# Victorian Murray Floodplain Restoration Project

## Desktop Groundwater Assessment - Vinifera

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# Executive Summary

The Vinifera project site is underlain by shallow groundwater, of good quality that is in direct connection to the Murray River. Due to the location of the project and surrounding land use, there are no groundwater users in the vicinity that may be affected. The beneficial uses to be protected are, thus, focussed on groundwater support of the environment and cultural values.

Construction of the project works may require groundwater dewatering and disposal of pumped groundwater. If this is the case, then minor impacts on adjacent vegetation and ecosystems are possible. This can be mitigated by planning construction to minimise dewatering and to provide watering for any ecosystems that may experience lowered groundwater levels.

Operation of the proposed works will result in elevated groundwater levels, wetting of soils and potentially mobilised salt from the unsaturated soil store. This could result in the displacement of salt to the Murray River and increased evapotranspiration of water from the floodplain, potentially concentrating salts in the soil. However, given the very low salt store in the project area and the generally fresh groundwater, these issues are regarded as being very low risk. Monitoring of flooding patterns and adaptive management of flooding to minimise waterlogging is expected to satisfactorily control this potential risk.

Beneficial uses of groundwater are not expected to be adversely affected by operation.

There are no groundwater users within the extent of expected impacts.

## Important note about your report

The purpose of R8's engagement under the Victorian Murray Floodplain Restoration Project (VMFRP) is to design infrastructure for the VMFRP including regulators, levees, roads, access tracks and culverts. Once constructed, Lower Murray Water (LMW), Goulburn-Murray Water (GMW) and Parks Victoria (PV) are intended to become the owner and operator of the structures and access tracks so this phase of development recognises these organisations as important stakeholders. The designs are required to be suitable for construction pricing to inform business case prioritisation. The purpose of this infrastructure is to allow floodplains to be watered at the hydraulic design levels nominated by VMFRP. R8 are also engaged to provide Regulatory Approvals and Cultural Heritage Services. The purpose of these services is to support VMFRP to lodge the necessary approvals documents for the project with the relevant approval authorities.

The sole purpose of this report and the associated services performed by R8 is to complete a Desktop Groundwater Assessment for VMFRP in accordance with the scope of services set out in the contract between R8 and VMFRP. That scope of services, as described in this report, was developed with VMFRP.

R8 has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. However, 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.

In preparing this report, R8 has relied on the information provided by VMFRP in the data handover pack at the commencement of the project. In particular VMFRP has developed ecological objectives and, based on these, has proposed inundation levels and extents. R8 is reliant on VMFRP's prior flood modelling work and has designed the infrastructure in response to the VMFRP defined inundation levels and extents.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by R8 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 VMFRP, and is subject to, and issued in accordance with, the provisions of the contract between R8 and VMFRP. R8 accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

# 1. Introduction

## 1.1 Project overview - Victorian Murray Floodplain Restoration Project

The Victorian Murray Floodplain Restoration Project (VMFRP) is being implemented as part of Victoria's obligations under the Murray Darling Basin Plan in partnership with Lower Murray Water, Goulburn Murray Water, Mallee Catchment Management Authority (CMA), North Central CMA, Parks Victoria and the Department of Environment, Land, Water and Planning (DELWP).

The VMFRP consists of nine discrete environmental works projects that aim to return a more natural inundation regime across approximately 14,000 ha of high-ecological-value Murray River floodplain in Victoria through the construction of new infrastructure and the modification of existing infrastructure. The proposed works will allow environmental water to be diverted from the Murray River water to high value wetlands and floodplains. This will mimic the impact of natural flood events and improve the condition of vegetation communities and provide habitat for native fish, birds, frogs and turtles and work to restore the floodplains.

## 1.2 Vinifera Floodplain Management Project

The main components of the project include:

- Two regulators located at the northern end of the proposed system (downstream), referred to as regulators V1 and V2 (main regulators). Regulator V1 is located about 330m north-west of regulator V2 and will pass flows through the broad depression leading to the Murray River.
- A regulator at the upstream end of the forest (referred to as regulator V3) to pass local drainage flows, pass overland flows in large events and prevent backflow onto private land during a managed event.
- A regulator at the upstream end of the system (referred to as regulator V4) to prevent backflow into the Murray River when retaining water in the forest and allow inflows from the Murray River.
- A water retaining embankment labelled Main Bank at the northern end of the forest, designed to contain water, including two overflow sills.
- Drop structure, located at the confluence of the River Murray and the outflow path from regulator V2. This will consist of:
  - rock erosion protection within the basin, gabion cut off beam/weir at the upstream end and rock mattress in the outlet cutting and extending to the edge of the Murray River
  - a second gabion cut off beam at the location where the channel steepens as it re-enters the river
  - rock mattresses down the river bank into the water.
- Two banks at the upstream end of Vinifera Park located between regulators V3 to V4 to separate the inundated area from private land, referred to as Forest Track Bank North and Forest Track Bank South.
- Seven sites comprising minor works, block banks and overflow sills between the Murray River and the forest to secure local low points in the natural levee system and contain the water within the floodplain.

For the purposes of this desktop assessment of groundwater considerations, the development footprint, construction footprint, and inundation footprints have all been considered.

In addition to the physical structures and works noted above, the project will inundate areas of the floodplain during operation.

## 1.3 Study area

This assessment covers the hydrogeology of the floodplain of the Murray River, in an area south of the township of Nyah, in and around the Vinifera State Forest. The area that has been considered for this desktop assessment is the area of the proposed construction and operational structures and associated works, as well as the area of inundation of the Vinifera VMFRP project. The hydrogeological layering and other information in the area has been reviewed and considered considering the proposed floodplain works. The focus of this assessment is the hydrogeology on the Victorian side of the Murray River, whilst recognising that the aquifers in question have hydraulic connection to the NSW side.

## 1.4 Purpose of this report

This report documents a desktop assessment of groundwater considerations associated with the Vinifera Floodplain restoration project and will feed into the referral documentation being prepared under the Environment Effects Act 1978 (EE Act) and Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

## 1.5 Limitations

The following limitations apply to the assessment contained in this report:

- No site visit has been undertaken;
- Reports and records available on the public record have been used;
- Knowhow and experience of Jacobs staff have informed the assessment; and,
- Detailed groundwater investigation and monitoring at the precise sites for the proposed works and area of inundation are not available and so general understanding of the hydrogeology and sites has been used. It is likely that future detailed studies may revise the findings presented here, once in possession of site-specific information.

# 2. Key legislation

The following are the key legislation for this groundwater assessment. Other legislation may also apply:

- Water Act 1989 – sets requirements for groundwater bore approval and licencing and regulates groundwater take and use from aquifers in Victoria. Groundwater users are regulated by this act and impacts on users and the environmental are also controlled. This act will control groundwater monitoring works undertaken by the project.
- Catchment and Land Protection Act 1994 – deals with diffuse source effects in catchment, such as recharge and water quality changes.
- Water Act 2007 (Cwth) – deals with the management of salinity in the Murray River and sets the requires for the Basin Plan, which includes groundwater management and sustainable diversion limits for aquifers (SDL).

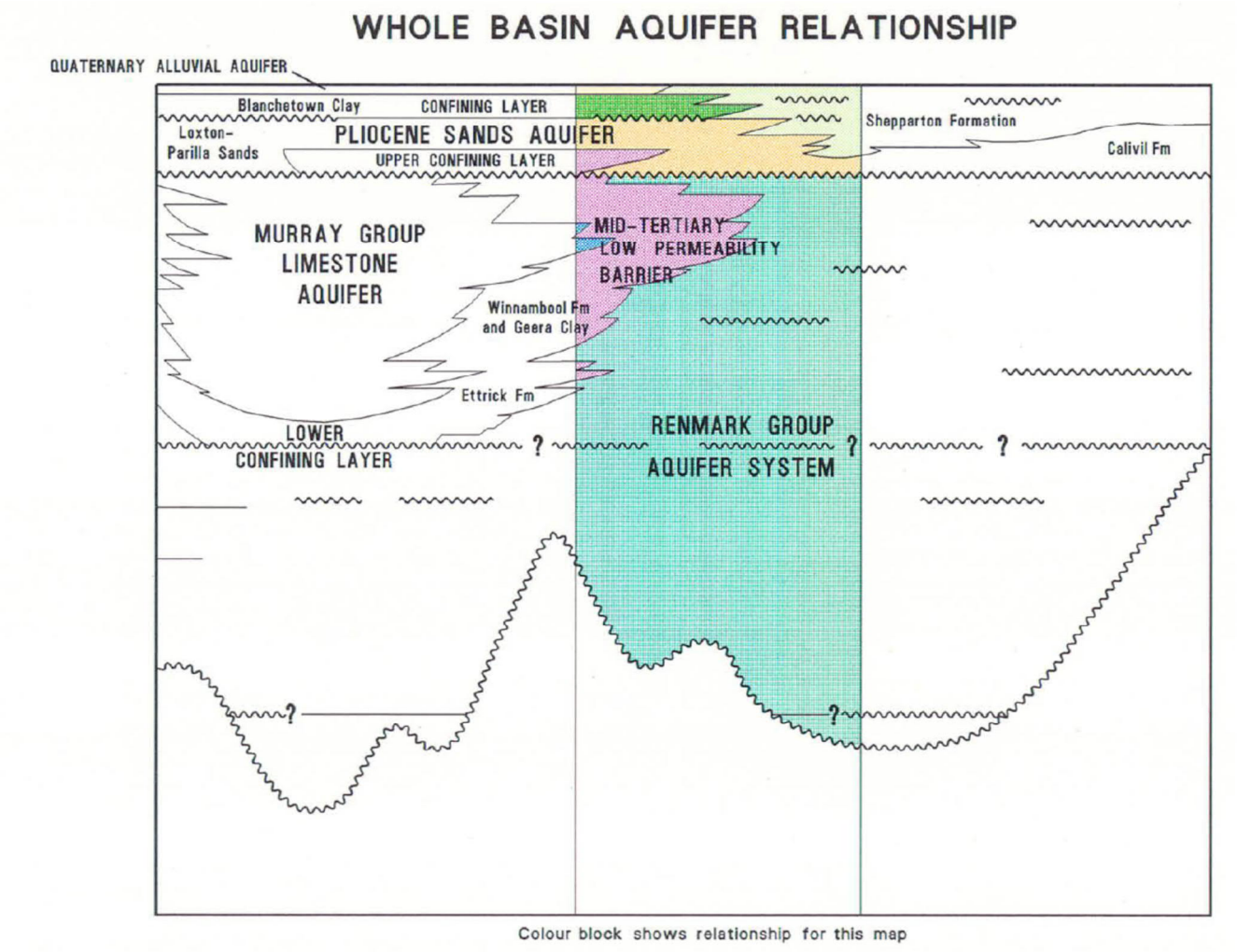
In addition to the relevant acts, regulations under these acts are also important. Specifically, for groundwater, the protocols and agreements made under the Basin Salinity Management Plan 2030 (BSM2030) are important as they define the conditions and controls relating to salt discharge to the Murray River and anabranches.

# 3. Existing conditions

## 3.1 Regional hydrogeology

The Vinifera project site is in the Murray Geological Basin. This basin was infilled with sediments during the Tertiary and Quaternary period. The regional hydrogeology is laid out in the Swan Hill 1:250,000 scale hydrogeological map (O'Rorke et al., 1992). Figure 1 shows a generalised hydrogeological cross section for this area, identifying the main units and their relationships. For this assessment, it is only the upper units that are of interest.

Figure 1: Regional hydrogeological units and thier relationship within the Vinifera area (Source: Swan Hill 1:250,000 Hydrogeological Map)




The project site is located within the Murray Geological Basin and sediments of the basin underly the project area. The geology and hydrogeology of shallow sediments in the area have been best described by Thorne et al. (1990). Other studies of the Murray River corridor on the Mallee have occurred but have not materially changed the understanding in the Vinifera project area.

For this assessment, the focus is on the groundwater environment and current conditions off the shallow aquifer systems. A series of aquifer layers are present at the site, to a depth of approximately 300m below ground. Of these layers, only the upper layers are relevant. The full geological sequence is published by the Government of Victoria through the Victorian Aquifer Framework and the 3D groundwater atlas of Victoria (see GHD & AWE, 2012).

## 3.2 Project area hydrogeology

The shallow groundwater hydrogeological conditions at the site are described in Thorne et al. (1990) and a cross section of hydrogeological conditions from this report is presented in Figure 2 with a longer and more regional section presented as Figure 3. The key features of these sections are as follows:

- Adjacent to the Murray River there is a shallow alluvial sequence of limited extent;
- The alluvial sediments are hydraulically connected to the river;
- Underlying the shallow alluvial sediments near the river is the regional aquifer;
- The regional aquifer has direct or near direct connection to the alluvial sediments in this area;
- The groundwater levels very close to the river level in the alluvial sediments, but groundwater is lower in the regional sediments further inland from the river.

Figure 2: Cross section showing key shallow hydrogeological layers near Vinifera (Thorne et al. 1990)

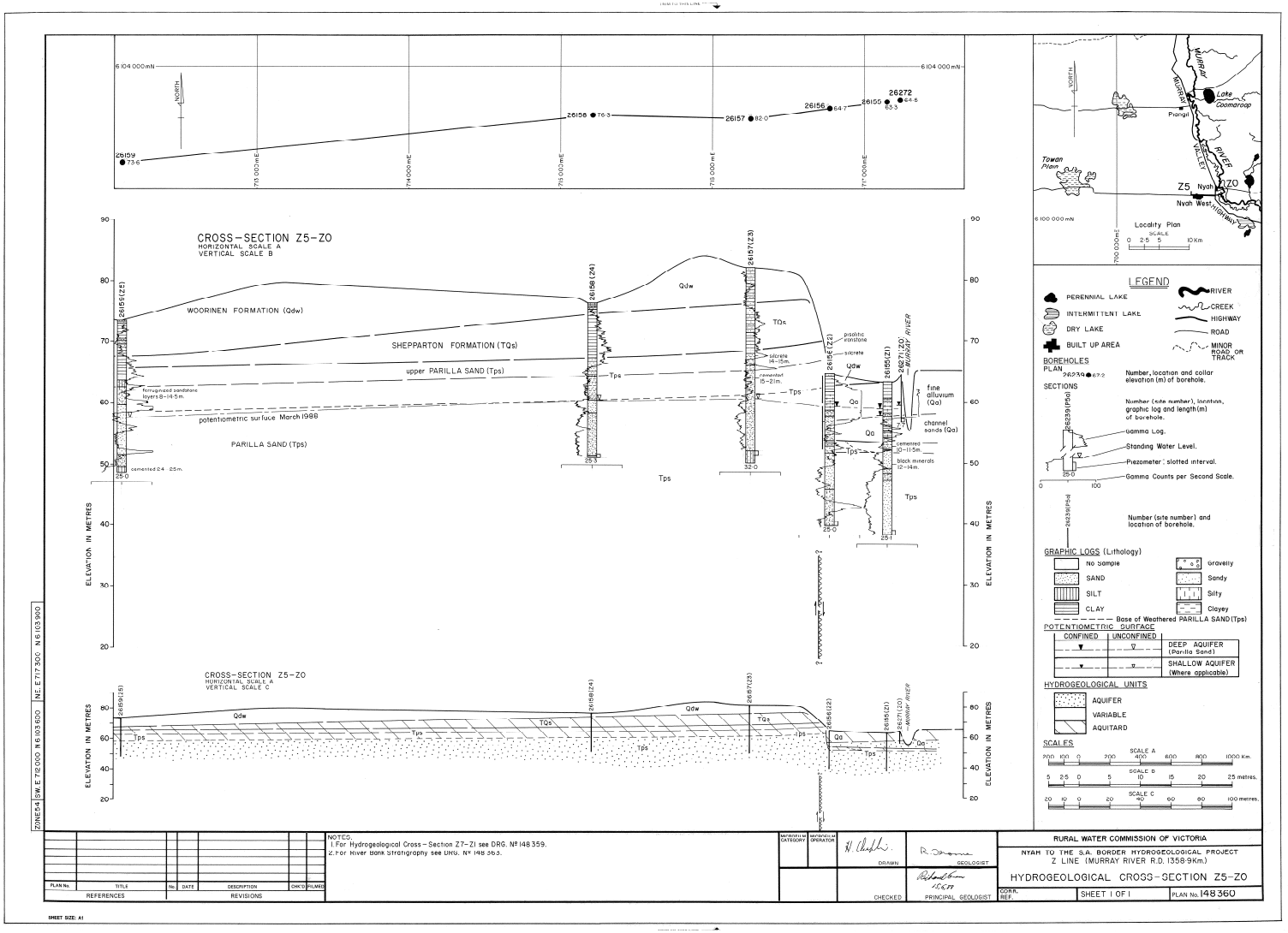
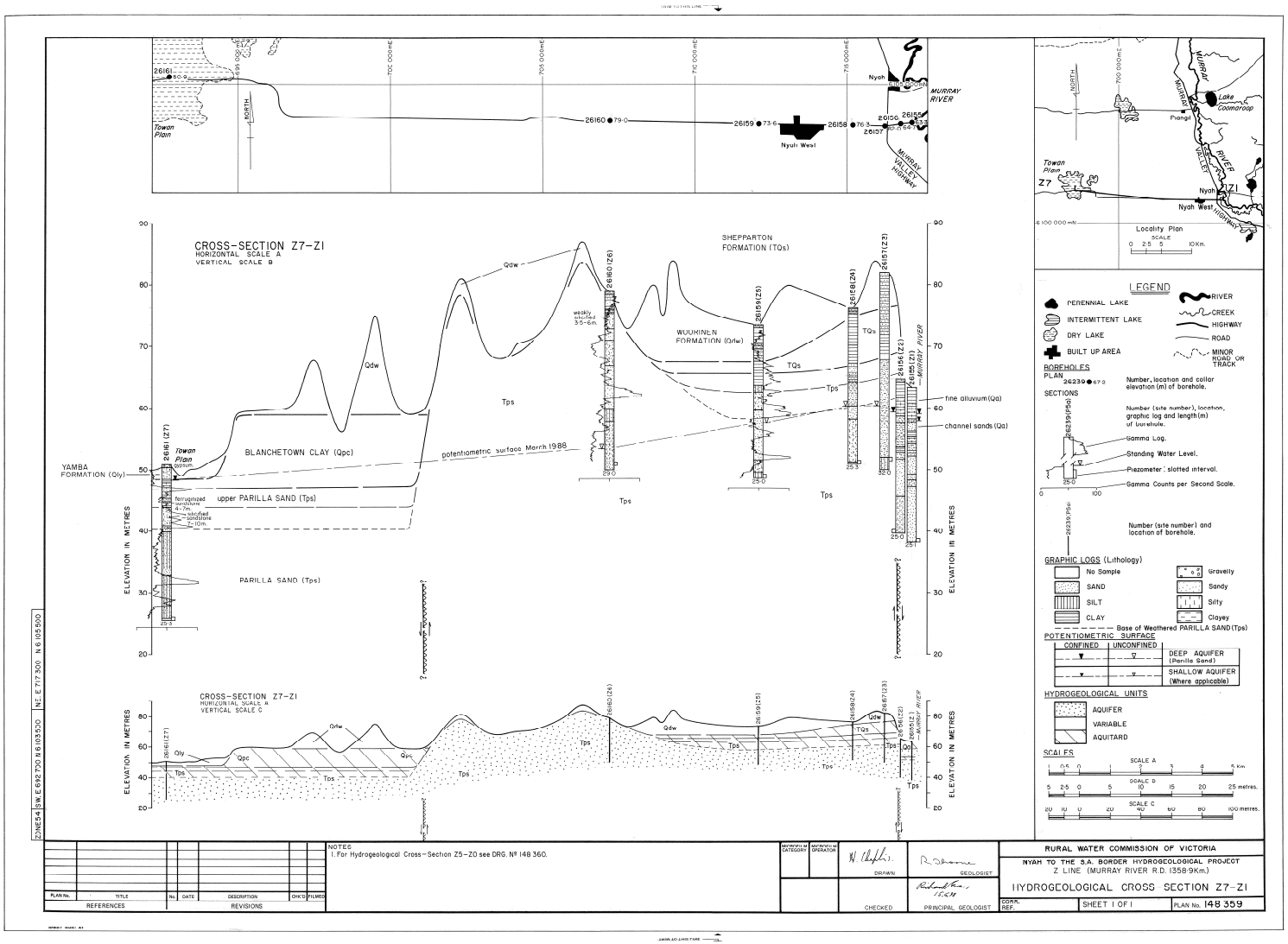


Figure 3: Cross section of the upper units of the regional hydrogeology near and inland from the floodplain (Thorne et al. 1990)

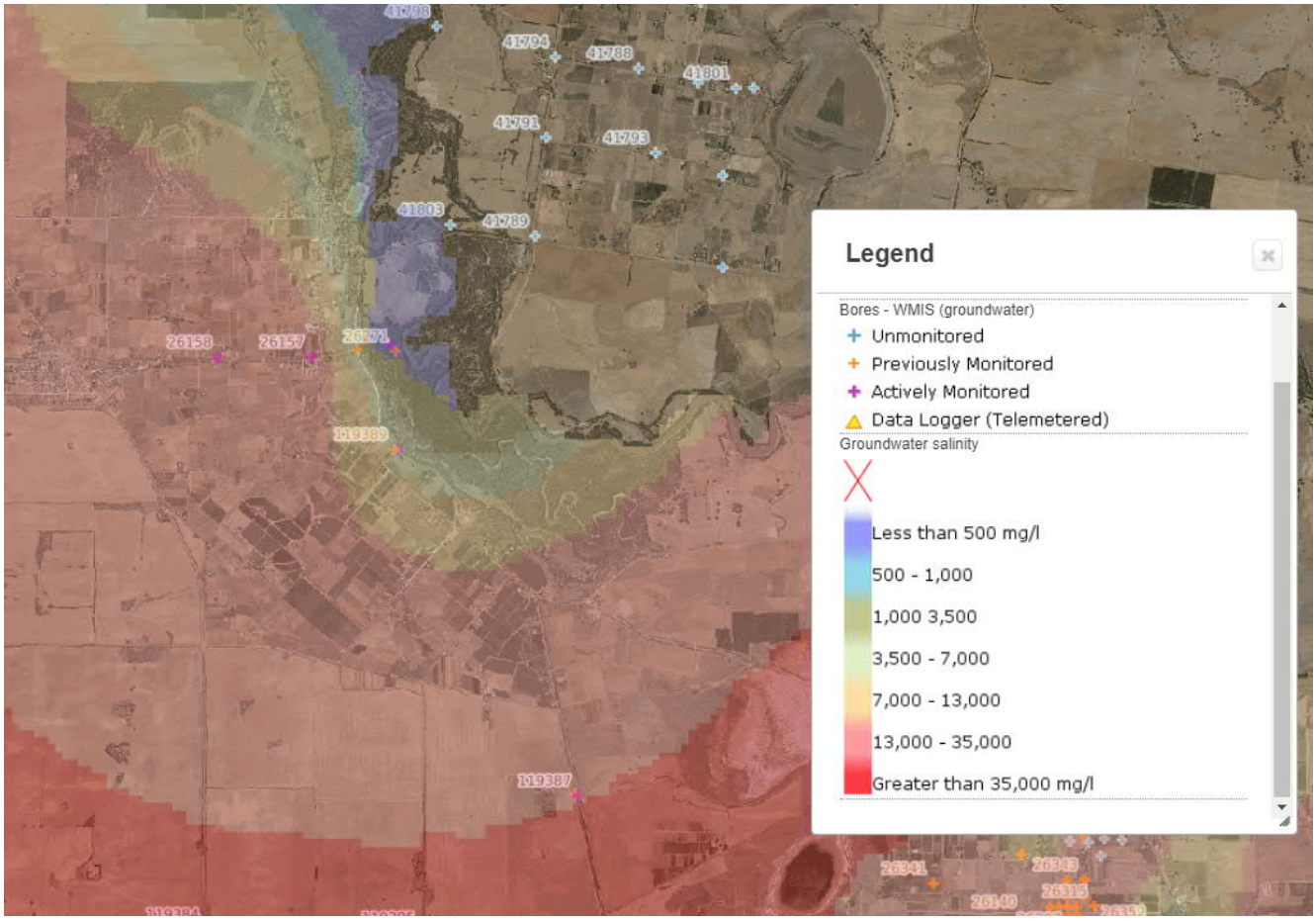


The aquifer sequence at the project site is summarised by the following hydrogeomorphic units (from the surface downward):

- The alluvial aquitard: Floodplain clays and silts that are part of the contemporary floodplain and the recent geological past;
- The Channel Sands Aquifer: This unit is the sands and silts of associate with the current and former river traces. It is also referred to as the Coonambidgal Formation or the Alluvial Aquifer. Within the contemporary floodplain it forms a sheet like deposit that is in hydraulic connection with the Murray River. The water quality in this aquifer is fresh to brackish.
- Parilla Sand Aquifer: A thick sequence of Tertiary age Marine sediments that underly the river and floodplain sediments. This is the regional aquifer and is typically saline or brackish in water quality.
- Inland and away from the project site there is also potential other clay rich units: the Shepparton Formation and the Blanchetown Clay. These sediments are not known to be present at the project site.

Groundwater salinity at the site is interpreted to range from about 500 mg/L to around 3,500 mg/L. Fresher water is adjacent to the river. Most of the site is underlain by groundwater of about 500 mg/L. The interpreted distribution of salinity is shown in figure 4.

Figure 4: Interpreted groundwater salinity for the Vinifera project area.




Groundwater flow is generally to the north and west, away from the Murray River. In some cases, there will be flow toward the Murray River. Local flow cells are possible that may change the local flow direction. The general regional groundwater flow gradient is shown in Figure 2.

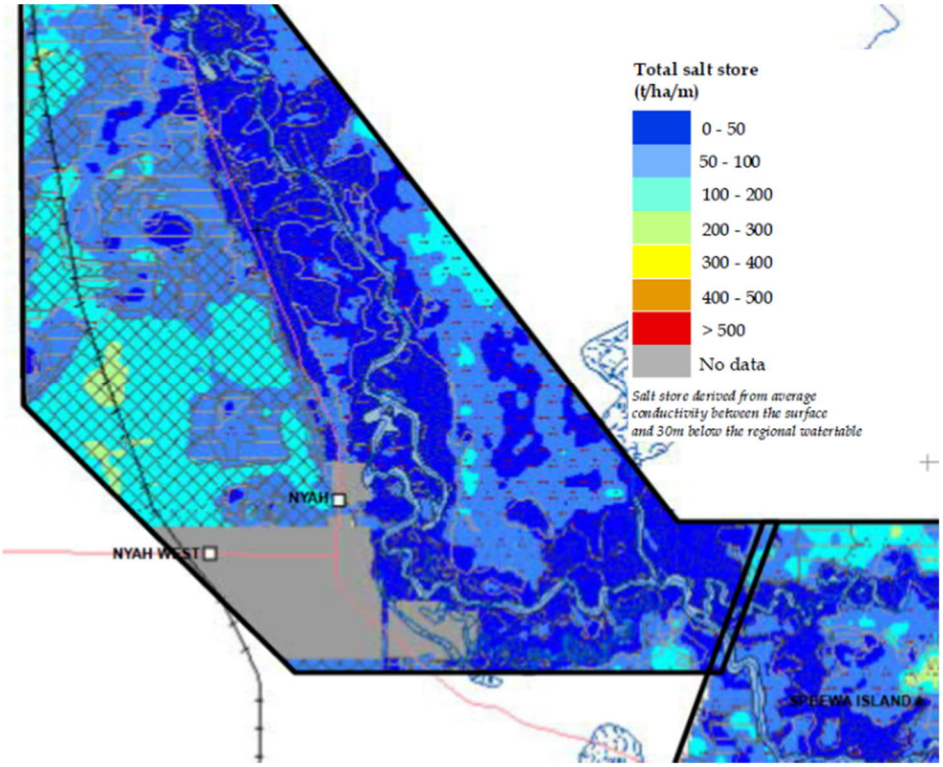
## 3.3 Salinity

Salt inflow to the Murray River in the Mallee tract (that is, downstream of Swan Hill) is a major source of salt load in the river. Accordingly, there is considerable concern about the soil and shallow groundwater salinity in the vicinity of the VMFRP sites and salinity risk is an area that should be considered.

Soil and groundwater salinity at the site are at low to moderate levels. Soil salinity has been mapped over part of the site and for the riverine corridor in the area by airborne electromagnetic surveys (AEM). The project site falls in the Boundary Bend to Speewa AEM survey area (Cullen et al. 2008).

Soil salinity in the project area has been mapped as low to moderate. Figure 5 shows the interpreted salt loads in the area from the AEM survey. It can be seen from this figure that the soil salt store is considered low for this region.

Figure 5: Interpreted Salt Store in the unsaturated zone for the project area (Cullen et al. 2008)




## 3.4 Beneficial uses of groundwater

In accordance with the SEPP (Waters) the following groundwater beneficial uses are protected in the project area:

- Potable water;
- Water dependent ecosystems and species;
- Potable water supply (desirable);
- Potable mineral water supply;
- Agriculture and irrigation (irrigation);
- Agriculture and irrigation (stock watering);
- Industrial and commercial;
- Water-based recreation (primary contact recreation);

- Traditional Owner cultural values;
- Cultural and spiritual values;
- Buildings and structures;
- Geothermal properties;

Water quality standards are described for most of these beneficial uses and are provided in the SEPP (waters)

## 3.5 Groundwater use

Because of the generally saline nature of the regional aquifer, the proximity to fresh water from the Murray River and limited access to floodplain aquifers by private landowners, there are no licence groundwater users in the vicinity of the project site. There are also no registered stock and domestic bores in the vicinity.

The primary use of groundwater at the project site is environmental use associated with floodplain vegetation and ecosystems.

# 4. Potential effects

The potential groundwater effects of the proposed construction and operation of the works are given below.

- Temporary and limited drawdown of groundwater levels during construction, specifically this may be required for the regulators and the drop structure, as these may need to be dug into the subsurface. Typically banks and surface earthworks will not intersect groundwater and thus are not expected to have a groundwater effect during construction. Temporary removal of groundwater may be required for safe access to excavations associated with the larger structures.
- Increased groundwater level as a result of flood recharge, across the inundated area.
- Reduced groundwater salinity immediately following flood events, as a result of flood recharge (of river water) that is generally lower salinity than the groundwater. This phenomenon is also observed during natural floods, so is not an unusual occurrence in the floodplain. What is different with respect to the application is that the recharge is augmented beyond the natural level for a given event. It is essentially impossible to control or mitigate this effect for a given level and duration of flooding.
- Modified groundwater quality of the watertable during and after flood events. This is an analogous response to the salinity change noted above. Trace amounts of contaminants (such as nutrients) that are present in the flood water may enter groundwater during inundation. This process naturally occurs but will be augmented by the operation of the works. There is little published information on the impact of this in groundwater and it has generally been considered that the impact is minor.
- Mobilisation of salt from either the soil surface or from shallow groundwater to return to the Murray River. Salt on the soil surface may be dissolved and entrained by flood water and then held in solution until the release of the flood water, which then discharges salts to the Murray River. This process has been extensively considered by SKM (2014) and the assessment of the possible salinity impacts is considered low for this site. Separate to this project the Murray Darling Basin Authority is developing an approach to accounting for the salinity effects of these works, however this does not form part of this assessment.
- Shallow groundwater in the vicinity of vegetation may occur for periods of time during and immediately after flooding. Vegetation that has shallow groundwater level for extended periods can become waterlogged. Potential implications of inundation and ongoing monitoring of vegetation would be undertaken in accordance with the project's operational guidelines and adapted as required to support achievement of the identified ecological objectives for the project.

The following table describes the potential effects on the beneficial use of groundwater as a result of the construction and operation of the project.

Table 1: Expected effect on groundwater beneficial uses

| Beneficial Use | Potential Effect |
|---|---|
| Potable water; | Negligible effect expected<br>River water is of similar character to the shallow groundwater, regular flooding of this area already occurs and an increase in frequency of flooding is expected to have negligible impact on water quality at this site |
| Water dependent ecosystems and species; | Beneficial effect expected<br>Water dependent ecosystems use soil water and shallow groundwater as a water source during dry periods. The intent of the project is to provide additional reserves of shallow soil water to enhance vegetation health and to thus support the ecology dependent on soil water and shallow groundwater. |
| Potable water supply (desirable); | Negligible effect expected<br>Refer to comments regarding potable water, above. |

| | |
|---|---|
| Potable mineral water supply; | Not applicable<br>The water does not classify as mineral water |
| Agriculture and irrigation (irrigation); | No effect expected<br>The water quality and availability for this beneficial use will not alter. |
| Agriculture and irrigation (stock watering); | No effect expected<br>The water quality and availability for this beneficial use will not alter. |
| Industrial and commercial; | No effect expected<br>The water quality and availability for this beneficial use will not alter. |
| Water-based recreation (primary contact recreation); | No effect expected<br>The water quality and availability for this beneficial use will not alter. See the comments under Potable water, above. |
| Traditional Owner cultural values; | Limited information – no significant effect expected<br>No specific cultural requirements have been identified for this assessment but given that the water quality is expected not to change and that the effect on reliant ecosystems is expected to be beneficial, it is presumed that there is minimal risk to cultural values. |
| Cultural and spiritual values; | No specific cultural requirements have been identified for this assessment. The Desktop Historical Heritage Assessment and the Cultural Heritage Management Plan deal with potential impacts of the project on historical and cultural values. Given that the water quality is not expected to change and the effect on reliant ecosystems is expected to be beneficial, it is presumed that there is minimal risk to cultural values. |
| Buildings and structures; | No effect expected<br>The water quality and availability for this beneficial use will not alter. |
| Geothermal properties; | No effect expected<br>The water temperature at the surface is below the threshold for geothermal water and no effects are expected at depth. |

# 5. Recommended mitigation measures

The following mitigation measures are recommended during the construction and operation of the project:

- Seek to minimise the total volume and rate of groundwater extracted for construction purposes
- Do not dispose of groundwater from construction activities to land.

## 5.1 Further work

Specific groundwater level and quality information is required for the site to form a baseline for the potential construction and operation impacts, as well as to monitor the effects of inundation outside of the inundated area. It is understood that a program of groundwater monitoring bores is proposed for the site and that these should be installed and in place by mid 2020. This will assist in setting the pre-scheme baseline.

# 6. References

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