔpH of 1-2 and a medium risk of containing RIS, while 26 samples exhibited a ΔpH of <1 and a low risk of containing RIS. Given the apparent absence of AASS, samples were prioritised for more detailed analysis based on their risk of being PASS or containing RIS, while retaining a spatial spread across the sample locations to enable spatial analysis of ASS distribution. The samples prioritised for CRS analysis is illustrated in red in Figure A-5. Screen test results (pHFOX vs Δ pH). Refer to Table A-18 in Appendix A for complete table of test results.

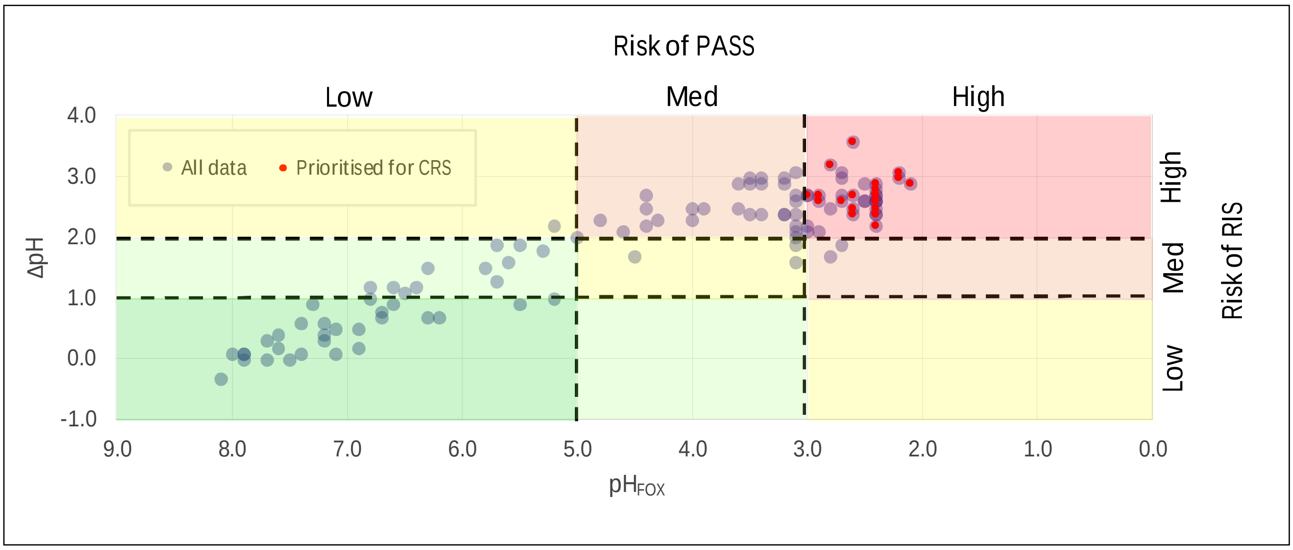


Figure A-5. Screen test results ($pH_{FOX}$ vs Δ pH). Refer to Table A-18 in Appendix A for complete table of test results.

While the above provides a numerical assessment of the risk of ASS occurrence across the site, trends in average screen test results with depth have been illustrated in Figure A-6 below. This shows that the risk of AASS, PASS and RIS generally decline with depth at the site, as $pH_F$ and $pH_{FOX}$ both tend to increase with depth, whilst the ΔpH tends to decline with depth.

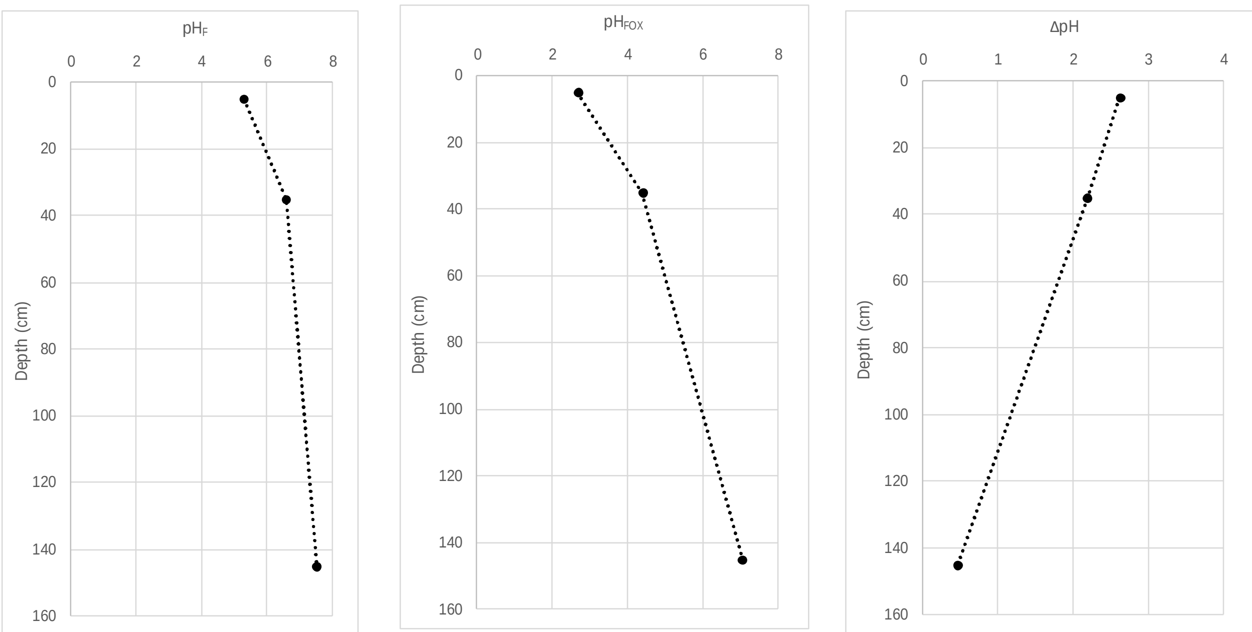


Figure A-6. Average of screen test results with depth across all sample locations.

As described above, the main components of the chromium reducible sulfur suite of analysis include TAA, CRS, ANC and the resulting net acidity. The full results of the 24 samples collected have been detailed in Table A-6 below.

Table A-6. CRS suite results (all results in mole $H^+$/tonne)[1]

| Sample ID | Current Acidity (TAA) | Potential Acidity (CRS) | Neutralising Capacity (ANC) | Net Acidity (NA) |
|---|---|---|---|---|
| MN2.0-10 | 19 | 5.4 | BD | 24.4 |
| MN4.0-10 | 39 | 5.4 | BD | 44.4 |
| MN6.0-10 | 19 | 10.2 | BD | 29.2 |
| MN8.0-10 | 49 | 4.2 | BD | 53.2 |
| MN10.0-10 | 59 | 7.8 | BD | 66.8 |
| MN11.0-10 | 22 | 10.2 | BD | 32.2 |
| MN15.0-10 | 16 | 6.6 | BD | 22.6 |
| MN16.0-10 | 62 | 6.6 | BD | 68.6 |
| MN19 0-10 | 7 | 7.8 | BD | 14.8 |
| MN21.30-40 | 31 | 3.6 | BD | 34.6 |
| MN22.0-10 | 53 | 7.8 | BD | 60.8 |
| MN23 0-10 | 99 | 9.6 | BD | 108.6 |
| MN24 0-10 | 105 | 9.6 | BD | 114.6 |
| MN26 0-10 | 1 | 8.4 | BD | 9.4 |
| MN27.0-10 | 38 | 8.4 | BD | 46.4 |
| MN29 0-10 | 31 | 4.8 | BD | 35.8 |
| MN31 0-10 | 47 | 6 | BD | 53 |
| MN32.0-10 | 26 | BD | BD | 26 |
| MN33 0-10 | 64 | BD | BD | 64 |
| MN34 0-10 | 73 | 16.8 | BD | 89.8 |
| MN35 0-10 | 62 | 6.6 | BD | 68.6 |
| MN37 0-10 | 55 | 7.2 | BD | 62.2 |
| MN39 0-10 | 28 | 7.2 | BD | 35.2 |
| MN40 0-10 | 13 | 7.8 | BD | 20.8 |

[1]BD indicates below detection.

According to relevant Victorian EPA guidelines (EPA 2009) an acid sulfate soil is defined as a soil with a net acidity concentration of >18 mole $H^+$/tonne when more than 1,000 tonnes of soil may be disturbed (as is likely to be the case at this site), provided that the acidity is derived from sulfide oxidation. The results detailed in Table A-6 above indicate that sulfides are above detection in all but two of the samples analysed. Given this, it is reasonable to assume that the acidity within these soils is derived from sulfide oxidation. In addition, the concentration of net acidity exceeds 18 mole $H^+$/tonne in all but two samples, indicating that ASS are relatively widely distributed across the site. Further, the acid neutralising capacity of the soils was below detection, indicating that the soils have little to no capacity to buffer any acidity generated by further sulfide oxidation.

While this is the case, the majority of the acidity within the soils analysed was related to total actual acidity. This is illustrated in Figure A-7 below, which shows the correlation between total actual acidity and net acidity, which has a better than 99% correlation (given by an $r^2$ value of >0.99), with the net acidity of soils given by the total actual acidity multiplied by a factor of 1.13, which accounts for minor concentrations of CRS which are relatively ubiquitous in soils at the site.

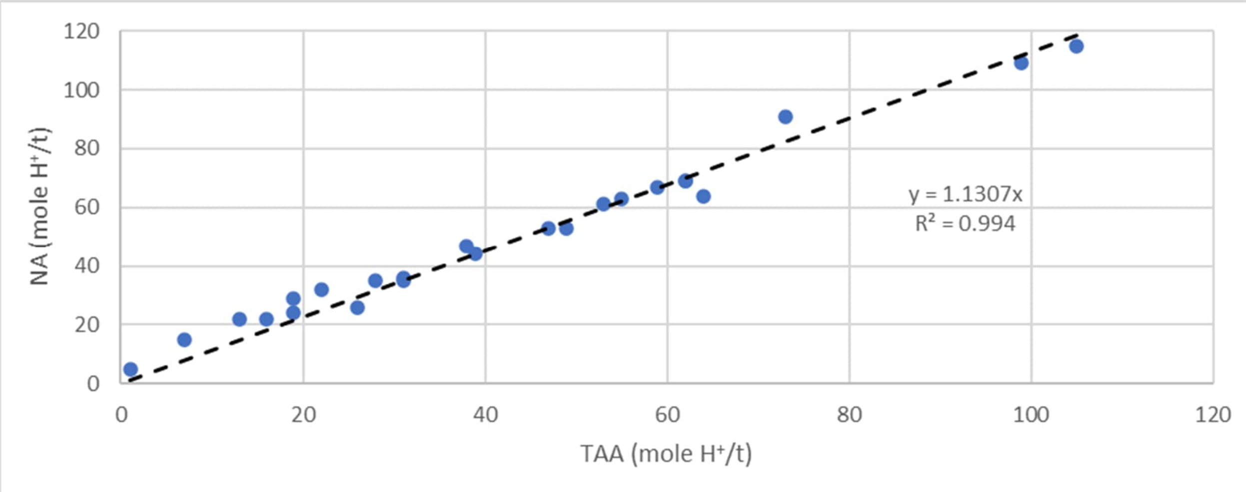


Figure A-7. Co-variance between Current Acidity (TAA) and Net Acidity (NA).

Within ASS studies there are various ways in which to correlate and extrapolate detailed ASS test work with screen tests to enable detailed mapping of the spatial and stratigraphic distribution of ASS. Often, the relationship between the net acidity of soils and the $pH_{FOX}$ of soils is used to derive net acidity values for soils which have not undergone CRS analysis. However, given that at this particular site, the net acidity of soils is primarily derived from its total actual acidity, which is related to its $pH_F$, the relationship between TAA and $pH_F$ has been used to extrapolate the TAA of soils which were not subject to CRS analysis. This relationship is illustrated in Figure A-8 below. Subsequently, the relationship between TAA and NA illustrated in Figure A-7 above has been used to account for minor concentrations of CRS which are relatively ubiquitous in soils.

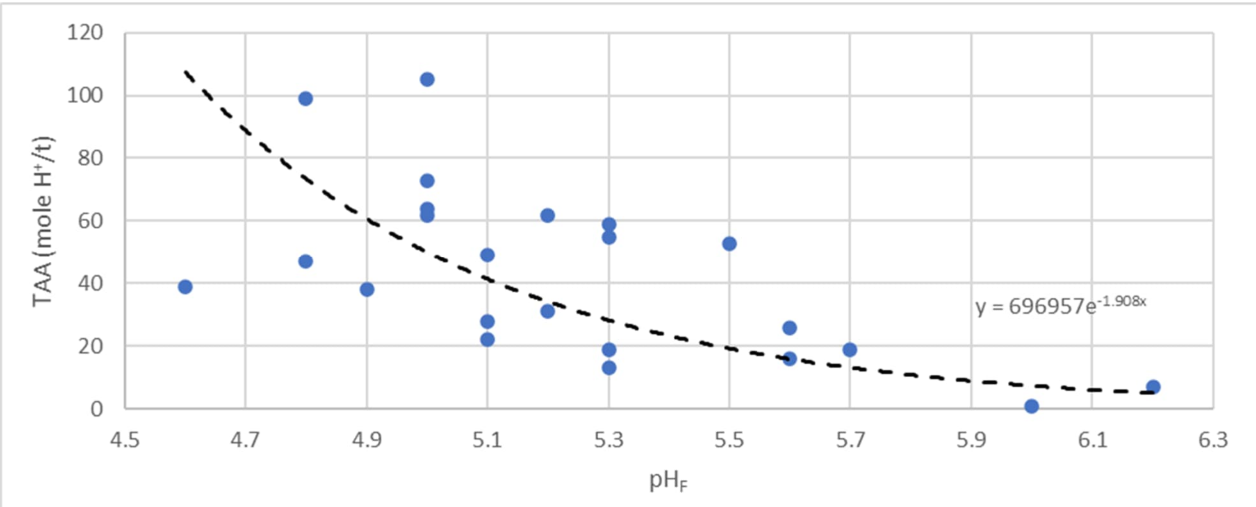


Figure A-8. Co-variance between pHF and TAA.

The resulting concentrations of total actual acidity and net acidity (as mole H+/tonne), given by the extrapolation of $pH_F$ data has been detailed in Table A-7 below, with spatial distributions illustrated in Figure 4-5 and Figure 4-6.

Accordingly, the results indicate that ASS (which require an ASSMP) primarily occur in topsoils, as evidenced by net acidity concentrations of >18 mole $H^+$/tonne in 77.5 % of samples. Conversely, net acidity concentrations only exceeded 18 mole $H^+$/tonne in 17.5% of subsoils. This indicates that the majority of topsoils are likely to require management under an ASSMP, while only isolated areas of subsoils in the north and southeast of the project area are likely to require management under an ASSMP.

While this may be the case, for those sampled where the concentration of net acidity in samples exceeding 18 mole $H^+$/tonne (threshold for development of an ASSMP), the net acidity tends to be below 90 mole $H^+$/tonne (i.e. between 1 and 5 times the action criteria) and are likely to be managed easily under a standard ASSMP (highlighted in light green in Table A-7). This represents 67.5% of topsoils at the site and all subsoils which exceed the action criteria (17.5% of soils). Only 4 locations at the site (10 %) exhibited net acidity concentrations ranging between 90 and 180 mole $H^+$/tonne (which all occurred in top soils) and may require more robust management under an ASSMP.

Table A-7. $pH_F$ values of topsoil and subsoil and calculated total actual acidity and net acidity (in moles $H^+$/tonne) given by covariance presented in Figure A-7 and Figure A-8.

| Sample ID | 0-0.1 m | | | 0.3-0.4 m | | |
|---|---|---|---|---|---|---|
| | $pH_F$ | TAA | NA[1] | $pH_F$ | TAA | NA[1] |
| MN01 | 4.5 | 130.1 | 147.0 | 5.0 | 50.1 | 56.6 |
| MN02 | 5.3 | 28.3 | 32.0 | 6.9 | 1.3 | 1.5 |
| MN03 | 5.3 | 28.3 | 32.0 | 7.0 | 1.1 | 1.2 |
| MN04 | 4.6 | 107.5 | 121.5 | 6.5 | 2.9 | 3.2 |
| MN05 | 5.4 | 23.4 | 26.4 | 7.1 | 0.9 | 1.0 |
| MN06 | 5.7 | 13.2 | 14.9 | 8.2 | 0.1 | 0.1 |
| MN07 | 5.2 | 34.2 | 38.7 | 7.6 | 0.4 | 0.4 |
| MN08 | 5.1 | 41.4 | 46.8 | 5.7 | 13.2 | 14.9 |
| MN09 | 5.7 | 13.2 | 14.9 | 5.6 | 16.0 | 18.0 |
| MN10 | 5.3 | 28.3 | 32.0 | 6.2 | 5.1 | 5.7 |
| MN11 | 5.1 | 41.4 | 46.8 | 7.4 | 0.5 | 0.6 |
| MN12 | 5.1 | 41.4 | 46.8 | 7.4 | 0.5 | 0.6 |
| MN13 | 4.6 | 107.5 | 121.5 | 7.1 | 0.9 | 1.0 |
| MN14 | 4.7 | 88.8 | 100.4 | 6.7 | 2.0 | 2.2 |
| MN15 | 5.6 | 16.0 | 18.0 | 7.3 | 0.6 | 0.7 |
| MN16 | 5 | 50.1 | 56.6 | 6.4 | 3.5 | 3.9 |
| MN17 | 5.1 | 41.4 | 46.8 | 5.5 | 19.3 | 21.8 |
| MN18 | 6.4 | 3.5 | 3.9 | 7.8 | 0.2 | 0.3 |
| MN19 | 6.2 | 5.1 | 5.7 | 7.2 | 0.8 | 0.9 |
| MN20 | 5.8 | 10.9 | 12.3 | 6.5 | 2.9 | 3.2 |
| MN21 | 6.2 | 5.1 | 5.7 | 8.8 | 0.0 | 0.0 |
| MN22 | 5.5 | 19.3 | 21.8 | 5.8 | 10.9 | 12.3 |
| MN23 | 4.8 | 73.4 | 83.0 | 5.1 | 41.4 | 46.8 |
| MN24 | 5 | 50.1 | 56.6 | 5.2 | 34.2 | 38.7 |
| MN25 | 5.4 | 23.4 | 26.4 | 7.4 | 0.5 | 0.6 |
| MN26 | 6 | 7.4 | 8.4 | 7.1 | 0.9 | 1.0 |

| Sample ID | 0-0.1 m | | | 0.3-0.4 m | | |
|---|---|---|---|---|---|---|
| | $pH_F$ | TAA | NA[1] | $pH_F$ | TAA | NA[1] |
| MN27 | 4.9 | 60.7 | 68.5 | 6.3 | 4.2 | 4.7 |
| MN28 | 5.7 | 13.2 | 14.9 | 7.0 | 1.1 | 1.2 |
| MN29 | 5.2 | 34.2 | 38.7 | 6.6 | 2.4 | 2.7 |
| MN30 | 5 | 50.1 | 56.6 | 6.4 | 3.5 | 3.9 |
| MN31 | 4.8 | 73.4 | 83.0 | 7.1 | 0.9 | 1.0 |
| MN32 | 5.6 | 16.0 | 18.0 | 6.5 | 2.9 | 3.2 |
| MN33 | 5 | 50.1 | 56.6 | 6.2 | 5.1 | 5.7 |
| MN34 | 5 | 50.1 | 56.6 | 5.1 | 41.4 | 46.8 |
| MN35 | 5.2 | 34.2 | 38.7 | 5.0 | 50.1 | 56.6 |
| MN36 | 5.3 | 28.3 | 32.0 | 6.6 | 2.4 | 2.7 |
| MN37 | 5.3 | 28.3 | 32.0 | 6.1 | 6.1 | 6.9 |
| MN38 | 5.8 | 10.9 | 12.3 | 5.9 | 9.0 | 10.2 |
| MN39 | 5.1 | 41.4 | 46.8 | 6.3 | 4.2 | 4.7 |
| MN40 | 5.3 | 28.3 | 32.0 | 7.5 | 0.4 | 0.5 |

[1]Shading according to net acidity concentrations (mole $H^+$/tonne): Dark green <18, Light green 18≥90, Yellow 90>180

Given the nature of the site, and that concentrations of sulfides are typically low (~7 mole H+/tonne on average), management of ASS would likely take the form of minimising and avoiding disturbance where possible, and applying lime to topsoils (either in situ or in stockpiles) where disturbance is unavoidable.

Specific liming rates for ASS treatment would need to be developed as part of the ASS management plan (ASSMP) according to localised acidity concentratiions and the proposed disturbance, which would require further sampling and analysis at the requisite sample density in accordance with Sullivan et al. (2018). However, based on the results from this program, treatment rates are likely to be modest and restricted to topsoils.

Indicative liming rates for ASS have been provided in Table A-8 below assuming a neautralising value of 98% for aglime, a soil bulk density of 1.3 kg/tonne and a safety factor of 1.5. Accordingly, based on the net acidity concentrations estimated across the site by extrapolating CRS results, the average liming rate for topsoils is estimated to be 3.5 kg $CaCO_3/m^3$, while a conservative liming rate (based on the 80$^{th}$ percentile net acidity value) is 5.6 kg $CaCO_3/m^3$. Liming rates have not been provided for subsoils as neither the mean nor 80$^{th}$ percentile net acidity concentration exceedes the criteria required for management of acid sulfate soils.

Table A-8. Indicative liming rates for treating ASS.

| ASS treatment | Topsoil (0-10cm) | Subsoil (30-40cm) | Deeper subsoil (80-150cm) |
|---|---|---|---|
| Average liming rate (kg $CaCO_3$/t) | 3.5 | N/A | N/A |
| Conservative liming rate (kg $CaCO_3$/t) | 5.6 | N/A | N/A |

## A.4 Analytical results

Table A-9. Merrifield North Field Sheet.

| | | | | Topsoil 0-10cm Sample | | | | | | Subsoil 30-40cm Sample | | | | | Deeper Sample below 40cm | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New Site Name | Photo Collect | Easting | Northing | Lab Barcode | 0-10cm Sample Collected | Depth of A Horizon (cm) | 0-10cm Sample Texture | 0-10cm Sample Visual Colour | 0-10cm Sample Munsell Colour | Lab Barcode | 30-40cm Samp Collected. | 30-40cm Sample Texture | 30-40cm Sample Visual Colour | 30-40cm Sample Munsell Colour | Lab Barcode | Deep Sample Collected | Deep Sample Depth | Deep Sample Texture | Deep Sample Visual Colour | Deep Sample Munsell Colour |
| MN1 | Y | 317792 | 5847878 | 130142870 | Y | 15 | Clay Loam | Dark Grey-Black | 10YR3/2 | 130142869 | Y | Heavy Clay | Black | 10YR3/1 | 130142868 | Y | 90-100 | Heavy Clay | Black | 2.5Y3/1 |
| MN2 | Y | 318290 | 5847946 | 130142873 | Y | 9 | Light Sandy Clay Loam | Dark Grey | 10YR4/2 | 130142872 | Y | Heavy Clay | Dark Grey | 10YR3/1 | 130142871 | Y | 110-120 | Heavy Clay | Grey | 2.5Y4/1 |
| MN3 | Y | 318791 | 5847946 | 130142885 | Y | 13 | Light Sandy Clay Loam | Grey Brown | 10YR4/3 | 130142884 | Y | Heavy Clay | Yellow Grey Brown | 2.5Y5/3 | 130142883 | Y | 140-150 | Medium-Heavy Clay/Weathered Rock | Grey | 2.5Y7/2 |
| MN4 | Y | 319291 | 5847946 | 130142882 | Y | 8 | Light Sandy Clay Loam | Grey Brown | 10YR4/3 | 130142881 | Y | Medium-Heavy Clay | Yellow Grey Brown | 10YR5/3 | 130142880 | Y | 140-150 | Heavy Clay | Yellow Grey | 2.5Y4/3 |
| MN5 | Y | 316749 | 5847451 | 130142278 | Y | 15 | Sandy Clay Loam | Grey Brown | 10YR4/2 | 130142277 | Y | Heavy Clay | Dark Grey Brown | 10YR4/1 | 130142276 | Y | 140-150 | Heavy Clay | Yellow Grey | 2.5Y5/3 |
| MN6 | Y | 317332 | 5847424 | 130142858 | Y | 10 | Medium Clay | Black | 10YR3/1 | 130142857 | Y | Heavy Clay | Black | 10YR3/1 | 130142864 | Y | 120-130 | Heavy Clay | Yellow Grey | 2.5Y5/2 |
| MN7 | Y | 317792 | 5847446 | 130142867 | Y | 7 | Medium Clay | Dark Grey-Black | 10YR3/2 | 130142866 | Y | Heavy Clay | Dark Grey-Black | 10YR3/1 | 130142865 | Y | 140-150 | Heavy Clay | Yellow Grey | 2.5Y7/2 |
| MN8 | Y | 318290 | 5847453 | 130142888 | Y | 25 | Light Sandy Clay Loam | Grey Brown | 10YR4/3 | 130142887 | Y | Sandy Clay | Grey Brown | 10YR4/3 | 130143886 | Y | 140-150 | Heavy Clay | Yellow Grey Brown | 2.5Y6/2 |
| MN9 | Y | 318791 | 5847446 | 130142879 | Y | 10 | Sandy Clay Loam | Dark Grey Brown | 10YR4/2 | 130142878 | Y | Sandy Clay | Grey Brown | 10YR4/3 | 130142877 | Y | 140-150 | Heavy Clay | Yellow Grey | 2.5Y6/2 |
| MN10 | Y | 315791 | 5846962 | 130142281 | Y | 40 | Fine Sandy Loam | Brown | 7.5YR5/3 | 130142280 | Y | Fine Sandy Loam | Grey | 10YR5/2 | 130142279 | Y | 140-150 | Heavy Clay | Yellow Grey Brown | 10YR5/3 |
| MN11 | Y | 316291 | 5846946 | 130142284 | Y | 70 | Fine Sandy Loam | Brown | 7.5YR5/3 | 130142283 | Y | Fine Sandy Loam | Yellow Brown | 10YR5/4 | 130142282 | Y | 140-150 | Sandy Clay | Grey | 10YR4/1 |
| MN12 | Y | 316805 | 5846891 | 130142275 | Y | 12 | Light Clay | Dark Grey Brown | 10YR5/2 | 130142274 | Y | Medium-Heavy Clay | Dark Grey | 10YR4/1 | 130142273 | Y | 140-150 | Heavy Clay | Yellow Grey | 2.5Y5/2 |
| MN13 | Y | 317317 | 5846925 | 130142859 | Y | 13 | Light-Medium Clay | Dark Grey | 10YR4/1 | 130142861 | Y | Medium Clay | Black | 10YR3/1 | 130142860 | Y | 110-120 | Heavy Clay | Dark Grey-Black | 10YR4/1 |
| MN14 | Y | 317790 | 5846946 | 130142863 | Y | 10 | Clay Loam | Dark Grey | 10YR5/2 | 130142862 | Y | Medium-Heavy Clay | Dark Grey | 10YR5/1 | 130142289 | Y | 120-130 | Heavy Clay | Grey | 2.5Y6/2 |
| MN15 | Y | 318291 | 5846946 | 130143159 | Y | 8 | Sandy Clay Loam | Grey Brown | 10YR4/2 | 130143160 | Y | Heavy Clay | Yellow Grey Brown | 2.5Y5/3 | 130142889 | Y | 140-150 | Heavy Clay | Yellow Grey Brown | 2.5Y6/3 |
| MN16 | Y | 318791 | 5846946 | 130142876 | Y | 25 | Light Sandy Clay Loam | Dark Grey Brown | 10YR4/2 | 130142875 | Y | Medium-Heavy Clay | Yellow Grey Brown | 10YR5/3 | 130142874 | Y | 140-150 | Heavy Clay | Grey | 2.5Y6/2 |
| MN17 | Y | 315706 | 5846458 | 130142728 | Y | 14 | Light Clay | Dark Grey | 10YR4/2 | 130142727 | Y | Medium-Heavy Clay | Dark Grey Brown | 10YR5/2 | 130142726 | Y | 140-150 | Heavy Clay | Yellow Grey | 10YR6/2 |
| MN18 | Y | 316138 | 5846460 | 130142747 | Y | 30 | Fine Sandy Clay Loam | Light Brown | 7.5YR5/4 | 130142746 | Y | Heavy Clay | Dark Grey Brown | 10YR4/1 | 130142745 | Y | 140-150 | Heavy Clay | Yellow Grey Brown | 2.5Y6/3 |
| MN19 | Y | 316596 | 5846452 | 130142750 | Y | 10 | Light Clay | Dark Grey Brown | 10YR4/1 | 130142749 | Y | Heavy Clay | Dark Grey | 10YR3/1 | 130142748 | Y | 140-150 | Heavy Clay | Yellow Grey | 2.5Y6/1 |
| MN20 | Y | 317730 | 5846437 | 130142267 | Y | 12 | Light Clay | Dark Grey | 10YR4/3 | 130142266 | Y | Heavy Clay | Dark Grey-Black | 10YR3/1 | | N | | | | |
| MN21 | Y | 318295 | 5846627 | 130143156 | Y | 60 | Medium Clay | Dark Grey | 10YR4/2 | 130143157 | Y | Light Sandy Clay Loam | Grey | 10YR5/3 | 130143158 | Y | 120-130 | Heavy Clay | Yellow Grey Brown | 2.5Y4/3 |
| MN22 | Y | 318642 | 5846329 | 130142286 | Y | 15 | Clay Loam | Dark Grey Brown | 10YR4/2 | 130142285 | Y | Heavy Clay | Dark Grey-Black | 10YR3/1 | | N | | | | |
| MN23 | Y | 315355 | 584607 | 130142730 | Y | 30 | Clay Loam | Grey Brown | 10YR5/2 | 130142729 | Y | Medium-Heavy Clay | Dark Grey Brown | 10YR4/1 | | N | | | | |
| MN24 | Y | 315648 | 5846044 | 130142733 | Y | 10 | Light Clay | Grey Brown | 10YR4/2 | 130142732 | Y | Medium-Heavy Clay | Dark Grey | 10YR3/1 | 130142731 | Y | 140-150 | Heavy Clay | Yellow Grey | 2.5Y6/2 |
| MN25 | Y | 316045 | 5845961 | 130142744 | Y | 30 | Fine Sandy Loam | Brown | 10YR5/3 | 130142743 | Y | Medium-Heavy Clay | Dark Grey | 10YR3/2 | 130142742 | Y | 140-150 | Heavy Clay | Yellow Grey | 2.5Y6/2 |
| MN26 | Y | 316529 | 5845930 | 130142753 | Y | 9 | Medium Clay | Dark Grey Brown | 10YR4/1 | 130142752 | Y | Heavy Clay | Dark Grey | 10YR3/1 | 130142751 | Y | 140-150 | Heavy Clay | Yellow Grey | 2.5Y6/2 |
| MN27 | Y | 317806 | 5845939 | 130142268 | Y | 12 | Sandy Clay Loam | Grey Brown | 10YR5/2 | 130142269 | Y | Heavy Clay | Dark Grey Brown | 10YR4/2 | | N | | | | |
| MN28 | Y | 318627 | 5845799 | 130142288 | Y | 12 | Loam | Grey Brown | 10YR4/3 | 130142287 | Y | Heavy Clay | Grey Brown | 10YR5/2 | | N | | | | |
| MN29 | Y | 315626 | 5845446 | 130142739 | Y | 9 | Light Clay | Dark Grey Brown | 10YR4/2 | 130142738 | Y | Heavy Clay | Grey Brown | 10YR5/2 | 130142737 | Y | 140-150 | Heavy Clay | Yellow Grey | 2.5Y5/2 |
| MN30 | Y | 316206 | 5845500 | 130142741 | Y | 9 | Medium Clay | Dark Grey | 10YR4/2 | 130142740 | Y | Heavy Clay | Dark Grey | 10YR4/1 | | N | | | | |
| MN31 | Y | 316850 | 5845505 | 130142756 | Y | 8 | Light-Medium Clay | Dark Grey Brown | 10YR4/2 | 130142755 | Y | Heavy Clay | Dark Grey | 2.5Y4/1 | 130142754 | Y | 140-150 | Heavy Clay | Yellow Grey Brown | 2.5Y5/3 |
| MN32 | Y | 317437 | 5845397 | 130142272 | Y | 8 | Medium Clay | Dark Grey | 10YR4/2 | 130142271 | Y | Medium-Heavy Clay | Dark Grey Brown | 10YR4/2 | 130142270 | Y | 80-90 | Heavy Clay | Black | 2.5Y3/1 |
| MN33 | Y | 315751 | 5845085 | 130142736 | Y | 12 | Light Clay | Dark Grey Brown | 10YR4/2 | 130142735 | Y | Heavy Clay | Dark Grey | 10YR4/1 | 130142734 | Y | 140-150 | Heavy Clay | Yellow Grey | 10YR6/2 |
| MN34 | Y | 316291 | 5844946 | 130142717 | Y | 15 | Light Clay | Grey Brown | 10YR4/2 | 130142716 | Y | Medium-Heavy Clay | Dark Grey Brown | 10YR4/1 | | N | | | | |
| MN35 | Y | 316791 | 5844946 | 130142718 | Y | 10 | Light Clay | Grey Brown | 10YR5/2 | 130142719 | Y | Medium-Heavy Clay | Grey Brown | 10YR5/1 | | N | | | | |
| MN36 | Y | 317325 | 5845113 | 130142721 | Y | 8 | Clay Loam | Grey Brown | 10YR5/2 | 130142720 | Y | Heavy Clay | Dark Grey | 10YR3/1 | | N | | | | |
| MN37 | Y | 317802 | 5845135 | 130142725 | Y | 7 | Light-Medium Clay | Dark Grey Brown | 10YR4/2 | 130142724 | Y | Heavy Clay | Dark Grey | 10YR3/1 | | N | | | | |
| MN38 | Y | 318214 | 5845150 | 130142723 | Y | 40 | Sandy Clay Loam | Grey Brown | 7.5YR5/2 | 130142722 | Y | Loamy Sand | Brown | 7.5YR5/4 | | N | | | | |
| MN39 | Y | 317176 | 5846208 | 130142762 | Y | 10 | Light-Medium Clay | Dark Grey Brown | 10YR4/2 | 130142761 | Y | Heavy Clay | Dark Grey | 10YR4/1 | 130142760 | Y | 140-150 | Heavy Clay | Dark Grey | 2.5Y5/2 |
| MN40 | Y | 317146 | 5845927 | 130142759 | Y | 7 | Medium Clay | Dark Grey | 10YR4/1 | 130142758 | Y | Heavy Clay | Dark Grey | 10YR5/1 | 130142757 | Y | 140-150 | Heavy Clay | Yellow Grey | 2.5Y6/2 |
| | | | | | **Average:** | **17** | | | | | | | | | | | | | | |

Table A-10. Merrifield North Field Sheet (Continued).

| New Site Name | Slope | Aspect | Notes |
|---|---|---|---|
| MN1 | Lower slope / drainage depression | South east | Black cracking self mulching clay. Refusal on basalt at 100cm. |
| MN2 | Lower slope / drainage line | South west | Shallow topsoil over heavy clay with calcium carbonate at 110-120cm. Refusal at basalt 120cm. |
| MN3 | Mid slope | North west | 80-90cm of clay over weathered rock. Weathered rock looks like sandstone (orange with strong mangenese at depth). |
| MN4 | Lower slope | North | Shallow light sandy clay loam over deep clay to <1.5m. |
| MN5 | Flat to gently undulating | South west | Strong cracking at the surface reflecting clay-dominant conditions. |
| MN6 | Lower to flat | South east | Black cracking self mulching clay, with strong calcium carbonate and weathered sandstone. Rock below 1.0m. |
| MN7 | Lower slope / drainage line | West | Self mulching clay, cracking, highly calcareous below 1.0m. |
| MN8 | Lower slope / drainage line | West | 30-40cm has bleaching and orange mottling (indicative of waterlogging), may be a transition zone between the A and B hor. Cracking at the surface. |
| MN9 | Mid slope / drainage line | West | Shallow topsoil over clay. Some orange mottling in the 30-40cm range. Very heavy clay. |
| MN10 | Flat to gently undulating | South east | 40cm of loam over heavy clay, bleached A2 horizon from 20-40cm. |
| MN11 | Flat to gently undulating | North east | Deep loam topsoil, A2 horizon to 70cm, no bleach, sandy clay subsoil. |
| MN12 | Flat to gently undulating | South | Strong cracking clay, cracking at the surface. Clay in the 140-150cm range is highly calcareous. |
| MN13 | Flat to gently undulating | South | Strong black, cracking, self-mulching clay. Refusal on basalt at 120cm. |
| MN14 | Flat to gently undulating | South east | Strong, black, cracking, self mulching clay. |
| MN15 | Lower slope | North west | Canola stubble. Shallow topsoil over heavy clay. Strong cracking to the surface. |
| MN16 | Mid slope | West | A1 horizon and bleached A2 horizon to 25cm over heavy clay. Calcium carbonate nodules at 140-150cm. |
| MN17 | Flat to gentle slope | South | Strong cracking clay soil with optimal grond cover (Phalaris) |
| MN18 | Flat to gently sloping | South | Clay fill from Kalkallo Creek drain on surface. This will influence pH results. Some calcium carbonate within clay fill. |
| MN19 | Flat to gently sloping | South | Strong cracking on surface. Good cover of organic matter. |
| MN20 | Flat to gently undulating | Slope | Augered. Thick pasture, high root density from 0-10cm. Cracking clay soil. |
| MN21 | Lower slope | North west | 12cm of clay fill. A2 horizon to 60cm over heavy clay. |
| MN22 | Mid slope | West | Strong crumb structure throughout the A and upper B horizon from long term pasture. |
| MN23 | Flat to gently sloping | South | Strong bleached A2 horizon from 15-30cm, self-mulching clay loam surface with strong gilgais. |
| MN24 | Flat to gently sloping | South | Strong cracking clay soil with good ground cover |
| MN25 | Flat to gently sloping | South | Clay fill from Kalkallo Creek drain has been spread across the surface. |
| MN26 | Flat to gently sloping | South | Strong cracking, significant ground cover. Site is stable in the current condition. |
| MN27 | Lower slope / gently undulating | North west | Hand augered. Thick Philaris pasture on deep cracking clay soil with basalt floaters. Thin bleached A2 horizon from 10-15cm. Organic carbon level is expected to be very high. |
| MN28 | Mid slope | South east | Hand auger. Loam over heavy clay subsoil. |
| MN29 | Flat to gently sloping | South | Cracking clay with good ground cover. Site located beside cleared area. |
| MN30 | Flat to gently sloping | South east | Strong cracking clay, high level of ground cover from Philaris |
| MN31 | Flat to gently undulating | South | Orange mottling and stong organic material 0-10cm range. Strong cracking at the surface. Some weathered rock at 150cm. |
| MN32 | Gently undulating | North west | Refusal on basalt at 90cm, deep cracking clay near southern bank of the retarding basin. |
| MN33 | Flat to gently sloping | South east | Strong cracking clay with optimal ground cover. |
| MN34 | Flat | East | Bleached A2 horizon from 10-15cm. Cracking soil, Juncus species present with Philaris, suspect area is seaonally inundated. |
| MN35 | Lower slope / gently sloping | North | B1 horizon of light clay from 10-25cm is bleached. Cracking at surface, full ground cover. |
| MN36 | Mid slope / gently sloping | North west | Volcanic soil on slope, no surface rock in this vicinity. Good ground cover. |
| MN37 | Mid to lower slope | North east | Surface cracking to 40cm, Gilgai. Occasional basalt boulder at surface. Site located above drainage basin level. Use these results to infer mapping across volcanic area to the east (exclude waterway corridor). |
| MN38 | Waterway | South east | This site reflects alluvial condtions adjacent to creek. Does not represent broader volcanic areas - has implications for mapping (separate out drainage line below RB) |
| MN39 | Flat to gently sloping | South west | Refusal at rock at 150cm. Very strong cracking to surface and site under dense Philaris. Strong orange mottling in 0-10cm range. |
| MN40 | Flat to gently undulating | South | Strong clacking clay soil, large cracks evident. Good ground cover - high level of organic matter at surface rendering site stable. |

Table A-11. Merrifield North 0-10cm Sample Analytical Results.

| Sample ID | Site | Sample Name | Sample Start Depth | Sample End Depth | Zone | GPS Easting | GPS Northing | Texture | pH (1:5 Water) | pH (1:5 CaCl2) | Electrical Conductivity (1:5 water) | Exchangeable Sodium Percentage | Emerson Class (Remoulded 20 Hours) | Remoulded Dispersion Observation 20 Hours (Emerson) | Disp. Index, Loveday/Pyle | Slaking 2Hrs | Calcium (Amm-acet.) | Magnesium (Amm-acet.) | Potassium (Amm-acet.) | Sodium (Amm-acet.) | Aluminium (KCl) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | cm | cm | | | | SESW Field Classification | | | dS/m | % | | | | | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| 130142870 | MN1 | MN1. 0-10 | 0 | 10 | 55H | 317792 | 5847878 | Clay Loam | 5.5 | 4.9 | 0.22 | 2.9 | 7 | Nil | 0 | Water Stable | 2400 | 1452 | 344 | 173 | 9 |
| 130142873 | MN2 | MN2. 0-10 | 0 | 10 | 55H | 318290 | 5847946 | Light Sandy Clay Loam | 6.0 | 5.3 | 0.16 | 4.5 | 7 | Slight | 2 | Water Stable | 1780 | 1210 | 336 | 219 | 9 |
| 130142885 | MN3 | MN3. 0-10 | 0 | 10 | 55H | 318791 | 5847946 | Light Sandy Clay Loam | 6.1 | 5.3 | 0.18 | 5.0 | 7 | Slight | 2 | Water Stable | 1360 | 496 | 587 | 152 | 9 |
| 130142882 | MN4 | MN4. 0-10 | 0 | 10 | 55H | 319291 | 5847946 | Light Sandy Clay Loam | 5.6 | 4.9 | 0.16 | 5.3 | 7 | Slight | 2 | Water Stable | 1260 | 605 | 215 | 156 | 13 |
| 130142278 | MN5 | MN5. 0-10 | 0 | 10 | 55H | 316749 | 5847451 | Sandy Clay Loam | 6.0 | 5.0 | 0.17 | 5.3 | 7 | Slight | 1 | Water Stable | 1140 | 714 | 321 | 161 | 9 |
| 130142858 | MN6 | MN6. 0-10 | 0 | 10 | 55H | 317332 | 5847424 | Medium Clay | 6.5 | 5.8 | 0.22 | 6.0 | 7 | Slight | 1 | Water Stable | 2200 | 2420 | 391 | 460 | 9 |
| 130142867 | MN7 | MN7. 0-10 | 0 | 10 | 55H | 317792 | 5847446 | Medium Clay | 6.2 | 5.2 | 0.15 | 5.3 | 7 | Moderate | 4 | Water Stable | 1180 | 2299 | 348 | 322 | 9 |
| 130142888 | MN8 | MN8. 0-10 | 0 | 10 | 55H | 318290 | 5847453 | Light Sandy Clay Loam | 5.9 | 5.2 | 0.17 | 4.2 | 7 | Slight | 2 | Water Stable | 1460 | 738 | 430 | 150 | 9 |
| 130142879 | MN9 | MN9. 0-10 | 0 | 10 | 55H | 318791 | 5847446 | Sandy Clay Loam | 6.0 | 5.4 | 0.23 | 4.2 | 7 | Slight | 1 | Water Stable | 2200 | 932 | 430 | 193 | 9 |
| 130142281 | MN10 | MN10. 0-10 | 0 | 10 | 55H | 315791 | 5846962 | Fine Sandy Loam | 5.5 | 4.5 | 0.10 | 3.4 | 7 | Slight | 2 | Water Stable | 760 | 484 | 129 | 67 | 22 |
| 130142284 | MN11 | MN11. 0-10 | 0 | 10 | 55H | 316291 | 5846946 | Fine Sandy Loam | 5.6 | 4.6 | 0.08 | 2.1 | 7 | Slight | 2 | Water Stable | 500 | 206 | 133 | 23 | 13 |
| 130142275 | MN12 | MN12. 0-10 | 0 | 10 | 55H | 316805 | 5846891 | Light Clay | 5.9 | 5.0 | 0.25 | 7.8 | 7 | Slight | 2 | Water Stable | 760 | 1210 | 293 | 299 | 9 |
| 130142859 | MN13 | MN13. 0-10 | 0 | 10 | 55H | 317317 | 5846925 | Light-Medium Clay | 5.3 | 4.7 | 0.31 | 5.0 | 7 | Nil | 0 | Water Stable | 1200 | 1573 | 391 | 253 | 12 |
| 130142863 | MN14 | MN14. 0-10 | 0 | 10 | 55H | 317790 | 5846946 | Clay Loam | 5.2 | 4.4 | 0.27 | 3.9 | 7 | Slight | 1 | Water Stable | 920 | 956 | 391 | 129 | 24 |
| 130143159 | MN15 | MN15. 0-10 | 0 | 10 | 55H | 318291 | 5846946 | Sandy Clay Loam | 6.0 | 5.4 | 0.21 | 5.7 | 7 | Nil | 1 | Water Stable | 1960 | 787 | 262 | 230 | 9 |
| 130142876 | MN16 | MN16. 0-10 | 0 | 10 | 55H | 318791 | 5846946 | Light Sandy Clay Loam | 5.8 | 5.0 | 0.19 | 7.6 | 7 | Slight | 2 | Water Stable | 1620 | 920 | 258 | 299 | 9 |
| 130142728 | MN17 | MN17. 0-10 | 0 | 10 | 55H | 315706 | 5846458 | Light Clay | 5.5 | 4.5 | 0.13 | 6.5 | 7 | Moderate | 3 | Water Stable | 1180 | 1101 | 375 | 253 | 36 |
| 130142747 | MN18 | MN18. 0-10 | 0 | 10 | 55H | 316138 | 5846460 | Fine Sandy Clay Loam | 7.5 | 6.9 | 0.16 | 1.8 | 7 | Slight | 3 | Water Stable | 1920 | 956 | 254 | 76 | 9 |
| 130142750 | MN19 | MN19. 0-10 | 0 | 10 | 55H | 316596 | 5846452 | Light Clay | 6.4 | 6.0 | 0.21 | 6.2 | 7 | Slight | 2 | Water Stable | 1580 | 1815 | 278 | 368 | 9 |
| 130142267 | MN20 | MN20. 0-10 | 0 | 10 | 55H | 317730 | 5846437 | Light Clay | 6.2 | 5.3 | 0.23 | 5.5 | 7 | Slight | 2 | Water Stable | 1260 | 1694 | 391 | 276 | 9 |
| 130143156 | MN21 | MN21. 0-10 | 0 | 10 | 55H | 318295 | 5846627 | Medium Clay | 7.1 | 6.4 | 0.16 | 6.8 | 7 | Slight | 4 | Water Stable | 1720 | 1077 | 270 | 299 | 9 |
| 130142286 | MN22 | MN22. 0-10 | 0 | 10 | 55H | 318642 | 5846329 | Clay Loam | 6.0 | 5.0 | 0.17 | 4.3 | 7 | Slight | 1 | Water Stable | 2800 | 1125 | 196 | 253 | 9 |
| 130142730 | MN23 | MN23. 0-10 | 0 | 10 | 55H | 315355 | 584607 | Clay Loam | 5.2 | 4.3 | 0.23 | 9.7 | 7 | Slight | 1 | Water Stable | 1000 | 593 | 231 | 276 | 52 |
| 130142733 | MN24 | MN24. 0-10 | 0 | 10 | 55H | 315648 | 5846044 | Light Clay | 5.1 | 4.6 | 0.25 | 5.9 | 7 | Slight | 1 | Water Stable | 1080 | 944 | 371 | 207 | 33 |
| 130142744 | MN25 | MN25. 0-10 | 0 | 10 | 55H | 316045 | 5845961 | Fine Sandy Loam | 6.1 | 5.2 | 0.09 | 3.6 | 7 | Slight | 2 | Water Stable | 880 | 617 | 309 | 90 | 9 |
| 130142753 | MN26 | MN26. 0-10 | 0 | 10 | 55H | 316529 | 5845930 | Medium Clay | 6.6 | 6.1 | 0.34 | 6.8 | 7 | Slight | 1 | Water Stable | 1400 | 1936 | 262 | 391 | 9 |
| 130142268 | MN27 | MN27. 0-10 | 0 | 10 | 55H | 317806 | 5845939 | Sandy Clay Loam | 5.6 | 4.3 | 0.13 | 6.7 | 7 | Slight | 2 | Water Stable | 760 | 799 | 285 | 191 | 36 |
| 130142288 | MN28 | MN28. 0-10 | 0 | 10 | 55H | 318627 | 5845799 | Loam | 6.1 | 4.5 | 0.10 | 15.0 | 7 | Strong | 8 | Water Stable | 500 | 508 | 176 | 299 | 40 |
| 130142739 | MN29 | MN29. 0-10 | 0 | 10 | 55H | 315626 | 5845446 | Light Clay | 5.8 | 4.9 | 0.12 | 7.7 | 7 | Slight | 2 | Water Stable | 1480 | 1210 | 325 | 345 | 12 |
| 130142741 | MN30 | MN30. 0-10 | 0 | 10 | 55H | 316206 | 5845500 | Medium Clay | 5.8 | 4.9 | 0.12 | 6.8 | 7 | Slight | 2 | Water Stable | 1240 | 1452 | 321 | 322 | 18 |
| 130142756 | MN31 | MN31. 0-10 | 0 | 10 | 55H | 316850 | 5845505 | Light-Medium Clay | 6.1 | 4.9 | 0.08 | 5.9 | 7 | Slight | 2 | Water Stable | 1100 | 1452 | 297 | 276 | 14 |
| 130142272 | MN32 | MN32. 0-10 | 0 | 10 | 55H | 317437 | 5845397 | Medium Clay | 6.3 | 5.1 | 0.08 | 3.5 | 7 | Slight | 2 | Water Stable | 1400 | 1452 | 469 | 168 | 9 |
| 130142736 | MN33 | MN33. 0-10 | 0 | 10 | 55H | 315751 | 5845085 | Light Clay | 5.9 | 5.0 | 0.14 | 6.1 | 7 | Slight | 2 | Water Stable | 1260 | 932 | 344 | 221 | 9 |
| 130142717 | MN34 | MN34. 0-10 | 0 | 10 | 55H | 316291 | 5844946 | Light Clay | 5.4 | 4.6 | 0.15 | 6.9 | 7 | Slight | 2 | Water Stable | 1040 | 787 | 250 | 212 | 17 |
| 130142718 | MN35 | MN35. 0-10 | 0 | 10 | 55H | 316791 | 5844946 | Light Clay | 6.1 | 4.5 | 0.05 | 9.9 | 7 | Strong | 11 | Water Stable | 640 | 835 | 113 | 276 | 33 |
| 130142721 | MN36 | MN36. 0-10 | 0 | 10 | 55H | 317325 | 5845113 | Clay Loam | 5.8 | 4.9 | 0.10 | 3.5 | 7 | Slight | 2 | Water Stable | 1160 | 847 | 665 | 122 | 9 |
| 130142725 | MN37 | MN37. 0-10 | 0 | 10 | 55H | 317802 | 5845135 | Light-Medium Clay | 5.8 | 4.9 | 0.08 | 2.3 | 7 | Slight | 2 | Water Stable | 1360 | 1053 | 352 | 90 | 11 |
| 130142723 | MN38 | MN38. 0-10 | 0 | 10 | 55H | 318214 | 5845150 | Sandy Clay Loam | 6.0 | 5.2 | 0.08 | 1.6 | 7 | Slight | 2 | Water Stable | 980 | 690 | 262 | 44 | 9 |
| 130142762 | MN39 | MN39. 0-10 | 0 | 10 | 55H | 317176 | 5846208 | Light-Medium Clay | 5.8 | 4.9 | 0.12 | 3.6 | 7 | Moderate | 4 | Water Stable | 1260 | 1210 | 587 | 154 | 9.2 |
| 130142759 | MN40 | MN40. 0-10 | 0 | 10 | 55H | 317146 | 5845927 | Medium Clay | 6.4 | 5.2 | 0.11 | 6.2 | 7 | Moderate | 9 | Water Stable | 1700 | 1452 | 215 | 322 | 9 |
| | | | | | | | | Average: | 5.9 | 5.1 | 0.2 | 5.5 | | | | | 1335 | 1088 | 321 | 220 | 15 |

Table A-12. Merrifield North 0-10cm Sample Analytical Results (Continued).

| Sample ID | Site | Sample Name | Calcium (Amm-acet.) | Magnesium (Amm-acet.) | Potassium (Amm-acet.) | Sodium (Amm-acet.) | Aluminium (KCl) | Cation Exch. Cap. | Calcium (Amm-acet.) | Magnesium (Amm-acet.) | Potassium (Amm-acet.) | Aluminium Saturation | Calcium / Magnesium Ratio | ESP% + EPP% Calculation | Organic Carbon (W&B) | Organic Matter (W&B * 1.72) | Available Potassium | Dry Dispersion 2 Hours (Emerson) | Dry Dispersion 20 Hours (Emerson) | Remoulded Dispersion 2 Hours (Emerson) | Remoulded Dispersion 20 Hours (Emerson) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | % | % | % | % | | SESW Calculation | % | % | mg/kg | | | | |
| 130142870 | MN1 | MN1. 0-10 | 12 | 12 | 0.88 | 0.75 | 0.1 | 25.5 | 46 | 47 | 3.4 | 1.0 | 1.0 | 6.3 | 3.4 | 5.8 | 340 | Nil | Nil | Nil | Nil |
| 130142873 | MN2 | MN2. 0-10 | 8.9 | 10 | 0.86 | 0.95 | 0.1 | 21.1 | 42 | 49 | 4.1 | 1.0 | 0.9 | 8.6 | 3.6 | 6.2 | 340 | Nil | Nil | Slight | Slight |
| 130142885 | MN3 | MN3. 0-10 | 6.8 | 4.1 | 1.5 | 0.66 | 0.1 | 13.1 | 52 | 32 | 11.0 | 1.0 | 1.7 | 16.0 | 2.7 | 4.6 | 580 | Nil | Nil | Slight | Slight |
| 130142882 | MN4 | MN4. 0-10 | 6.3 | 5 | 0.55 | 0.68 | 0.1 | 12.7 | 50 | 40 | 4.3 | 1.1 | 1.3 | 9.6 | 3.1 | 5.3 | 220 | Nil | Nil | Slight | Slight |
| 130142278 | MN5 | MN5. 0-10 | 5.7 | 5.9 | 0.82 | 0.7 | 0.1 | 13.2 | 43 | 45 | 6.2 | 1.0 | 1.0 | 11.5 | 3.8 | 6.5 | 320 | Nil | Nil | Nil | Slight |
| 130142858 | MN6 | MN6. 0-10 | 11 | 20 | 1 | 2 | 0.1 | 33.4 | 32 | 59 | 3.1 | 1.0 | 0.6 | 9.1 | 2.9 | 4.9 | 410 | Nil | Nil | Nil | Slight |
| 130142867 | MN7 | MN7. 0-10 | 5.9 | 19 | 0.89 | 1.4 | 0.1 | 27.3 | 22 | 70 | 3.3 | 1.0 | 0.3 | 8.6 | 2.4 | 4.1 | 350 | Nil | Slight | Slight | Moderate |
| 130142888 | MN8 | MN8. 0-10 | 7.3 | 6.1 | 1.1 | 0.65 | 0.1 | 15.2 | 48 | 40 | 7.2 | 1.0 | 1.2 | 11.4 | 2.6 | 4.4 | 430 | Nil | Slight | Nil | Slight |
| 130142879 | MN9 | MN9. 0-10 | 11 | 7.7 | 1.1 | 0.84 | 0.1 | 20.3 | 52 | 38 | 5.6 | 1.0 | 1.4 | 9.8 | 3.0 | 5.2 | 440 | Nil | Nil | Nil | Slight |
| 130142281 | MN10 | MN10. 0-10 | 3.8 | 4 | 0.33 | 0.29 | 0.3 | 8.7 | 44 | 46 | 3.8 | 2.9 | 1.0 | 7.2 | 3.2 | 5.5 | 130 | Nil | Nil | Slight | Slight |
| 130142284 | MN11 | MN11. 0-10 | 2.5 | 1.7 | 0.34 | 0.1 | 0.2 | 4.9 | 52 | 36 | 7.1 | 3.1 | 1.5 | 9.2 | 1.8 | 3.1 | 130 | Nil | Nil | Slight | Slight |
| 130142275 | MN12 | MN12. 0-10 | 3.8 | 10 | 0.75 | 1.3 | 0.1 | 16.2 | 24 | 64 | 4.6 | 1.0 | 0.4 | 12.4 | 3.1 | 5.4 | 290 | Nil | Nil | Slight | Slight |
| 130142859 | MN13 | MN13. 0-10 | 6 | 13 | 1 | 1.1 | 0.1 | 21.1 | 28 | 61 | 4.9 | 0.6 | 0.5 | 9.9 | 2.9 | 5.0 | 410 | Nil | Nil | Nil | Nil |
| 130142863 | MN14 | MN14. 0-10 | 4.6 | 7.9 | 1 | 0.56 | 0.3 | 14.3 | 32 | 55 | 7.2 | 1.9 | 0.6 | 11.1 | 3.7 | 6.3 | 400 | Nil | Nil | Nil | Slight |
| 130143159 | MN15 | MN15. 0-10 | 9.8 | 6.5 | 0.67 | 1 | 0.1 | 18 | 54 | 36 | 3.7 | 1.0 | 1.5 | 9.4 | 2.4 | 4.2 | 260 | Nil | Slight | Nil | Nil |
| 130142876 | MN16 | MN16. 0-10 | 8.1 | 7.6 | 0.66 | 1.3 | 0.1 | 17.7 | 46 | 43 | 3.7 | 1.0 | 1.1 | 11.3 | 3.2 | 5.4 | 260 | Nil | Nil | Slight | Slight |
| 130142728 | MN17 | MN17. 0-10 | 5.9 | 9.1 | 0.96 | 1.1 | 0.4 | 17.4 | 34 | 52 | 5.5 | 2.3 | 0.7 | 12.0 | 3.5 | 6.1 | 370 | Nil | Nil | Slight | Moderate |
| 130142747 | MN18 | MN18. 0-10 | 9.6 | 7.9 | 0.65 | 0.33 | 0.1 | 18.4 | 52 | 43 | 3.5 | 1.0 | 1.2 | 5.3 | 2.5 | 4.4 | 250 | Slight | Slight | Nil | Slight |
| 130142750 | MN19 | MN19. 0-10 | 7.9 | 15 | 0.71 | 1.6 | 0.1 | 25 | 31 | 60 | 2.8 | 1.0 | 0.5 | 9.0 | 3.7 | 6.4 | 280 | Nil | Nil | Slight | Slight |
| 130142267 | MN20 | MN20. 0-10 | 6.3 | 14 | 1 | 1.2 | 0.1 | 22.7 | 28 | 62 | 4.5 | 1.0 | 0.5 | 10.0 | 3.9 | 6.7 | 400 | Nil | Nil | Slight | Slight |
| 130143156 | MN21 | MN21. 0-10 | 8.6 | 8.9 | 0.69 | 1.3 | 0.1 | 19.5 | 44 | 46 | 3.6 | 1.0 | 1.0 | 10.4 | 1.7 | 3.0 | 270 | Slight | Slight | Slight | Slight |
| 130142286 | MN22 | MN22. 0-10 | 14 | 9.3 | 0.5 | 1.1 | 0.1 | 25.3 | 57 | 37 | 2.0 | 1.0 | 1.5 | 6.3 | 5.5 | 9.4 | 200 | Nil | Nil | Nil | Slight |
| 130142730 | MN23 | MN23. 0-10 | 5 | 4.9 | 0.59 | 1.2 | 0.6 | 12.2 | 41 | 40 | 4.8 | 4.8 | 1.0 | 14.5 | 4.1 | 7.1 | 230 | Nil | Nil | Nil | Slight |
| 130142733 | MN24 | MN24. 0-10 | 5.4 | 7.8 | 0.95 | 0.9 | 0.4 | 15.4 | 35 | 51 | 6.1 | 2.4 | 0.7 | 12.0 | 4.5 | 7.7 | 370 | Nil | Nil | Nil | Slight |
| 130142744 | MN25 | MN25. 0-10 | 4.4 | 5.1 | 0.79 | 0.39 | 0.1 | 10.8 | 41 | 48 | 7.3 | 1.0 | 0.9 | 10.9 | 2.9 | 4.9 | 310 | Nil | Nil | Slight | Slight |
| 130142753 | MN26 | MN26. 0-10 | 7 | 16 | 0.67 | 1.7 | 0.1 | 25.4 | 27 | 63 | 2.6 | 1.0 | 0.4 | 9.4 | 4.0 | 6.8 | 260 | Nil | Nil | Nil | Slight |
| 130142268 | MN27 | MN27. 0-10 | 3.8 | 6.6 | 0.73 | 0.83 | 0.4 | 12.4 | 31 | 54 | 5.9 | 3.2 | 0.6 | 12.6 | 3.4 | 5.9 | 280 | Nil | Nil | Slight | Slight |
| 130142288 | MN28 | MN28. 0-10 | 2.5 | 4.2 | 0.45 | 1.3 | 0.5 | 8.9 | 28 | 47 | 5.1 | 5.1 | 0.6 | 20.1 | 2.6 | 4.4 | 180 | Slight | Moderate | Moderate | Strong |
| 130142739 | MN29 | MN29. 0-10 | 7.4 | 10 | 0.83 | 1.5 | 0.1 | 20 | 37 | 51 | 4.1 | 0.7 | 0.7 | 11.8 | 3.6 | 6.3 | 320 | Nil | Nil | Slight | Slight |
| 130142741 | MN30 | MN30. 0-10 | 6.2 | 12 | 0.82 | 1.4 | 0.2 | 20.3 | 30 | 58 | 4.1 | 1.0 | 0.5 | 10.9 | 3.0 | 5.2 | 320 | Nil | Nil | Slight | Slight |
| 130142756 | MN31 | MN31. 0-10 | 5.5 | 12 | 0.76 | 1.2 | 0.2 | 19.5 | 28 | 61 | 3.9 | 0.8 | 0.5 | 9.8 | 2.3 | 4.0 | 300 | Nil | Nil | Slight | Slight |
| 130142272 | MN32 | MN32. 0-10 | 7 | 12 | 1.2 | 0.73 | 0.1 | 20.8 | 34 | 57 | 5.6 | 1.0 | 0.6 | 9.1 | 1.5 | 2.6 | 460 | Nil | Nil | Slight | Slight |
| 130142736 | MN33 | MN33. 0-10 | 6.3 | 7.7 | 0.88 | 0.96 | 0.1 | 15.9 | 40 | 49 | 5.6 | 1.0 | 0.8 | 11.7 | 3.7 | 6.3 | 350 | Nil | Nil | Slight | Slight |
| 130142717 | MN34 | MN34. 0-10 | 5.2 | 6.5 | 0.64 | 0.92 | 0.2 | 13.4 | 39 | 48 | 4.8 | 1.4 | 0.8 | 11.7 | 3.2 | 5.5 | 250 | Nil | Nil | Slight | Slight |
| 130142718 | MN35 | MN35. 0-10 | 3.2 | 6.9 | 0.29 | 1.2 | 0.4 | 11.9 | 27 | 58 | 2.4 | 3.0 | 0.5 | 12.3 | 0.7 | 1.2 | 110 | Moderate | Strong | Strong | Strong |
| 130142721 | MN36 | MN36. 0-10 | 5.8 | 7 | 1.7 | 0.53 | 0.1 | 15 | 39 | 47 | 11.0 | 1.0 | 0.8 | 14.5 | 3.5 | 6.1 | 650 | Nil | Nil | Slight | Slight |
| 130142725 | MN37 | MN37. 0-10 | 6.8 | 8.7 | 0.9 | 0.39 | 0.1 | 17 | 40 | 51 | 5.3 | 0.7 | 0.8 | 7.6 | 2.8 | 4.9 | 350 | Nil | Nil | Slight | Slight |
| 130142723 | MN38 | MN38. 0-10 | 4.9 | 5.7 | 0.67 | 0.19 | 0.1 | 11.5 | 43 | 49 | 5.8 | 1.0 | 0.9 | 7.4 | 2.8 | 4.8 | 260 | Nil | Nil | Slight | Slight |
| 130142762 | MN39 | MN39. 0-10 | 6.3 | 10 | 1.5 | 0.67 | 0.1 | 18.6 | 34 | 54 | 8.2 | 0.6 | 0.6 | 11.8 | 3.4 | 5.9 | 600 | Nil | Slight | Slight | Moderate |
| 130142759 | MN40 | MN40. 0-10 | 8.5 | 12 | 0.55 | 1.4 | 0.1 | 22.8 | 37 | 54 | 2.4 | 1.0 | 0.7 | 8.6 | 2.4 | 4.1 | 210 | Moderate | Strong | Moderate | Moderate |
| | | | 6.7 | 9.0 | 0.8 | 1.0 | 0.2 | 17.6 | 39 | 50 | 5.0 | 1.5 | 0.8 | 10.5 | 3.1 | 5.3 | 322 | | | | |

Table A-13. Merrifield North 30-40cm Sample Analytical Results.

| Sample ID | Site | Sample Name | Sample Start Depth | Sample End Depth | Zone | GPS Easting | GPS Northing | Texture | pH (1:5 Water) | pH (1:5 CaCl2) | Electrical Conductivity (1:5 water) | Exchangeable Sodium Percentage | Emerson Class (Remoulded 20 Hours) | Remoulded Dispersion Observation 20 Hours (Emerson) | Disp. Index, Loveday/Pyle | Slaking 2Hrs | Calcium (Amm-acet.) | Magnesium (Amm-acet.) | Potassium (Amm-acet.) | Sodium (Amm-acet.) | Aluminium (KCl) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | cm | cm | | | | SESW Field Classification | | | dS/m | % | | | | | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| 130142869 | MN1 | MN1. 30-40 | 30 | 40 | 55H | 317792 | 5847878 | Heavy Clay | 6.2 | 5.2 | 0.08 | 2.8 | 7 | Nil | 1 | Water Stable | 2400 | 1694 | 129 | 168 | 9 |
| 130142872 | MN2 | MN2. 30-40 | 30 | 40 | 55H | 318290 | 5847946 | Heavy Clay | 7.8 | 6.7 | 0.20 | 9.3 | 7 | Moderate | 11 | Water Stable | 2400 | 2420 | 184 | 759 | 9 |
| 130142884 | MN3 | MN3. 30-40 | 30 | 40 | 55H | 318791 | 5847946 | Heavy Clay | 7.0 | 5.3 | 0.18 | 18.0 | 8 | Complete | 14 | Water Stable | 940 | 1452 | 587 | 897 | 9 |
| 130142881 | MN4 | MN4. 30-40 | 30 | 40 | 55H | 319291 | 5847946 | Medium-Heavy Clay | 7.5 | 6.7 | 0.23 | 9.2 | 7 | Strong | 12 | Water Stable | 1400 | 1815 | 430 | 552 | 9 |
| 130142277 | MN5 | MN5. 30-40 | 30 | 40 | 55H | 316749 | 5847451 | Heavy Clay | 7.9 | 6.5 | 0.14 | 10.0 | 7 | Strong | 13 | Water Stable | 1300 | 2178 | 192 | 644 | 9 |
| 130142857 | MN6 | MN6. 30-40 | 30 | 40 | 55H | 317332 | 5847424 | Heavy Clay | 8.9 | 7.7 | 0.45 | 14.0 | 2 | Slight | 7 | Considerable | 2200 | 3872 | 301 | 1610 | 9 |
| 130142866 | MN7 | MN7. 30-40 | 30 | 40 | 55H | 317792 | 5847446 | Heavy Clay | 8.6 | 7.7 | 0.26 | 12.0 | 1 | Strong | 13 | Considerable | 1440 | 4477 | 313 | 1403 | 9 |
| 130142887 | MN8 | MN8. 30-40 | 30 | 40 | 55H | 318290 | 5847453 | Sandy Clay | 6.5 | 5.1 | 0.10 | 11.0 | 1 | Strong | 13 | Considerable | 540 | 738 | 188 | 276 | 9 |
| 130142878 | MN9 | MN9. 30-40 | 30 | 40 | 55H | 318791 | 5847446 | Heavy Clay | 6.5 | 5.0 | 0.07 | 12.0 | 1 | Strong | 14 | Considerable | 600 | 678 | 113 | 299 | 12 |
| 130142280 | MN10 | MN10. 30-40 | 30 | 40 | 55H | 315791 | 5846962 | Fine Sandy Loam | 7.0 | 5.6 | 0.07 | 10.0 | 1 | Complete | 15 | Considerable | 440 | 339 | 47 | 133 | 9 |
| 130142283 | MN11 | MN11. 30-40 | 30 | 40 | 55H | 316291 | 5846946 | Fine Sandy Loam | 8.5 | 7.6 | 0.10 | 2.3 | 6 | Nil | 1 | Considerable | 1000 | 496 | 78 | 51 | 9 |
| 130142274 | MN12 | MN12. 30-40 | 30 | 40 | 55H | 316805 | 5846891 | Medium-Heavy Clay | 7.9 | 6.6 | 0.45 | 17.0 | 8 | Strong | 12 | Water Stable | 1060 | 3146 | 203 | 1472 | 9 |
| 130142861 | MN13 | MN13. 30-40 | 30 | 40 | 55H | 317317 | 5846925 | Medium Clay | 7.7 | 6.8 | 0.33 | 7.8 | 2 | Moderate | 10 | Considerable | 2000 | 2541 | 219 | 621 | 9 |
| 130142862 | MN14 | MN14. 30-40 | 30 | 40 | 55H | 317790 | 5846946 | Medium-Heavy Clay | 7.6 | 6.3 | 0.19 | 10.0 | 1 | Complete | 14 | Considerable | 1140 | 2420 | 285 | 690 | 9 |
| 130143160 | MN15 | MN15. 30-40 | 30 | 40 | 55H | 318291 | 5846946 | Heavy Clay | 8.0 | 6.6 | 0.40 | 20.0 | 8 | Strong | 13 | Water Stable | 1740 | 2420 | 262 | 1725 | 9 |
| 130142875 | MN16 | MN16. 30-40 | 30 | 40 | 55H | 318791 | 5846946 | Medium-Heavy Clay | 7.2 | 5.8 | 0.15 | 18.0 | 1 | Strong | 13 | Considerable | 1280 | 1573 | 141 | 989 | 9 |
| 130142727 | MN17 | MN17. 30-40 | 30 | 40 | 55H | 315706 | 5846458 | Medium-Heavy Clay | 6.5 | 5.4 | 0.25 | 18.0 | 1 | Complete | 14 | Considerable | 1180 | 1331 | 219 | 851 | 9 |
| 130142746 | MN18 | MN18. 30-40 | 30 | 40 | 55H | 316138 | 5846460 | Heavy Clay | 8.5 | 7.4 | 0.86 | 24.0 | 2 | Strong | 10 | Considerable | 1260 | 3025 | 278 | 2300 | 9 |
| 130142749 | MN19 | MN19. 30-40 | 30 | 40 | 55H | 316596 | 5846452 | Heavy Clay | 8.1 | 6.8 | 0.32 | 13.0 | 7 | Complete | 14 | Water Stable | 1460 | 3388 | 285 | 1288 | 9 |
| 130142266 | MN20 | MN20. 30-40 | 30 | 40 | 55H | 317730 | 5846437 | Heavy Clay | 7.3 | 6.0 | 0.18 | 8.3 | 7 | Strong | 10 | Water Stable | 1300 | 2178 | 274 | 529 | 9 |
| 130143157 | MN21 | MN21. 30-40 | 30 | 40 | 55H | 318295 | 5846627 | Light Sandy Clay Loam | 6.4 | 5.0 | 0.09 | 13.0 | 2 | Strong | 11 | Considerable | 780 | 641 | 94 | 345 | 9 |
| 130142285 | MN22 | MN22. 30-40 | 30 | 40 | 55H | 318642 | 5846329 | Heavy Clay | 6.6 | 5.2 | 0.07 | 3.0 | 7 | Slight | 3 | Water Stable | 3800 | 1694 | 125 | 230 | 9 |
| 130142729 | MN23 | MN23. 30-40 | 30 | 40 | 55H | 315355 | 584607 | Medium-Heavy Clay | 6.3 | 4.6 | 0.09 | 14.0 | 7 | Complete | 13 | Water Stable | 800 | 666 | 78 | 368 | 9 |
| 130142732 | MN24 | MN24. 30-40 | 30 | 40 | 55H | 315648 | 5846044 | Medium-Heavy Clay | 6.5 | 5.4 | 0.15 | 15.0 | 1 | Complete | 14 | Considerable | 1160 | 1137 | 184 | 621 | 9 |
| 130142743 | MN25 | MN25. 30-40 | 30 | 40 | 55H | 316045 | 5845961 | Medium-Heavy Clay | 8.2 | 6.9 | 0.26 | 13.0 | 1 | Complete | 14 | Considerable | 1560 | 2783 | 199 | 1127 | 9 |
| 130142752 | MN26 | MN26. 30-40 | 30 | 40 | 55H | 316529 | 5845930 | Heavy Clay | 8.0 | 6.5 | 0.28 | 11.0 | 7 | Strong | 13 | Water Stable | 1760 | 3630 | 305 | 1150 | 9 |
| 130142269 | MN27 | MN27. 30-40 | 30 | 40 | 55H | 317806 | 5845939 | Heavy Clay | 7.0 | 5.6 | 0.15 | 15.0 | 1 | Complete | 14 | Considerable | 1160 | 1573 | 192 | 759 | 9 |
| 130142287 | MN28 | MN28. 30-40 | 30 | 40 | 55H | 318627 | 5845799 | Heavy Clay | 7.4 | 6.0 | 0.18 | 19.0 | 1 | Complete | 14 | Considerable | 840 | 1210 | 289 | 828 | 9 |
| 130142738 | MN29 | MN29. 30-40 | 30 | 40 | 55H | 315626 | 5845446 | Heavy Clay | 7.6 | 6.4 | 0.22 | 12.0 | 8 | Strong | 12 | Water Stable | 2200 | 1936 | 258 | 805 | 9 |
| 130142740 | MN30 | MN30. 30-40 | 30 | 40 | 55H | 316206 | 5845500 | Heavy Clay | 7.3 | 5.6 | 0.13 | 9.7 | 7 | Strong | 12 | Water Stable | 1860 | 2541 | 430 | 782 | 9 |
| 130142755 | MN31 | MN31. 30-40 | 30 | 40 | 55H | 316850 | 5845505 | Heavy Clay | 8.7 | 7.5 | 0.51 | 13.0 | 2 | Moderate | 10 | Considerable | 2400 | 3267 | 340 | 1380 | 9 |
| 130142271 | MN32 | MN32. 30-40 | 30 | 40 | 55H | 317437 | 5845397 | Medium-Heavy Clay | 7.3 | 6.0 | 0.10 | 5.2 | 7 | Strong | 9 | Water Stable | 2000 | 1815 | 391 | 322 | 9 |
| 130142735 | MN33 | MN33. 30-40 | 30 | 40 | 55H | 315751 | 5845085 | Heavy Clay | 7.0 | 5.6 | 0.22 | 13.0 | 8 | Strong | 12 | Water Stable | 2000 | 1936 | 254 | 920 | 9 |
| 130142716 | MN34 | MN34. 30-40 | 30 | 40 | 55H | 316291 | 5844946 | Medium-Heavy Clay | 6.2 | 4.8 | 0.12 | 13.0 | 7 | Complete | 13 | Water Stable | 740 | 980 | 106 | 414 | 9 |
| 130142719 | MN35 | MN35. 30-40 | 30 | 40 | 55H | 316791 | 5844946 | Medium-Heavy Clay | 5.3 | 4.4 | 0.09 | 4.4 | 7 | Slight | 2 | Water Stable | 760 | 690 | 176 | 110 | 41 |
| 130142720 | MN36 | MN36. 30-40 | 30 | 40 | 55H | 317325 | 5845113 | Heavy Clay | 7.7 | 6.1 | 0.11 | 8.4 | 7 | Complete | 11 | Water Stable | 1840 | 2420 | 743 | 644 | 9 |
| 130142724 | MN37 | MN37. 30-40 | 30 | 40 | 55H | 317802 | 5845135 | Heavy Clay | 7.2 | 5.8 | 0.07 | 4.9 | 7 | Moderate | 5 | Water Stable | 1860 | 1573 | 160 | 276 | 9 |
| 130142722 | MN38 | MN38. 30-40 | 30 | 40 | 55H | 318214 | 5845150 | Loamy Sand | 6.9 | 5.7 | 0.03 | 1.7 | 7 | Moderate | 6 | Water Stable | 400 | 303 | 78 | 18 | 9 |
| 130142761 | MN39 | MN39. 30-40 | 30 | 40 | 55H | 317176 | 5846208 | Heavy Clay | 6.7 | 5.5 | 0.19 | 10.0 | 1 | Strong | 13 | Considerable | 1220 | 1936 | 262 | 598 | 9 |
| 130142758 | MN40 | MN40. 30-40 | 30 | 40 | 55H | 317146 | 5845927 | Heavy Clay | 8.3 | 7.6 | 0.69 | 16.0 | 2 | Slight | 3 | Considerable | 2400 | 3267 | 285 | 1702 | 9 |
| | | | | | | | | Average: | 7.3 | 6.1 | 0.22 | 11.5 | | | | | 1466 | 1954 | 242 | 766 | 10 |

Table A-14. Merrifield North 30-40cm Sample Analytical Results (Continued).

| Sample ID | Site | Sample Name | Calcium (Amm-acet.) | Magnesium (Amm-acet.) | Potassium (Amm-acet.) | Sodium (Amm-acet.) | Aluminium (KCl) | Cation Exch. Cap. | Calcium (Amm-acet.) | Magnesium (Amm-acet.) | Potassium (Amm-acet.) | Aluminium Saturation | Calcium / Magnesium Ratio | ESP% + EPP% Calculation | Available Potassium | Dry Dispersion 2 Hours (Emerson) | Dry Dispersion 20 Hours (Emerson) | Remoulded Dispersion 2 Hours (Emerson) | Remoulded Dispersion 20 Hours (Emerson) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | % | % | % | % | | SESW Calculation | mg/kg | | | | |
| 130142869 | MN1 | MN1. 30-40 | 12 | 14 | 0.33 | 0.73 | 0.1 | 26.5 | 44 | 52 | 1.3 | 1.0 | 0.9 | 4.1 | 130 | Nil | Slight | Nil | Nil |
| 130142872 | MN2 | MN2. 30-40 | 12 | 20 | 0.47 | 3.3 | 0.1 | 35.5 | 34 | 55 | 1.3 | 1.0 | 0.6 | 10.6 | 180 | Strong | Complete | Moderate | Moderate |
| 130142884 | MN3 | MN3. 30-40 | 4.7 | 12 | 1.5 | 3.9 | 0.1 | 22.1 | 21 | 54 | 6.7 | 1.0 | 0.4 | 24.7 | 580 | Strong | Complete | Strong | Complete |
| 130142881 | MN4 | MN4. 30-40 | 7 | 15 | 1.1 | 2.4 | 0.1 | 25.6 | 27 | 59 | 4.2 | 1.0 | 0.5 | 13.4 | 420 | Strong | Strong | Strong | Strong |
| 130142277 | MN5 | MN5. 30-40 | 6.5 | 18 | 0.49 | 2.8 | 0.1 | 28.2 | 23 | 65 | 1.7 | 1.0 | 0.4 | 11.7 | 190 | Strong | Complete | Strong | Strong |
| 130142857 | MN6 | MN6. 30-40 | 11 | 32 | 0.77 | 7 | 0.1 | 51.5 | 22 | 63 | 1.5 | 1.0 | 0.3 | 15.5 | 300 | Moderate | Strong | Slight | Slight |
| 130142866 | MN7 | MN7. 30-40 | 7.2 | 37 | 0.8 | 6.1 | 0.1 | 50.9 | 14 | 72 | 1.6 | 1.0 | 0.2 | 13.6 | 310 | Strong | Complete | Strong | Strong |
| 130142887 | MN8 | MN8. 30-40 | 2.7 | 6.1 | 0.48 | 1.2 | 0.1 | 10.5 | 25 | 58 | 4.6 | 1.0 | 0.4 | 15.6 | 190 | Strong | Complete | Strong | Strong |
| 130142878 | MN9 | MN9. 30-40 | 3 | 5.6 | 0.29 | 1.3 | 0.1 | 10.3 | 29 | 54 | 2.8 | 1.3 | 0.5 | 14.8 | 110 | Complete | Complete | Strong | Strong |
| 130142280 | MN10 | MN10. 30-40 | 2.2 | 2.8 | 0.12 | 0.58 | 0.1 | 5.7 | 39 | 49 | 2.2 | 1.0 | 0.8 | 12.2 | 49 | Strong | Complete | Complete | Complete |
| 130142283 | MN11 | MN11. 30-40 | 5 | 4.1 | 0.2 | 0.22 | 0.1 | 9.5 | 53 | 43 | 2.1 | 1.0 | 1.2 | 4.4 | 77 | Nil | Slight | Nil | Nil |
| 130142274 | MN12 | MN12. 30-40 | 5.3 | 26 | 0.52 | 6.4 | 0.1 | 38.3 | 14 | 68 | 1.4 | 1.0 | 0.2 | 18.4 | 200 | Strong | Strong | Strong | Strong |
| 130142861 | MN13 | MN13. 30-40 | 10 | 21 | 0.56 | 2.7 | 0.1 | 34.4 | 29 | 62 | 1.6 | 1.0 | 0.5 | 9.4 | 220 | Strong | Strong | Moderate | Moderate |
| 130142862 | MN14 | MN14. 30-40 | 5.7 | 20 | 0.73 | 3 | 0.1 | 29.2 | 20 | 68 | 2.5 | 1.0 | 0.3 | 12.5 | 290 | Strong | Complete | Strong | Complete |
| 130143160 | MN15 | MN15. 30-40 | 8.7 | 20 | 0.67 | 7.5 | 0.1 | 36.7 | 24 | 54 | 1.8 | 1.0 | 0.4 | 21.8 | 260 | Strong | Complete | Strong | Strong |
| 130142875 | MN16 | MN16. 30-40 | 6.4 | 13 | 0.36 | 4.3 | 0.1 | 24.1 | 27 | 54 | 1.5 | 1.0 | 0.5 | 19.5 | 140 | Strong | Complete | Strong | Strong |
| 130142727 | MN17 | MN17. 30-40 | 5.9 | 11 | 0.56 | 3.7 | 0.1 | 21.2 | 28 | 52 | 2.6 | 1.0 | 0.5 | 20.6 | 220 | Strong | Complete | Strong | Complete |
| 130142746 | MN18 | MN18. 30-40 | 6.3 | 25 | 0.71 | 10 | 0.1 | 42.6 | 15 | 60 | 1.7 | 1.0 | 0.3 | 25.7 | 280 | Slight | Strong | Strong | Strong |
| 130142749 | MN19 | MN19. 30-40 | 7.3 | 28 | 0.73 | 5.6 | 0.1 | 42.1 | 17 | 68 | 1.7 | 1.0 | 0.3 | 14.7 | 280 | Strong | Complete | Strong | Complete |
| 130142266 | MN20 | MN20. 30-40 | 6.5 | 18 | 0.7 | 2.3 | 0.1 | 27.9 | 23 | 66 | 2.5 | 1.0 | 0.4 | 10.8 | 270 | Moderate | Moderate | Strong | Strong |
| 130143157 | MN21 | MN21. 30-40 | 3.9 | 5.3 | 0.24 | 1.5 | 0.1 | 11 | 36 | 48 | 2.2 | 1.0 | 0.7 | 15.2 | 95 | Moderate | Strong | Strong | Strong |
| 130142285 | MN22 | MN22. 30-40 | 19 | 14 | 0.32 | 1 | 0.1 | 34.2 | 54 | 42 | 0.9 | 1.0 | 1.4 | 3.9 | 120 | Slight | Slight | Nil | Slight |
| 130142729 | MN23 | MN23. 30-40 | 4 | 5.5 | 0.2 | 1.6 | 0.1 | 11.3 | 36 | 49 | 1.8 | 1.0 | 0.7 | 15.8 | 78 | Strong | Strong | Strong | Complete |
| 130142732 | MN24 | MN24. 30-40 | 5.8 | 9.4 | 0.47 | 2.7 | 0.1 | 18.4 | 32 | 51 | 2.6 | 1.0 | 0.6 | 17.6 | 190 | Strong | Complete | Strong | Complete |
| 130142743 | MN25 | MN25. 30-40 | 7.8 | 23 | 0.51 | 4.9 | 0.1 | 36.6 | 21 | 64 | 1.4 | 1.0 | 0.3 | 14.4 | 200 | Strong | Complete | Strong | Complete |
| 130142752 | MN26 | MN26. 30-40 | 8.8 | 30 | 0.78 | 5 | 0.1 | 44.9 | 20 | 67 | 1.7 | 1.0 | 0.3 | 12.7 | 310 | Strong | Complete | Strong | Strong |
| 130142269 | MN27 | MN27. 30-40 | 5.8 | 13 | 0.49 | 3.3 | 0.1 | 22.5 | 26 | 57 | 2.2 | 1.0 | 0.5 | 17.2 | 190 | Strong | Complete | Strong | Complete |
| 130142287 | MN28 | MN28. 30-40 | 4.2 | 10 | 0.74 | 3.6 | 0.1 | 19 | 22 | 55 | 3.9 | 1.0 | 0.4 | 22.9 | 290 | Strong | Complete | Strong | Complete |
| 130142738 | MN29 | MN29. 30-40 | 11 | 16 | 0.66 | 3.5 | 0.1 | 30.3 | 35 | 51 | 2.2 | 1.0 | 0.7 | 14.2 | 260 | Strong | Strong | Strong | Strong |
| 130142740 | MN30 | MN30. 30-40 | 9.3 | 21 | 1.1 | 3.4 | 0.1 | 34.6 | 27 | 60 | 3.3 | 1.0 | 0.4 | 13.0 | 450 | Strong | Strong | Strong | Strong |
| 130142755 | MN31 | MN31. 30-40 | 12 | 27 | 0.87 | 6 | 0.1 | 46.3 | 27 | 59 | 1.9 | 1.0 | 0.4 | 14.9 | 340 | Strong | Strong | Moderate | Moderate |
| 130142271 | MN32 | MN32. 30-40 | 10 | 15 | 1 | 1.4 | 0.1 | 28 | 37 | 54 | 3.7 | 1.0 | 0.7 | 8.9 | 400 | Slight | Moderate | Strong | Strong |
| 130142735 | MN33 | MN33. 30-40 | 10 | 16 | 0.65 | 4 | 0.1 | 30.7 | 33 | 51 | 2.1 | 1.0 | 0.6 | 15.1 | 250 | Strong | Strong | Strong | Strong |
| 130142716 | MN34 | MN34. 30-40 | 3.7 | 8.1 | 0.27 | 1.8 | 0.1 | 13.9 | 27 | 59 | 2.0 | 1.0 | 0.5 | 15.0 | 110 | Strong | Strong | Strong | Complete |
| 130142719 | MN35 | MN35. 30-40 | 3.8 | 5.7 | 0.45 | 0.48 | 0.5 | 10.9 | 35 | 53 | 4.1 | 4.2 | 0.7 | 8.5 | 180 | Nil | Nil | Slight | Slight |
| 130142720 | MN36 | MN36. 30-40 | 9.2 | 20 | 1.9 | 2.8 | 0.1 | 33.8 | 27 | 59 | 5.5 | 1.0 | 0.5 | 13.9 | 730 | Moderate | Moderate | Strong | Complete |
| 130142724 | MN37 | MN37. 30-40 | 9.3 | 13 | 0.41 | 1.2 | 0.1 | 24.3 | 38 | 55 | 1.7 | 1.0 | 0.7 | 6.6 | 160 | Slight | Slight | Slight | Moderate |
| 130142722 | MN38 | MN38. 30-40 | 2 | 2.5 | 0.2 | 0.08 | 0.1 | 4.8 | 42 | 53 | 4.1 | 1.0 | 0.8 | 5.8 | 77 | Slight | Slight | Moderate | Moderate |
| 130142761 | MN39 | MN39. 30-40 | 6.1 | 16 | 0.67 | 2.6 | 0.1 | 25.7 | 24 | 63 | 2.6 | 1.0 | 0.4 | 12.6 | 260 | Strong | Complete | Strong | Strong |
| 130142758 | MN40 | MN40. 30-40 | 12 | 27 | 0.73 | 7.4 | 0.1 | 46.6 | 25 | 58 | 1.6 | 1.0 | 0.4 | 17.6 | 290 | Slight | Slight | Nil | Slight |
| | | | 7.3 | 16.2 | 0.6 | 3.3 | 0.1 | 27.5 | 29 | 57 | 2.5 | 1.1 | 0.5 | 14.0 | 242 | | | | |

Table A-15. Merrifield North >40cm Sample Analytical Results.

| Sample ID | Site | Sample Name | Sample Start Depth | Sample End Depth | Zone | GPS Easting | GPS Northing | Texture | pH (1:5 Water) | pH (1:5 CaCl2) | Electrical Conductivity (1:5 water) | Exchangeable Sodium Percentage | Emerson Class (Remoulded 20 Hours) | Remoulded Dispersion Observation 20 Hours (Emerson) | Disp. Index, Loveday/Pyle | Slaking 2Hrs | Calcium (Amm-acet.) | Magnesium (Amm-acet.) | Potassium (Amm-acet.) | Sodium (Amm-acet.) | Aluminium (KCl) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | cm | cm | | | | SESW Field Classification | | | dS/m | % | | | | | mg/kg | mg/kg | mg/kg | mg/kg | mg/kg |
| 130426263 | EW1 | EW1. 140-150 | 140 | 150 | 55H | 298015 | 5801402 | Heavy Clay | 9.9 | 8.9 | 0.54 | 35.0 | 2 | Strong | 12 | Partial | 1580 | 1815 | 587 | 2990 | 9 |
| 130426260 | EW2 | EW2. 140-150 | 140 | 150 | 55H | 298485 | 5801393 | Heavy Clay | 9.8 | 9.1 | 0.78 | 32.0 | 3 | Moderate | 5 | Partial | 4000 | 2420 | 665 | 4370 | 9 |
| 130425877 | EW3 | EW3. 140-150 | 140 | 150 | 55H | 298924 | 5801399 | Heavy Clay | 8.9 | 8.0 | 1.09 | 35.0 | 2 | Strong | 12 | Partial | 1040 | 1936 | 430 | 2760 | 9 |
| 130426266 | EW4 | EW4. 140-150 | 140 | 150 | 55H | 297433 | 5801855 | Heavy Clay | 9.3 | 8.3 | 0.38 | 15.0 | 7 | Complete | 14 | Water Stable | 1160 | 1452 | 430 | 759 | 9 |
| 130426269 | EW5 | EW5. 140-150 | 140 | 150 | 55H | 297917 | 5801869 | Heavy Clay | 9.0 | 8.6 | 1.54 | 38.0 | 2 | Strong | 10 | Partial | 1020 | 2420 | 547 | 3680 | 9 |
| 130425876 | EW6 | EW6. 140-150 | 140 | 150 | 55H | 298447 | 5801870 | Heavy Clay | 9.4 | 8.5 | 1.50 | 31.0 | 3 | Slight | 3 | Partial | 3800 | 2299 | 665 | 4140 | 9 |
| 130425880 | EW7 | EW7. 140-150 | 140 | 150 | 55H | 298947 | 5801877 | Heavy Clay | 9.7 | 9.7 | 1.20 | 35.0 | 2 | Moderate | 8 | Partial | 3000 | 2541 | 626 | 4600 | 9 |
| 130425852 | EW8 | EW8. 140-150 | 140 | 150 | 55H | 296403 | 5802354 | Medium Clay | 9.1 | 8.2 | 0.56 | 10.0 | 2 | Nil | 2 | Partial | 4800 | 2057 | 547 | 1127 | 9 |
| 130425855 | EW9 | EW9. 140-150 | 140 | 150 | 55H | 296918 | 5802347 | Heavy Clay | 9.9 | 9.2 | 0.56 | 20.0 | 7 | Strong | 12 | Water Stable | 4600 | 1452 | 626 | 2116 | 9 |
| 130425858 | EW10 | EW10. 140-150 | 140 | 150 | 55H | 297394 | 5802346 | Medium Clay | 9.4 | 8.4 | 0.92 | 25.0 | 8 | Strong | 12 | Water Stable | 3600 | 1452 | 508 | 2530 | 9 |
| 130426272 | EW11 | EW11. 140-150 | 140 | 150 | 55H | 297887 | 5802353 | Heavy Clay | 9.3 | 8.7 | 1.61 | 32.0 | 2 | Slight | 4 | Partial | 3400 | 2299 | 626 | 4140 | 9 |
| 130425873 | EW12 | EW12. 140-150 | 140 | 150 | 55H | 298425 | 5802362 | Heavy Clay | 9.7 | 9.4 | 1.54 | 32.0 | 8 | Moderate | 8 | Water Stable | 3600 | 2541 | 547 | 4370 | 9 |
| 130426306 | EW13 | EW13. 140-150 | 140 | 150 | 55H | 298940 | 5802355 | Heavy Clay | 9.6 | 9.6 | 1.15 | 38.0 | 8 | Strong | 10 | Water Stable | 1980 | 2178 | 547 | 4140 | 9.4 |
| 130425849 | EW14 | EW14. 140-150 | 140 | 150 | 55H | 295568 | 5802873 | Light Sandy Clay Loam | 8.5 | 7.7 | 0.24 | 9.5 | 2 | Nil | 2 | Partial | 1340 | 448 | 184 | 276 | 9 |
| 130425846 | EW15 | EW15. 140-150 | 140 | 150 | 55H | 295965 | 5802788 | Fine Sandy Loam | 8.2 | 7.3 | 0.19 | 8.1 | 2 | Slight | 4 | Partial | 1340 | 557 | 188 | 230 | 9 |
| 130425864 | EW16 | EW16. 140-150 | 140 | 150 | 55H | 296590 | 5802509 | Heavy Clay | 9.3 | 8.4 | 1.08 | 21.0 | 2 | Slight | 7 | Partial | 4400 | 2541 | 821 | 2760 | 9 |
| 130425861 | EW17 | EW17. 140-150 | 140 | 150 | 55H | 296973 | 5802735 | Heavy Clay | 9.3 | 9.1 | 1.63 | 27.0 | 2 | Slight | 3 | Partial | 3400 | 2299 | 938 | 3220 | 9 |
| 130425870 | EW18 | EW18. 140-150 | 140 | 150 | 55H | 297461 | 5802803 | Medium Clay | 9.5 | 8.6 | 1.09 | 24.0 | 2 | Slight | 4 | Partial | 4400 | 1452 | 430 | 2530 | 9 |
| 130425867 | EW19 | EW19. 140-150 | 140 | 150 | 55H | 298015 | 5802887 | Heavy Clay | 9.6 | 9.2 | 1.15 | 34.0 | 2 | Slight | 4 | Partial | 3800 | 2662 | 665 | 5060 | 9 |
| 130380793 | EW20 | EW20. 140-150 | 140 | 150 | 55H | 298393 | 5802749 | Heavy Clay | 9.5 | 8.5 | 1.54 | 29.0 | 2 | Slight | 4 | Partial | 4200 | 1694 | 430 | 3450 | 9 |
| 130426275 | EW21 | EW21. 140-150 | 140 | 150 | 55H | 298939 | 5802900 | Heavy Clay | 8.8 | 8.8 | 1.16 | 42.0 | 8 | Moderate | 8 | Water Stable | 1120 | 2541 | 547 | 4830 | 9 |
| 130426257 | EW22 | EW22. 140-150 | 140 | 150 | 55H | 295949 | 5803257 | Medium Clay | 8.7 | 7.7 | 0.35 | 30.0 | 2 | Strong | 12 | Partial | 3800 | 2541 | 704 | 4140 | 9 |
| 130426254 | EW23 | EW23. 140-150 | 140 | 150 | 55H | 296934 | 5803131 | Heavy Clay | 9.1 | 8.3 | 1.28 | 32.0 | 2 | Moderate | 10 | Partial | 1900 | 1573 | 626 | 2760 | 9 |
| 130380778 | EW24 | EW24. 140-150 | 140 | 150 | 55H | 297473 | 5803239 | Heavy Clay | 9.3 | 8.7 | 1.45 | 40.0 | 2 | Strong | 12 | Partial | 1700 | 2541 | 665 | 4600 | 9 |
| 130380790 | EW25 | EW25. 140-150 | 140 | 150 | 55H | 298049 | 5803262 | Medium Clay | 9.1 | 8.3 | 1.02 | 14.0 | 2 | Moderate | 6 | Partial | 440 | 424 | 121 | 225 | 9 |
| 130380787 | EW26 | EW26. 120-130 | 120 | 130 | 55H | 298339 | 5803567 | Heavy Clay | 9.2 | 8.3 | 1.27 | 30.0 | 2 | Moderate | 9 | Partial | 3400 | 1815 | 469 | 3220 | 9 |
| 130426251 | EW27 | EW27. 140-150 | 140 | 150 | 55H | 296664 | 5803549 | Heavy Clay | 9.5 | 8.7 | 1.54 | 32.0 | 2 | Slight | 4 | Partial | 3600 | 1694 | 469 | 3680 | 9 |
| 130380774 | EW28 | EW28. 110-120 | 110 | 120 | 55H | 297411 | 5803801 | Heavy Clay | 9.5 | 8.5 | 1.30 | 28.0 | 2 | Slight | 4 | Partial | 4000 | 1936 | 587 | 3450 | 9 |
| 130380784 | EW29 | EW29. 140-150 | 140 | 150 | 55H | 298046 | 5803822 | Heavy Clay | 9.2 | 9.2 | 1.78 | 43.0 | 2 | Strong | 10 | Partial | 940 | 2783 | 626 | 5290 | 9 |
| 130380781 | EW30 | EW30. 140-150 | 140 | 150 | 55H | 298410 | 5804240 | Heavy Clay | 9.8 | 9.3 | 1.38 | 34.0 | 2 | Moderate | 8 | Partial | 3600 | 2541 | 587 | 4830 | 9 |
| | | | | | | | | Average: | 9.3 | 8.6 | 1.1 | 28.5 | | | | | | | | 3209 | |

Table A-16. Merrifield North >40cm Sample Analytical Results (Continued).

| Sample ID | Site | Sample Name | Calcium (Amm-acet.) | Magnesium (Amm-acet.) | Potassium (Amm-acet.) | Sodium (Amm-acet.) | Aluminium (KCl) | Cation Exch. Cap. | Calcium (Amm-acet.) | Magnesium (Amm-acet.) | Potassium (Amm-acet.) | Exchangeable Sodium Percentage | Aluminium Saturation | Calcium / Magnesium Ratio | ESP% + EPP% Calculation | Available Potassium | Dry Dispersion 2 Hours (Emerson) | Dry Dispersion 20 Hours (Emerson) | Remoulded Dispersion 2 Hours (Emerson) | Remoulded Dispersion 20 Hours (Emerson) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | cmol(+)/kg | % | % | % | % | % | | SESW Calculation | mg/kg | | | | |
| 130426263 | EW1 | EW1. 140-150 | 7.9 | 15 | 1.5 | 13 | 0.1 | 37.8 | 21 | 40 | 3.9 | 35.0 | 1.0 | 0.5 | 38.9 | 570 | Strong | Strong | Strong | Strong |
| 130426260 | EW2 | EW2. 140-150 | 20 | 20 | 1.7 | 19 | 0.1 | 60.7 | 32 | 33 | 2.7 | 32.0 | 1.0 | 1.0 | 34.7 | 650 | Nil | Slight | Moderate | Moderate |
| 130425877 | EW3 | EW3. 140-150 | 5.2 | 16 | 1.1 | 12 | 0.1 | 34.4 | 15 | 46 | 3.3 | 35.0 | 1.0 | 0.3 | 38.3 | 450 | Strong | Strong | Strong | Strong |
| 130426266 | EW4 | EW4. 140-150 | 5.8 | 12 | 1.1 | 3.3 | 0.1 | 22.2 | 26 | 54 | 5.1 | 15.0 | 1.0 | 0.5 | 20.1 | 440 | Strong | Complete | Strong | Complete |
| 130426269 | EW5 | EW5. 140-150 | 5.1 | 20 | 1.4 | 16 | 0.1 | 42.4 | 12 | 47 | 3.2 | 38.0 | 1.0 | 0.3 | 41.2 | 530 | Moderate | Moderate | Strong | Strong |
| 130425876 | EW6 | EW6. 140-150 | 19 | 19 | 1.7 | 18 | 0.1 | 57.2 | 33 | 33 | 3.0 | 31.0 | 1.0 | 1.0 | 34.0 | 660 | Nil | Slight | Slight | Slight |
| 130425880 | EW7 | EW7. 140-150 | 15 | 21 | 1.6 | 20 | 0.1 | 58.6 | 26 | 37 | 2.8 | 35.0 | 1.0 | 0.7 | 37.8 | 640 | Moderate | Moderate | Moderate | Moderate |
| 130425852 | EW8 | EW8. 140-150 | 24 | 17 | 1.4 | 4.9 | 0.1 | 46.8 | 50 | 36 | 2.9 | 10.0 | 1.0 | 1.4 | 12.9 | 530 | Slight | Slight | Nil | Nil |
| 130425855 | EW9 | EW9. 140-150 | 23 | 12 | 1.6 | 9.2 | 0.1 | 46.3 | 50 | 27 | 3.4 | 20.0 | 1.0 | 1.9 | 23.4 | 610 | Strong | Strong | Strong | Strong |
| 130425858 | EW10 | EW10. 140-150 | 18 | 12 | 1.3 | 11 | 0.1 | 41.7 | 43 | 29 | 3.2 | 25.0 | 1.0 | 1.5 | 28.2 | 520 | Strong | Strong | Strong | Strong |
| 130426272 | EW11 | EW11. 140-150 | 17 | 19 | 1.6 | 18 | 0.1 | 55.1 | 31 | 34 | 2.8 | 32.0 | 1.0 | 0.9 | 34.8 | 610 | Slight | Slight | Slight | Slight |
| 130425873 | EW12 | EW12. 140-150 | 18 | 21 | 1.4 | 19 | 0.1 | 59.2 | 30 | 36 | 2.4 | 32.0 | 1.0 | 0.9 | 34.4 | 560 | Moderate | Moderate | Moderate | Moderate |
| 130426306 | EW13 | EW13. 140-150 | 9.9 | 18 | 1.4 | 18 | 0.1 | 46.8 | 21 | 38 | 3.0 | 38.0 | 0.2 | 0.6 | 41.0 | 550 | Moderate | Moderate | Strong | Strong |
| 130425849 | EW14 | EW14. 140-150 | 6.7 | 3.7 | 0.47 | 1.2 | 0.1 | 12.1 | 56 | 31 | 3.9 | 9.5 | 1.0 | 1.8 | 13.4 | 190 | Slight | Slight | Nil | Nil |
| 130425846 | EW15 | EW15. 140-150 | 6.7 | 4.6 | 0.48 | 1 | 0.1 | 12.9 | 52 | 35 | 3.7 | 8.1 | 1.0 | 1.5 | 11.8 | 190 | Slight | Slight | Slight | Slight |
| 130425864 | EW16 | EW16. 140-150 | 22 | 21 | 2.1 | 12 | 0.1 | 57.4 | 39 | 36 | 3.7 | 21.0 | 1.0 | 1.0 | 24.7 | 840 | Moderate | Strong | Slight | Slight |
| 130425861 | EW17 | EW17. 140-150 | 17 | 19 | 2.4 | 14 | 0.1 | 53.2 | 32 | 36 | 4.5 | 27.0 | 1.0 | 0.9 | 31.5 | 940 | Slight | Slight | Nil | Slight |
| 130425870 | EW18 | EW18. 140-150 | 22 | 12 | 1.1 | 11 | 0.1 | 46.2 | 47 | 26 | 2.3 | 24.0 | 1.0 | 1.8 | 26.3 | 420 | Slight | Slight | Slight | Slight |
| 130425867 | EW19 | EW19. 140-150 | 19 | 22 | 1.7 | 22 | 0.1 | 64.6 | 29 | 35 | 2.6 | 34.0 | 1.0 | 0.9 | 36.6 | 660 | Slight | Slight | Slight | Slight |
| 130380793 | EW20 | EW20. 140-150 | 21 | 14 | 1.1 | 15 | 0.1 | 50.9 | 42 | 28 | 2.1 | 29.0 | 1.0 | 1.5 | 31.1 | 420 | Slight | Slight | Slight | Slight |
| 130426275 | EW21 | EW21. 140-150 | 5.6 | 21 | 1.4 | 21 | 0.1 | 49.2 | 11 | 43 | 2.9 | 42.0 | 1.0 | 0.3 | 44.9 | 560 | Moderate | Moderate | Moderate | Moderate |
| 130426257 | EW22 | EW22. 140-150 | 19 | 21 | 1.8 | 18 | 0.1 | 59.2 | 32 | 35 | 3.0 | 30.0 | 1.0 | 0.9 | 33.0 | 700 | Strong | Strong | Strong | Strong |
| 130426254 | EW23 | EW23. 140-150 | 9.5 | 13 | 1.6 | 12 | 0.1 | 35.9 | 27 | 37 | 4.4 | 32.0 | 1.0 | 0.7 | 36.4 | 620 | Strong | Strong | Moderate | Moderate |
| 130380778 | EW24 | EW24. 140-150 | 8.5 | 21 | 1.7 | 20 | 0.1 | 51.6 | 17 | 41 | 3.3 | 40.0 | 1.0 | 0.4 | 43.3 | 660 | Strong | Strong | Strong | Strong |
| 130380790 | EW25 | EW25. 140-150 | 2.2 | 3.5 | 0.31 | 0.98 | 0.1 | 7 | 31 | 50 | 4.5 | 14.0 | 1.0 | 0.6 | 18.5 | 120 | Slight | Slight | Moderate | Moderate |
| 130380787 | EW26 | EW26. 120-130 | 17 | 15 | 1.2 | 14 | 0.1 | 47.5 | 37 | 31 | 2.6 | 30.0 | 1.0 | 1.1 | 32.6 | 470 | Moderate | Moderate | Strong | Moderate |
| 130426251 | EW27 | EW27. 140-150 | 18 | 14 | 1.2 | 16 | 0.1 | 49.2 | 36 | 29 | 2.4 | 32.0 | 1.0 | 1.3 | 34.4 | 470 | Slight | Slight | Slight | Slight |
| 130380774 | EW28 | EW28. 110-120 | 20 | 16 | 1.5 | 15 | 0.1 | 53.2 | 38 | 31 | 2.9 | 28.0 | 1.0 | 1.3 | 30.9 | 600 | Slight | Slight | Slight | Slight |
| 130380784 | EW29 | EW29. 140-150 | 4.7 | 23 | 1.6 | 23 | 0.1 | 52.4 | 9 | 45 | 3.0 | 43.0 | 1.0 | 0.2 | 46.0 | 620 | Moderate | Moderate | Strong | Strong |
| 130380781 | EW30 | EW30. 140-150 | 18 | 21 | 1.5 | 21 | 0.1 | 61.1 | 30 | 34 | 2.4 | 34.0 | 1.0 | 0.9 | 36.4 | 580 | Moderate | Moderate | Moderate | Moderate |
| | | | | | | | | | 31.8 | 36.4 | 3.2 | 28.5 | 1.0 | 1.0 | 31.7 | | | | | |

Table A-17. Soil colours/ranges and interpretation.

**Exchangeable Sodium Percentage (ESP) Interpretation**

| Colour | ESP Range | Interpretation |
|---|---|---|
| | <6%. | Non-sodic. |
| | 6.1-10%. | Moderately Sodic |
| | 10.1-15.0% | Strongly Sodic |
| | >15.1% | Very Strongly Sodic |

**Emerson Dispersion Class Interpretation**

| Colour | Emerson Class | Interpretation |
|---|---|---|
| | 4, 5, 6, 7, 8 | Non-dispersive. |
| | 3 | Partial Dispersion after remoulding |
| | 2 | Partial Dispersion |
| | 1 | Complete Dispersion |

**Loveday & Pyle (L&P) Score Interpretation**

| Colour | L&P Score | Interpretation |
|---|---|---|
| | 0, 1, 2, 3, 4 | Low to moderate. Nil to slight gypsum resonse expected where dispersive. |
| | 5, 6, 7, 8 | Moderate to high. Gypsum response expected to control dispersion. |
| | 9, 10, 11, 12 | High. Gypsum response expected to control dispersion. High rates required. |
| | 13, 14, 15, 16 | Very high. Very high rates required to control dispersion. |

**Slaking Class Interpretation**

| Colour | Slaking Class | Interpretation |
|---|---|---|
| | Water Stable | Aggregate stable when wetted, nil or minimal breakdown in structure. |
| | Partial | Low aggregate stability. Partial breakdown in structure when wetted. |
| | Considerable | Unstable. High or significant loss of structure when wetted. |

**Organic Carbon Interpretation**

| Colour | Organic Carbon % | Interpretation |
|---|---|---|
| | <0.5 | Deficient. Low or poor aggregate stability expected. |
| | 0.5-0.99 | Low to very low. Low or poor aggregate stability expected. |
| | 1.0-1.9 | Slightly low. Aggregates expected to be unstable, or partially stable. |
| | 2.0-2.9 | Acceptable. Variable water stability expected. |
| | 3.0-3.9 | Optimal. Water stable aggregates expected. |
| | 4.0+ | Optimal to high. Aggregate stability likely. |

**Remoulded Laboratory Dispersion (20 Hours) Interpretation**

| Colour | Dispersion Class |
|---|---|
| | Nil |
| | Slight |
| | Moderate |
| | Strong |
| | Complete |

Table A-18. Screen test results for all samples and risk criteria.

| Sample No | Site / Depth | $pH_F$ | $pH_{FOX}$ | ΔpH | CRS |
|---|---|---|---|---|---|
| 8270077 | MN1.0-10 | 4.5 | 2.8 | 1.7 | |
| 8270078 | MN1.30-40 | 5.0 | 3.1 | 1.9 | |
| 8270079 | MN1.90-100 | 6.1 | 3.6 | 2.5 | |
| 8270080 | MN2.0-10 | 5.3 | 2.6 | 2.7 | x |
| 8270081 | MN2.30-40 | 6.9 | 4.4 | 2.5 | |
| 8270082 | MN2.110-120 | 8.0 | 7.4 | 0.6 | |
| 8270083 | MN3.0-10 | 5.3 | 3.1 | 2.2 | |
| 8270084 | MN3.30-40 | 7.0 | 5.7 | 1.3 | |
| 8270085 | MN3.140-150 | 8.0 | 7.9 | 0.1 | |
| 8270086 | MN4.0-10 | 4.6 | 2.4 | 2.2 | x |
| 8270087 | MN4.30-40 | 6.5 | 4.0 | 2.5 | |
| 8270088 | MN4.140-150 | 7.8 | 7.2 | 0.6 | |
| 8270089 | MN5.0-10 | 5.4 | 2.7 | 2.7 | |
| 8270090 | MN5.30-40 | 7.1 | 4.4 | 2.7 | |
| 8270091 | MN5.140-150 | 8.0 | 7.7 | 0.3 | |
| 8270092 | MN6.0-10 | 5.7 | 3.0 | 2.7 | x |
| 8270093 | MN6.30-40 | 8.2 | 7.3 | 0.9 | |
| 8270094 | MN6.120-130 | 8.0 | 7.9 | 0.1 | |
| 8270095 | MN7.0-10 | 5.2 | 3.0 | 2.2 | |
| 8270096 | MN7.30-40 | 7.6 | 5.7 | 1.9 | |
| 8270097 | MN7.140-150 | 7.9 | 7.9 | 0.0 | |
| 8270098 | MN8.0-10 | 5.1 | 2.6 | 2.5 | x |
| 8270099 | MN8.30-40 | 5.7 | 3.1 | 2.6 | |
| 8270100 | MN8.140-150 | 7.8 | 6.6 | 1.2 | |
| 8270101 | MN9.0-10 | 5.7 | 3.0 | 2.7 | |
| 8270102 | MN9.30-40 | 5.6 | 3.2 | 2.4 | |
| 8270103 | MN9.140-150 | 7.6 | 6.4 | 1.2 | |
| 8270104 | MN10.0-10 | 5.3 | 2.2 | 3.1 | x |
| 8270105 | MN10.30-40 | 6.2 | 3.1 | 3.1 | |
| 8270106 | MN10.140-150 | 7.6 | 6.5 | 1.1 | |
| 8270107 | MN11.0-10 | 5.1 | 2.4 | 2.7 | x |
| 8270108 | MN11.30-40 | 7.4 | 6.9 | 0.5 | |
| 8270109 | MN11.140-150 | 7.7 | 7.7 | 0.0 | |
| 8270110 | MN12.0-10 | 5.1 | 3.1 | 2.0 | |
| 8270111 | MN12.30-40 | 7.4 | 5.5 | 1.9 | |
| 8270112 | MN12.140-150 | 7.8 | 8.1 | -0.3 | |

| Sample No | Site / Depth | $pH_F$ | $pH_{FOX}$ | ΔpH | CRS |
|---|---|---|---|---|---|
| 8270113 | MN13.0-10 | 4.6 | 2.7 | 1.9 | |
| 8270114 | MN13.30-40 | 7.1 | 5.3 | 1.8 | |
| 8270115 | MN13.110-120 | 8.0 | 6.8 | 1.2 | |
| 8270116 | MN14.0-10 | 4.7 | 3.1 | 1.6 | |
| 8270117 | MN14.30-40 | 6.7 | 4.6 | 2.1 | |
| 8270118 | MN14.120-130 | 8.0 | 7.6 | 0.4 | |
| 8270119 | MN15.0-10 | 5.6 | 2.9 | 2.7 | x |
| 8270120 | MN15.30-40 | 7.3 | 5.8 | 1.5 | |
| 8270121 | MN15.140-150 | 7.8 | 6.8 | 1.0 | |
| 8270122 | MN16.0-10 | 5.0 | 2.4 | 2.6 | x |
| 8270123 | MN16.30-40 | 6.4 | 3.9 | 2.5 | |
| 8270124 | MN16.140-150 | 8.1 | 8.0 | 0.1 | |
| 8307905 | MN17 0-10 | 5.1 | 2.5 | 2.6 | |
| 8307906 | MN17 30-40 | 5.5 | 3.1 | 2.4 | |
| 8307907 | MN17 150 | 6.4 | 5.5 | 0.9 | |
| 8307886 | MN18 0-10 | 6.4 | 3.4 | 3.0 | |
| 8307887 | MN18 30-40 | 7.8 | 6.3 | 1.5 | |
| 8307888 | MN18 150 | 7.5 | 7.2 | 0.3 | |
| 8307883 | MN19 0-10 | 6.2 | 2.6 | 3.6 | x |
| 8307884 | MN19 30-40 | 7.2 | 5.6 | 1.6 | |
| 8307885 | MN19 150 | 7.5 | 7.5 | 0.0 | |
| 8270125 | MN20.0-10 | 5.8 | 3.1 | 2.7 | |
| 8270126 | MN20.30-40 | 6.5 | 3.5 | 3.0 | |
| 8270127 | MN21.0-10 | 6.2 | 3.2 | 3.0 | |
| 8270128 | MN21.30-40 | 8.8 | 3.1 | 5.7 | x |
| 8270129 | MN21.120-130 | 7.4 | 6.7 | 0.7 | |
| 8270130 | MN22.0-10 | 5.5 | 2.9 | 2.6 | x |
| 8270131 | MN22.30-40 | 5.8 | 3.4 | 2.4 | |
| 8307903 | MN23 0-10 | 4.8 | 2.4 | 2.4 | x |
| 8307904 | MN23 30-40 | 5.1 | 3.0 | 2.1 | |
| 8307900 | MN24 0-10 | 5.0 | 2.1 | 2.9 | x |
| 8307901 | MN24 30-40 | 5.2 | 3.1 | 2.1 | |
| 8307902 | MN24 150 | 6.2 | 5.2 | 1.0 | |
| 8307889 | MN25 0-10 | 5.4 | 2.5 | 2.9 | |
| 8307890 | MN25 30-40 | 7.4 | 5.2 | 2.2 | |
| 8307891 | MN25 150 | 7.6 | 7.1 | 0.5 | |

| Sample No | Site / Depth | $pH_F$ | $pH_{FOX}$ | ΔpH | CRS |
|---|---|---|---|---|---|
| 8307880 | MN26 0-10 | 6.0 | 2.8 | 3.2 | x |
| 8307881 | MN26 30-40 | 7.1 | 4.8 | 2.3 | |
| 8307882 | MN26 150 | 7.8 | 7.6 | 0.2 | |
| 8270132 | MN27.0-10 | 4.9 | 2.4 | 2.5 | x |
| 8270133 | MN27.30-40 | 6.3 | 3.4 | 2.9 | |
| 8270134 | MN28.0-10 | 5.7 | 2.7 | 3.0 | |
| 8270135 | MN28.30-40 | 7.0 | 5.0 | 2.0 | |
| 8307894 | MN29 0-10 | 5.2 | 2.4 | 2.8 | x |
| 8307895 | MN29 30-40 | 6.6 | 4.3 | 2.3 | |
| 8307896 | MN29 150 | 7.0 | 6.3 | 0.7 | |
| 8307892 | MN30 0-10 | 5.0 | 2.4 | 2.6 | |
| 8307893 | MN30 30-40 | 6.4 | 3.5 | 2.9 | |
| 8307877 | MN31 0-10 | 4.8 | 2.4 | 2.4 | x |
| 8307878 | MN31 30-40 | 7.1 | 6.9 | 0.2 | |
| 8307879 | MN31 150 | 7.6 | 7.2 | 0.4 | |
| 8270136 | MN32.0-10 | 5.6 | 3.2 | 2.4 | x |
| 8270137 | MN32.30-40 | 6.5 | 3.6 | 2.9 | |
| 8270138 | MN32.80-90 | 7.5 | 6.6 | 0.9 | |
| 8307897 | MN33 0-10 | 5.0 | 2.6 | 2.4 | x |
| 8307898 | MN33 30-40 | 6.2 | 4.5 | 1.7 | |
| 8307899 | MN33 150 | 6.9 | 6.2 | 0.7 | |
| 8307916 | MN34 0-10 | 5.0 | 2.4 | 2.6 | x |
| 8307917 | MN34 30-40 | 5.1 | 2.5 | 2.6 | |
| 8307914 | MN35 0-10 | 5.2 | 2.2 | 3.0 | x |
| 8307915 | MN35 30-40 | 5.0 | 2.9 | 2.1 | |
| 8307912 | MN36 0-10 | 5.3 | 2.8 | 2.5 | |
| 8307913 | MN36 30-40 | 6.6 | 4.4 | 2.2 | |
| 8307908 | MN37 0-10 | 5.3 | 2.4 | 2.9 | x |
| 8307909 | MN37 30-40 | 6.1 | 3.2 | 2.9 | |
| 8307910 | MN38 0-10 | 5.8 | 2.7 | 3.1 | |
| 8307911 | MN38 30-40 | 5.9 | 3.5 | 2.4 | |
| 8307871 | MN39 0-10 | 5.1 | 2.4 | 2.7 | x |
| 8307872 | MN39 30-40 | 6.3 | 4.0 | 2.3 | |
| 8307873 | MN39 150 | 7.5 | 7.4 | 0.1 | |
| 8307874 | MN40 0-10 | 5.3 | 2.7 | 2.6 | x |
| 8307875 | MN40 30-40 | 7.5 | 6.7 | 0.8 | |
| 8307876 | MN40 150 | 7.2 | 7.1 | 0.1 | |

| $pH_F$ | AASS risk | $pH_{FOX}$ | PASS Risk | ΔpH | RIS Risk |
|---|---|---|---|---|---|
| <4 | High | <3 | High | >2 | High |
| 4-5 | Medium | 3-5 | Medium | 1-2 | Medium |
| >5 | Low | >5 | Low | <1 | Low |