Technical Review Board

02 February 2011

Our Ref:TRB.L14

The Hon. Michael O'Brien
Minister for Energy and Resources
1 Spring Street
MELBOURNE VIC 3000

Dear Minister,

Subject: Maryvale Work Plan Variation

INTRODUCTION

This letter is presented in response to a request from the Department to advise the Minister on the Maryvale Work Plan Variation (WPV) for Yallourn Mine.

It is understood the WPV should contain the information required under Section 13 of the MRSDA Regulations. This should include a clear idea of how the mine will develop. Designs presented in the WPV should be supported by analysis, reports and studies, but should not contain detail that may change or require regular updating. In regards to the geotechnical and groundwater areas, designs and design performance targets should be linked into the Ground Control Management Plan (GCMP) where appropriate.

BRIEF

The Department requested a view as to the technical veracity of stability related reports and any associated monitoring; together with recommendations for the ongoing management of mine stability. In particular the Department requested that the following issues be addressed:

1. The location of conveyors along the MRD and associated risks.
2. Location of Morwell West Drain south of furthest extraction.
3. Are the mine design and layout basically feasible and safe from the stability perspective?
4. If not, why not, and does this have implications for redesign or for monitoring requirements or systems?

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5. Issues related to the rehabilitation plan and/or consideration of the rehabilitation requirements for ongoing stability. In particular the stability of rehabilitated slopes and the impact of ceasing aquifer depressurisation. If these plans are not adequate, is there a process for determining and reviewing alternative rehabilitation plans as they are developed?
6. Are the "support and management" systems proposed, that is the GCMP, appropriate and robust?

MARYVALE FIELD MINE DEVELOPMENT

The stage plans (Reference 12) show that the style of mine development for Maryvale Field will be similar to the early YEF. The active faces will advance toward the South and final batters will be formed on the eastern and western sides as the mine advances. This is different to the mining in the YEF in the period from 2002 to 2007, when the direction of mine advance was towards the final Latrobe River Batters.

There will be three coal batters, Upper Slope, Lower Slope and Lower Clean. Significant coal development commences with the Upper Slope in coal and by January 2012 there will be about a 200 m upper final batter formed in the first year. The rates of advance of final batters are then generally of this order, annually.

This rate and style of advance are relatively favourable from a stability view point because there is considered to be sufficient time to review the situation, evaluate stability and implement remedial measures on an ongoing basis.

The Maryvale Field will be developed beside the southern end of the existing second Morwell River Diversion (MRD). In this area the MRD comprises a man made fill structure founded on top of coal. The Maryvale Field will excavate the coal to the base of the Yallourn Seam alongside, but some distance from the MRD.

HISTORY AND GEOTECHNICAL INVESTIGATIONS

In July 2003, following an annual pin survey, the southeast side of the MRD was found to have undergone a "sudden" 0.5m horizontal movement towards the YEF.

The movement occurred on a remnant coal dyke. This area had also undergone some previous movements, in April 2001, when an inclinometer was found to have been sheared off and a 70 m long crack was found (Reference 9).

Review of the MRD stability in early 2003 (Reference 2) showed the movement had occurred on a clay layer 10 m below the base of the Yallourn Seam. Geotechnical investigations at the time gave the shear strength parameters in Table 1. Significantly the clay layer in which the shearing and sliding had occurred had a residual angle of friction of 12°, this is the N57 series boreholes in Table 1.

TABLE 1
RESULTS OF DIRECT SHEAR TESTS

BOREHOLE	DEPTH or (RL) (m)	PEAK STRENGTH PARAMETERS		RESIDUAL STRENGTH PARAMETERS	
		ϕ' (deg)	c' (kPa)	ϕ' (deg)	c' (kPa)
N5742	(-32.6 to -33.3)	17	6	17	0
N5744	(-32.6 to -36.8)	15	15	12	0
N5745*	(-30.1 to 30.5)	17	25	17	0
N5745	(-37.6 to -38.1)	17	15	17	0
N6380	85.3 to 85.7	20	35	14	0
N6380	103.8 to 104.0	15	41	10	0
N6380	105.7 to 106	18	53	12	0
N6378	88.0 to 88.2	22	69	11	0
N6378	95.57 to 96.0	18	57	16	0

*sample of the clay layer immediately underlying the Yallourn seam

The core indicated this clay layer had indications of previous movement, which were postulated to be related to the geological history, Reference 2. Experience indicates this layer may have been a sub-horizontal fault or bedding plane shear, which are common in coal measure rocks.

Recent investigations for the MRD in Maryvale Field (References 6, 7 and 11) has yielded additional testing. The area is immediately to the south of the zone where the previous block sliding had occurred in the YEF as described above.

These new laboratory test results for the N63 series boreholes are also included in Table 1 and give residual angles of friction of 10° to 16°. Figure 1 presents this recent test data.

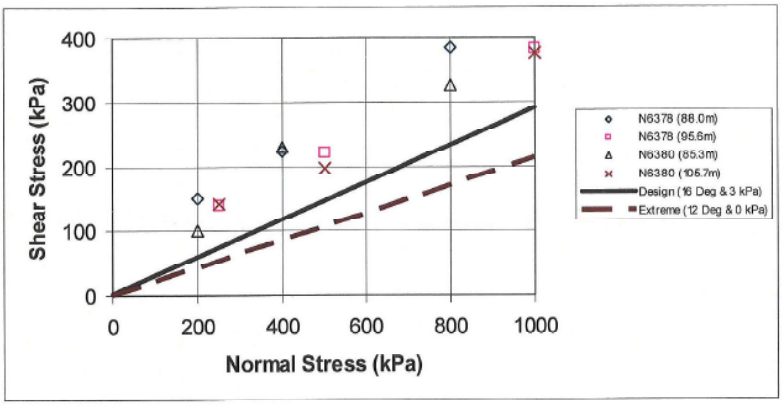

Figure 1: Summary of Direct Shear Test Results - Peak Strength

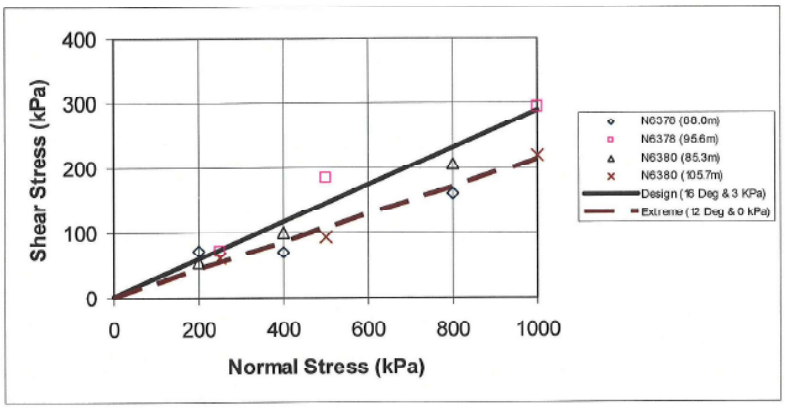

Figure 2: Summary of Direct Shear Test Results - Residual Strength

Figure 1: Summary of Direct Shear Test Results – Peak and Residual Strengths (after Reference 7)

MARYVALE DESIGN PARAMETERS

Based on the initial testing in 2003, the following design parameters were adopted for Maryvale (Reference 2):

- Design Case - Cohesion = 3 kPa and
  - Angle of Friction = 16°.
- Extreme Case - Cohesion = 0 kPa and
  - Angle of Friction = 12°.

These design parameters were apparently based on back analysis of the movements described above (Reference 2), with the extreme case strength giving a Factor of Safety (FOS) of 0.9 and the design case strength giving a FOS of 1.1. Based on this analysis, experience would dictate that a strength intermediate between these two values would normally be adopted for design.

The design FOS adopted for slopes using these parameters were:

- Design Case - FOS = 1.5 and,
- Extreme - FOS = 1.1.

The 12° angle of friction is based on actual testing of a known weak layer, along which the large scale block movement had occurred. This layer also appeared to be a pre-existing geological structure. Recent testing of samples of similar low strength layers from clay seams beneath the MRD gave lower residual angles of friction, 10° and 11°.

It should be noted that residual angles of friction of 12° or 13 °, were the design shear strengths adopted by the SECV for block sliding on interseams in the 1980's.

In this context, it is difficult to see how an angle of friction of 12° could be called "extreme". Rather this appears to be a strength towards the lower bound of the envelope of strengths obtained by testing of clay layers. However if the population selected for testing and design is only "weak clay layers" then this would not be either the lower bound or the extreme value, but the design value for weak clay layers. In a layered horizontally bedded sedimentary sequence experience dictates that if weak clay layers are present, then this is the design case strength.

In this case, the design FOS generated for the MRD, may actually be too high and the "design" FOS for the slope should be based on 12°. Thus, it would be closer to 1.0 or 1.1 rather than 1.5.

STABILITY AND MINE DESIGN

There have been six earlier studies into the stability of the Maryvale Field Batters, mainly by Geo-Eng. None of these earlier studies have been reviewed as part of this assessment. In regards to the main slope design document (Reference 1), it should be understood that:

1. This is a Preliminary Study only.
2. The report does not refer to any site specific geotechnical data.
3. The report and analyses use assumed groundwater profiles.
4. The analyses use assumed shear strength parameters.
5. The report uses non-specific mine site wide geology.
6. The analyses demonstrate that for small changes in the assumed groundwater profile, from 9° to 13°, that the slopes are unstable.

In addition, if weak clay layers occur elsewhere in the Maryvale Field then the slopes are likely to be only marginally stable for the assumed design groundwater profile of 9°, and thus also unstable for higher groundwater profiles.

The overburden thickness is substantial in some cases and is noted as an aquifer, but no local overburden groundwater control measures or design levels are included. Furthermore no overburden groundwater levels were included in the stability analyses. The potential for filled tension cracks due to the overburden aquifer has not been included in the analysis or design.

In the absence of site specific geotechnical investigations and data, the use of assumed parameters, that are greater than the long established SECV design parameters is questioned.

There are no site specific facts included in this report and since all the parameters are assumed and there are significant limitations in the analyses, it is not possible to comment further on either the designs or the stability of the planned slopes at this time.

The report is considered inadequate as the base design document to support the development of a mine of the scale of Maryvale Field.

IMPACT OF MARYVALE DEVELOPMENT ON MRD

The potential impact of Maryvale Development on the MRD was assessed by Golder Associates (References 4 and 5) and reviewed by SMEC (Reference 8). The objectives of the assessment were to:

1. Assess whether the proposed batter design could result in instability in the MRD.
2. If instability is predicted, assess alternate measures or batter designs to achieve acceptable stability.

The design FOS were 1.5 for “design strengths” and 1.1 for “extreme strengths”. However as discussed above, if weak clay layers exist in this area of the MRD, then the investigations, previous experience with the MRD in YEF and historic experience in the Latrobe Valley indicates the actual “design FOS” may be closer to 1.1 not 1.5 as indicated.

Another important assumption is the groundwater level, which is assumed to fall to zero at the end of the 400 m long drains. These drains are recommended to be installed at 42° to the batter slope and hence the actual depth, normal to the batter is about 270 m. Based on experience this assumption appears optimistic and no supporting information is provided in the report to support this assumption.

If current designs are based on assumptions and predicated on achieving some future performance, then details of actual historic performance are required in order to test the feasibility of the performance measures as proposed.

Notwithstanding this, the design is essentially based on verifying key assumptions sometime in the future, including:

- Subsurface profile,
- Presence of weaker clay layers,

- Design strength and
- Effectiveness of the horizontal drains.

It is understood this will be achieved by a program of investigation, instrumentation and ongoing monitoring and review.

If numerical modelling (such as FLAC) of either stability or deformation, is undertaken for a project using assumed parameters then it is considered good practice to model for a range of assumptions that bracket the expected design conditions, not a single case. In this instance, there is also the added question on the actual design shear strength to be used.

It is recommended that additional modelling be undertaken for:

1. Lower shear strengths for the weaker clays.
2. A range of water levels dictated by Yallourn experience, with horizontal drains in similar batters, factored for the time taken to achieve certain design groundwater levels, as required by historic performance and the rate of mine development.
3. All the engineering functions used in the modelling for each parameter also need to be clearly stated in the report.
4. Complete contours on the base of the Yallourn Seam extending under the MRD, with the actual drill hole "pierce points" shown, are required to assess the section locations selected.

MONITORING

"Monitoring Parameters – Design and Alert Values" are included in the Executive Summary (Reference 5) and the MRD Design Report (Reference 4). This planned monitoring needs to be reviewed.

In situations like this, when a sensitive structure will be impacted by what are as yet unknown, future movements and strains due to remote mining, it is usual when setting monitoring limits that:

1. The "Alert Value" is set to be less than the "Design Value" not higher as in Reference 5, because the whole concept is to get advance warning that the design value may be exceeded.
2. In addition to design values, to also set the maximum allowable value.
3. The inclinometer casing is less than 100 mm diameter. Before this total deformation occurs, the casing either shears or deforms such that the instrument cannot be used. It is unclear what the design values of 150 to 500 mm refer to in Reference 5.
4. The Alert Value monitoring level for groundwater is based on a single value also higher than the Design Value. The experience from the Northeast batter collapse shows that this is probably not adequate.

The monitoring should be reviewed in detail and a more comprehensive Trigger Action Response Plan (TARP) developed.

AQUIFER DEPRESSURISATION

A discussion on aquifer depressurisation is not included in the design report for Maryvale, but in the overall geotechnical review, Reference 13. This document predicts that aquifer pressures in Maryvale will be slightly above weight balance and concludes that depressurisation will be minor. However, there are a number of recommendations for further study.

These recommendations should be included in the conditions and also include a consideration of the relationship between aquifer pressures, interseam pressures and batter stability. These studies should be carried out in conjunction with the other planned work.

INVESTIGATIONS

The previous experience with the MRD and movements, the subsequent geotechnical investigations and analyses for the MRD, plus the experience after the collapse of the Latrobe River Batter, shows there is a gap in the approach to geotechnical investigations at Yallourn. It would be expected that for a major mine development such as Maryvale the minimum expectation regarding geotechnical investigations would entail:

1. One or two fully cored geotechnical holes for each batter.
2. Holes extended at depth into the next coal seam.
3. A full suite of geophysical logs.
4. A suite of engineering index testing of the inter seams.
5. Comprehensive geotechnical logging and core photography.
6. Direct shear strength testing of weaker clay layers.

These investigations may exist, but there is no documentation in the design reports to support this.

CONCLUSIONS AND RECOMMENDATIONS

Overall the TRB considers there is no fundamental flaw in the planned Maryvale Field development, however at this stage all designs are considered to be at Preliminary Level only.

In regards to the issues raised by the Department the advice is:

1. The issue of MRD stability and risks to the conveyors is still to be resolved.
2. The relocated Morwell West Drain should not have a major impact on Maryvale.

3. The mine designs and layout are feasible in principle, but the batter stability is still to be resolved.
4. At this stage no recommendations can be made for any redesign. However, an improved monitoring system will be required.
5. Most aspects of rehabilitation for Maryvale are still to be resolved.
6. The Yallourn GCMP has been reviewed by the TRB and this will be discussed directly with Truenergy.

The TRB advice to the Minister is:

1. Approve the Maryville WPV subject to a number of conditions.
2. The main concern is the slope adjacent to the MRD. The concerns are:
    a) The current designs have not adequately captured the experience and performance of the MRD within the YEF;
    b) The current designs may be based on optimistic parameters and
    c) The real stability and FOS for these slopes may be less than reported.
3. Further investigation and analysis of the MRD and also Maryvale slopes is required.
4. The planned monitoring should be reviewed and comprehensive TARP established for the MRD slopes.
5. Given the performance of the MRD in the YEF to date, an independent third party review of the stability and deformation of the MRD slopes is required. This review should also focus on both the short and long term potential impacts on the MRD itself.
6. Further study of aquifer depressurisation and the impacts of this on interseam pressures is required. This should include assessment of:
    a) Stratigraphy of Maryvale,
    b) Aquifer depressurisation requirements,
    c) Aquifer and interseam monitoring requirements;
    d) Practicalities of depressurisation bore installation and
    e) Impacts of interseam pressures on batter stability.
7. The current Yallourn Mine rehabilitation strategy of flooding the mine has been shown to be not feasible because of insufficient water. Further consideration of rehabilitation should be included as a condition of the WPV, including aspects such as:
    - Formation of safe and stable batters;
    - Long term water balance studies,
    - Mine floor heave,
    - Strategic use of overburden,

- Reducing the long term potential for coal fires and
- Progressive rehabilitation.

The Maryvale mine development plans show that significant new coal batters are not formed until 2012. Based on this, the recommendations and review and additional investigations and design should be finalised by the end of 2012.

Yours Sincerely,

Tim Sullivan
Chairman
Technical Review Board

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