Great Western Winery Storage Pond

Anthony Spiteri, Victorian Sales Manager, Geofabrics Australasia Pty Ltd

SUMMARY:

This paper details the investigation, design and construction of an artificially lined 200ML treated effluent water storage pond. The base of the pond incorporated a clay liner and a geosynthetic clay liner, due to the differing geological features present at the site. The pond is situated outside the township of Great Western, a small regional town two hundred and twenty kilometres northwest of Melbourne. The construction of the pond was essential as the treated effluent water, piped from the Ararat Treatment Plant, is required to irrigate vineyards situated in the district. Major expansion of the vineyards could not take place without these major infrastructure works being carried out by the Grampians Region Water Authority.

1 INTRODUCTION

Great Western is a small regional town situated approximately two hundred and twenty kilometres northwest of Melbourne, nestled in the foothills of the Grampians mountain range. The township and its surrounds are famous for producing quality table and fortified wines, with vineyards visible as far as the eye can see on the surrounding hills. Both Seppelts and Bests wineries have been present in the district since the 1880's, their wines famous throughout the world.

Vineyards in the district have traditionally relied on rainfall to irrigate their vines. Expansion of the vineyards has always been looked at, but a lack of confidence amongst the wineries in enough rainfall to sustain the winery has held this development back. In 1997, with assistance from the Victorian Government and Grampians Water, a feasibility study was carried out to look at the option of building a water storage off Sugarloaf Road to allow expansion of the vineyards in the district to take place. Treated effluent water from the Ararat Treatment Plant, situated sixteen kilometres to the south, would be piped to the new storage to allow the vineyards to be irrigated during the summer months.

2 DESIGN AND SITE INVESTIGATION

Fisher Stewart were engaged by Grampians Water to design the proposed storage and pipeline. Piper and Associates in turn were engaged to provide geotechnical information for the proposed works, and Nolan ITU being engaged to provide a hydrogeological assessment. The project comprised the construction of a 200 megalitre storage dam, located within the Sugarloaf Creek catchment.

It also incorporated the following works:

* Earth-fill embankments complete with geofabric and rock beaching erosion protection;

* A clay liner and Geosynthetic Clay Liner (G.C.L) lagoon floor, including an under drainage system for the clay lagoon floor area. This was required to reduce uplift pressure on the liner systems, and was seen as environmentally sound, as salinity was an issue.

* Laying of a 200 mm diameter pipeline from the Ararat Treatment Plant to pipe treated effluent to the storage. Grampians Water previously discharged treated wastewater to the Hopkins River, with some minor reuse.

2.1 Geology

The proposed winter storage is located in an area of alluvial deposits overlying weathered granite. The following primary soil profile was encountered by Piper and Associates (1) :

* Rootmatter extending to a depth of 20 mm.
* medium density, brown, fine to medium grained, silty sand (SP) or sandy or clayey silt (ML) extending to a depth of between 0.2 and 0.6 metres.
* very stiff to hard, mottled grey, orange - brown and red - brown, slightly sandy silty clay (CH), often highly fissured with slickensided joints extending to a depth of between 1.8 and 6.1 metres.
* low to very low strength, orange - brown, white - grey, highly to completely weathered granite (HW-CW) extending to the full depth explored of 12.5 metres.

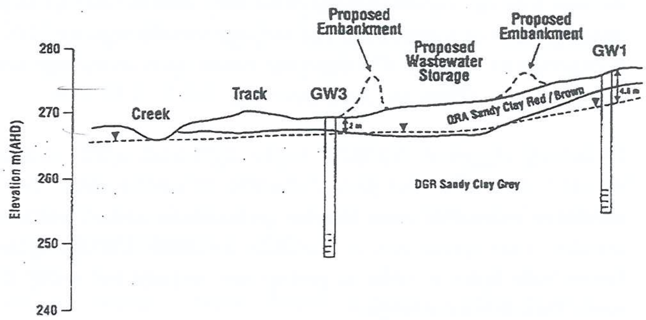

Figure 1: *shows a cross section (East/West) through the site. Note the location of sand, silt and clay deposits (QRA) and the granite (DGR). (Piper and Associates (1))*

2.2 Laboratory Test Results

Laboratory permeability tests were conducted on samples drilled from the site. The remoulded compacted clay samples achieved an average hydraulic conductivity of 5.7 x 10^{-9} m/s. (Piper and Associates (1)). The test results varied considerably and reflected the variability of the ground encountered.

2.3 Slope Stability of the Embankments

A slope stability analysis of the embankments was carried out in order to assess stability under the following conditions:

i) steady state seepage
ii) construction conditions with excess pore water pressures
iii) seismic condition in the event of an earthquake
iv) drawdown condition.

Factors of safety of 1.5, 1.3, 1.1 and 1.2 respectively were adopted for the above analysis. The steady state seepage (downstream) results varied between 1.43 and 1.48. (Piper and Associates (1)). These were lower than first desired, but could be tolerated provided there was a high level of construction quality control.

Construction conditions factor of safety varied between 1.27 and 1.9. (Piper and Associates (1)). This will generally be adequate and did not cause construction delays, provided that these pressures were monitored by vibrating wire piezometers placed within the embankments and the floor of the lagoon.

2.4 Hydrogeological Design

The floor on the western half of the storage (uniform elevation) was lined with a 600 mm thick layer of compacted clay. The assumed design hydraulic (vertical) conductivity was 7 x 10^{-9} m/s. (Piper and Associates (1)).

The eastern half of the storage has a shallow depth to the granite. Due to this condition, an inclined floor was designed (difference in elevation of two metres) and was lined with Bentofix X2000, a geosynthetic clay liner. It has a design thickness of 10 mm and a vertical hydraulic conductivity of 3 x 10^{-11} m/s. (Fisher Stewart (2)).

The head of water in the storage is a maximum of 6 metres on the clay liner and reduces from 6 to 5.4 metres on the G.C.L. The seepage loss rate expected through the clay liner is 1803 mm/year (average head of 4.3 metres). The seepage loss through the G.C.L. is expected to be about 630 mm/year, based upon an average head of 6.65 metres. (Piper and Associates (1)).

Modelling suggested that there maybe significant uplift pressures on the G.C.L. when the storage water level was lowered. Clearly excessive leakage of water into the groundwater stream was to be avoided. One option was to introduce an under drainage system below both liners in order to pickup any seepage and pump this water back into the storage.

2.5 Geofabric Specification

The geofabric specification for both the embankments and the gravel drains consisted of the following (Fisher Stewart (2)):

i) Manufacture: ultra violet stabilized, needle punched polyester.
ii) Mass: 180 gsm
iii) Thickness: 1.7 mm
iv) Wide Width Tensile Strength: 14.5 kN/m (mean)
v) Trapezoidal Tear Strength: 310 N (mean)
vi) Drop Cone (h50): 1500 mm
vii) CBR Burst: 2700 N (mean)
viii) G Rating: 2000
ix) Mullen Burst: 2400 kPa
x) Pore Size (O95) Dry: 190 microns (maximum)

All values stated are minimum unless otherwise noted.

3 TENDER PROCESS

Tenders were advertised by the Grampians Authority in late January 1999. In May, following consideration of all tenders, the contract was awarded to Midwest Earthmovers. The contract duration for practical completion was set at 22 weeks.

4 CONSTRUCTION

Works were carried out on site by Midwest Earthmovers, an experienced construction company based in Ballarat. The construction sequence was dependent upon both a mild winter and area limitations on site. The following sequence was carried out:

i) Materials were stripped, separated and stockpiled from the lagoon floor and embankment area: topsoil; clayey silt; clayey and silty sand; silty and sandy clay; and weathered granite. The topsoil, clayey silt and clayey sand overlaid the site in depths ranging from 0.2 to 1.8 metres. The sandy and silty clay varied in thickness from 0.2 to 6.1 metres and was located beneath the silt. The weathered granite was found beneath the above materials.

ii) Construction of the under drainage system in the western flat area of the lagoon floor. A herringbone gravel underdrainage system was constructed, consisting of geofabric lined trenches, slotted Class 18 pipe, and 6 mm diameter gravel screenings. Overall 8000 square metres of Bidim A24 geofabric was used to line the trenches.

iii) Removal of clay from the stockpile and place and compact to form embankments. All sand filter and coarse gravel finger drains were constructed concurrently with the clay placement.

iv) Installation of a G.C.L. on the sloping eastern area of the lagoon floor. A 300 mm layer of silty and clayey sand, won from the borrow pit area, was evenly spread over the liner and lightly compacted in two layers. To monitor pore pressures beneath the liner, three vibrating wire piezometers were installed underneath it. The piezometers were also required to monitor embankment stability throughout the construction phase. Overall 19,500 square metres of Bentofix X2000 G.C.L. was installed.

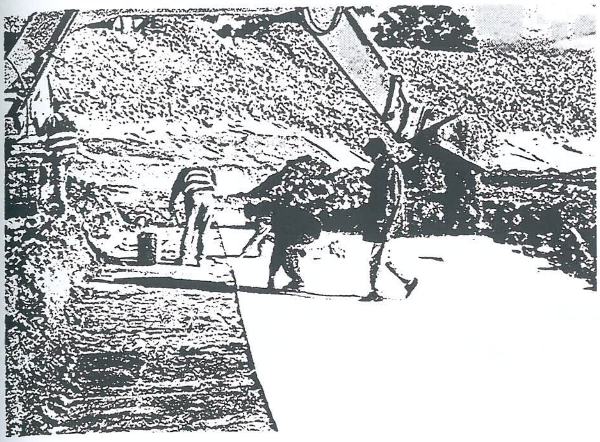

Figure 2: Installation of the Bentofix X2000 G.C.L. on the sloping lagoon floor.

v) Construction of a 600 mm thick layer of compacted clay to form the lagoon floor liner in the flat western area. The clay was moisture conditioned to between 0 and 3 % above Optimum Moisture Content, and compacted to a minimum of 96 % Standard Maximum Dry Density. In order to monitor pore pressures beneath the clay liner, a further three vibrating wire piezometers were installed beneath it. Overall 25,600 square metres of clay was installed.

Figure 3: Piezometers being installed beneath the clay liner

vi) Placement of geofabric and rip rap armour rock on the upstream embankment to prevent erosion. The geofabric filter was anchored in a trench at the top of the embankment and laid down the slope. A minimum overlap of 500 mm was provided between adjacent geofabric runs, and pinned down with galvanized staples at two metre centres along the overlap. An overall 14,000 square metres of Bidim A24 was placed on the embankments.

Following the placement of the geofabric, a minimum 200 mm layer of rip rap rock was placed over it. The specification (Fisher Stewart (2)) for the rip rap rock stated:

i) nominal maximum diameter shall be 150 mm
ii) not more than 5 per cent by mass to pass a 50 mm sieve
iii) not more than 15 per cent by mass to pass a 100 mm sieve.

Figure 4: placement of rip rap rock over the Bidim A24 geofabric filter cloth.

5 CONCLUSION

Overall the project proceeded smoothly with the earthworks and lining operations taking place between May and September. The contractor was able to install the Bentofix liner with a minimum of fuss, as they had installed Bentofix on a number of occasions. The completion of the project has ensured that the wineries in the Great Western region can carry out capital works and expand their vineyard area significantly. The existance of a 200 megalitre water storage now ensures expansion can proceed without the risk of water shortages in the summer months.

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7 REFERENCES

Piper and Associates "Geotechnical and Hydrogeological Investigation for Proposed Winter Storage, Pipeline and Tank, Great Western, Victoria – Volume 1 – Text and Volume 2 – Appendices" (December 1998).

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