Melton East Precinct - Sodic Soils Assessment

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Jacobs

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Executive summary

Jacobs was engaged by the Victorian Planning Authority (VPA) to provide an assessment of the distribution of sodic and dispersive soils, erosion risks and consider their implications for future planned development in the Melton East Precinct Area.

The soils of the Melton East Precinct Area that were assessed in this investigation are predominantly classified as Chromosols and Sodosols, both which exhibit strong texture contrast between the A and B horizons. The average Exchangeable Sodium Percentage (ESP) levels across the precinct were 4.6% in the 0-10cm range and 8.1% in the 30-40cm range. While Sodosols were sodic (ESP of 6% or greater), Chromosols are generally non-sodic (ESP of <6%) within both of the depth ranges previously listed. Both sodic and non-sodic soils were identified across the precinct area. Approximately half of the sites and samples recorded non-sodic soils, yet all sites recorded dispersion confirming soils are dispersive, even where non-sodic. Other factors including high exchangeable potassium may be influencing soil dispersion potential.

A vulnerability assessment approach was used to assess the implications of sodic and dispersive 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 and propensity to erosion. Exposure criteria included sodicity of topsoil and subsoil, dispersion scores for topsoil and subsoil, A horizon depth, organic carbon in topsoil and slope.

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 dispersive soils. Sensitivity criteria included position relative to waterway, 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 drainage/waterway reserves and steeper slopes. Activities that expose these soils to rainfall and associated runoff will present significant construction challenges and need to be managed carefully.

Water balance changes resulting from future developed land use and associated impervious areas will generate high volumes of runoff, which will drain into the surrounding depressions/wetlands and waterways, including Kororoit Creek. Further increases in runoff could accelerate erosion of bed and bank materials.

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

- **Drainage depressions/seasonal wetlands -** Ideally these areas should be identified and reserved as linear green spaces to maintain their important hydrological function in retaining and temporarily storing water in the landscape and regulating the flow of water and nutrients throughout a catchment. Surface ground cover measures 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 to the erosion risks associated with sodic and dispersive 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.
- **Kororoit Creek -** Further increases in runoff from urban development may result in increased erosion. Engineering works may be required to stabilise this waterway so that it is resilient to stormwater runoff from future land development. Further consideration should be given to discharge of stormwater into constructed wetlands on the Kororoit Creek floodplain, prior to entering the waterway.
- **Steeper slopes -** Cutting into these slopes will expose underlying subsoils, and erosion risk is increased with slope. Cut batters must be designed with consideration of the erodibility of the soils. Stable linings that are resistant to rainfall and runoff will be required.

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

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 soils and erosion 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 Melton East Precinct Area. Advice is also provided on the range of treatment options that are available to manage identified sodic soils and erosion 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 in December 2022. Should the FUS structure change materially (as precinct development is refined), this could affect the distribution of erosion 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 soils and erosion risk and provide advice on treatment options in light of future planned development in Melton East Precinct Area.

1.2 Scope

This report provides an assessment of the distribution of sodic and dispersive soils, erosion risks and considers their implications for future planned development in the Melton East Precinct Area.

The Melton East Precinct Structure Plan (PSP) is being prepared in line with the PSP 2.0 process. The VPA will work closely with Melton City Council and local communities, government agencies, landowners, and developers to prepare the Melton East PSP. The PSP 2.0 process shapes future communities by considering a range of aspects such as transport, roads, buildings, housing, community facilities, environment, and open space.

The Precinct covers an area of approximately 1,005 hectares and is bounded by Kororoit Creek to the north-east, Western Freeway to the south, Leakes Road to the east and the Melton Highway to the north-west. It is located 30km north-west of Melbourne central business district (CBD), and to the immediate east of the existing Melton township. The precinct is included in the Melbourne Strategic Assessment area and includes Biodiversity Conservation Strategy Conservation Areas along Kororoit Creek (Conservations Area 15). It is understood that much of the precinct will comprise areas set aside for residential and commercial uses.

Figure 1-1 shows an indicative plan that has been prepared for the Melton East PSP area. It represents the direction for the PSP area and key elements that it should contain following the next phase, agency endorsement and public consultation.

Vulnerability assessment was used to explore the implications of sodic 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 soils and erosion risks.

1.3 Report structure

This report has been structured as follows:

- Section 2 provides a brief summary of sodic and dispersive soils definitions and terms used in this report, Victorian context regarding the distribution of sodic soils and their implications for urban development.
- Section 3 describes our approach to mapping sodic soils and erosion risks.
- Section 4 presents the results of the assessment.
- Section 5 provides discussion and recommendations on options to manage identified erosion 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 soils and erosion risks.

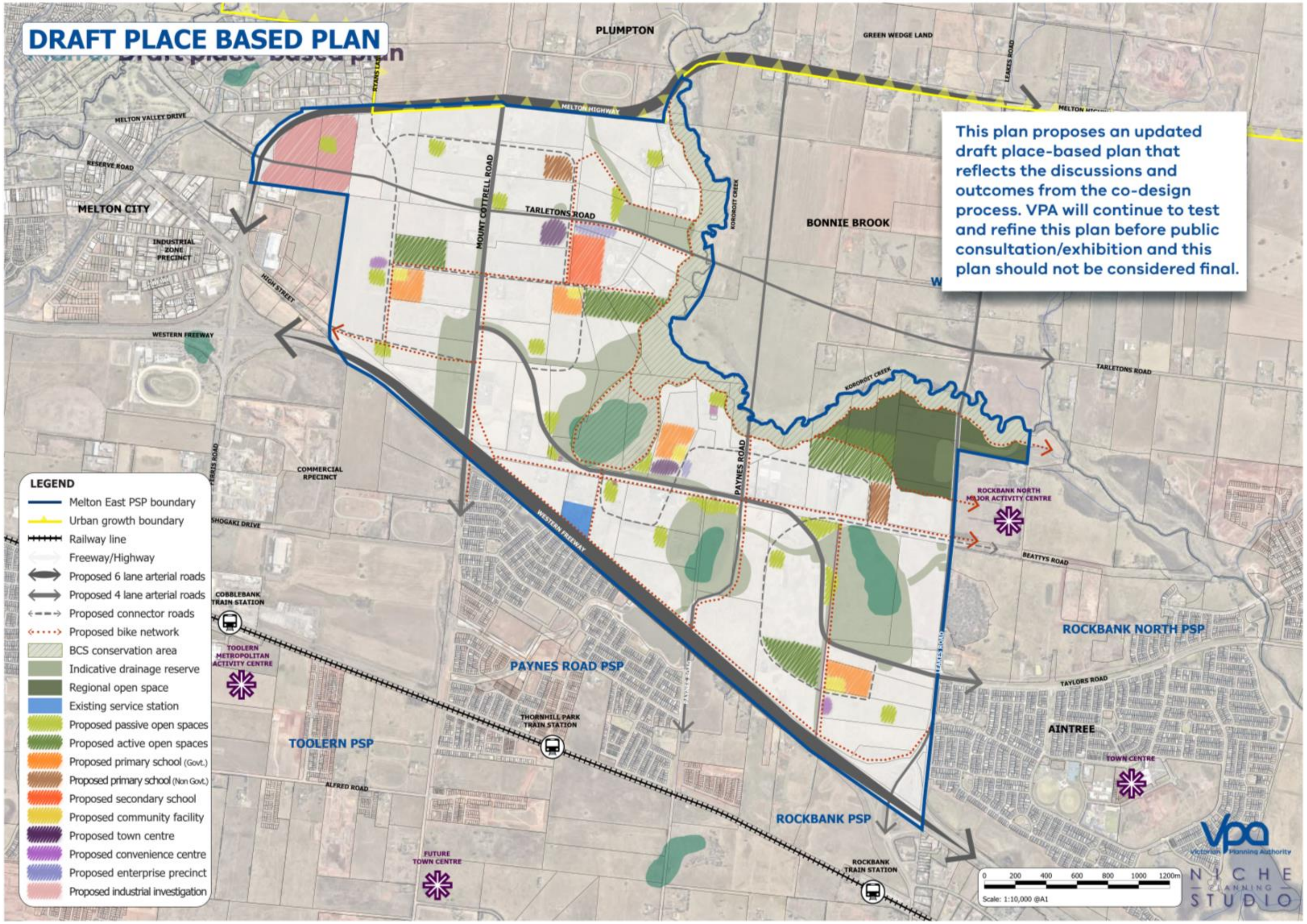

Figure 1-1. Melton East PSP Indicative Plan (Victorian Planning Authority 2023).

2. Sodic and dispersive soils

2.1 Sodic and dispersive 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.

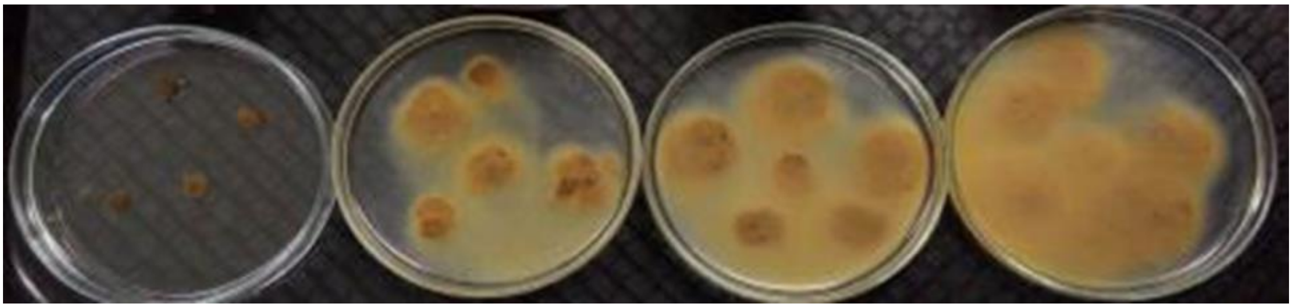

Figure 2-1. Examples of soil aggregates subject to the Emerson Aggregate Test, showing nil dispersion on the left with increasing levels of dispersion to the right (Armstrong 2019).

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 Melton East Precinct. Soil orders other than Sodosols can be identified with sodic and dispersive properties.

2.2 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.

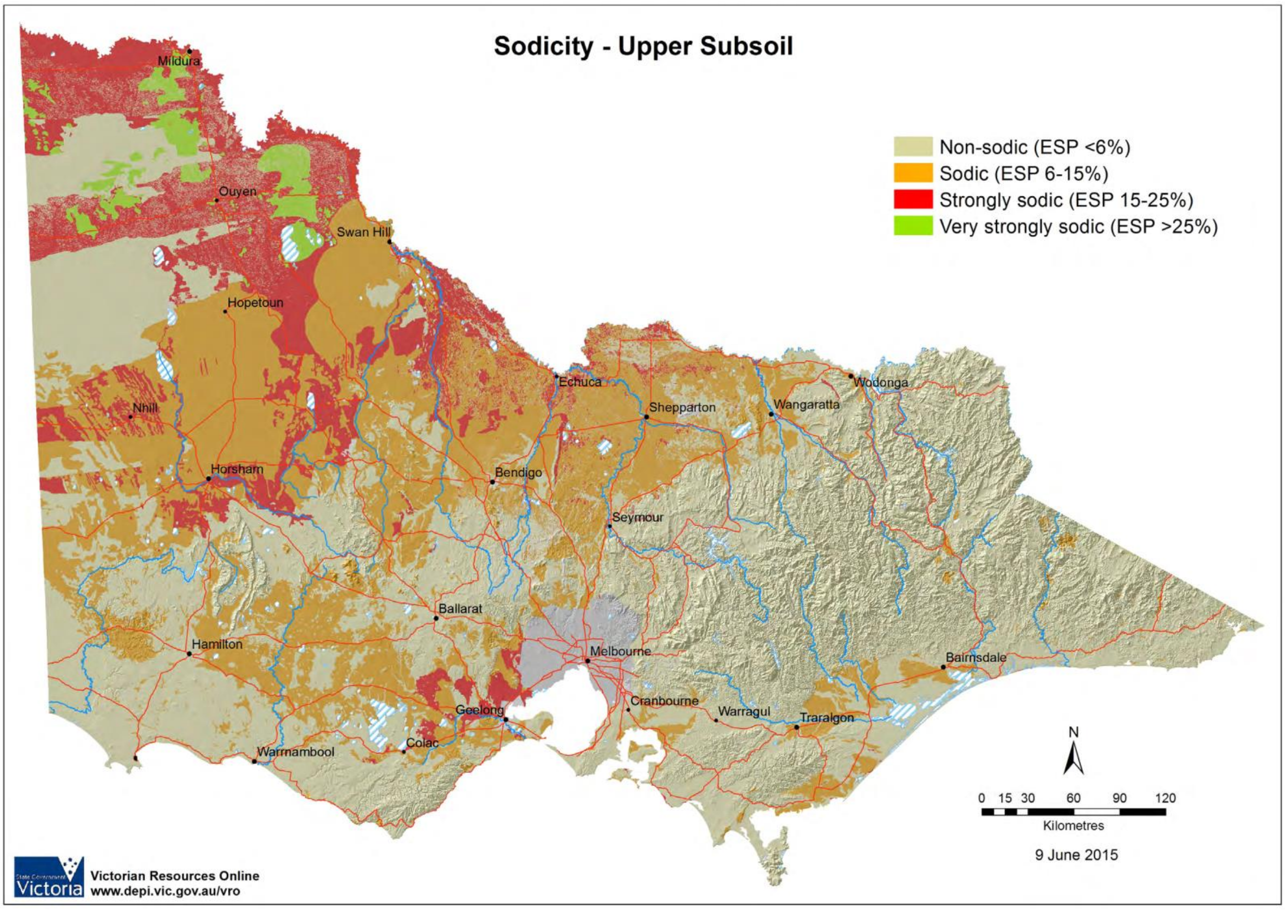

Figure 2-3. Distribution of soils in Victoria with elevated sodicity in the upper subsoil (Agriculture Victoria 2020).

2.3 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. On-site and off-site impacts potentially include:

- 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, increasing groundwater recharge.
- 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.

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 soils' extent and their level of vulnerability to proposed future land uses.

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

- **Define –** Define the sodic soil/landscape profile relationships, scenarios for assessment and supporting 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 soil extent, severity and/or risk. The assessment indicates where sodic/dispersible 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.

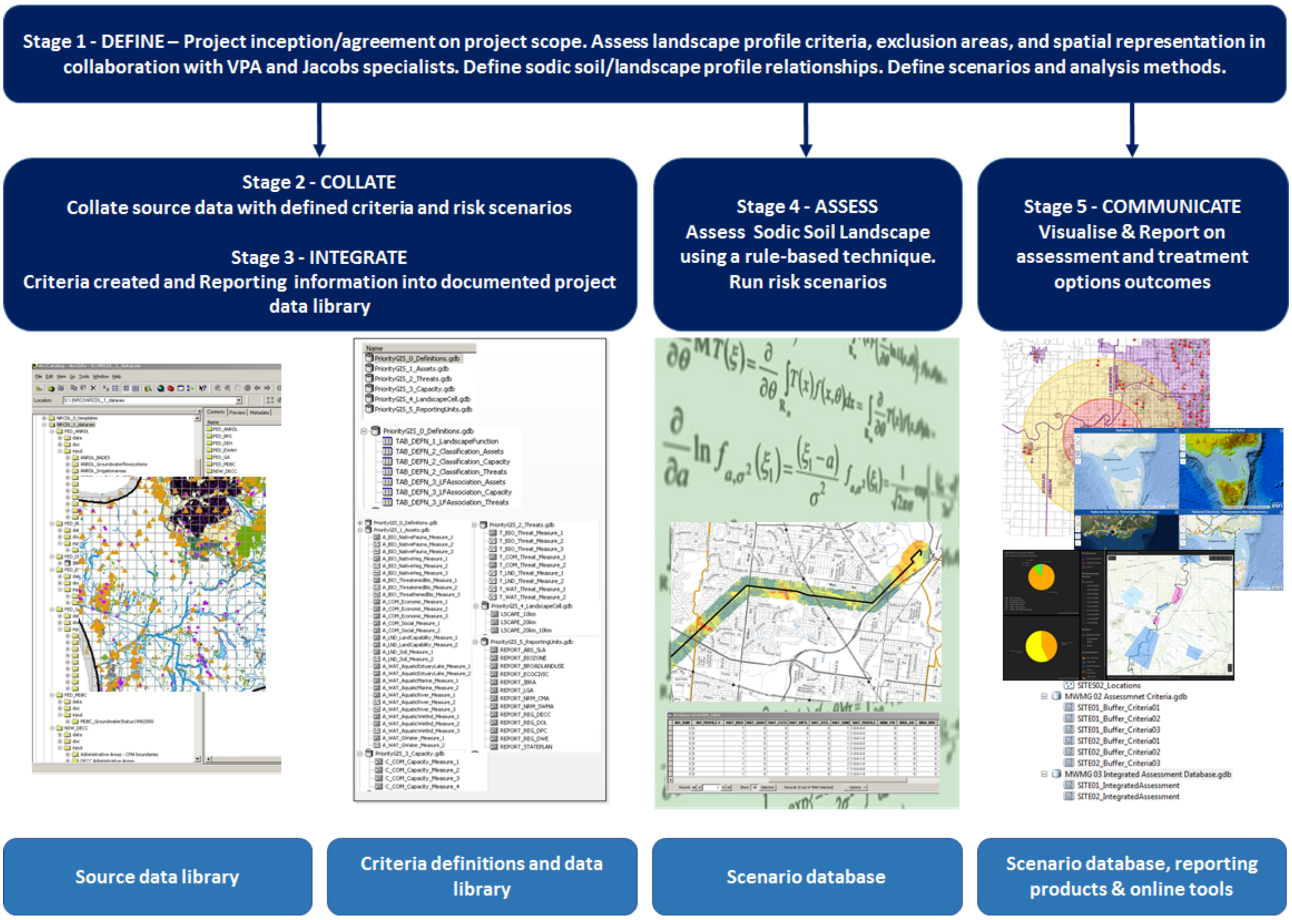

Figure 3-1. Application of the Spatial Logic Assessment Framework to the assessment of sodic and dispersive soil vulnerability.

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 determine their sodicity 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 soils.

3.2.1 Exposure criteria

Attributes of soils that were used to determine their sodicity and exposure to erosion are:

- Sodicity of topsoil (0-10 cm) - Exchangeable Sodium Percentage (ESP) values. This soil layer is also referred to as 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.
- Emerson Dispersion Topsoil (Remoulded 20 hr) - Level of dispersion of remoulded topsoil aggregates 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 declines with low organic carbon content.
- Slope – erosion risk increases with slope (which, for this assessment, was derived using 50cm contours)

These attributes form the exposure criteria, with criteria values ranked according to the scoring system outlined in Table 3-1. Table 3-2 and Table 3-3 provide a description of the Exchangeable Sodium Percentage (ESP) and Organic Carbon values used to define the exposure criteria.

3.2.2 Sensitivity criteria

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

- Position relative to indicative drainage and waterway reserves – Based on mapped drainage extent in Future Urban Structure (FUS) Dataset[2]. Drainage and waterway reserves are points of convergence for runoff and flows which makes these areas more prone to erosion.
- Construction activity – Potential disturbance of construction for future land use sub types mapped in FUS Dataset. Sensitivity to sodic 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)[3]. This considers potential for increases in overland flow from impervious surfaces and stormwater pipes in proposed developments. Sensitivity to sodic soils is heightened as a result of increases in runoff.

These attributes form the Sensitivity criteria, with criteria values ranked according to the scoring system outlined in Table 3-4. Table 3-5 and Table 3-6 provides a description of scorings used for Construction Activity and Water Balance Change criteria.

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[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.

[2] This assessment is based on an Indicative Plan/Future Urban Structure (FUS) dataset provided by the Victorian Planning Authority dated 6 December 2022. The distribution of land uses in this earlier plan does vary slightly from that outlined in Figure 1-1 (updated and provided in April 2023). Refer to Appendix A for copy of earlier plan and corresponding land uses as mapped in FUS dataset.

[3] 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 area, this potential has not been considered by this high-level assessment.

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

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%
Emerson Dispersion Topsoil (Remoulded 20 hr)	Nil	Slight	Moderate	Strong	Complete
Emerson Dispersion 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%

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

Criteria	Score				
	1	2	3	4	5
Indicative drainage and waterway reserves[1]	No	-	-	-	Yes
Construction activity	Minimal disturbance				High level of disturbance
Water balance change	Low (stay the same, infiltration)				High (generate runoff)

[1] Based on waterway extent as mapped as Drainage and Conservation (LU_TYPE Attribute) in Future Urban Structure (FUS).

Table 3-5. Descriptions of scorings for Construction Activity ranked by level of disturbance expected for Land Use Sub Types (LU_SUBTYPE Attribute) mapped in the Future Urban Structure (FUS).

Score	Level of Disturbance	Land Use Sub Types (LU_SUBTYPE)
1	Minimal disturbance	Post Contact (Heritage/Uncredited Open Space)
2		Local Park, State Metropolitan Park (Regional Open Space)
3		Local Sports Reserve
4		Business, Community Facilities, Existing Road Reserve, Future Arterial Road, Government School, Local Convenience Centre, Local Town Centre, Non-Government School, Office, Residential, Widening/Intersection Flaring
5	High level of disturbance	Retarding Basin/WQT Wetland, Waterways, Growling Grass Frog (BCS)

Table 3-6. Description of scorings for Water Balance Change expected for Land Use Sub Types (LU_SUBTYPE Attribute) mapped in the Future Urban Structure (FUS).

Score	Water Balance Change	Land Use Sub Types (LU_SUBTYPE)
1	Low (stay the same, infiltration)	Local Park, Local Sports Reserve, State Metropolitan Park (Regional Open Space), Post Contact (Uncredited Open Space)
2		*(No land use classes fall in this category)*
3		*(No land use classes fall in this category)*
4		Business, Office, Local Convenience Centre, Local Town Centre, Residential, Community Facilities, Government School, Non-Government School, Business
5	High (generate runoff)	Existing Road Reserve, Future Arterial Road, Widening/Intersection Flaring, Growling Grass Frog (BCS), Retarding Basin/WQT Wetland, Waterways

3.2.3 Risk scenarios

The distribution of erosion risk associated with sodic 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 soils for the following two scenarios:

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

4. Results

4.1 Sodicity of soils and their exposure to erosion

The soils of the Melton East Precinct sampled for this investigation are predominantly classified as Chromosols and Sodosols, with minor occurrence of Dermosols. The characteristics of these soils is consistent with soil definitions outlined in Isbell and NCST (2021), summarised as follows with comments regarding sodicity and dispersion:

- Chromosols: Soils which display strong texture contrast between the A and B horizons, with B horizons which are not strongly acid and non-sodic (ESP <6.0%). Chromosols are generally non-dispersive, however under various circumstances can be dispersive yet non-sodic.
- Sodosols: 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. Sodosols are sodic and generally dispersive.
- Dermosols: Soils lacking in strong texture contrast, including sites with shallow topsoil over basalt rock. No B horizon was identified. Soils are generally non-dispersive.

Across volcanic areas of the Precinct, both weathered and impenetrable rock were encountered in most areas within 1.0-1.5 metres of the ground surface, limiting the depth of sampling.

The stability provided by organic matter including ground cover, plant growth and plant roots is vital for preventing erosion of both Sodosols and Chromosols with sodic and dispersive soil horizons. Disturbance to land such as clearing of vegetation, topsoil removal or construction of drainage channels impacts these sources of organic matter and exposes subsoil layers with negligible organic matter to fresh rainfall, increasing susceptibility to erosion. A good cover of grasses was present at the time of sampling.

Some photographs of the field area showing ground cover and wet ground conditions (water logging of paddocks and flooding of wetland), dryer seasonal wetland and Kororoit Creek valley are shown in Figure 4-1. There is an existing depression/wetland along Paynes Road, which is currently being used by Melbourne Water to assist in managing urban drainage from an adjacent residential development within the Rockbank PSP/Shogaki Drainage Services Scheme (DSS). Water is being periodically pumped into this area from a retarding basin in the Shogaki Drive DSS.

The sodic and dispersive characteristics of soils of the Melton East Precinct are summarised with reference to exchangeable sodium percentage (ESP) values and dispersion observations as follows:

- 22 sites (56%) were non-sodic within both the A horizon (0-10cm) and B horizon (30-40cm). Of these, all were found to be dispersive based on a remoulded dispersion at 20 hours. This confirms that although many soils on volcanic basalt flows are non-sodic, all have a high potential to disperse once disturbed by cultivation or earthworks. Dispersion may be influenced by very high exchangeable potassium in conjunction with exchangeable sodium (Smiles 2006).
- 17 sites (44%) were sodic. Of these, all were dispersive in the B horizons. Where sodic values are identified, soils are dispersive.

Average ESP values for soils within segregated depth ranges across the precinct area are presented below. ESP itself is not discussed in detail given the lack of correlation and relevance to soil dispersion potential within Chromosol and Dermosol soil types. Average ESP values are as follows:

- 0-10cm (A1 horizon topsoil): 4.6%.
- 30-40cm (B horizon subsoil): 8.1%.
- >40cm (deep B horizons): 6.2%. Of the 14 samples collected, 9 were dispersive.

Based on comparison with other sodic soil investigations by Jacobs covering the northern growth corridor (Jacobs 2020a, Jacobs 2020b, Jacobs 2021b, Jacobs 2021a), volcanic soils on basalt flows in this area differ from previous investigations. Approximately half of the samples are non-sodic, yet they are dispersive. This outcome does not change the importance of managing soils and treating dispersion in the same fashion as all soils deemed sodic. There is a high likelihood that high exchangeable potassium levels are influencing soil dispersion potential. Average exchangeable potassium percentage (EPP) for the 0-10cm horizon is 17.0% across all tested samples from the precinct area, with levels of 3-8% deemed optimal and normal in soils (Agriculture Victoria 2022).

Figure 4-1. Selected photos of Melton East Precinct: Waterlogged soils within the vicinity of ME31 (top left), flooded wetland on Paynes Road (top right), edge of seasonal wetland north of Beattys Road within the vicinity of ME20 (bottom left) and Kororoit Creek Valley with basalt outcrops in foreground (bottom right).

Erosion risks resulting from exposure of sodic and dispersive soil are high. For this site, the measure of sodicity with reference to ESP values is effective for inferring dispersive soil risks to erosion across the precinct, however non-sodic soils which are dispersive should also be viewed as a risk for erosion.

In summary, the precinct area soils are predominantly dispersive, even though only 35 of the 90 soil samples (48%) were deemed sodic. Although the exposure risk by mapping indicates that exposure to sodic soil conditions varies from low to high, dispersion results confirm that all soils should be treated as dispersive, or potentially dispersive following disturbance, with a moderate to high erosion risk should they be exposed to rainfall and runoff. Organic carbon was tested in all samples to gain an understanding on soil condition and the likely influence on surface soil stability. Average organic carbon levels are 2.0% across the topsoils of the Precinct.

Detailed tables of soil test results are included in Appendix B.

An inverse distance weighted (IDW) interpolation was used to estimate values of soil sodicity (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 six exposure criteria are presented on the following pages (Topsoil Sodicity - Figure 4-2, Subsoil Sodicity - Figure 4-3; Topsoil Emerson Dispersion - Figure 4-4, Subsoil Emerson Dispersion - Figure 4-5, A horizon depth - Figure 4-6, Topsoil Organic Carbon - Figure 4-7). The final exposure criteria used is slope, with classes shown in Figure 4-8. The precinct is relatively flat, and there is internal drainage to a series of low lying depressions/wetlands. Steeper slopes are present at the margins of Kororoit Creek valley.

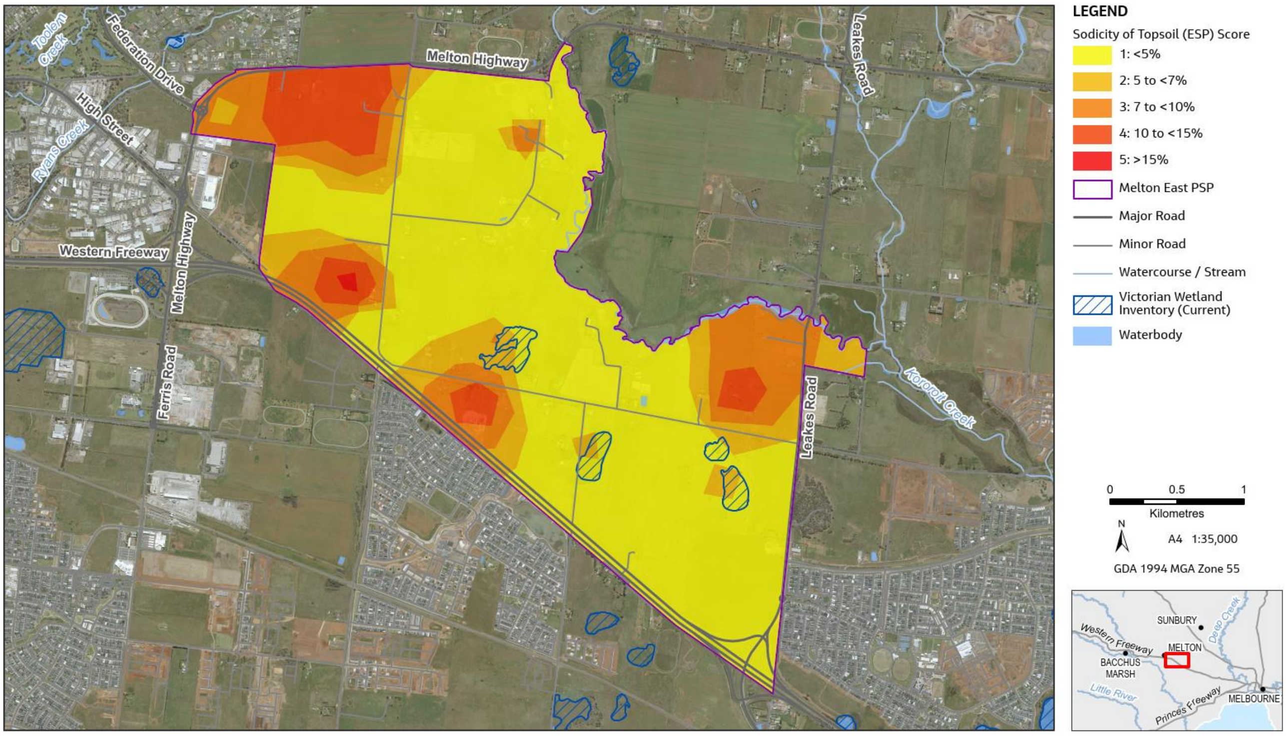


Figure 4-2. Sodicity of topsoil.

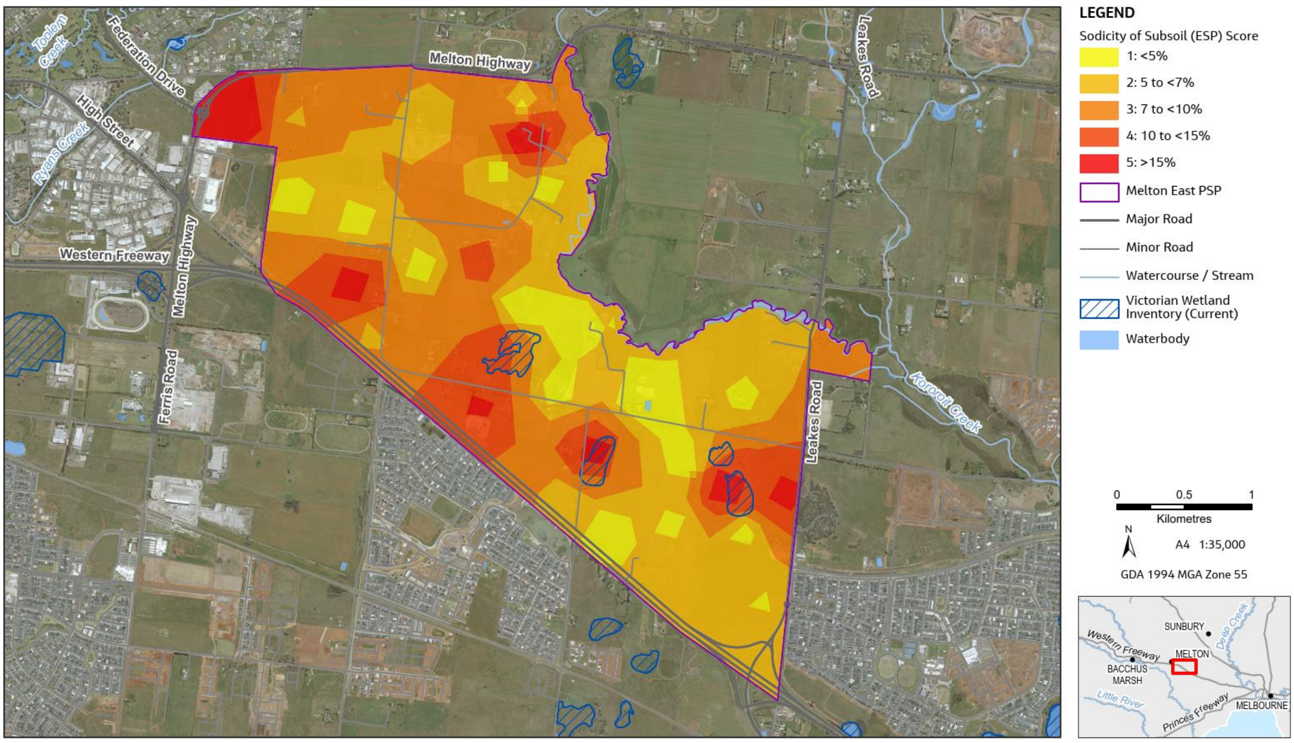


Figure 4-3. Sodicity of subsoil.

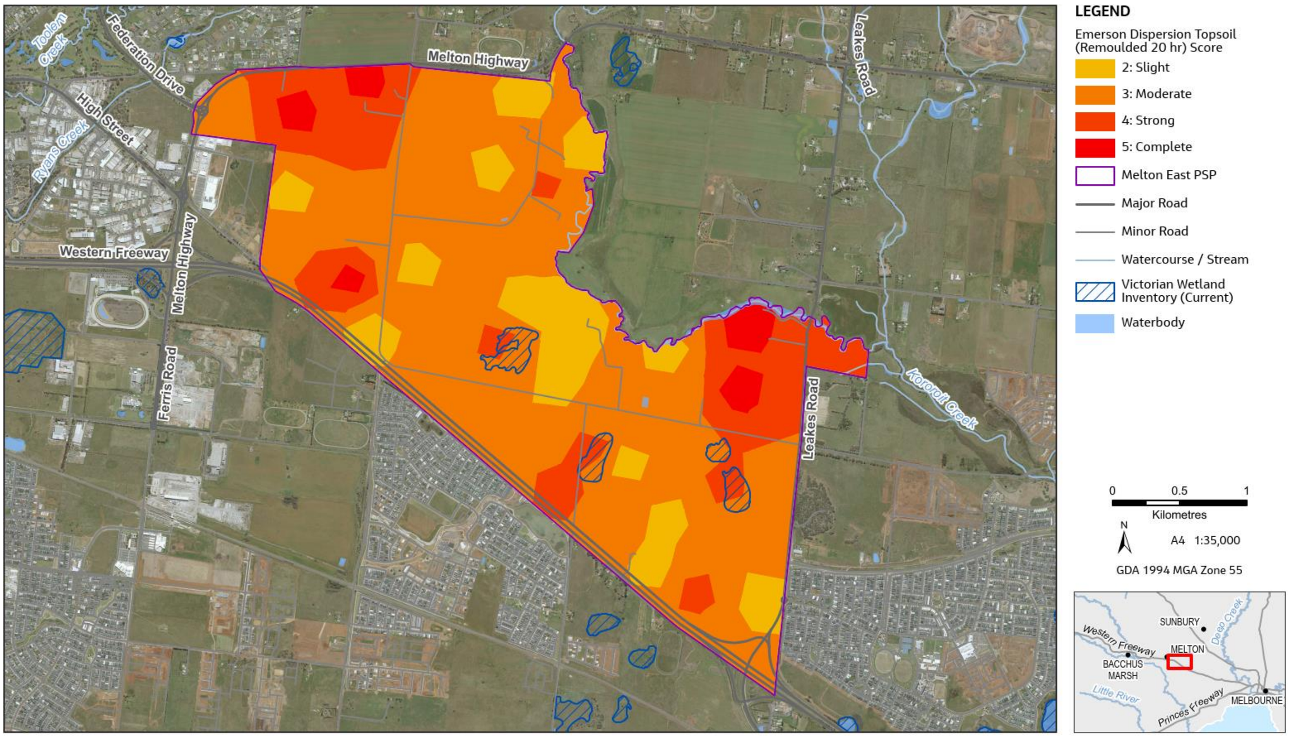


Figure 4-4. Emerson Dispersion Topsoil (Remoulded 20 hours).

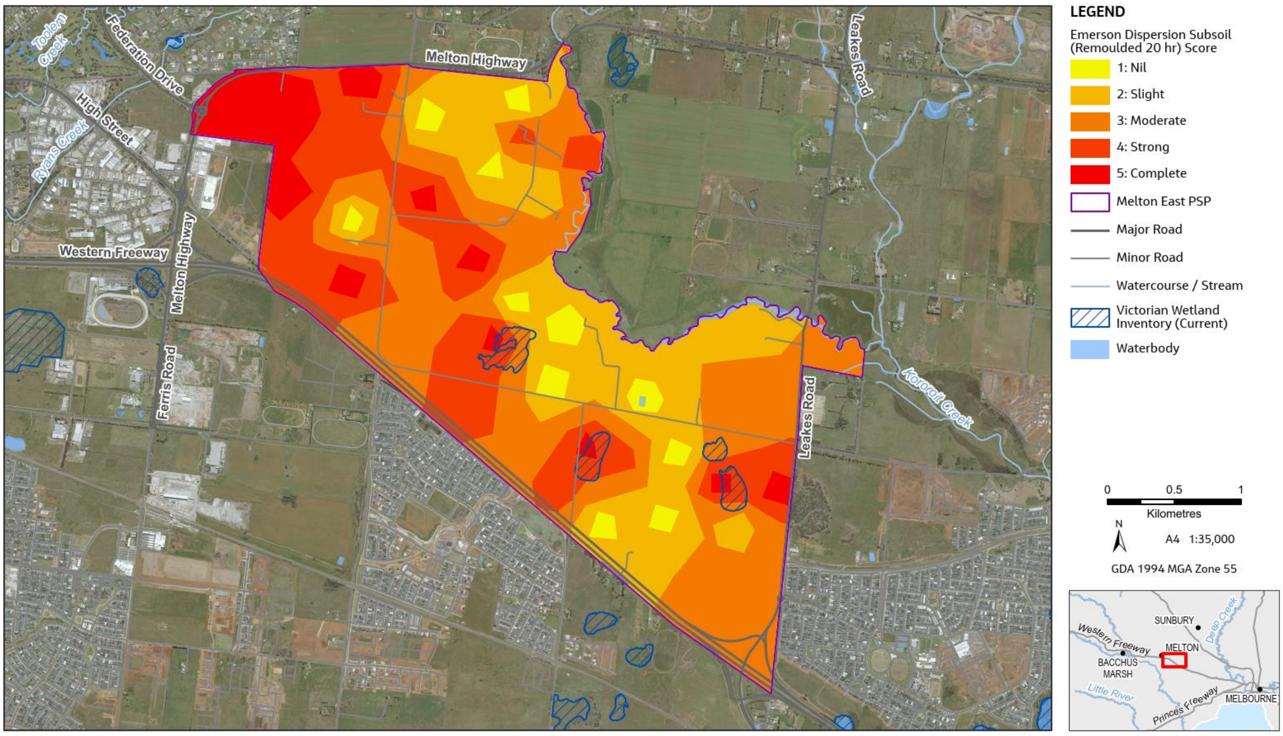


Figure 4-5. Emerson Dispersion Subsoil (Remoulded 20 hours).

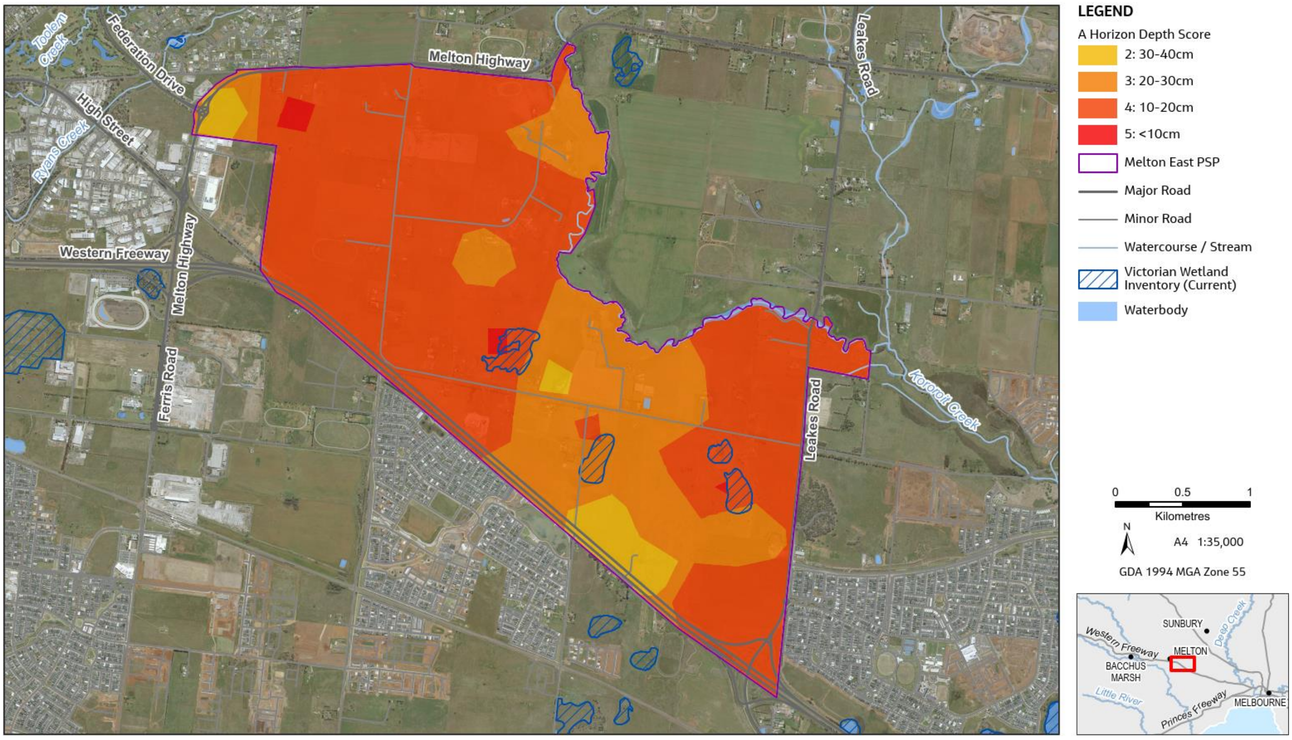


Figure 4-6. A horizon depth.

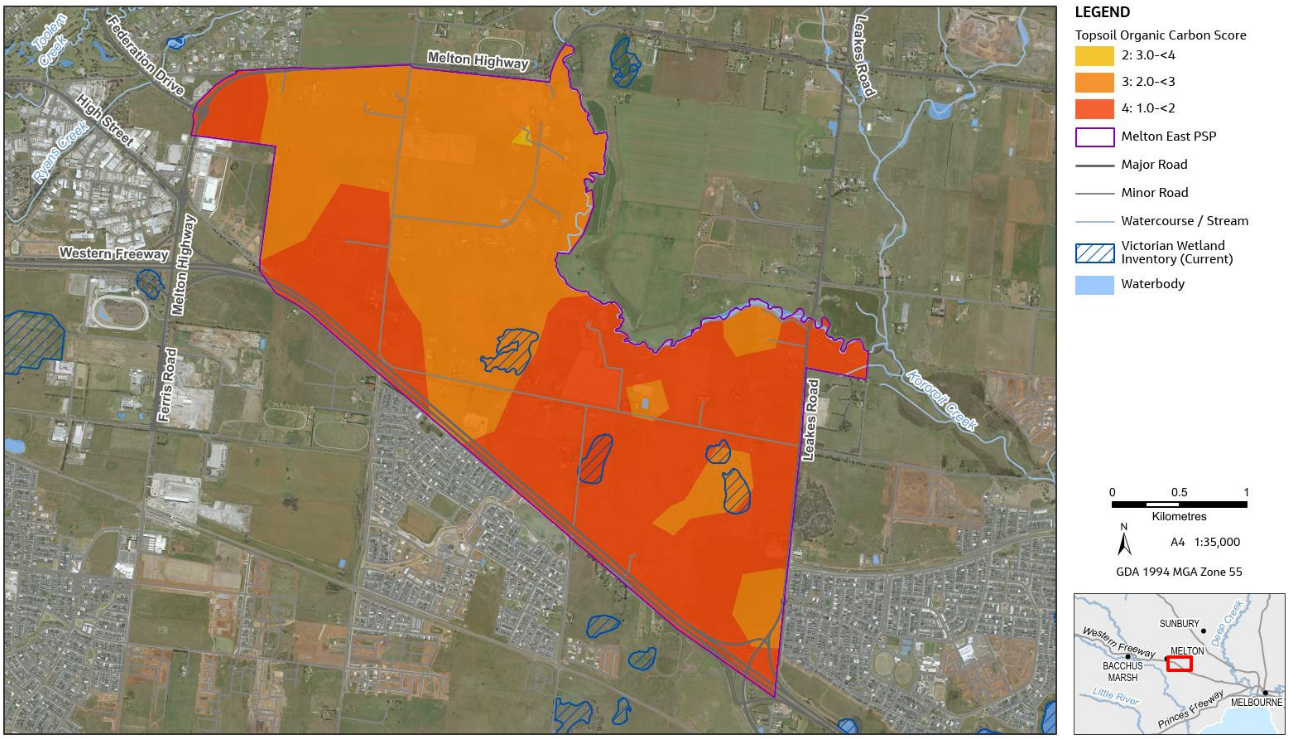


Figure 4-7. Topsoil Organic Carbon.

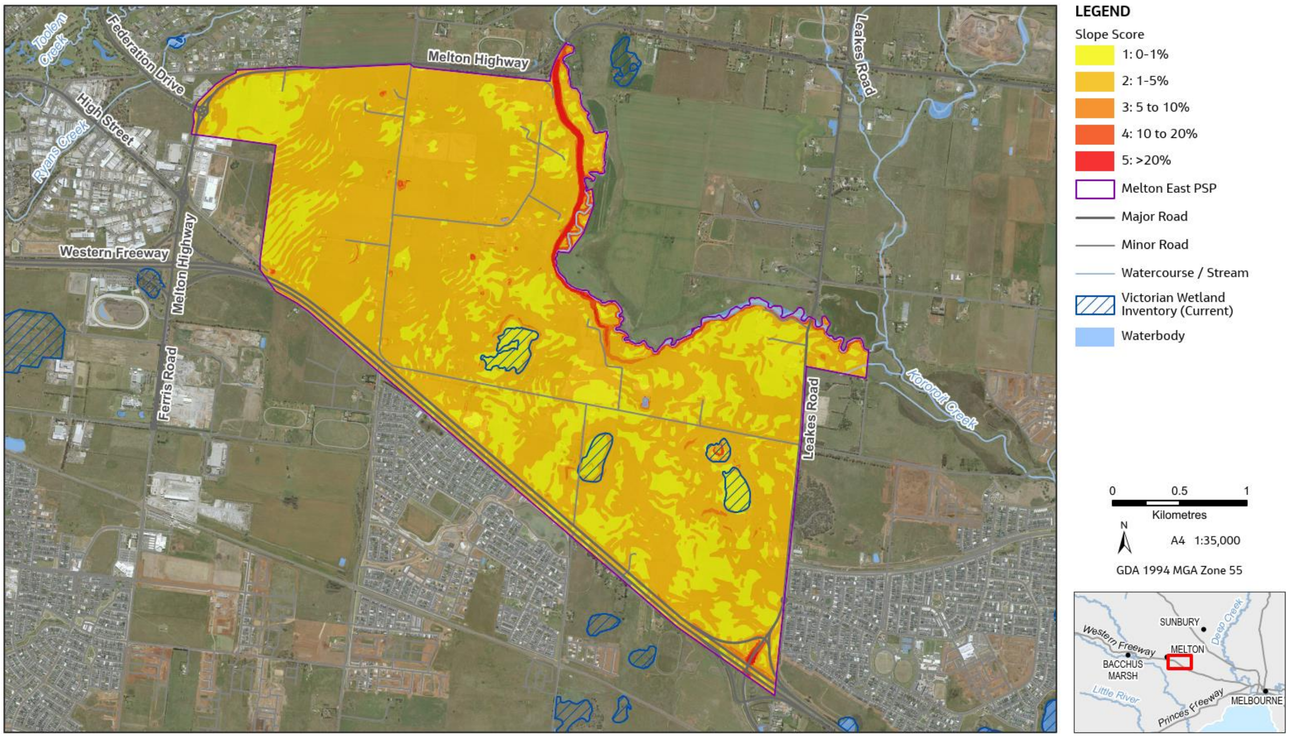


Figure 4-8. Slope.

Figure 4-9 presents the sum of the seven exposure criteria (Topsoil sodicity, Subsoil sodicity, Topsoil Emerson Dispersion, Subsoil Emerson Dispersion, A horizon depth, Topsoil Organic Carbon and slope). Soils that have higher ESP values and also recorded strong or complete dispersion are a greater erosion risk. Slope influences exposure to erosion, particularly in areas where gradients are higher than 10%.

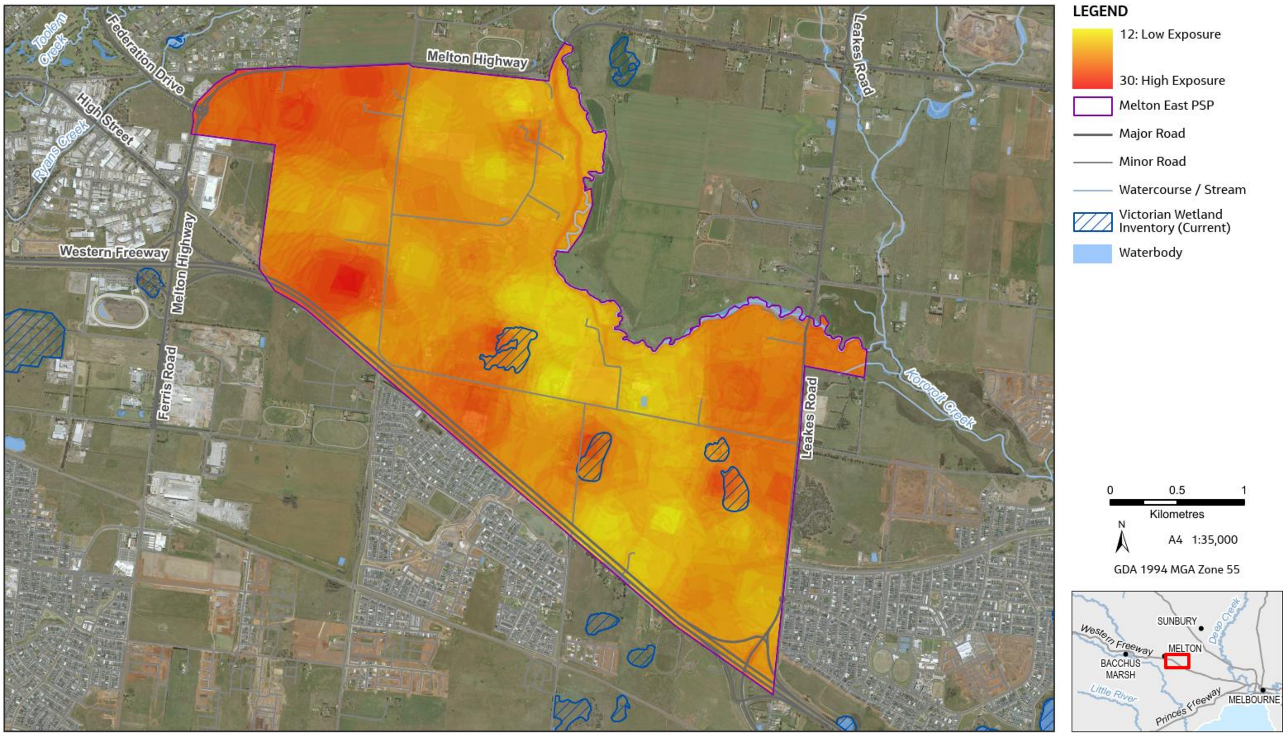


Figure 4-9. Sum of exposure criteria.

4.2 Sensitivity of land and urban development to sodic soils

The Future Urban Structure (FUS) dataset has been used as the basis for defining the sensitivity of land and urban development to sodic soils. Indicative drainage and waterway reserves are identified as areas that are particularly sensitive to disturbance of sodic and dispersive soils. The drainage and waterway extent across the Precinct is mapped as Drainage and Conservation (Growling Grass Frog area) in the FUS. These areas score 5, whereas all other areas outside of the waterway extent score 1 (Figure 4-10).

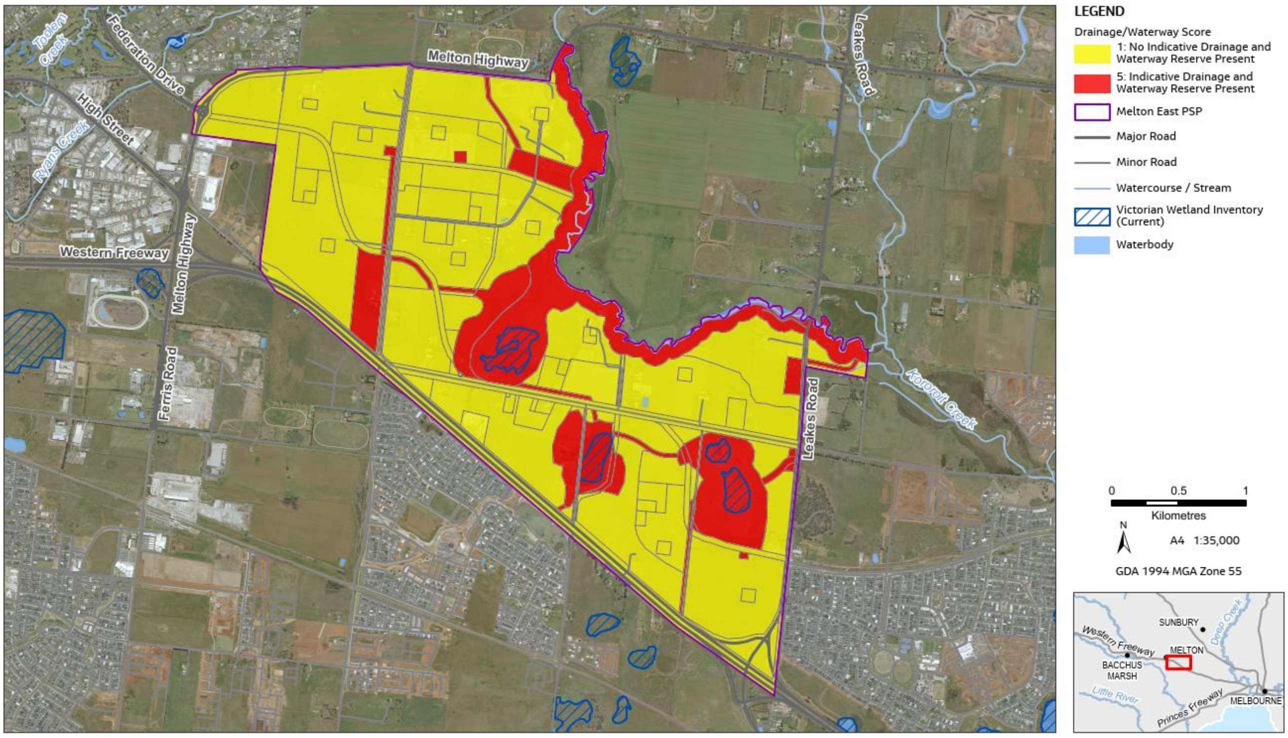


Figure 4-10. Indicative drainage and waterway reserve extent as mapped as Drainage and Conservation (Growling Grass Frog area) in Future Urban Structure (FUS) Dataset.

Figure 4-11 and Figure 4-12 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 / local park 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 Drainage/Waterway reserves (Retarding Basin/WQT Wetland, Waterway and Growling Grass Frog (BCS)) experiencing the highest level of disturbance (5). Similarly, in scoring water balance change, open space areas, with the exception of Drainage/Waterway reserves are expected to experience low levels of water balance change (1). Increasing development of land use, will result in development of impervious areas that generate runoff and therefore result in high levels of water balance change (5).

Figure 4-13 and Figure 4-14 present the combined sensitivity scores for the construction and future development scenarios. These show a similar pattern in that Drainage/Waterway reserves are identified as areas of highest sensitivity. Transport corridors are also identified as areas with high sensitivity in the future urban structure, due to the high water balance change and generation of runoff associated with impervious surfaces in these corridors.

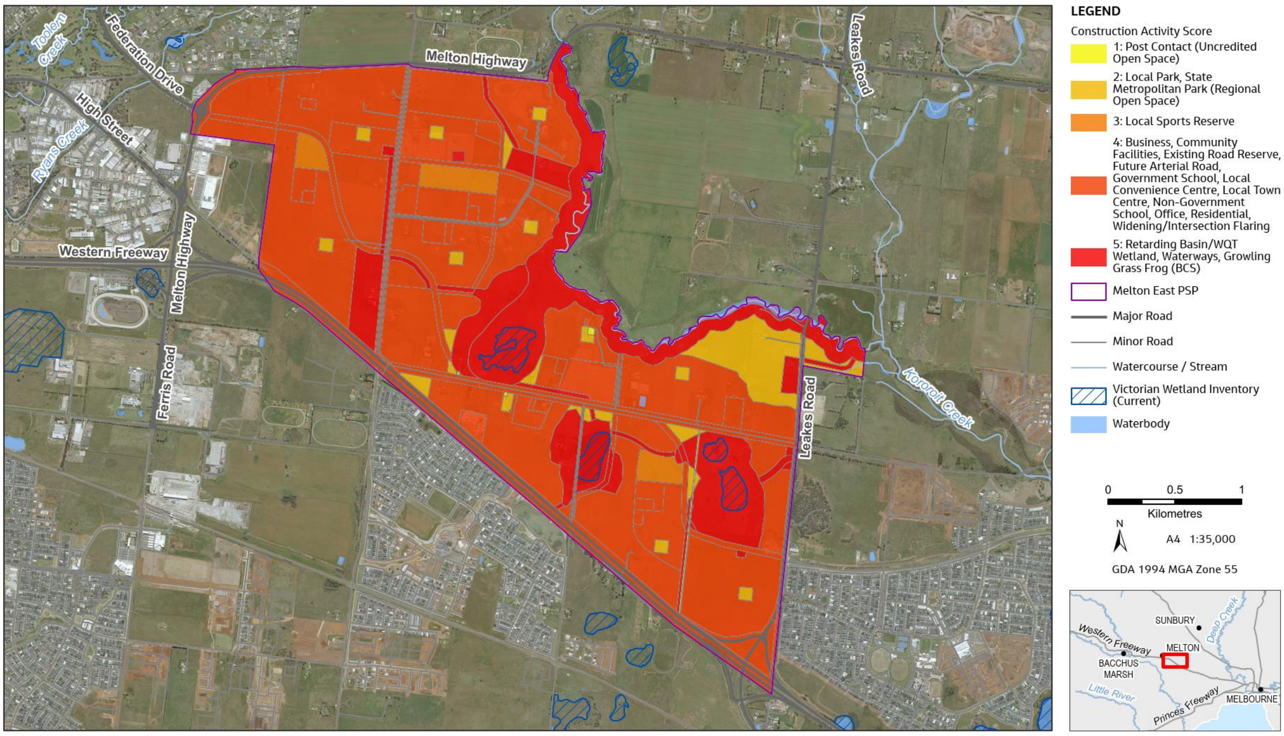


Figure 4-11. Construction activity.

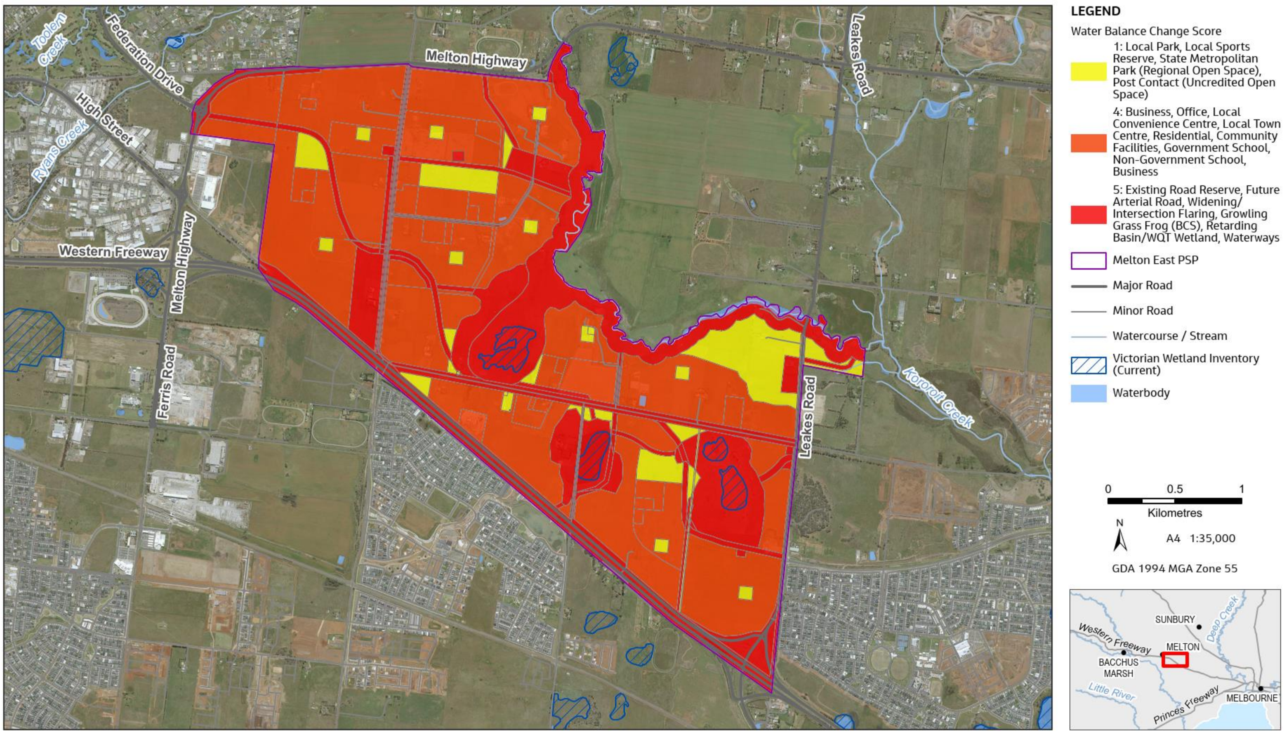


Figure 4-12. Water balance change.

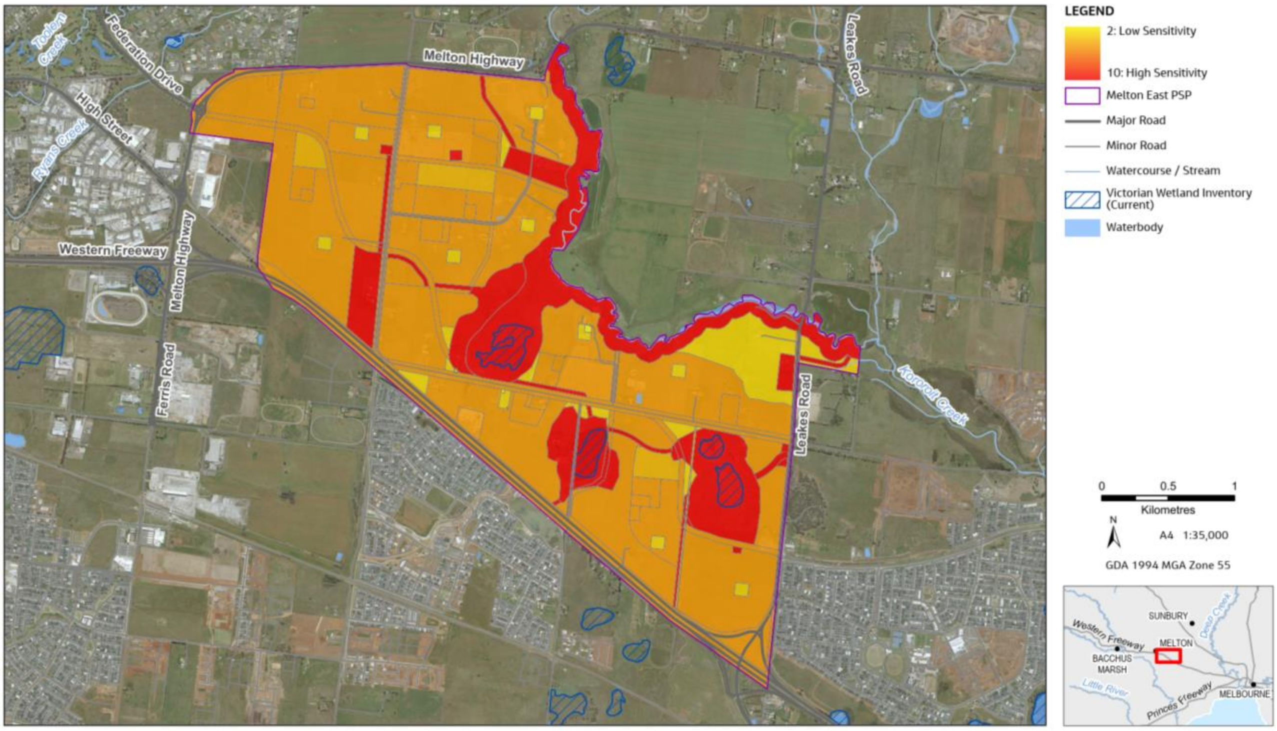


Figure 4-13. Sum of Sensitivity Criteria for Construction.

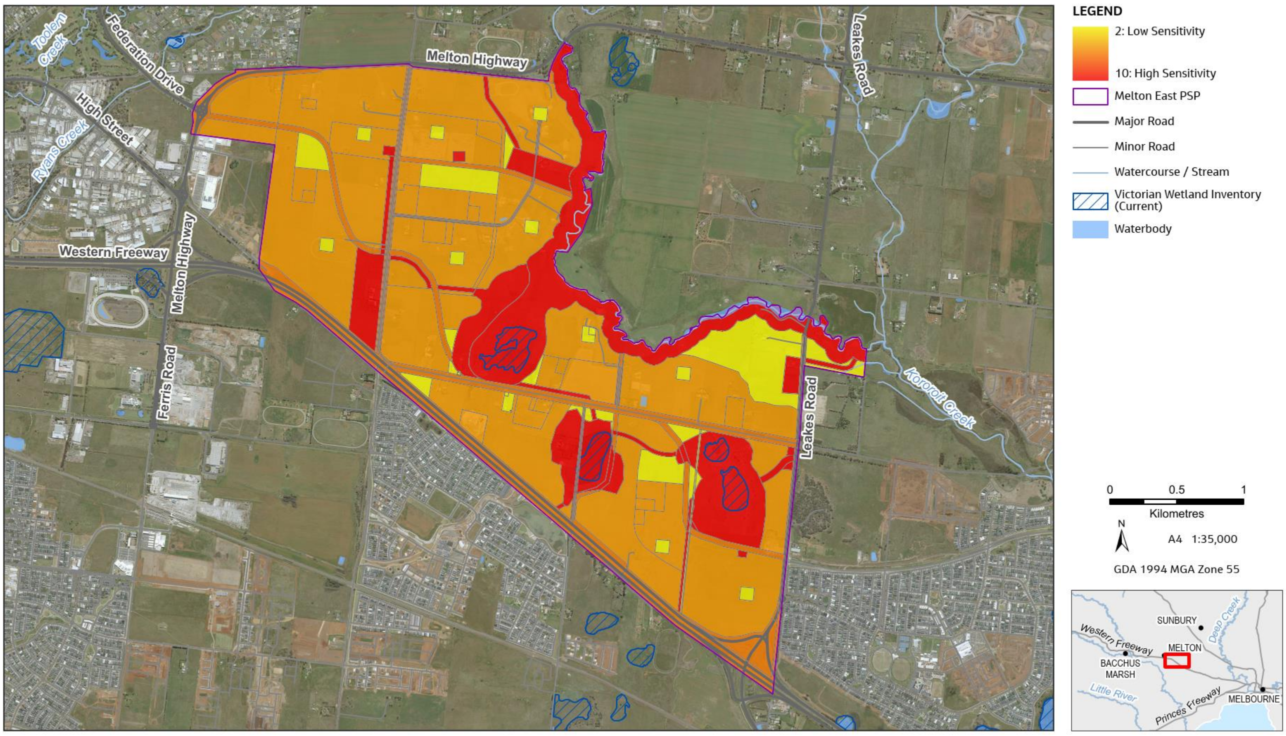


Figure 4-14. Sum of Sensitivity Criteria for Future Urban Structure.

4.3 Vulnerability assessment

The outcomes of the vulnerability assessment for the construction phase and future developed land use scenarios are presented in Figure 4-15 and Figure 4-16. 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 drainage/waterway reserves and steeper slopes (Figure 4-12). There is also an area in the west which has high inherent dispersibility. Activities that expose these soils to rainfall and associated runoff will present significant construction challenges and need to be managed carefully.

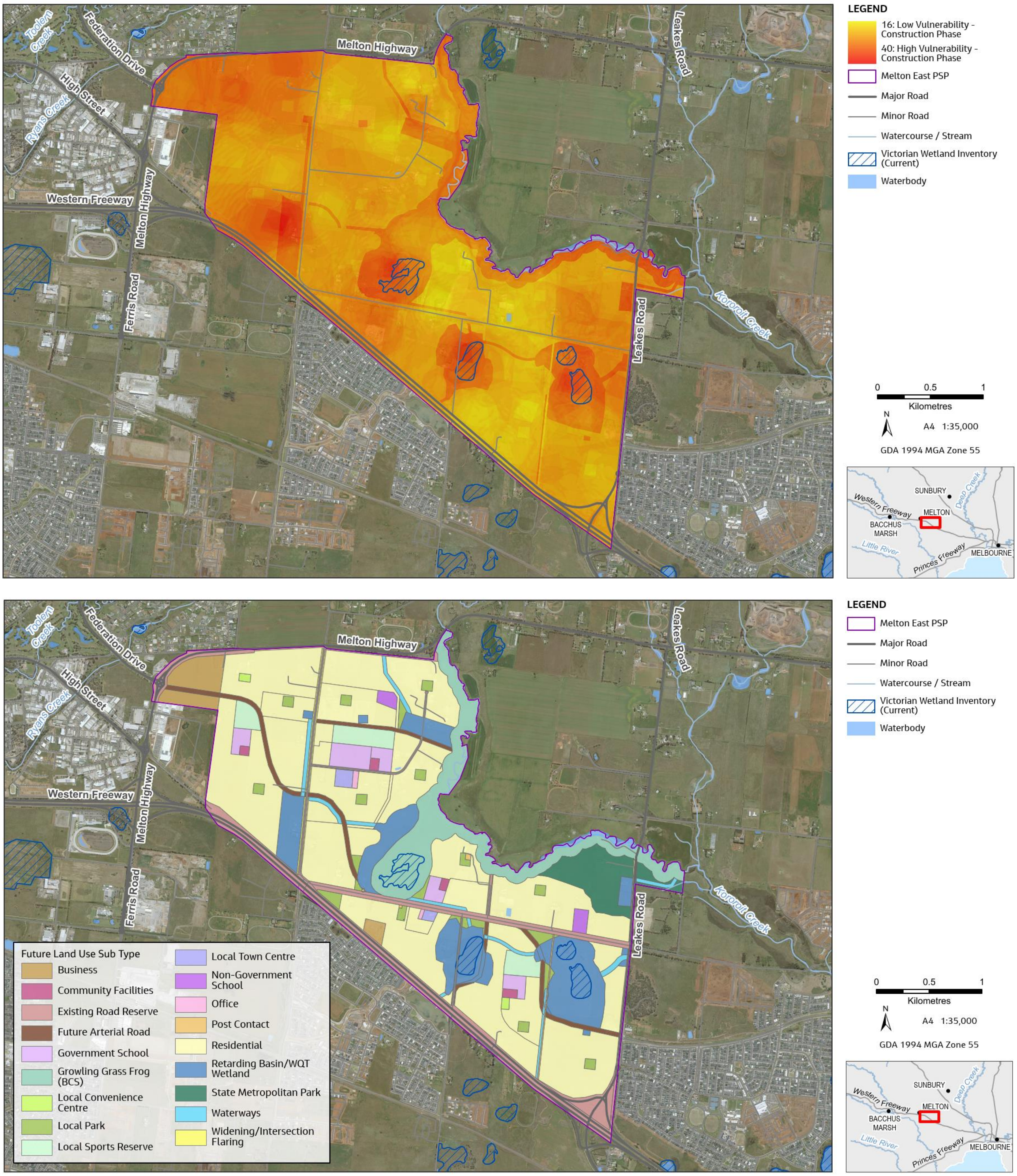
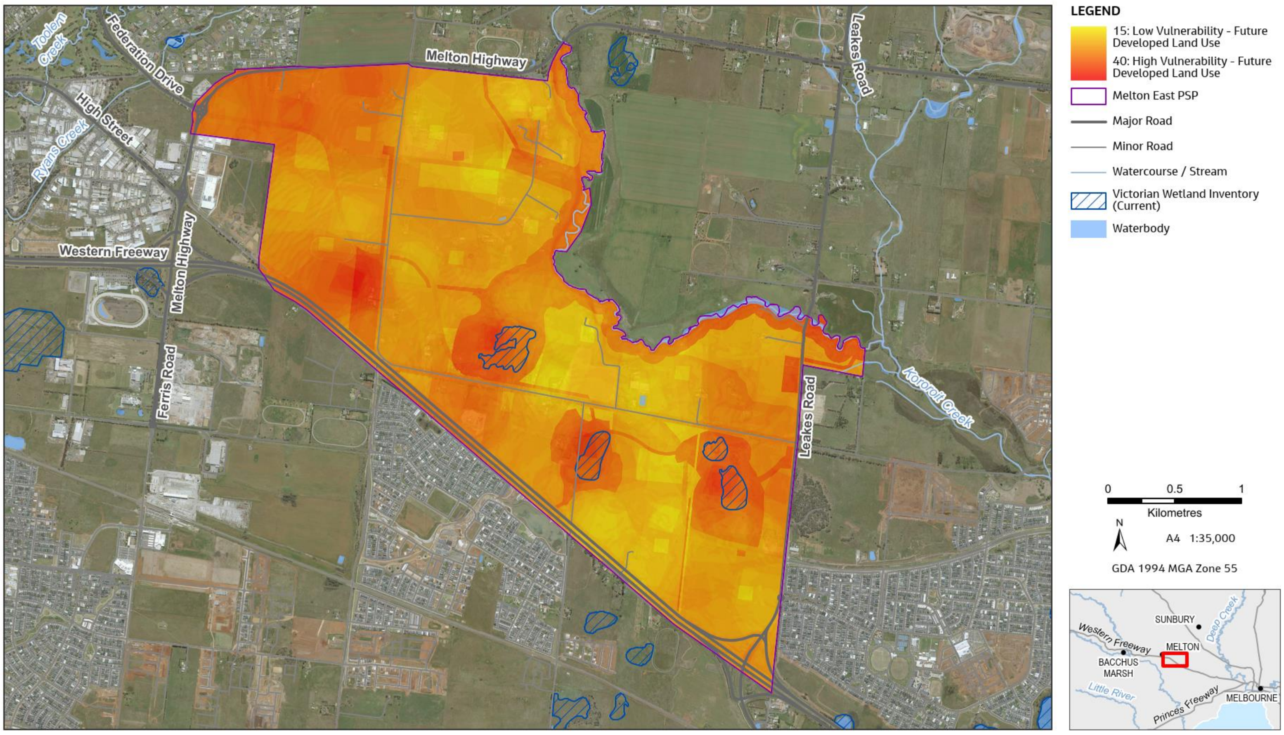


Figure 4-15. Vulnerability Construction Phase (upper). Map of Future Land Use Sub Types (below).

For future developed land use, drainage/waterway reserves and steeper slopes are areas identified with a high vulnerability to soil erosion (Figure 4-13). Water balance changes resulting from future developed land use and associated impervious areas will generate high volumes of runoff, which will drain into the surrounding depressions/wetlands and waterways, including Kororoit Creek. Further increases in flows have the potential to accelerate erosion of bed and bank materials.



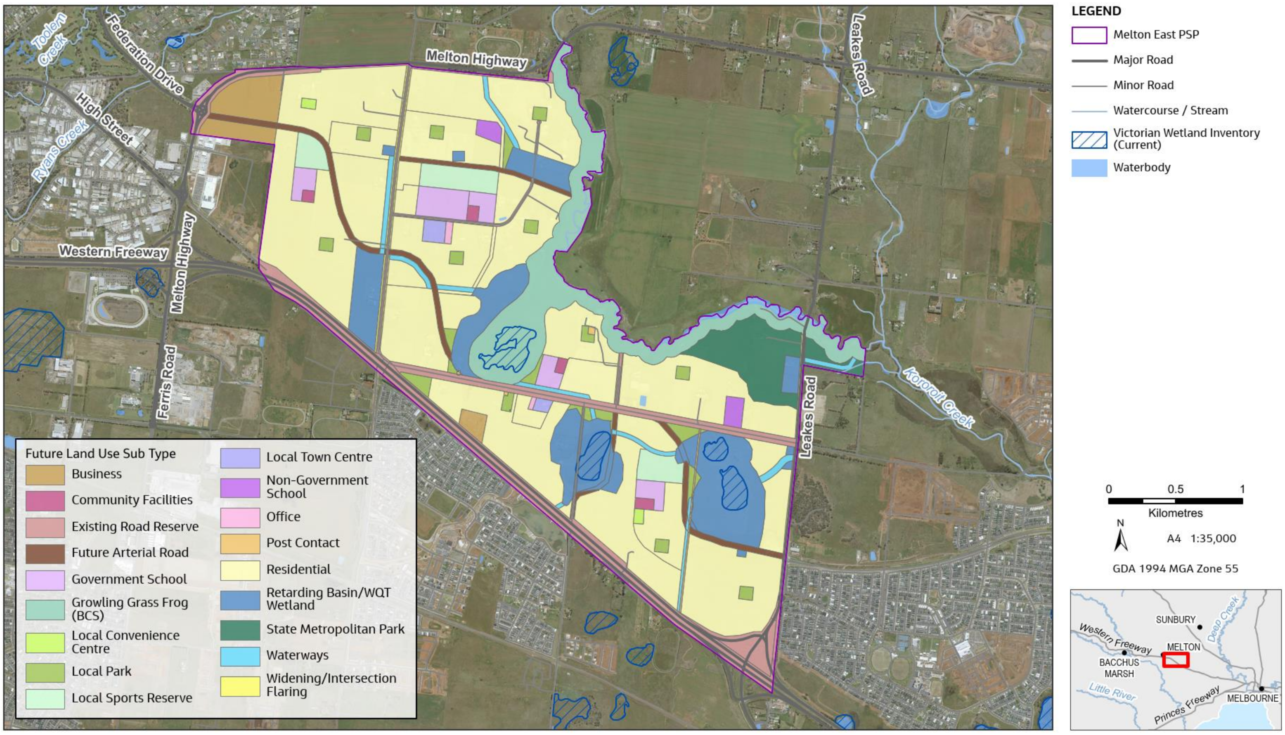


Figure 4-16. Vulnerability Future Developed Land Use (upper). Map of Future Land Use Sub Types (below).

5. Discussion and recommendations

5.1 Erosion risks

Erosion risks are directly influenced by soil exposure and changes in landscape hydrology. Examples of activities that may potentially expose sodic and dispersive 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.

Loam to clay-loam soil textures were dominant across the precinct area, with clay-dominant surface textures recorded within wetland areas. Soils with these characteristics evince slow or poor infiltration and permeability. Consequently, when rainfall intensity exceeds the soils' capacity to infiltrate water, or when profiles are at field capacity, rainfall is rejected and becomes subject to accessions by overland flow. 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. Clay dispersion from fresh rainfall contact with sodic and dispersive characteristics may induce sheet or rill erosion on exposed surfaces. This is the primary threat to the quality of stormwater, where turbidity will be high if soils on disturbed areas remain untreated. Turbid water will pond in localised depressions, or enter drainage lines and result in increased turbidity in connecting waterways off-site.

Erosion may also occur in areas of localised groundwater discharge, following recharge of rainfall upslope, seepage on top of clay or rock layers and a soak or discharge point appearing where clay or rock is close to the surface and/or there is break in slope. Erosion risk is potentially compounded by the accumulation of salt in groundwater discharge areas as water is evaporated. This increased erosion risk is typically associated with the break of slope below steeper slopes and was observed across several sample areas along Kororoit Creek.

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 heavy by comparison with 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 risk:

- **Drainage depressions/seasonal wetlands** - These areas can be broadly classified as headwater streams – small flow lines (swales/wetlands), creeks and streams that are closely linked to adjacent slopes. They may only flow or have ponds of water immediately following larger rainfall events, however they do play an important role in retaining and temporarily storing water in the landscape (Jacobs 2016). They slow the rate of flow over the land and assist in regulating flows and reducing downstream flood peaks. The infiltration of surface water in headwater streams into the local groundwater system also contributes to groundwater levels and maintaining base flows in downstream waterways. In fact, many headwater streams have their source of water as groundwater. If small headwater streams are destroyed because of urbanisation there is likely to be an increase in the frequency of high flows to downstream reaches. These high flow events can cause bed and bank erosion that significantly degrade community and environmental values (Bond and Cottingham 2008).
  There are several Seasonal Herbaceous Wetlands (SWH) in the Melton East PSP area. SHW are isolated freshwater wetlands that are seasonally or intermittently filled by a local non-riverine catchment. They are usually inundated by seasonal winter and spring rainfall and then dry out completely. In drought periods, they may be dry for many years (Papas et al. 2016). These wetlands and their catchment area are hydrological disconnected from Kororoit Creek. Further increases in runoff into these wetlands from urbanised catchment and modifications to drainage, through creation of connections to surrounding waterways has the potential to degrade the ecological values and functions of these wetlands.

- **Constructed waterway/drainage assets –** The landscape in its existing condition is predominantly characterised by internal drainage, with runoff draining into existing depression/wetlands on the volcanic plains. With future urban development, there will be a need to provide drainage of stormwater runoff to surrounding waterways, this being either Kororoit Creek in the north or constructed waterways in the south. A new constructed drainage network will need to be established.
- **Kororoit Creek -** Kororoit creek at present is largely hydrologically disconnected from the wetlands and their catchment areas. Establishment of drainage from these catchment areas to Kororoit Creek, will result in further increases in runoff from urban development which may result in increased erosion along the waterway.
- **Steeper slopes -** The slopes in the precinct area vary in gradient, the majority of the precinct area is flat to very gently inclined with steeper slopes adjacent to Kororoit Creek. Cutting into steeper slopes will likely lead to the exposure of dispersive subsoils. Runoff from steep slopes will result in higher velocity flow with a greater risk of scour and erosion. Sediments eroded from these areas will be deposited on lower slopes or be carried into connecting waterways, adversely affecting water quality.

5.2 Planning measures

Erosion risks associated with sodic and dispersive soils can 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 are reproduced in Table 5-1.

Table 5-1. Integrated Water Management Requirements and Guidelines.

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: ▪ Waterways and integrated water management design enable land to be used for multiple recreation and environmental purposes. ▪ Overland flow paths and piping within road reserves will be connected and integrated across property/parcel boundaries. ▪ Melbourne Water and the responsible authority freeboard requirements for overland flow paths will be adequately contained within the road reserves. ▪ 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. Potential management methods may include but is not limited to: ▪ Widening the buffer distances between the core riparian zone and the outside vegetated buffers that allows sufficient tolerances for channel migration.

Requirements
▪ Diversion of water away from sodic and/or dispersive materials ▪ Minimising potential convergence and/or ponding of surface flows ▪ Compacting to reduce pore spaces and minimise water movement through material ▪ Physical and chemical soil ameliorants. ▪ Maintenance of topsoil across undisturbed land, preferably with grasses to provide surface soil stability and root anchorage. ▪ Minimise the amount of time land is exposed (e.g. by staging development). ▪ 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 Melton East PSP Melbourne Water, City West Water, Greater Western Water and Southern Rural Water are the responsible Water Authorities.

The Melton East Precinct Area is located in one of the Stormwater Priority Areas identified in the 2018 Healthy Waterways Strategy (Melbourne Water 2018b, Melbourne Water 2018a). One of the specific performance objectives that have been set for this area is to constrain directly connected imperviousness (DCI) levels long the main stem of Kororoit Creek to <0.4% and this will require undertaking significant harvesting and infiltration of stormwater. For every hectare of new impervious area, this requires harvesting around 3.8 ML/y and infiltrating 0.7 ML/y (Melbourne Water 2018a).

The Melton East Precinct Area consists of two Melbourne Water Drainage Schemes - High Street Melton Drainage Scheme (4174) to the west and Kororoit Creek Upper Drainage Scheme (4140) to the east (Figure 5-1). Kororoit Creek, a designated waterway, follows the boundary of the PSP to the east, while Ryans Creek runs just north of the PSP. The 1 in 100 Year Flood Extent obtained from the Victorian Flood Database covers Kororoit Creek, as well as north-east sections and two areas that cross the Western Freeway, south of the Melton East PSP boundary. There is a Land Subject to Inundation Overlay (LSIO) covering Kororoit Creek just east of the boundary.

Melbourne Water are currently in the process of preparing a drainage scheme for the precinct (Jacobs 2022). Alluvium (2022) have undertaken an assessment of Integrated Water Management (IWM) issues and opportunities for the precinct. The IWM report includes some draft layouts for future drainage scheme, these show the provision of approximately 11 wetland/retarding basin combined assets. References are also made in the Alluvium (2022) report to other investigations that have been undertaken for Melbourne Water preparing wetland layouts, in preparation for the Melton Regional Stormwater Harvesting Scheme project.

Further investigations and design are required to develop the concepts for stormwater harvesting and changes in drainage required to support urban development in the Precinct. The landscape in its existing condition is predominantly characterised by internal drainage, with runoff draining into existing depression/wetlands on the volcanic plains. With future urban development, there will be a need to provide drainage of stormwater runoff to surrounding waterways, this being either Kororoit Creek in the north or constructed waterways in the south.

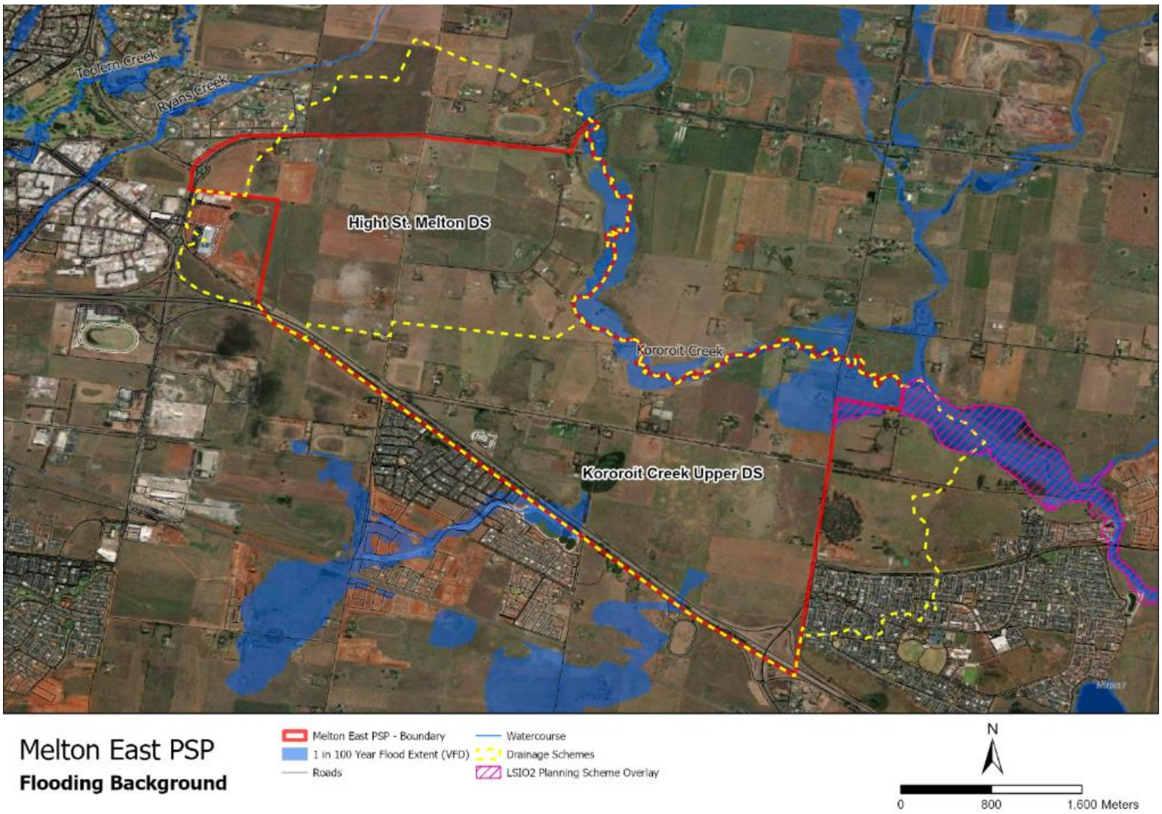


Figure 5-1. Melton East PSP Flooding Background: Map illustrating the 1 in 100 Year Flood Extent (Victorian Flood Database), relevant drainage schemes (Kororoit Creek Upper Drainage Scheme 4140 and High Street Melton Drainage Scheme 4174) (Jacobs 2022).

GHD (2017) completed a hydrogeological desktop assessment to inform the design of a drainage strategy for the Kororoit Creek Upper Development Services Scheme (DSS). The broader objective of this work was to assess the feasibility of using onsite landforms (depressions) and/or underlying aquifer systems to assist in managing urban drainage in this DSS, by temporarily retarding flows and reducing stormwater impacts to Kororoit Creek. The following is a summary of key findings from this work:

- Using landscape depressions to recharge stormwater to groundwater is not considered a practicable option. Furthermore, a review of the hydrogeological setting indicated there are unlikely to be any opportunities for Managed aquifer recharge (MAR) into deeper aquifers at the site.
- Use of the onsite surface depression for temporary or permanent management of urban drainage has the potential to result in local shallow groundwater levels or water logging due to mounding. This has the potential to impact vegetation condition, soil salinity and constructed foundations.
- Groundwater is expected to be more saline than stormwater. Any stormwater reuse schemes involving below grade excavations may need to factor a potential deterioration in water quality due to interaction with groundwater.
- Depth to basalt was unknown, but potentially within 2 m to 4 m of the surface. The potential to encounter shallow basalt rock has implications for earthworks (makes deep excavations costly). Concerns were also raised about the potential to remove (either wholly or partially) low permeability residual clay soils, and thus expose excavations to a risk of increased leakage to groundwater.

The sampling for soils completed as part of this project, showed that the thickness of soils over basalt ranges from <10cm (topsoil only) to 1.0-1.2 metres, considerably shallower than 2-4 m estimated in the GHD (2017) report. Taking into account the findings from the report by GHD (2017) and the outcomes of Jacobs field survey, in which considerably shallower depths to rock were encountered, Jacobs consider the opportunities for stormwater harvesting may be more limited. It is recommended that further investigations are undertaken to assess the feasibility of stormwater harvesting in the precinct as a guide to the design of wetland/retarding basin assets.

5.3 Treatment options

5.3.1 Areas with high vulnerability of sodic and dispersive soil erosion risk

For areas identified with a high vulnerability to sodic and dispersive soil erosion risks, treatment options include:

- **Drainage depressions/seasonal wetlands –** Ideally these areas should be identified and reserved as linear green spaces to maintain their important hydrological function in retaining and temporarily storing water in the landscape and regulating the flow of water and nutrients throughout a catchment. Ecosystem services provided by these landscape features include reducing flood peaks, supporting infiltration to groundwater, maintaining base flows and reducing downstream export of nutrient and sediment to receiving waters (Jacobs 2016, Walsh et al. 2016). 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 to the erosion risks associated with sodic and dispersive 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.
- **Kororoit Creek –** Further increases in runoff from urban development could increase erosion. Engineering works may be required to stabilise this waterway so that is resilient to stormwater runoff from future land development (chemical and physical amelioration of sodic and dispersive soils, topsoil and revegetation, construction of drainage outfalls, grade-control structures, geosynthetic clay liners / rock treatment of low-flow channels and where water spills into wetlands). Further consideration should be given to discharge of stormwater into constructed wetlands in the Kororoit floodplain, prior to entering the waterway.
- **Steeper slopes –** Cutting into these slopes exposes underlying subsoils, and erosion risk is increased with slope. Cut batters must be designed with consideration of the erodibility of the soils. Stable linings that are resistant to rainfall and runoff will be required. Appropriate drainage at the base of cuttings is also essential to manage flows, reduce velocities and trap sediments, which if not checked could have detrimental effects to waterways.

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 to the erosion risks associated with sodic and dispersive 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 of the 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.

Photographs of DSS assets in the adjacent Paynes Road Precinct are shown in Figure 5-2. It may be too early to assess the effectiveness of treatments of channel batters, which in most instances consists of geofabric with planting direct into underlying clay soils. Rock treatment of bank was noted within the vicinity of drainage outfalls. Further monitoring of the constructed waterway corridor is recommended to assess whether these batter treatments remain stable and if vegetation establishment is successful.

Figure 5-2. Constructed retardation basin near Western Freeway in Paynes Road Precinct/Shogaki Drive DSS (Top left and right) and connecting waterway corridor (Bottom left and right). Batter treatments comprised of geofabric with direct planting into underlying clay soils. Rock work is evident within the vicinity of drainage outfalls. Photos dated 4 October 2022.

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. Disturbances to high risk areas should be minimised, if not totally avoided, especially during the most erosive periods of the year (wetter months). 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).

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. ▪ Topsoils with loam and clay-loam textures have a greater resilience to erosion by comparison with finer textured clay-dominant subsoils. Topsoils are also easier to stabilise from dispersion and erosion. ▪ 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.
Undisturbed sites	▪ Maintenance of topsoil across undisturbed land, preferably with grasses to provide surface soil stability and root anchorage. ▪ Maintenance of tree cover where trees exist. ▪ 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). ▪ Apply gypsum to all topsoils for improved stability. ▪ Avoiding removal or disturbance to topsoil or vegetation until absolutely necessary. ▪ Covering dispersive subsoils with a shroud of stabilised topsoil (100-150mm), should works cease for any period of time or prolonged rainfall is forecast. ▪ 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. ▪ Re-vegetate exposed areas immediately after completion of earthworks, with specific emphasis on steep slopes (Gyasi-Agyei et al. 2007). ▪ Avoid construction techniques that result in exposure of dispersive subsoils. ▪ Use alternatives to 'cut and fill' construction such as pier and pile foundations. ▪ Use of interception trenches stabilised with topsoil to catch runoff in a controlled fashion and divert flow to sedimentation ponds to capture sediments. ▪ 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. ▪ 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. ▪ Limit extents of trench open at any one time. Material stockpiles from trenching, particularly dispersive soils, to be covered temporarily as required. ▪ 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. ▪ Ensure runoff from hardstand areas is not discharged into areas with dispersive soils. ▪ If necessary, create safe areas for discharge of runoff. ▪ If possible do not excavate culverts and drains in dispersive soils. ▪ Following engineered design, consider placement of non-sodic soil to create appropriate road surfaces and drains without the need for excavation. ▪ 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 a key tool in 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 could be achieved 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 dispersive soils on construction sites. Three primary soil chemical ameliorants and their uses for stabilising dispersive 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 average 6) 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 by comparison with gypsum. 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 because it provides a source of cover and protection of dispersive subsoil. Lighter textured topsoils are also easier to ameliorate by comparison with 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 treatment is recommended to reduce potential dispersion of clay with rainfall and runoff events.

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 a guide only and should be further refined with the development of sodic soil management plans at an individual subdivision level.

Table 5-3. Calculated rates of gypsum to minimise or eliminate dispersion of soils in the Melton East Precinct.

Gypsum treatment	Topsoil (0-10cm)	Subsoil (30-40cm)	Deeper subsoil (>40cm)
Full gypsum rate to displace exc. Na, Mg and K to optimum levels (t/Ha/100mm).	4.57	11.84	13.17
Gypsum rate to displace exc. Na to below 5% (t/Ha/100mm).	0.32	1.19	0.71
Gypsum rate to displace exc. Mg to below 15%.	2.30	9.96	11.81
Gypsum rate to displace exc. K to below 5% (t/Ha/100mm).	1.95	0.82	0.66

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.

6. Knowledge gaps and recommendations for further investigations

6.1 Knowledge gaps

This assessment has focused on sodic and dispersive characteristic of soils as they relate to erosion risks. Some of the soils assessed may experience significant shrinking and swelling, resulting from drying and wetting. This often results in the development of features such as surface cracking, heaving and gilgai formation. These features are of significant importance for engineering purposes and controls against the adverse impacts of these soils character will be important if there is to be proposed development (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, it is recommended that the potential adverse effects of reactive 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 & 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 Area. 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 soil 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.

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. Future Urban Structure Dataset

For this assessment the Future Urban Structure (FUS) Dataset is based on a Concept Based Plan that was developed and provided by Victorian Planning Authority in December 2022 (Figure A-1).

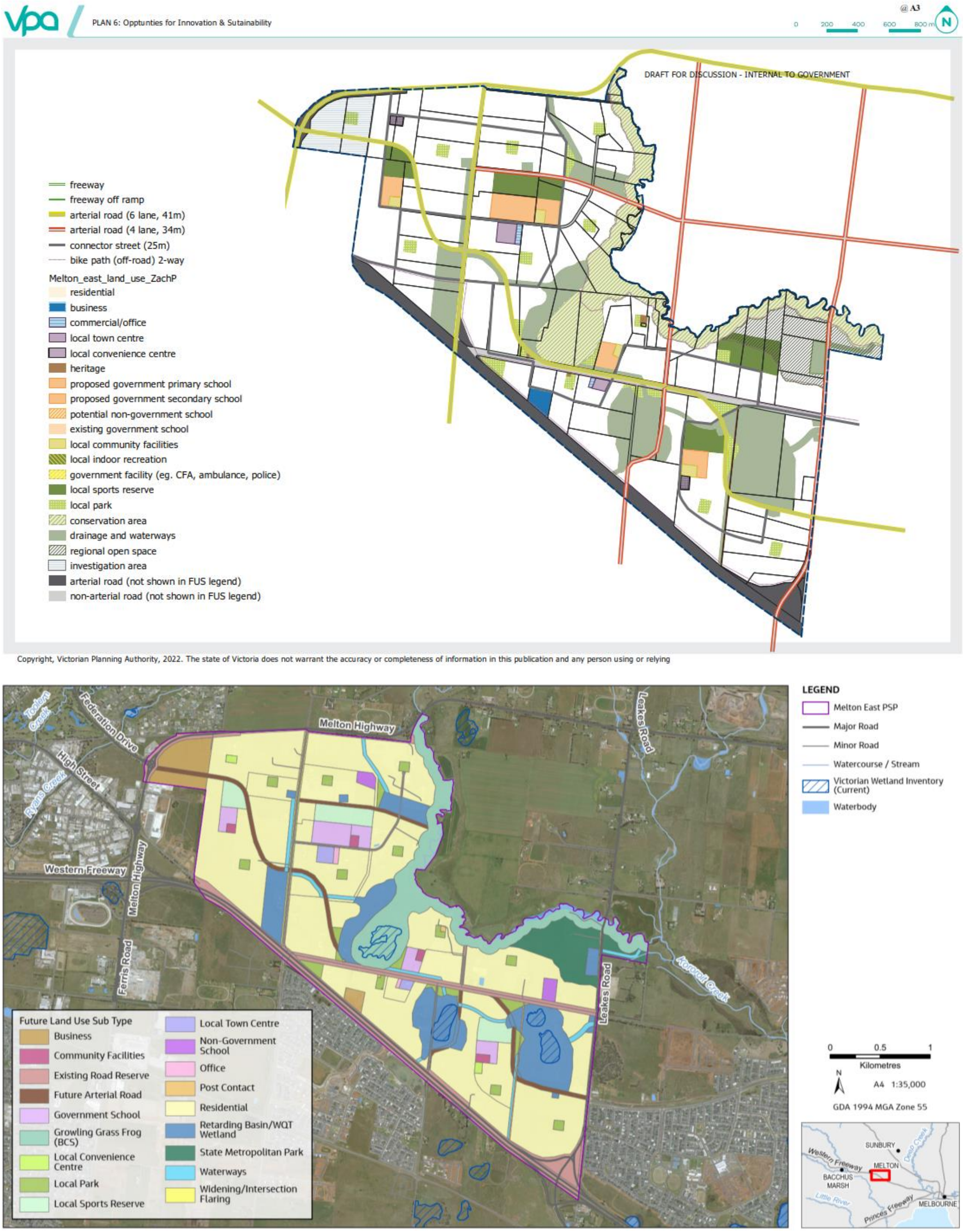

Figure A-1. Melton East PSP Indicative plan and map of Future Land Use Sub Types as represented in Future Urban Structure (FUS) dataset. Above based on dataset developed and provided by Victorian Planning Authority in December 2022.

Appendix B. Soil Sampling and Analysis

B.1 Project scope

Jacobs and project partners South East Soil and Water (SESW) were engaged by Victorian Planning Authority to complete additional soil sampling and analysis so as to obtain additional data on the sodicity of soils in the Melton East Precinct. The soil sampling and analysis methodology is similar to that which was undertaken for the Sodic Soils Assessment of the Beveridge North West, Shenstone Park, Wallan South and Wallan East (Part 1) Precincts (Jacobs 2020a, Jacobs 2020b, Jacobs 2021b, Jacobs 2021a).

Fieldwork of the Melton East precinct area was carried out by Peter Sandercock of Jacobs and Christian Bannan of South East Soil and Water on the 6-9 November 2022. Initially a grid pattern was selected across the Precinct area with approximately one sampling set for one site per 10-hectares of land. Following a review of property access based on landowner permission, a drive of the Precinct 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 Melton East was 39 with the total number of samples collected recorded at 90. A Garmin 76CX handheld GPS was used to locate sites in the field. Figure A provides an overview of the sampling sites. The breakdown of samples comprised of:

- 0-10cm samples: 39
- 30-40cm samples: 37
- Deeper samples from 60-140cm: 14

Soil cores, drill samples and hand auger samples were collected from proposed sample points at 0-10cm and 30-40cm, limited by the depth to rock. There were 14 selected sites where samples were collected from depths greater than 40cm to gain general information on deeper sodicity and textural characteristics. Examples of soil cores from selected sites are shown in Figure B-2 and Figure B-3.

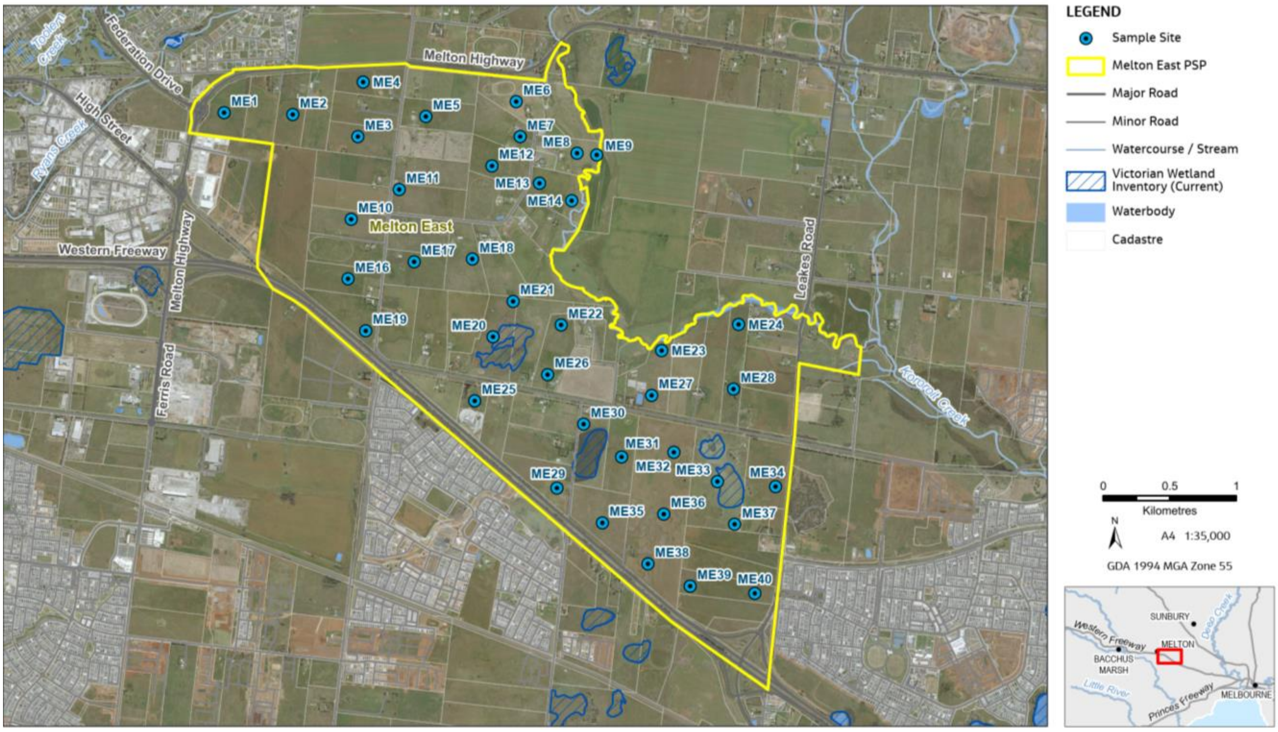

Figure B-1. Melton East Sample Sites October 2022.

Figure B-2. Soil core from point ME6.

Figure B-3. Soil core from point ME26.

B.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 core or sample collected.

Samples were collected from two depths, A horizon topsoil (0-10cm) and B horizon subsoil (30-40cm). Additional samples were also collected at greater depths at some locations (ranging from 60-150cm) sporadically across the sample areas, in most areas where impenetrable rock was not encountered.

Soil samples were dispatched to Nutrient Advantage (NA) Laboratories, Werribee, Victoria on 10 November 2022 with results received on the 18 November 2022.

NA are an ASPAC and NATA accredited laboratory. The following laboratory analysis were undertaken of the soil samples:

- Soil pH (water)
- Soil pH ($CaCl_2$)
- Electrical Conductivity (1:5 soil water) (uS/cm and dS/m)
- 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.

B.3 Summary

B.3.1 Surface Geology and Soils

The Melton East PSP lies within a broad volcanic plain, mapped as Quaternary, Volcanics (Douglas and Ferguson 1988). Amongst this geological unit are alluvial deposits found in the area of the Kororoit Creek and swamp deposits found in an isolated zone in the centre of the investigation area. A map showing local geology for the project area is shown in Figure B-4.

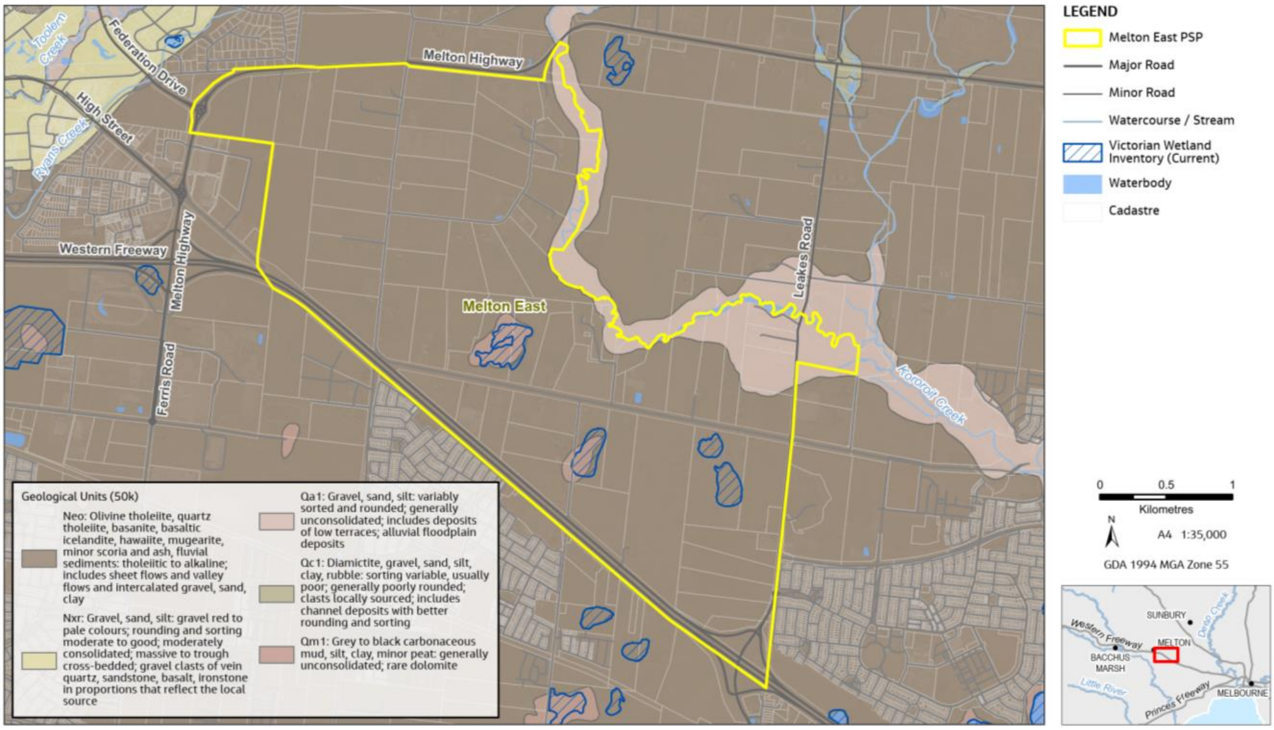

Figure B-4. Local geology.

Soil properties occur in association with the underlying surface geology, slope and landscape drainage, with volcanic areas on gently undulating landscapes characterized by good to moderate profile drainage. Where clay content increases in lower sloping or lower-lying areas, profile drainage decreases causing water retention in the landscape, as observed in the south of the PSP area on Paynes road.

Soils across the precinct area can be generally divided into the following groups:

- Volcanic soils from basalt flows, covering most of the Precinct area apart from zones near the Kororoit Creeks. Geology is listed as unit 'Neo' – Newer Volcanic Group (basalt flows). Soil profiles lie across gently undulating land consist of loam and clay-loam topsoil overlying light clay subsoils, resting on basalt rock. The thickness of soil over basalt ranges from <10cm (topsoil only) to 1.0-1.2 metres. Soils are described as duplex across most of this landform.
- Soils on alluvial deposits located in the east of the PSP adjacent to the Kororoit Creek. Geology is listed as unit 'Qa1' – Quaternary, alluvium, including unconsolidated deposits of gravel, sand, silt and clay found in association with the waterway. Soils profiles lie on flat to gently sloping land and are duplex to gradational, with a marked transition (weak to strong) between loamy A horizons and clayey upper-B horizons. Profiles transition to sandy clays, or clays with an increasing sand content at depths of 1.3-1.5 metres.
- Soils on swamp or lakebed deposits, covering small zones to the north and south of Beatty Road. Geology is listed as 'Qm1', which include deposits of silt and clay. The three zones marked as this mapping unit presents as terminal drainage basins which retain water during wet periods, as observed during fieldwork. Soils vary from uniform to duplex, including clays or loams over clay-dominant subsoils.

Soils across the precinct area closely relate to geology and geomorphology, with a consistent pattern of occurrence which relates directly to site drainage. Volcanic basalt flows reveal good to moderate drainage both on the surface and throughout soil profiles. Swamp and lakebed deposits with sodic and dispersive clays retain landscape drainage while alluvial deposits reveal good surface drainage with generally slow and variable profile drainage. Volcanic soils on basalt are the dominant geology and soil conditions which require consideration for urban planning.

B.3.2 Soil Classification

Soils across the PSP area are broadly classified as follows in accordance with Isbell and NCST (2021):

- Duplex, volcanic soils on basalt flows:
  - Chromosols: Soils which display strong texture contrast between the A and B horizons, with B horizons which are not strongly acid and non-sodic (ESP <6.0%). Chromosols are generally non-dispersive, however under various circumstances can be dispersive yet non-sodic. Sites include ME6, 8, 10, 12, 13, 17, 21, 22, 26-29, 32, 35-40.
  - Sodosols: 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. Sodosols are sodic and generally dispersive. Sites include ME1-5, 7, 11, 16, 18, 19, 24, 25, 28, 30, 31, 33 and 34.
  - Dermosols: Soils lacking in strong texture contrast, including sites with shallow topsoil over basalt rock. No B horizon was identified. Soils are generally non-dispersive. Sites include ME14 and 23.
- Duplex soils on alluvial deposits (ME9 and 24):
  - Chromosols: Non-sodic but dispersive. This includes site ME9.
  - Sodosols: Site ME24
- Uniform to duplex soils on swamp and lakebed deposits:
  - Sodosols: Sites ME20 and 33

B.3.3 Soil Sodicity and Dispersion

A total of 39 sites and 90 samples were collected across the precinct area to characterise soil sodicity trends throughout soil profiles and understand correlations with soil dispersion and potential for erosion. In developing exposure criteria (refer to Section 3.2.1) Jacobs has chosen to base this on the Exchangeable Sodium Percentage (ESP), or 'sodicity' value where 6.0% is the trigger level (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). Observations on soil dispersion are discussed simultaneously below with respect to sodicity values.

Jacobs has also added into exposure criteria, attributes that relate to potential for soil dispersion, using laboratory results of observations which support the Emerson Aggregate Test. 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 exposure to dispersive soil. 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. Adopting the dispersion scores for remoulded aggregates after 20 hours better reflects soil conditions during earthworks where sites are disturbed, similar to cultivation effects in agricultural landscapes.

The following exchangeable sodium percentage (ESP) values (sodic soil values) and dispersion observations are made from the laboratory data set:

- 22 sites (56%) were non-sodic within both the A horizon (0-10cm) and B horizon (30-40cm). Of these, all were found to be dispersive based on a remoulded dispersion at 20 hours. This confirms that although many soils on volcanic basalt flows are non-sodic, all have a high potential to disperse once disturbed by cultivation or earthworks. Dispersion may be influenced by very high exchangeable potassium in conjunction with exchangeable sodium (Smiles 2006).
- 17 sites (44%) were sodic. Of these, all were dispersive in the B horizons. Where sodic values are identified, soils are dispersive.

Average ESP values for soils within segregated depth ranges across the precinct area are listed as follows. ESP itself is not discussed in detail given the lack of correlation and relevance to soil dispersion potential within Chromosol and Dermosol soil types. Average ESP values are as follows:

- 0-10cm (A1 horizon topsoil): 4.6%.
- 30-40cm (B horizon subsoil): 8.1%.
- >40cm (deep B horizons): 6.2%. Of the 14 samples collected, 9 were dispersive.

Based on comparison with other sodic soil investigations by Jacobs covering the northern growth corridor (Jacobs 2020a, Jacobs 2020b, Jacobs 2021b, Jacobs 2021a), volcanic soils on basalt flows in this area differ from previous investigations. Approximately half of the samples are non-sodic, yet they are dispersive. This outcome does not change the importance of managing soils and treating dispersion in the same fashion as all soils deemed sodic. There is a high likelihood that high exchangeable potassium levels are influencing soil dispersion potential. Average exchangeable potassium percentage (EPP) for the 0-10cm horizon is 17.0% across all tested samples from the precinct area, with levels of 3-8% deemed optimal and normal in soils (Agriculture Victoria 2022).

Organic carbon was tested in all samples to gain an understanding on soil condition and the likely influence on surface soil stability. Average organic carbon levels are 2.0% across the topsoils of the Precinct, which is deemed acceptable to slightly low. Levels correspond with an organic matter level averaging 3.5%. These levels are not high for sites that have been subject to long term pasture, both improved and unimproved and in some instances dominated by native grasses. Organic carbon levels may assist with maintaining soil stability, particularly where soils are not disturbed. Where disturbed by earthworks, organic carbon may not provide the same level of stability by comparison to undisturbed zones.

Across this Precinct area, exposure and risk of sodic and dispersive soil impacts are likely to increase as the following disturbances occur during land development:

1. Removal of the surface A1 horizon topsoil (0-10cm). This material has:
    a. Variable ESP values, from low to high
    b. Shallow to moderate depth, averaging 20cm
    c. Acceptable to slightly low organic carbon levels, providing stability to some undisturbed soils, but to a lesser extent with disturbed soil
    d. Removal of surface organic material from the site, which may increase the rate of runoff from surface drainage and reduce infiltration characteristics
2. Exposure of B-horizon subsoil clay with sodic and dispersive characteristics.
    a. Approximately 45% of subsoil samples (30-40cm and >40cm samples) contain ESP levels of >6.0%, while approximately 20% of samples contain very high ESP levels of >12%.
    b. Approximately 80% of all subsoil samples were dispersive.
3. Increased depth of excavation or stripping, where higher ESP subsoil becomes exposed, or
4. Larger areas or footprints subject to soil stripping, increasing the catchment area for rainfall and runoff in contact with unstable or dispersive subsoil.

Erosion risks resulting from exposure of sodic and dispersive soil are high and increase proportional to the extent or depth of exposure. For this site, the measure of sodicity with reference to ESP values is effective for inferring dispersive soil risks to erosion across the precinct, however non-sodic soils which are dispersive should also be viewed as a risk for erosion.

In summary, the precinct area soils are predominantly dispersive, even though only 35 of the 90 soil samples (48%) were deemed sodic. Although the exposure risk by mapping indicates that exposure to sodic soil conditions varies from low to high, dispersion results confirm that all soils should be treated as dispersive, or potentially dispersive following disturbance, with a moderate to high erosion risk should they be exposed to rainfall and runoff.

B.3.4 Gypsum Stabilisation

The results confirm that gypsum responses are likely to be observed. Table B-1 provides calculated rates of gypsum to minimise or eliminate dispersion. Calculations adopt the following criteria:

- Reduce ESP to below 5%
- Reduce exchangeable magnesium to below 15%
- Reduce exchangeable potassium to below 5%.

Table B-1. Calculated rates of gypsum to minimise or eliminate dispersion.

Gypsum treatment	Topsoil (0-10cm)	Subsoil (30-40cm)	Deeper subsoil (>40cm)
Full gypsum rate to displace exc. Na, Mg and K to optimum levels (t/Ha/100mm).	4.57	11.84	13.17
Gypsum rate to displace exc. Na to below 5% (t/Ha/100mm).	0.32	1.19	0.71

Gypsum treatment	Topsoil (0-10cm)	Subsoil (30-40cm)	Deeper subsoil (>40cm)
Gypsum rate to displace exc. Mg to below 15%.	2.30	9.96	11.81
Gypsum rate to displace exc. K to below 5% (t/Ha/100mm).	1.95	0.82	0.66

B.4 Analytical results

Table B-2. Melton East 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
ME1	Y	289145	5826401	130143171	Y	35	Loam	Dark Brown	5YR4/4	130143170	Y	Medium-Heavy Clay	Dark Red-Brown	5YR4/6		N				
ME2	Y	289661	5826387	130143174	Y	7	Loam	Grey-Brown	5YR4/2	130143173	Y	Heavy Clay	Dark Red-Brown	5YR4/6		N				
ME3	Y	290150	5826221	130143245	Y	17	Light Sandy Clay Loam	Dark Brown	5YR4/4	130143244	Y	Medium-Heavy Clay	Dark Red-Brown	5YR3/3	130143243	Y	120-130	Heavy Clay	Yellow-Grey	10YR6/3
ME4	Y	290190	5826631	130143247	Y	14	Light Sandy Clay Loam	Dark Brown	5YR4/4	130143246	Y	Medium-Heavy Clay	Dark Brown	5YR3/4		N				
ME5	Y	290661	5826372	130143250	Y	13	Light Sandy Clay Loam	Dark Brown	5YR4/4	130143249	Y	Medium-Heavy Clay	Dark Red-Brown	2.5YR3/3	130143248	Y	100-110	Medium-Heavy Clay	Dark Red-Brown	5YR3/4
ME6	Y	291340	5826484	130143256	Y	18	Clay Loam	Dark Red-Brown	5YR3/4	130143255	Y	Light-Medium Clay	Dark Red-Brown	2.5YR3/4		N				
ME7	Y	291370	5826221	130143202	Y	22	Loam	Dark Brown	5YR4/4	130143201	Y	Medium Clay	Dark Red-Brown	2.5YR3/3	130143200	Y	140-150	Medium-Heavy Clay	Yellow-Grey	10YR6/4
ME8	Y	291797	5826096	130143206	Y	30	Fine Sandy Loam	Grey-Brown	7.5YR3/4	130143208	Y	Medium-Heavy Clay	Dark Grey-Brown	7.5YR3/3	130143207	Y	140-150	Medium Clay	Grey	10YR4/2
ME9	Y	291945	5826083	130143205	Y	25	Loam	Dark Grey	10YR4/2	130143204	Y	Clay Loam	Dark Grey	10YR3/2	130143203	Y	130-140	Sandy Clay	Grey-Brown	7.5YR4/2
ME10	Y	290100	5825599	130143252	Y	18	Light Sandy Clay Loam	Dark Red-Brown	5YR3/4	130143251	Y	Medium-Heavy Clay	Dark Red-Brown	2.5YR3/4		N				
ME11	Y	290461	5825823	130143241	Y	20	Loam	Dark Brown	5YR3/4	130143242	Y	Heavy Clay	Dark Red-Brown	2.5YR3/4	130143240	Y	60-70	Heavy Clay	Brown	7.5YR4/6
ME12	Y	291158	5826000	130143254	Y	15	Sandy Clay Loam	Dark Brown	5YR4/6	130143253	Y	Light Clay	Dark Red-Brown	2.5YR4/6		N				
ME13	Y	291515	5825870	130143212	Y	17	Light Sandy Clay Loam	Dark Red-Brown	2.5YR3/4	130143211	Y	Light-Medium Clay	Dark Red-Brown	2.5YR4/4	130143210	Y	120-130	Medium Clay/Weathered Rock	Grey	10YR4/2
ME14	Y	291757	5825739	130143209	Y	10	Medium-Heavy Clay	Dark Red-Brown	5YR3/4							N				
ME15		289632	5825311													N				
ME16	Y	290076	5825151	130143180	Y	14	Light Sandy Clay Loam	Dark Brown	5YR4/3	130143179	Y	Light-Medium Clay	Dark Red-Brown	2.5YR3/4		N				
ME17	Y	290573	5825279	130143178	Y	15	Loam	Red-Brown	2.5YR4/4	130143177	Y	Light Clay	Dark Red-Brown	2.5YR4/6		N				
ME18	Y	291011	5825300	130143176	Y	25	Light Sandy Clay Loam	Dark Brown	5YR4/4	130143175	Y	Light-Medium Clay	Dark Red-Brown	5YR3/4		N				
ME19	Y	290209	5824760	130143182	Y	12	Loam	Dark Red-Brown	5YR4/4	130143181	Y	Light Clay	Dark Red-Brown	2.5YR4/6		N				
ME20	Y	291166	5824715	130143186	Y	7	Medium Clay	Dark Grey	10YR5/2	130143185	Y	Heavy Clay	Dark Grey	2.5Y5/1		N				
ME21	Y	291317	5824981	130143184	Y	18	Light Sandy Clay Loam	Dark Red-Brown	2.5YR3/3	130143183	Y	Light Clay	Dark Red-Brown	2.5YR3/4		N				
ME22	Y	291678	5824804	130143192	Y	25	Loam	Dark Brown	5YR4/4	130143191	Y	Medium Clay	Grey-Brown	5YR3/2	130143190	Y	90-100	Medium-Heavy Clay	Grey-Brown	5YR3/3
ME23	Y	292433	5824611	130143199	Y	20	Loam	Dark Brown	5YR3/4		N					N				
ME24	Y	293011	5824808	130143236	Y	13	Fine Sandy Loam	Grey-Brown	7.5YR5/4	130143235	Y	Medium-Heavy Clay	Yellow-Grey	10YR4/2	130143234	Y	140-150	Sandy Clay	Yellow-Grey	10YR3/3
ME25	Y	291028	5824233	130143189	Y	12	Loam	Dark Red-Brown	2.5YR3/4	130143188	Y	Medium Clay	Dark Red-Brown	2.5YR3/3	130143187	Y	140-150	Medium-Heavy Clay	Yellow-Brown	10YR5/4
ME26	Y	291576	5824430	130143195	Y	35	Loam	Dark Red-Brown	5YR4/4	130143194	Y	Medium Clay	Dark Brown	5YR3/4	130143193	Y	80-90	Medium-Heavy Clay	Dark Brown	7.5YR5/4
ME27	Y	292358	5824274	130143197	Y	30	Light Sandy Clay Loam	Dark Red-Brown	2.5YR4/4	130143198	Y	Light Clay	Dark Red-Brown	2.5YR3/4	130143196	Y	90-100	Heavy Clay	Dark Red-Brown	2.5YR3/3
ME28	Y	292973	5824322	130143233	Y	18	Sandy Loam	Brown	5YR4/4	130143232	Y	Light Clay	Dark Red-Brown	2.5YR3/4	130143231	Y	140-150	Medium Clay/Weathered Rock	Yellow-Grey	10YR5/3
ME29	Y	291646	5823577	130143216	Y	30	Light Clay	Dark Red-Brown	2.5YR3/4	130143215	Y	Sandy Clay	Brown	5YR5/6		N				
ME30	Y	291847	5824058	130143239	Y	18	Loam	Dark Brown	5YR3/4	130143238	Y	Heavy Clay	Dark Red-Brown	5YR3/3	130143237	Y	140-150	Medium Clay	Yellow-Grey-Brown	7.5YR5/4
ME31	Y	292132	5823811	130143214	Y	25	Loam	Dark Red-Brown	2.5YR4/4	130143213	Y	Light Sandy Clay Loam	Dark Red-Brown	2.5YR3/4		N				
ME32	Y	292525	5823846	130143224	Y	17	Loam	Dark Brown	5YR4/4	130143223	Y	Light Clay	Dark Red-Brown	2.5YR3/4		N				
ME33	Y	292852	5823626	130143226	Y	9	Light Sandy Clay Loam	Grey-Brown	10YR4/2	130143225	Y	Heavy Clay	Dark Grey	10YR5/2		N				
ME34	Y	293289	5823588	130143230	Y	15	Loam	Dark Brown	5YR4/4	130143230	Y	Light-Medium Clay	Dark Red-Brown	2.5YR3/4		N				
ME35	Y	291988	5823315	130143218	Y	40	Loam	Dark Brown	2.5YR4/4	130143217	Y	Loam	Brown	5YR4/4		N				
ME36	Y	292449	5823381	130143222	Y	20	Light Sandy Clay Loam	Dark Red-Brown	2.5YR4/4	130143221	Y	Light Clay	Dark Red-Brown	2.5YR4/6		N				
ME37	Y	292981	5823305	130143228	Y	30	Loam	Dark Brown	5YR4/4	130143227	Y	Light Clay	Dark Red-Brown	2.5YR3/4		N				
ME38	Y	292330	5823007	130143220	Y	40	Loam	Dark Red-Brown	2.5YR4/4	130143219	Y	Loam	Dark Red-Brown	2.5YR3/4		N				
ME39	Y	292647	5822839	130143258	Y	10	Fine Sandy Loam	Dark Brown	5YR3/3	130143257	Y	Light Clay	Dark Red-Brown	5YR3/4		N				
ME40	Y	293133	5822785	130143260	Y	12	Light Sandy Clay Loam	Dark Brown	5YR3/3	130143259	Y	Light-Medium Clay	Dark Red-Brown	5YR3/4		N			Dark Grey	

Table B-3. Melton East Field Sheet (Continued).

New Site Name	Slope	Aspect	Notes
ME1	Flat-Gentle Slope	North-West	Deep topsoil with bleached A2 horizon and buckshot. Saturated A2 horizon overlying clay subsoil.
ME2	Flat-Gently Undulating	North-East	Wet, flat poorly drained shalow topsoil over heavy clay. Site has poor drainage in comparison with other volcanic areas we have looked at.
ME3	Lower Slope - Drainage Depression		Site located in slight drainage line. Soil deeper over weathered rock. Sandstone and basalt at 1.3m.
ME4	Mid Slope (long planar)	South-East	Shallow soil over basalt, hit basalt at approximately 50cm.
ME5	Mid Slope	South	Refusal at 1.1m. Basalt throughout profile, increasing with depth.
ME6	Mid Slope	South West	Red volcanic duplex to gradational soil over basalt, shallow, refusal basalt at 50cm.
ME7	Gently Undulating - Flat Crest	South	Clay at depth contains CaC03. Red loam over red and yellow clay.
ME8	Flat	East	On floodplain. Note basalt outcrop/escarpment at valley margin.
ME9	Flat	East	Site core to 140cm, alluvial floodplain, some deep drainage in this profile.
ME10	Mid Slope	South East	Basalt throughout the upper profile, refusal at 40-50cm.
ME11	Mid Slope	East	Refusal on basalt at 70cm, basalt throughout the upper profile. Deep loam topsoil below dam.
ME12	Mid Slope	South	Basalt rock throughout upper profile, refusal at 40cm. Roots throughout all soil above basalt.
ME13	Mid-Upper Slope	South	Refusal at 130cm. Red volcanic soil, good ground cover.
ME14			Shallow soil over basalt rock. Site located 10m from escarpment.
ME15			NO SAMPLES. SITE NOT INSPECTED.
ME16	Mid Slope	South East	Red volcanic soil, well structured clay loam over light clay and medium clay subsoil. Hand augered.
ME17	Mid Slope	East	Red voLight Clayanic soil, loam over light clay.
ME18	Gently Undulating-Depression	South	Red voLight Clayanic soil, clay loam over light clay and medium clay clay. Hand augered.
ME19	Mid Slope-Undulating	East	Basalt gravel thoughout the profile, red volcanic loam over well strucured light clay.(Decomposed basalt rock with clay)
ME20	Flat-Lower Slope / Depression (Wetland)	North	Heavy clay, soils within wetland, poorly drained. Lignum within wetland.
ME21	Gently Undulating	South	Red volcanic clay loam and well structured light clay.
ME22	Lower Slope - Flat	South	Refusal at 100cm on rock.
ME23	Mid-Lower Slope	North-East	Shallow soil over weathered basalt rock at 20cm.
ME24	Lower Slope	North	High level floodplain of Koroirit Creek, deep grey alluvial soil.
ME25	Mid Slope-Gently Undulating	North	
ME26	Lower Slope / Drainage Line	North East	Refusal a 90cm (rock).
ME27	Mid-Upper Slope / Gently Sloping	East	Refusal at 100cm.Red volcanic soils.
ME28	Upper Slope- Undulating	North-East	Point located on rise, well drained loamy topsoil over light clay.
ME29	Mid Slope / Undulating	North	Light clay may have been spread on the surface, loamy from 10 to 30 cm and clay from 30 to 40cm.
ME30	Gently Undulating	South-East	Heavy clay to 1.3m overlying clay with sand and weathered rock from 1.3 to 1.5m.
ME31	Mid Slope-Undulating	North-East	Augered, undulating volcanic soils with deep loam topsoils. High ground cover.
ME32	Lower Slope	South	Red volcanic duplex loam over light clay, basalt at 40cm. Waterlogging throughout this area.
ME33	Depression/Wetland	North-East	Hand augered. Shallow duplex soil, grey loam over grey heavy clay. Alluvial.
ME34	Mid Slope	North-East	Hand augered. Duplex soil, loam over well structured dark red brown clay.
ME35	Mid-Upper Slope / Undulating	West	Hand augered. Deep loam topsoil, very pale bleached A2 from 30-40cm.
ME36	Mid-Slope	North	Hand augered, some basalt throughout the profle.
ME37	Mid-Upper Slope / Undulating	North-East	Hand augered, deep topsoil with very slight bleach at 25-30cm, light clay subsoil is well structured.
ME38	Upper Slope	North East	Deep loam on rising volcanics. Basalt outcrops,irregular spacing.
ME39	Mid Slope	North	Shallow soils over rock, refusal at 40cm. Full ground cover.
ME40	Mid Slope	South-West	Shallow soils over rock, refusal at 35cm. Large boulders. Good grass cover with weeds.

Table B-4. Melton East 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
			cm	cm				SESW Field Classification			dS/m	%				
130143171	ME1	ME1. 0-10	0	10	55H	289145	5826401	Loam	6.0	4.7	0.04	6.8	2	Moderate	8	Partial
130143174	ME2	ME2. 0-10	0	10	55H	289661	5826387	Loam	6.4	5.2	0.12	15.0	8	Complete	12	Water Stable
130143245	ME3	ME3. 0-10	0	10	55H	290150	5826221	Light Sandy Clay Loam	6.2	5.0	0.10	12.0	7	Strong	9	Water Stable
130143247	ME4	ME4. 0-10	0	10	55H	290190	5826631	Light Sandy Clay Loam	6.3	4.9	0.10	14.0	7	Complete	12	Water Stable
130143250	ME5	ME5. 0-10	0	10	55H	290661	5826372	Light Sandy Clay Loam	5.7	4.9	0.08	0.8	7	Moderate	6	Water Stable
130143256	ME6	ME6. 0-10	0	10	55H	291340	5826484	Clay Loam	5.6	4.6	0.06	1.1	7	Slight	4	Water Stable
130143202	ME7	ME7. 0-10	0	10	55H	291370	5826221	Loam	6.1	5.4	0.09	10.0	2	Moderate	5	Partial
130143206	ME8	ME8. 0-10	0	10	55H	291797	5826096	Fine Sandy Loam	6.0	5.0	0.06	1.8	7	Slight	3	Water Stable
130143205	ME9	ME9. 0-10	0	10	55H	289632	5825811	Loam	6.4	5.6	0.08	0.8	7	Slight	2	Water Stable
130143252	ME10	ME10. 0-10	0	10	55H	290100	5825599	Light Sandy Clay Loam	6.0	4.9	0.05	2.7	7	Moderate	6	Water Stable
130143241	ME11	ME11. 0-10	0	10	55H	290649	5825758	Loam	6.0	5.0	0.06	2.4	7	Moderate	5	Water Stable
130143254	ME12	ME12. 0-10	0	10	55H	291158	5826000	Sandy Clay Loam	5.8	5.0	0.09	1.1	7	Slight	4	Water Stable
130143212	ME13	ME13. 0-10	0	10	55H	291515	5825870	Light Sandy Clay Loam	5.5	4.5	0.06	1.2	7	Strong	8	Water Stable
130143209	ME14	ME14. 0-10	0	10	55H	291771	5825731	Medium-Heavy Clay	6.7	6.1	0.09	1.0	7	Moderate	5	Water Stable
130143180	ME16	ME16. 0-10	0	10	55H	290076	5825151	Light Sandy Clay Loam	6.5	5.0	0.07	17.0	2	Complete	12	Partial
130143178	ME17	ME17. 0-10	0	10	55H	290573	5825279	Loam	5.7	4.8	0.06	1.4	7	Slight	4	Water Stable
130143176	ME18	ME18. 0-10	0	10	55H	291011	5825300	Light Sandy Clay Loam	6.2	5.3	0.09	0.9	2	Moderate	6	Partial
130143182	ME19	ME19. 0-10	0	10	55H	290209	5824760	Loam	5.7	4.6	0.04	2.2	7	Slight	4	Water Stable
130143186	ME20	ME20. 0-10	0	10	55H	291166	5824715	Medium Clay	6.0	4.5	0.07	7.2	7	Strong	11	Water Stable
130143184	ME21	ME21. 0-10	0	10	55H	291317	5824981	Light Sandy Clay Loam	5.2	4.4	0.03	1.0	7	Slight	3	Water Stable
130143192	ME22	ME22. 0-10	0	10	55H	291678	5824804	Loam	5.9	5.1	0.06	1.1	7	Slight	2	Water Stable
130143199	ME23	ME23. 0-10	0	10	55H	292433	5824611	Loam	7.2	6.4	0.08	4.2	7	Slight	4	Water Stable
130143236	ME24	ME24. 0-10	0	10	55H	293011	5824808	Fine Sandy Loam	6.7	5.9	0.12	9.6	7	Complete	9	Water Stable
130143189	ME25	ME25. 0-10	0	10	55H	291028	5824233	Loam	6.0	5.0	0.18	13.0	7	Moderate	7	Water Stable
130143195	ME26	ME26. 0-10	0	10	55H	291593	5824377	Loam	5.6	4.6	0.04	1.4	7	Slight	3	Water Stable
130143197	ME27	ME27. 0-10	0	10	55H	292275	5824264	Light Sandy Clay Loam	6.2	5.3	0.07	0.9	7	Moderate	6	Water Stable
130143233	ME28	ME28. 0-10	0	10	55H	292973	5824322	Sandy Loam	6.5	5.8	0.30	13.0	7	Complete	9	Water Stable
130143216	ME29	ME29. 0-10	0	10	55H	291646	5823577	Light Clay	6.4	5.2	0.06	5.0	2	Strong	10	Partial
130143239	ME30	ME30. 0-10	0	10	55H	291875	5823903	Loam	6.3	5.2	0.08	6.1	7	Strong	9	Water Stable
130143214	ME31	ME31. 0-10	0	10	55H	292132	5823811	Loam	5.3	4.3	0.04	0.7	7	Slight	3	Water Stable
130143224	ME32	ME32. 0-10	0	10	55H	292525	5823846	Loam	6.5	5.5	0.07	2.2	2	Moderate	7	Partial
130143226	ME33	ME33. 0-10	0	10	55H	292852	5823626	Light Sandy Clay Loam	5.6	4.6	0.12	6.4	2	Strong	12	Partial
130143230	ME34	ME34. 0-10	0	10	55H	293289	5823588	Loam	5.6	4.5	0.06	3.0	3	Moderate	5	Partial
130143218	ME35	ME35. 0-10	0	10	55H	291988	5823315	Loam	5.5	4.5	0.06	1.4	7	Moderate	5	Water Stable
130143222	ME36	ME36. 0-10	0	10	55H	292449	5823381	Light Sandy Clay Loam	5.7	4.8	0.08	1.5	7	Slight	4	Water Stable
130143228	ME37	ME37. 0-10	0	10	55H	292981	5823305	Loam	5.1	4.2	0.07	1.5	7	Moderate	5	Water Stable
130143220	ME38	ME38. 0-10	0	10	55H	292330	5823007	Loam	5.3	4.4	0.08	1.4	3	Slight	3	Partial
130143258	ME39	ME39. 0-10	0	10	55H	292647	5822839	Fine Sandy Loam	6.3	5.4	0.09	3.2	7	Strong	8	Water Stable
130143260	ME40	ME40. 0-10	0	10	55H	293133	5822785	Light Sandy Clay Loam	6.1	5.2	0.08	1.9	2	Slight	4	Partial

Table B-5. Melton East 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)	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)
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	%	%	%	%		SESW Calculation	%	%	mg/kg				
130143171	ME1	ME1. 0-10	500	206	223	83	23	2.5	1.7	0.57	0.36	0.3	5.4	47	31	11	4.7	1.5	17.8	1.2	2.0	220	Moderate	Moderate	Moderate	Moderate
130143174	ME2	ME2. 0-10	800	569	626	414	9	4	4.7	1.6	1.8	0.1	12.1	33	38	13	1	0.9	28.0	2.5	4.4	630	Moderate	Moderate	Complete	Complete
130143245	ME3	ME3. 0-10	660	315	469	228	14	3.3	2.6	1.2	0.99	0.2	8.2	40	31	14	1.9	1.3	26.0	2.3	3.9	460	Moderate	Moderate	Moderate	Strong
130143247	ME4	ME4. 0-10	660	520	665	368	14	3.3	4.3	1.7	1.6	0.2	11	30	39	15	1.4	0.8	29.0	2.2	3.8	650	Moderate	Moderate	Complete	Complete
130143250	ME5	ME5. 0-10	860	206	782	14	22	4.3	1.7	2	0.06	0.3	8.3	51	21	24	3	2.5	24.8	2.1	3.6	790	Slight	Slight	Moderate	Moderate
130143256	ME6	ME6. 0-10	920	242	547	23	42	4.6	2	1.4	0.1	0.5	8.6	54	24	16	5.4	2.3	17.1	2.2	3.8	540	Slight	Slight	Slight	Slight
130143202	ME7	ME7. 0-10	1120	339	547	253	9	5.6	2.8	1.4	1.1	0.1	10.9	52	25	12	1	2	22.0	3.2	5.5	530	Slight	Slight	Slight	Moderate
130143206	ME8	ME8. 0-10	1340	303	430	44	9	6.7	2.5	1.1	0.19	0.1	10.5	63	24	11	1	2.7	12.8	2.2	3.8	430	Nil	Slight	Slight	Slight
130143205	ME9	ME9. 0-10	1920	593	293	30	9	9.6	4.9	0.75	0.13	0.1	15.4	63	32	4.9	1	2	5.7	2.7	4.6	290	Nil	Slight	Nil	Slight
130143252	ME10	ME10. 0-10	740	327	587	53	15	3.7	2.7	1.5	0.23	0.2	8.3	45	33	18	2	1.4	20.7	1.5	2.5	580	Slight	Slight	Moderate	Moderate
130143241	ME11	ME11. 0-10	880	266	547	46	13	4.4	2.2	1.4	0.2	0.1	8.3	53	26	17	1.7	2	19.4	2.1	3.5	560	Slight	Slight	Slight	Moderate
130143254	ME12	ME12. 0-10	1080	303	626	23	15	5.4	2.5	1.6	0.1	0.2	9.8	55	25	17	1.7	2.2	18.1	2.6	4.5	640	Slight	Slight	Slight	Slight
130143212	ME13	ME13. 0-10	780	194	626	21	73	3.9	1.6	1.6	0.09	0.8	7.9	49	20	20	10	2.4	21.2	2.2	3.8	620	Slight	Slight	Strong	Strong
130143209	ME14	ME14. 0-10	2000	690	899	44	9	10	5.7	2.3	0.19	0.1	18.2	55	31	13	1	1.8	14.0	2.3	4.0	900	Slight	Slight	Slight	Moderate
130143180	ME16	ME16. 0-10	400	218	508	253	16	2	1.8	1.3	1.1	0.2	6.4	32	28	21	2.8	1.1	38.0	1.2	2.0	520	Moderate	Moderate	Complete	Complete
130143178	ME17	ME17. 0-10	1100	315	547	32	20	5.5	2.6	1.4	0.14	0.2	9.8	56	26	14	2.2	2.1	15.4	2.4	4.2	550	Slight	Slight	Slight	Slight
130143176	ME18	ME18. 0-10	1460	375	1095	25	9	7.3	3.1	2.8	0.11	0.1	13.3	55	23	21	1	2.4	21.9	2.6	4.5	1,100	Slight	Moderate	Slight	Moderate
130143182	ME19	ME19. 0-10	680	266	469	39	38	3.4	2.2	1.2	0.17	0.4	7.4	46	30	16	5.6	1.5	18.2	1.4	2.5	480	Slight	Slight	Slight	Slight
130143186	ME20	ME20. 0-10	1440	871	860	299	56	7.2	7.2	2.2	1.3	0.6	18.6	39	39	12	3.3	1	19.2	2.8	4.7	860	Strong	Strong	Moderate	Strong
130143184	ME21	ME21. 0-10	660	218	821	21	120	3.3	1.8	2.1	0.09	1.3	8.7	38	21	24	15	1.8	25.0	2.7	4.7	810	Nil	Slight	Slight	Slight
130143192	ME22	ME22. 0-10	1000	278	508	23	9.5	5	2.3	1.3	0.1	0.1	8.8	57	26	15	1.2	2.2	16.1	1.5	2.6	520	Nil	Nil	Slight	Slight
130143199	ME23	ME23. 0-10	1780	424	368	133	9	8.9	3.5	0.94	0.58	0.1	13.9	64	26	6.8	1	2.5	11.0	1.8	3.1	370	Slight	Slight	Slight	Slight
130143236	ME24	ME24. 0-10	1080	617	242	276	9	5.4	5.1	0.62	1.2	0.1	12.3	44	41	5.1	1	1.1	14.7	2.1	3.6	240	Slight	Slight	Strong	Complete
130143189	ME25	ME25. 0-10	740	242	626	253	11	3.7	2	1.6	1.1	0.1	8.6	44	23	19	1.4	1.9	32.0	2.1	3.5	630	Slight	Slight	Moderate	Moderate
130143195	ME26	ME26. 0-10	620	194	469	21	28	3.1	1.6	1.2	0.09	0.3	6.2	49	25	19	5	1.9	20.4	1.4	2.5	470	Nil	Slight	Slight	Slight
130143197	ME27	ME27. 0-10	960	290	704	18	9	4.8	2.4	1.8	0.08	0.1	9.1	53	26	20	1	2	20.9	2.2	3.8	700	Slight	Slight	Moderate	Moderate
130143233	ME28	ME28. 0-10	860	448	1017	345	9	4.3	3.7	2.6	1.5	0.1	12.2	36	31	21	1	1.2	34.0	1.9	3.3	1,000	Slight	Slight	Strong	Complete
130143216	ME29	ME29. 0-10	820	339	704	104	9	4.1	2.8	1.8	0.45	0.1	9.1	45	30	20	1	1.5	25.0	1.5	2.5	700	Moderate	Moderate	Strong	Strong
130143239	ME30	ME30. 0-10	660	315	626	113	9	3.3	2.6	1.6	0.49	0.1	7.9	42	32	20	1	1.3	26.1	1.8	3.2	620	Slight	Moderate	Strong	Strong
130143214	ME31	ME31. 0-10	500	182	508	12	96	2.5	1.5	1.3	0.05	1.1	6.4	39	24	20	17	1.7	20.7	1.3	2.2	500	Nil	Slight	Slight	Slight
130143224	ME32	ME32. 0-10	1420	278	665	58	9	7.1	2.3	1.7	0.25	0.1	11.4	62	21	15	1	3.1	17.2	1.7	2.9	670	Moderate	Moderate	Slight	Moderate
130143226	ME33	ME33. 0-10	1060	520	547	177	26	5.3	4.3	1.4	0.77	0.3	12	44	36	12	2.4	1.2	18.4	2.6	4.5	540	Strong	Strong	Strong	Strong
130143230	ME34	ME34. 0-10	520	230	587	46	54	2.6	1.9	1.5	0.2	0.6	6.8	39	28	22	8.8	1.4	25.0	1.5	2.6	580	Nil	Slight	Moderate	Moderate
130143218	ME35	ME35. 0-10	540	194	626	23	61	2.7	1.6	1.6	0.1	0.7	6.7	41	23	24	10	1.7	25.4	1.8	3.0	630	Nil	Slight	Moderate	Moderate
130143222	ME36	ME36. 0-10	900	230	782	30	21	4.5	1.9	2	0.13	0.2	8.8	52	22	23	2.7	2.4	24.5	2.1	3.6	770	Slight	Slight	Slight	Slight
130143228	ME37	ME37. 0-10	660	206	665	28	150	3.3	1.7	1.7	0.12	1.7	8.5	39	20	20	20	1.9	21.5	1.7	2.9	650	Slight	Slight	Slight	Moderate
130143220	ME38	ME38. 0-10	740	218	782	28	68	3.7	1.8	2	0.12	0.8	8.4	44	22	24	9	2.1	25.4	1.6	2.7	780	Nil	Slight	Slight	Slight
130143258	ME39	ME39. 0-10	920	242	821	64	9	4.6	2	2.1	0.28	0.1	8.9	51	22	23	1	2.3	26.2	1.6	2.8	820	Slight	Slight	Strong	Strong
130143260	ME40	ME40. 0-10	1020	290	743	44	9	5.1	2.4	1.9	0.19	0.1	9.7	53	25	20	1	2.1	21.9	2.3	4.0	760	Slight	Slight	Slight	Slight

Table B-6. Melton East 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
			cm	cm				SESW Field Classification			dS/m	%				
130143170	ME1	ME1. 30-40	30	40	55H	289145	5826401	Medium-Heavy Clay	7.7	6.1	0.09	25.0	1	Complete	16	Partial
130143173	ME2	ME2. 30-40	30	40	55H	289661	5826387	Heavy Clay	8.3	7.2	0.40	6.7	2	Complete	13	Partial
130143244	ME3	ME3. 30-40	30	40	55H	290150	5826221	Medium-Heavy Clay	8.7	8.2	0.82	6.8	7	Strong	13	Water Stable
130143246	ME4	ME4. 30-40	30	40	55H	290190	5826631	Medium-Heavy Clay	8.5	7.5	0.60	8.2	7	Complete	14	Water Stable
130143249	ME5	ME5. 30-40	30	40	55H	290661	5826372	Medium-Heavy Clay	6.9	6.0	0.10	6.0	2	Nil	2	Partial
130143255	ME6	ME6. 30-40	30	40	55H	291340	5826484	Light-Medium Clay	7.0	6.1	0.12	4.7	7	Nil	1	Water Stable
130143201	ME7	ME7. 30-40	30	40	55H	291370	5826221	Medium Clay	6.8	5.6	0.17	25.0	2	Strong	12	Partial
130143208	ME8	ME8. 30-40	30	40	55H	291797	5826096	Medium-Heavy Clay	7.3	6.2	0.07	5.7	2	Strong	9	Partial
130143204	ME9	ME9. 30-40	30	40	55H	289632	5825811	Clay Loam	7.7	6.7	0.06	3.5	2	Complete	10	Partial
130143251	ME10	ME10. 30-40	30	40	55H	290100	5825599	Medium-Heavy Clay	7.6	7.1	0.31	3.4	2	Nil	4	Partial
130143242	ME11	ME11. 30-40	30	40	55H	290649	5825758	Heavy Clay	7.9	7.3	0.24	7.7	1	Complete	15	Partial
130143253	ME12	ME12. 30-40	30	40	55H	291158	5826000	Light Clay	7.1	6.0	0.06	3.5	2	Nil	2	Partial
130143211	ME13	ME13. 30-40	30	40	55H	291515	5825870	Light-Medium Clay	6.9	5.9	0.07	3.8	2	Slight	4	Partial
130143179	ME16	ME16. 30-40	30	40	55H	290076	5825151	Light-Medium Clay	7.1	5.6	0.09	19.0	2	Complete	14	Partial
130143177	ME17	ME17. 30-40	30	40	55H	290573	5825279	Light Clay	6.7	5.7	0.07	3.5	2	Moderate	6	Partial
130143175	ME18	ME18. 30-40	30	40	55H	291011	5825300	Light-Medium Clay	7.5	6.2	0.07	12.0	2	Complete	14	Partial
130143181	ME19	ME19. 30-40	30	40	55H	290209	5824760	Light Clay	7.1	6.1	0.03	6.4	2	Moderate	6	Partial
130143185	ME20	ME20. 30-40	30	40	55H	291166	5824715	Heavy Clay	6.3	5.0	0.14	13.0	1	Complete	14	Partial
130143183	ME21	ME21. 30-40	30	40	55H	291317	5824981	Light Clay	7.0	6.0	0.07	2.4	2	Nil	2	Partial
130143191	ME22	ME22. 30-40	30	40	55H	291678	5824804	Medium Clay	7.2	6.3	0.07	3.2	6	Nil	0	Partial
130143235	ME24	ME24. 30-40	30	40	55H	293011	5824808	Medium-Heavy Clay	8.5	7.8	1.05	6.5	3	Slight	3	Partial
130143188	ME25	ME25. 30-40	30	40	55H	291028	5824233	Medium Clay	6.9	5.6	0.09	16.0	2	Strong	12	Partial
130143194	ME26	ME26. 30-40	30	40	55H	291593	5824377	Medium Clay	7.2	6.4	0.10	3.3	8	Nil	2	Water Stable
130143198	ME27	ME27. 30-40	30	40	55H	292275	5824264	Light Clay	6.8	6.0	0.08	1.6	6	Nil	0	Considerable
130143232	ME28	ME28. 30-40	30	40	55H	292973	5824322	Light Clay	7.8	7.1	0.74	4.3	2	Moderate	8	Partial
130143215	ME29	ME29. 30-40	30	40	55H	291646	5823577	Sandy Clay	7.2	6.0	0.06	5.9	2	Strong	8	Partial
130143238	ME30	ME30. 30-40	30	40	55H	291875	5823903	Heavy Clay	6.8	5.7	0.16	19.0	2	Complete	13	Partial
130143213	ME31	ME31. 30-40	30	40	55H	292132	5823811	Light Sandy Clay Loam	6.9	5.7	0.05	7.2	2	Strong	12	Partial
130143223	ME32	ME32. 30-40	30	40	55H	292525	5823846	Light Clay	7.5	6.6	0.07	1.8	2	Nil	2	Partial
130143225	ME33	ME33. 30-40	30	40	55H	292852	5823626	Heavy Clay	6.4	5.7	0.45	20.0	1	Complete	14	Partial
130143229	ME34	ME34. 30-40	30	40	55H	293289	5823588	Light-Medium Clay	7.2	5.9	0.11	17.0	2	Complete	13	Partial
130143217	ME35	ME35. 30-40	30	40	55H	291988	5823315	Loam	6.9	5.8	0.04	3.0	2	Nil	2	Partial
130143221	ME36	ME36. 30-40	30	40	55H	292449	5823381	Light Clay	7.3	6.4	0.09	4.2	2	Nil	2	Partial
130143227	ME37	ME37. 30-40	30	40	55H	292981	5823305	Light Clay	7.0	6.1	0.08	3.9	3	Slight	2	Partial
130143219	ME38	ME38. 30-40	30	40	55H	292330	5823007	Loam	6.8	6.0	0.11	5.1	3	Slight	3	Partial
130143257	ME39	ME39. 30-40	30	40	55H	292647	5822839	Light Clay	7.4	6.4	0.09	5.8	3	Moderate	5	Partial
130143259	ME40	ME40. 30-40	30	40	55H	293133	5822785	Light-Medium Clay	7.6	6.5	0.07	4.8	2	Moderate	6	Partial

Table B-7. Melton East 30-40cm Sample Analytical Results (Continued).

Sample ID	Site	Magnesium (Amm-acet.)	Potassium (Amm-acet.)	Sodium (Amm-acet.)	Aluminium (KCl)	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)
		mg/kg	mg/kg	mg/kg	mg/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	%	%	%	%		SESW Calculation	%	%	mg/kg				
130143170	ME1	1137	547	1035	9	3	9.4	1.4	4.5	0.1	18.4	17	51	7.4	1	0.3	32.4	0.5	0.9	540	Complete	Complete	Complete	Complete
130143173	ME2	1573	821	345	9	6.1	13	2.1	1.5	0.1	22.5	27	57	9.5	1	0.5	16.2	1.3	2.2	840	Strong	Strong	Strong	Complete
130143244	ME3	1936	899	460	9	9.1	16	2.3	2	0.1	29.3	31	54	7.7	1	0.6	14.5	0.4	0.7	880	Strong	Complete	Strong	Strong
130143246	ME4	2057	860	506	9	5.4	17	2.2	2.2	0.1	26.4	20	63	8.5	1	0.3	16.7	0.7	1.2	870	Strong	Complete	Strong	Complete
130143249	ME5	1162	293	276	9	8.1	9.6	0.75	1.2	0.1	19.6	42	49	3.8	1	0.8	9.8	1.0	1.7	290	Slight	Slight	Nil	Nil
130143255	ME6	980	293	223	9	11	8.1	0.75	0.97	0.1	20.9	53	39	3.6	1	1.4	8.3	1.3	2.3	290	Nil	Slight	Nil	Nil
130143201	ME7	762	587	874	9	3.6	6.3	1.5	3.8	0.1	15.1	24	42	9.9	1	0.6	34.9	0.9	1.6	590	Strong	Strong	Strong	Strong
130143208	ME8	629	129	184	9	7.8	5.2	0.33	0.8	0.1	14.1	55	37	2.4	1	1.5	8.1	0.8	1.4	130	Slight	Strong	Moderate	Strong
130143204	ME9	944	125	163	9	11	7.8	0.32	0.71	0.1	20.3	56	38	1.6	1	1.4	5.1	1.3	2.2	130	Slight	Moderate	Strong	Complete
130143251	ME10	1573	665	276	9	19	13	1.7	1.2	0.1	34.7	54	38	5	1	1.5	8.4	0.9	1.6	680	Moderate	Moderate	Nil	Nil
130143242	ME11	1210	587	322	9	4.5	10	1.5	1.4	0.1	17.9	25	59	8.6	1	0.5	16.3	0.9	1.5	600	Complete	Complete	Strong	Complete
130143253	ME12	895	340	136	9	7.8	7.4	0.87	0.59	0.1	16.7	47	44	5.2	1	1.1	8.7	1.3	2.2	340	Slight	Slight	Nil	Nil
130143211	ME13	968	430	152	35	7.4	8	1.1	0.66	0.4	17.5	42	45	6.5	2.2	0.9	10.3	0.7	1.2	440	Slight	Slight	Slight	Slight
130143179	ME16	932	782	759	9	3.8	7.7	2	3.3	0.1	16.9	23	46	12	1	0.5	31.0	0.7	1.2	800	Strong	Strong	Complete	Complete
130143177	ME17	871	626	140	9	8	7.2	1.6	0.61	0.1	17.4	46	41	8.9	1	1.1	12.4	1.2	2.0	610	Slight	Slight	Moderate	Moderate
130143175	ME18	932	860	483	9	5.8	7.7	2.2	2.1	0.1	17.8	33	43	12	1	0.8	24.0	0.8	1.4	850	Strong	Strong	Complete	Complete
130143181	ME19	762	219	214	9	6.7	6.3	0.56	0.93	0.1	14.5	46	44	3.8	1	1.1	10.2	1.0	1.7	220	Slight	Slight	Moderate	Moderate
130143185	ME20	1452	743	828	16	9.8	12	1.9	3.6	0.2	27.7	35	44	6.7	0.7	0.8	19.7	0.6	1.0	730	Strong	Complete	Strong	Complete
130143183	ME21	799	704	90	9	7.7	6.6	1.8	0.39	0.1	16.6	47	40	11	1	1.2	13.4	1.1	1.8	710	Slight	Slight	Nil	Nil
130143191	ME22	835	203	131	9	9.9	6.9	0.52	0.57	0.1	17.9	56	38	2.9	1	1.4	6.1	0.9	1.5	200	Nil	Nil	Nil	Nil
130143235	ME24	1331	203	368	9	11	11	0.52	1.6	0.1	24.6	46	46	2.1	1	1	8.6	0.6	1.0	200	Nil	Slight	Slight	Slight
130143188	ME25	581	508	460	9	4.4	4.8	1.3	2	0.1	12.5	35	39	11	1	0.9	27.0	0.8	1.4	520	Strong	Strong	Strong	Strong
130143194	ME26	932	587	143	9	8.9	7.7	1.5	0.62	0.1	18.8	48	41	8	1	1.2	11.3	0.8	1.3	590	Slight	Slight	Nil	Nil
130143198	ME27	835	587	62	9	8.3	6.9	1.5	0.27	0.1	16.9	49	41	8.8	1	1.2	10.4	0.9	1.5	580	Nil	Nil	Nil	Nil
130143232	ME28	1573	821	253	9	8.7	13	2.1	1.1	0.1	25	35	52	8.4	1	0.7	12.7	0.8	1.3	820	Moderate	Moderate	Moderate	Moderate
130143215	ME29	871	665	221	16	6.2	7.2	1.7	0.96	0.2	16.3	38	44	11	1.1	0.9	16.9	0.9	1.5	670	Slight	Moderate	Moderate	Strong
130143238	ME30	750	743	667	9	4.4	6.2	1.9	2.9	0.1	15.4	29	40	12	1	0.7	31.0	1.0	1.8	720	Strong	Strong	Strong	Complete
130143213	ME31	472	215	150	9	3.9	3.9	0.55	0.65	0.1	9	43	43	6.1	1	1	13.3	0.8	1.4	220	Strong	Strong	Strong	Strong
130143223	ME32	956	364	104	9	17	7.9	0.93	0.45	0.1	25.7	64	31	3.6	1	2.2	5.4	1.1	1.9	360	Slight	Slight	Nil	Nil
130143225	ME33	1210	587	1150	9	8.4	10	1.5	5	0.1	25.2	33	41	5.9	1	0.8	25.9	0.7	1.2	580	Strong	Complete	Strong	Complete
130143229	ME34	1125	704	736	9	4.2	9.3	1.8	3.2	0.1	18.6	23	50	9.8	1	0.5	26.8	0.7	1.2	710	Strong	Strong	Strong	Complete
130143217	ME35	520	379	78	12	5.5	4.3	0.97	0.34	0.1	11.2	49	38	8.6	1.2	1.3	11.6	0.9	1.6	380	Slight	Slight	Nil	Nil
130143221	ME36	871	297	159	9	7.7	7.2	0.76	0.69	0.1	16.4	47	44	4.7	1	1.1	8.9	0.9	1.5	300	Slight	Slight	Nil	Nil
130143227	ME37	895	430	166	9	9.3	7.4	1.1	0.72	0.1	18.5	50	40	6	1	1.3	9.9	1.0	1.7	430	Nil	Slight	Nil	Slight
130143219	ME38	678	430	159	9	6.3	5.6	1.1	0.69	0.1	13.6	46	41	8.1	1	1.1	13.2	1.0	1.6	430	Nil	Slight	Slight	Slight
130143257	ME39	750	430	200	9	6.8	6.2	1.1	0.87	0.1	15	45	41	7.5	1	1.1	13.3	0.9	1.5	440	Nil	Slight	Moderate	Moderate
130143259	ME40	1065	508	216	9	8.5	8.8	1.3	0.94	0.1	19.5	44	45	6.6	1	1	11.4	1.1	1.8	500	Slight	Slight	Moderate	Moderate

Table B-8. Melton East >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
			cm	cm				SESW Field Classification			dS/m	%				
130143243	ME3	ME3. 120-130	120	130	55H	290150	5826221	Heavy Clay	9.2	8.3	1.23	14.0	2	Strong	12	Partial
130143248	ME5	ME5. 100-110	100	110	55H	290661	5826372	Medium-Heavy Clay	7.2	6.5	0.24	6.9	2	Slight	5	Partial
130143200	ME7	ME7. 140-150	140	150	55H	291370	5826221	Medium-Heavy Clay	9.5	8.1	0.82	6.0	8	Strong	12	Water Stable
130143207	ME8	ME8. 140-150	140	150	55H	291797	5826096	Medium Clay	9.0	7.6	0.13	13.0	7	Strong	12	Water Stable
130143203	ME9	ME9. 130-140	130	140	55H	289632	5825811	Sandy Clay	8.1	6.9	0.06	4.7	3	Strong	7	Partial
130143240	ME11	ME11. 60-70	60	70	55H	290649	5825758	Heavy Clay	8.4	7.5	0.49	7.3	1	Complete	14	Partial
130143210	ME13	ME13. 120-130	120	130	55H	291515	5825870	Medium Clay/Weathered Rock	8.6	7.9	0.27	4.4	2	Nil	2	Partial
130143190	ME22	ME22. 90-100	90	100	55H	291678	5824804	Medium-Heavy Clay	8.1	7.6	0.29	2.6	6	Nil	0	Partial
130143234	ME24	ME24. 140-150	140	150	55H	293011	5824808	Sandy Clay	8.7	8.2	1.63	8.4	6	Nil	0	Considerable
130143187	ME25	ME25. 140-150	140	150	55H	291028	5824233	Medium-Heavy Clay	9.2	8.1	0.47	5.2	2	Strong	12	Partial
130143193	ME26	ME26. 80-90	80	90	55H	291593	5824377	Medium-Heavy Clay	7.6	6.8	0.13	4.4	8	Moderate	6	Water Stable
130143196	ME27	ME27. 90-100	90	100	55H	292275	5824264	Heavy Clay	8.2	7.7	0.24	0.9	6	Nil	0	Partial
130143231	ME28	ME28. 140-150	140	150	55H	292973	5824322	Medium Clay/Weathered Rock	9.2	8.5	1.21	5.2	2	Nil	4	Partial
130143237	ME30	ME30. 140-150	140	150	55H	291875	5823903	Medium Clay	9.0	7.8	0.71	4.5	8	Strong	11	Water Stable

Table B-9. Melton East >40cm Sample Analytical Results (Continued).

ple ID	Site	Sample Name	Calcium (Amm-acet.)	Magnesium (Amm-acet.)	Potassium (Amm-acet.)	Sodium (Amm-acet.)	Aluminium (KCl)	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)
			mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	cmol(+)/kg	%	%	%	%		SESW Calculation	%	%	mg/kg				
130143243	ME3	ME3. 120-130	2600	472	978	736	9	13	3.9	2.5	3.2	0.1	22.3	57	18	11	1	3.3	25.0	0.2	0.3	980	Strong	Strong	Strong	Strong
130143248	ME5	ME5. 100-110	1900	1573	469	414	9	9.5	13	1.2	1.8	0.1	25.9	37	52	4.7	1	0.7	11.6	0.4	0.7	470	Slight	Moderate	Slight	Slight
130143200	ME7	ME7. 140-150	3400	1573	860	483	9	17	13	2.2	2.1	0.1	34.1	49	39	6.3	1	1.3	12.3	0.2	0.3	840	Strong	Strong	Strong	Strong
130143207	ME8	ME8. 140-150	1240	774	152	460	9	6.2	6.4	0.39	2	0.1	15.1	41	42	2.6	1	1	15.6	0.2	0.3	150	Strong	Strong	Strong	Strong
130143203	ME9	ME9. 130-140	1560	799	109	163	9	7.8	6.6	0.28	0.71	0.1	15.3	51	43	1.9	1	1.2	6.6	0.4	0.6	110	Nil	Slight	Strong	Strong
130143240	ME11	ME11. 60-70	1300	1452	626	368	9	6.5	12	1.6	1.6	0.1	21.7	30	56	7.3	1	0.5	14.6	0.8	1.4	620	Strong	Complete	Strong	Complete
130143210	ME13	ME13. 120-130	3000	1452	587	299	9	15	12	1.5	1.3	0.1	30.5	50	41	5	1	1.3	9.4	0.2	0.3	590	Slight	Slight	Nil	Nil
130143190	ME22	ME22. 90-100	4000	1089	364	184	9	20	9	0.93	0.8	0.1	31.2	65	29	3	1	2.2	5.6	0.4	0.7	360	Nil	Nil	Nil	Nil
130143234	ME24	ME24. 140-150	1900	1137	188	414	9	9.5	9.4	0.48	1.8	0.1	21.3	45	44	2.3	1	1	10.7	0.2	0.3	190	Nil	Nil	Nil	Nil
130143187	ME25	ME25. 140-150	1960	1694	1056	322	9	9.8	14	2.7	1.4	0.1	27.8	35	50	9.7	1	0.7	14.9	0.2	0.3	1,100	Strong	Strong	Strong	Strong
130143193	ME26	ME26. 80-90	1920	1331	743	230	9	9.6	11	1.9	1	0.1	23.5	41	47	8.1	1	0.9	12.5	0.5	0.9	750	Slight	Slight	Moderate	Moderate
130143196	ME27	ME27. 90-100	5200	1210	665	78	9	26	10	1.7	0.34	0.1	38.1	68	26	4.5	1	2.6	5.4	0.3	0.5	670	Nil	Nil	Nil	Nil
130143231	ME28	ME28. 140-150	3400	1694	587	414	9	17	14	1.5	1.8	0.1	33.7	50	41	4.3	1	1.2	9.5	0.2	0.3	570	Moderate	Moderate	Nil	Nil
130143237	ME30	ME30. 140-150	3400	1815	1017	368	9	17	15	2.6	1.6	0.1	36.2	48	41	7.3	1	1.1	11.8	0.3	0.6	1,000	Moderate	Strong	Strong	Strong

Table B-10. 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