Appendix 15 Geotechnical Stability Assessment

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Geotechnical Engineers

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Dear Mr Foster

Update of Low wall Stability Modelling for Proposed Bickham Open Cut Mine

This letter report describes the results of stability modelling of selected parts of the low wall for the proposed Bickham Open Cut Mine, located near Wingen, New South Wales.

Modelling of the low wall was requested by Bickham Coal Pty Limited as a consequence of refinement to the footprint and mining sequence for the open cut. The pit shell has a number of changes when compared with a preliminary plan that was examined for stability in our initial analysis.

Pit Shell and Mining Sequence

A plan of the pit shell is shown in Figure 1.

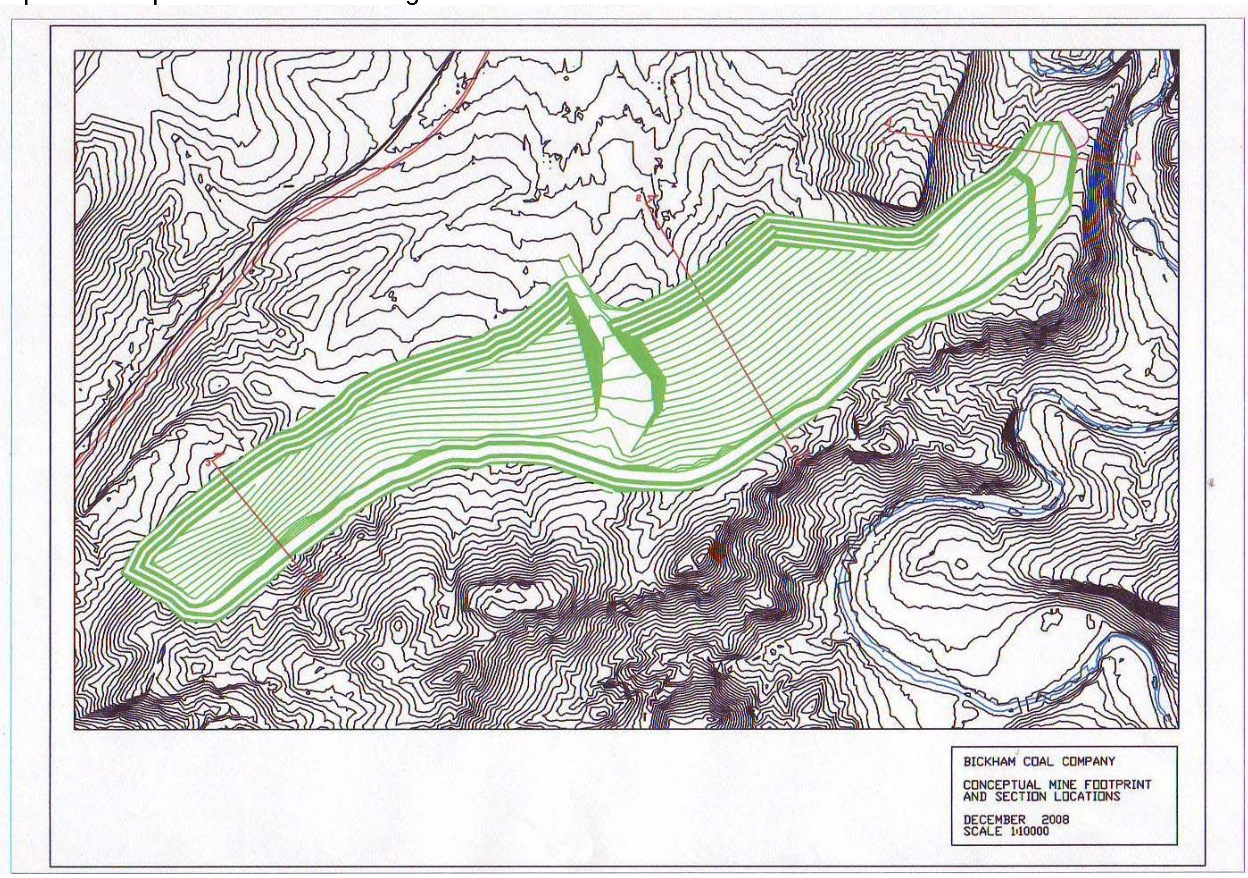

Figure 1: Pit shell for proposed Bickham Open Cut Mine

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In the eastern end of the pit adjacent to the Pages River the floor of the pit is above river level within 300m of the river. This involves leaving a large bench at the E seam level. A low wall ramp joins the E seam bench to the south of the section. In this section of the pit the walls have a batter of approximately 60 to 65 degrees. Section 1 shown in Figure 2 shows the eastern end of the pit with the pit only reaching the level of the E seam.

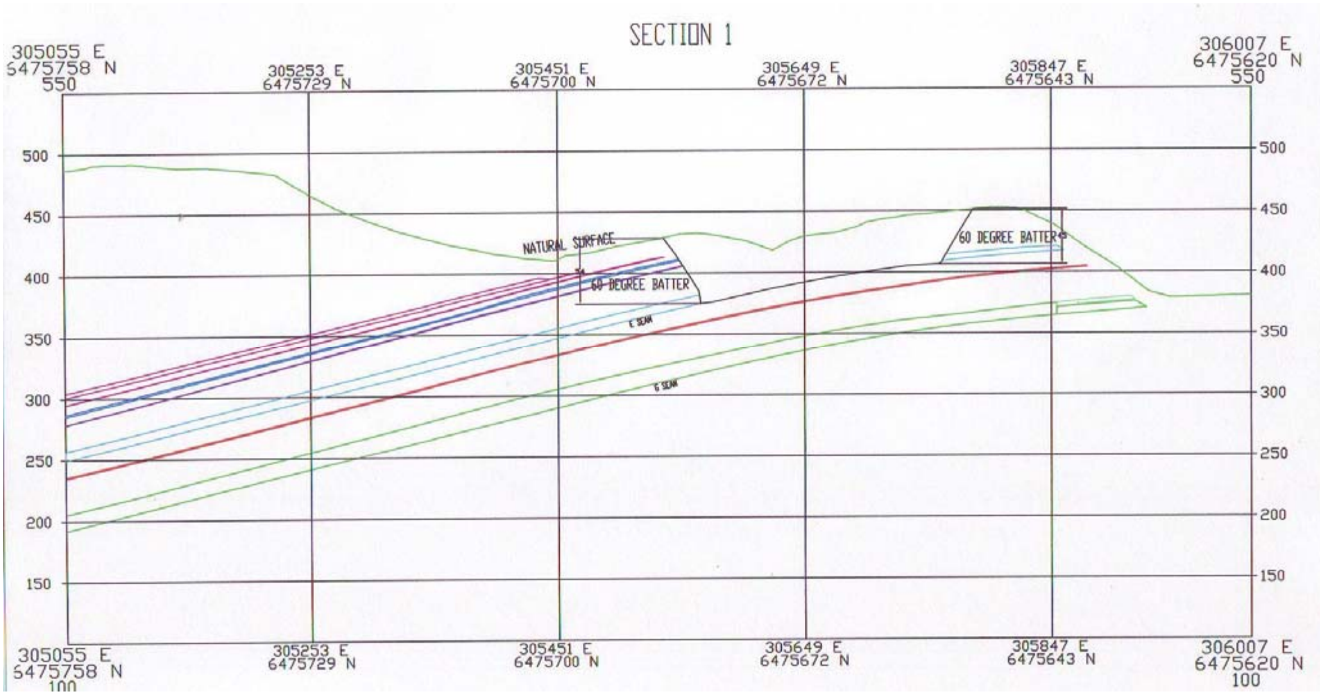

Figure 2: Cross section 1 through pit at northern end of pit closest to Pages River

The high wall in the middle part of the pit is approximately 250m deep. Section 2 shown in Figure 3 shows the middle part where the pit mines to the G seam. The low wall has a 16m wide bench with a vertical spacing of 50m. The low wall also has a 36m wide ramp or bench that serves as access and to reduce the steepness of the overall low wall batter which is approximately 55 degrees. The high wall as shown in section 2 has 16m wide benches also with a vertical spacing of 50m. This leaves the high wall with an overall batter of approximately 63 degrees.

The western end of the pit is shallower and is planned to be mined to the E seam level. The design of the high wall and low wall as shown in Section 3 (Figure 4), and is similar to the eastern end of the pit, although the seams dip slightly steeper in the western end.

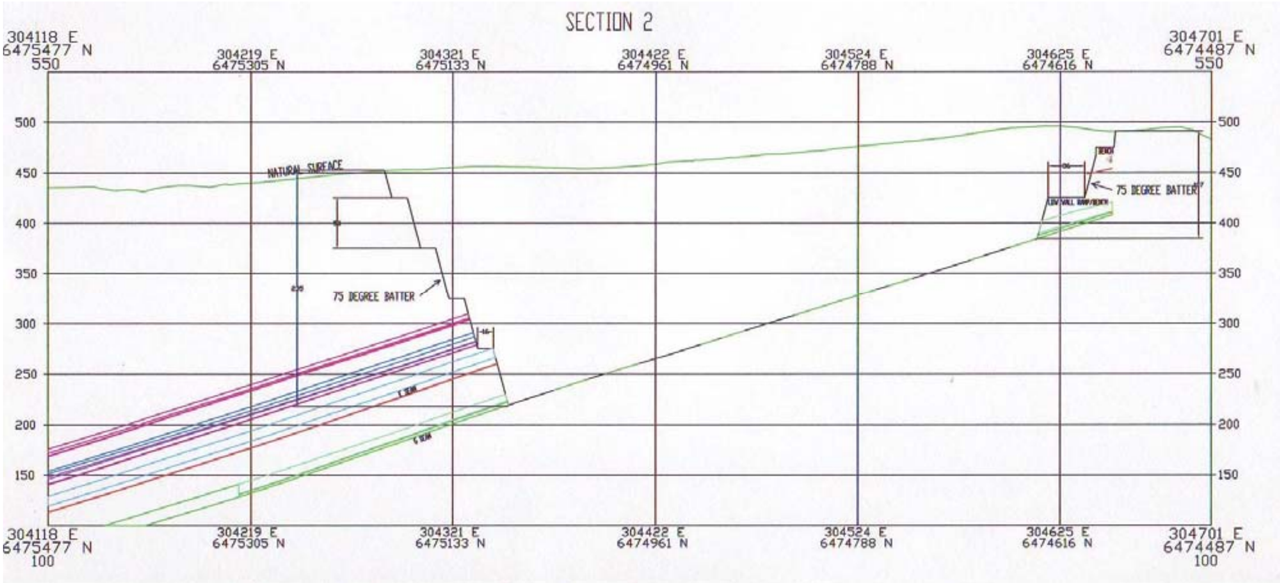

Figure 3: Cross Section 2 through centre of pit

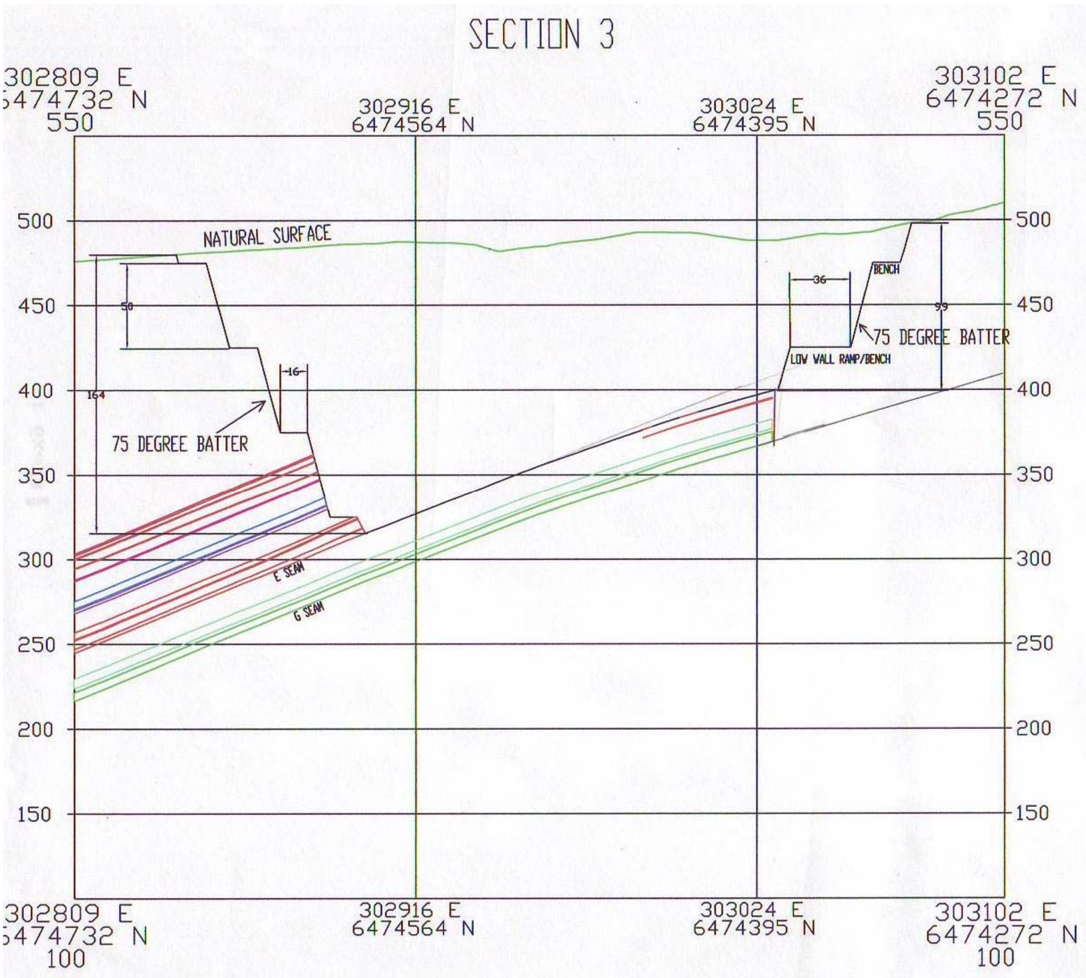

Figure 4: Cross Section 3 through western end of proposed pit

Modelling of Low wall Stability

Both the eastern and western ends do not mine to the lowest seam (G seam) so the height of the low wall is reduced in these areas. The floor of the pit is not directly down-dip at the eastern end so the floor dip is less than previously modeled for this area. Slip circle analysis of the low wall was undertaken using the three cross sections provided in Figures 2, 3 and 4. The slip circle approach generalises a potential failure along jointing at the back of a slip, then breakage through strata following small joints, and finally slip along a bedding plane. Properties used in an analysis are principally the shear properties applicable to geological discontinuities so this type of approach is appropriate at this early stage of stability examination. It is also backed by more than 14 years in the use of this method in the Hunter Valley region, and comparison of modeling with actual mine wall results.

The same model properties were used as in the earlier work undertaken by Parsons Brinkerhoff in the earlier study, so a direct comparison can be made if required. These are shown in Table 1.

Table 1: Materials Parameters

Material	Cohesion (kPa)	Friction (°)	Bulk Density (kN/m^3)
Fresh Interburden	300	35	25
Weathered Overburden	200	30	25
Coal	200	35	14

The water table has not been modelled in these sections. Groundwater impacts of the proposed mine have been assessed by others (Aquaterra). The ground water table does not impact the low wall at the eastern end of the pit closest to the Pages River as it is below the pit floor at the toe of the low wall. The central and western parts of the proposed pit are at a much greater distance from the river, and the low wall is elevated above the river bed, leading to a low risk of ground water influencing low wall stability.

Model Results

The model results for the cross sections through the pit shell are shown in Figures 5, 6 and 7.

The Factor of Safety for the Eastern end of the pit is 2.4. The reduction in dip out of the low wall coupled with the reduction in low wall height act to increase the Factor of Safety. Given that a Factor of Safety of 1.3 indicates long term stability, using this program for stability modelling in Hunter Valley open cut mines, the indications are that there would be long term stability for the eastern end of the Bickham Pit, even without backfilling.

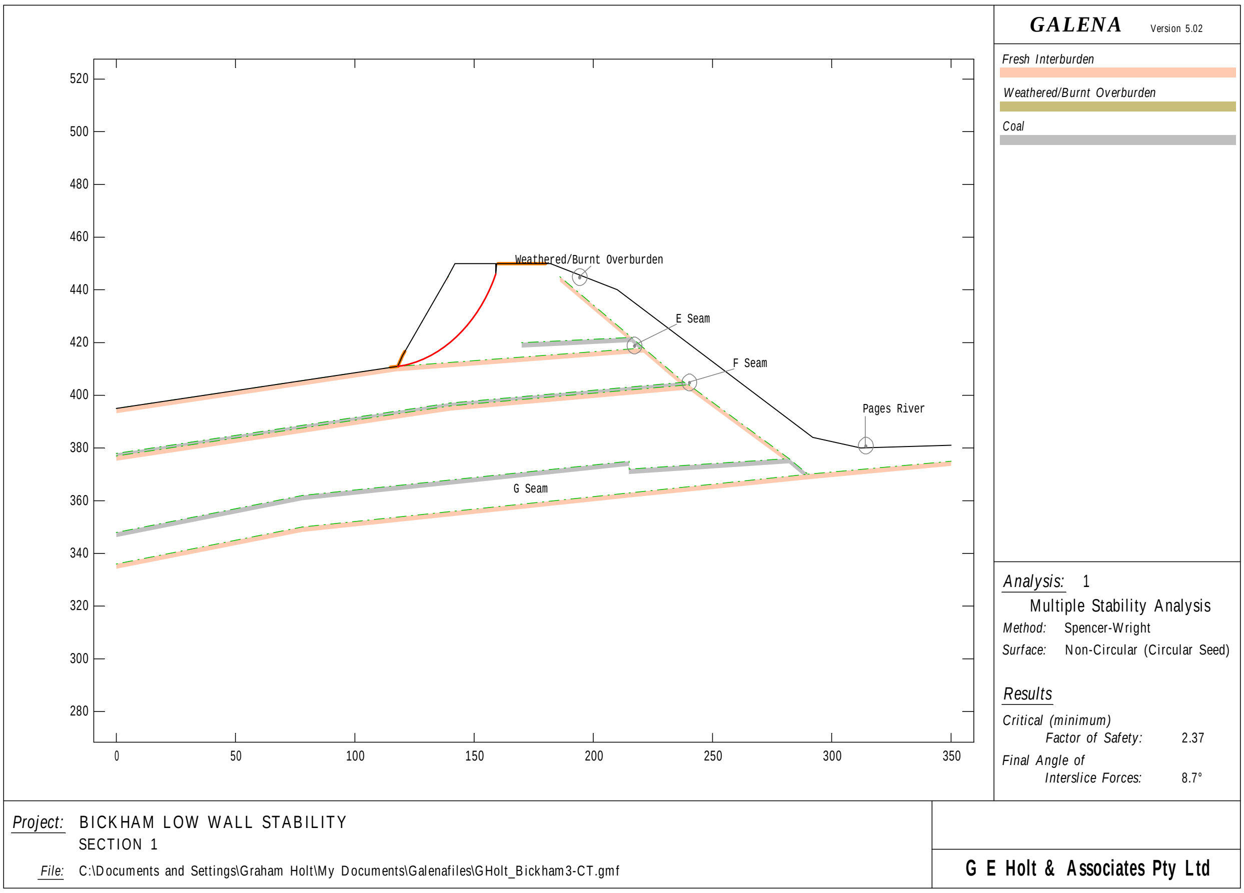

Figure 5: Galena model result for cross section 1 through eastern end of proposed pit at the closest point to the Pages River.

Modelling of the low wall at the central part of the proposed pit indicates a Factor of Safety of 1.4.

When the Angle of Internal friction for the slip plane, positioned at the base of the G Seam is varied between 25^0 and 15^0 the Factor of Safety drops from 1.4 to 1.3. This also indicates the likelihood of long term stability

The pit attains maximum dip of up to 17^0 out of the low wall. The stability of the wall depends on the block of fresh overburden buttressing the collapsed and burnt rock behind. Fired, or burnt rock has high shear strength properties generally, and consequently a high resistance to slip. It is relevant to note that the stronger rock sequence at the Bickham site, when compared with strata in the Hunter Valley, means that strata can stand at a much higher dip out of the face. This is a feature that will require further detailed work to confirm initial findings.

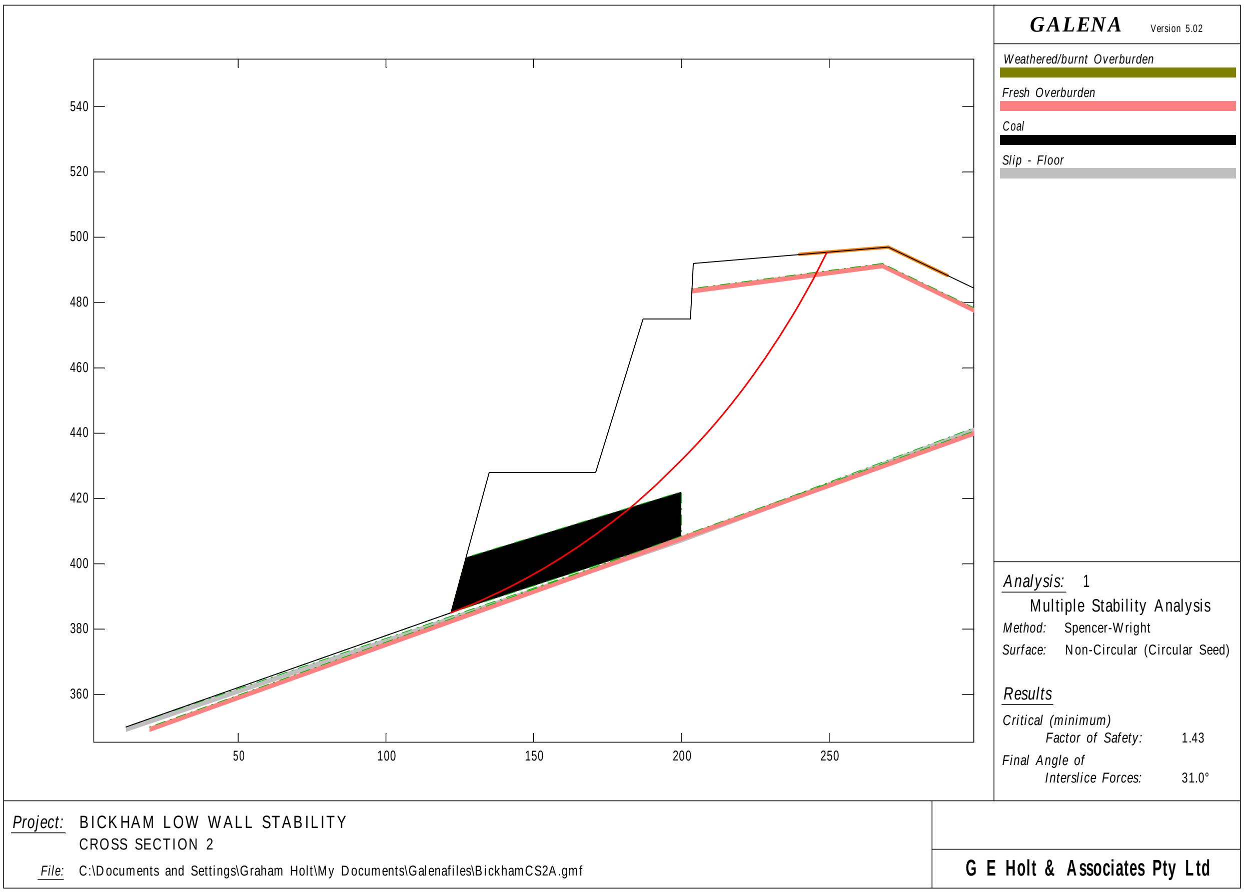

Figure 6: Galena model result for cross section 2 through central part of proposed open cut.

At the western end of the pit, the pit floor will be at the floor of the E seam. This reduces the height of the low wall. The strata dip out of the face is 16^0. The Factor of Safety is 1.4, the same as for the central part of the pit that mines to the lower seam. The model result is provided in Figure 7. The western end of the pit does not have the same thickness of fresh rock buttress in front of the coal fired overburden, and this coupled with the extra height brings about the similar result. Again the preliminary modeling results will require confirmation by more detailed examination of the low wall strata conditions.

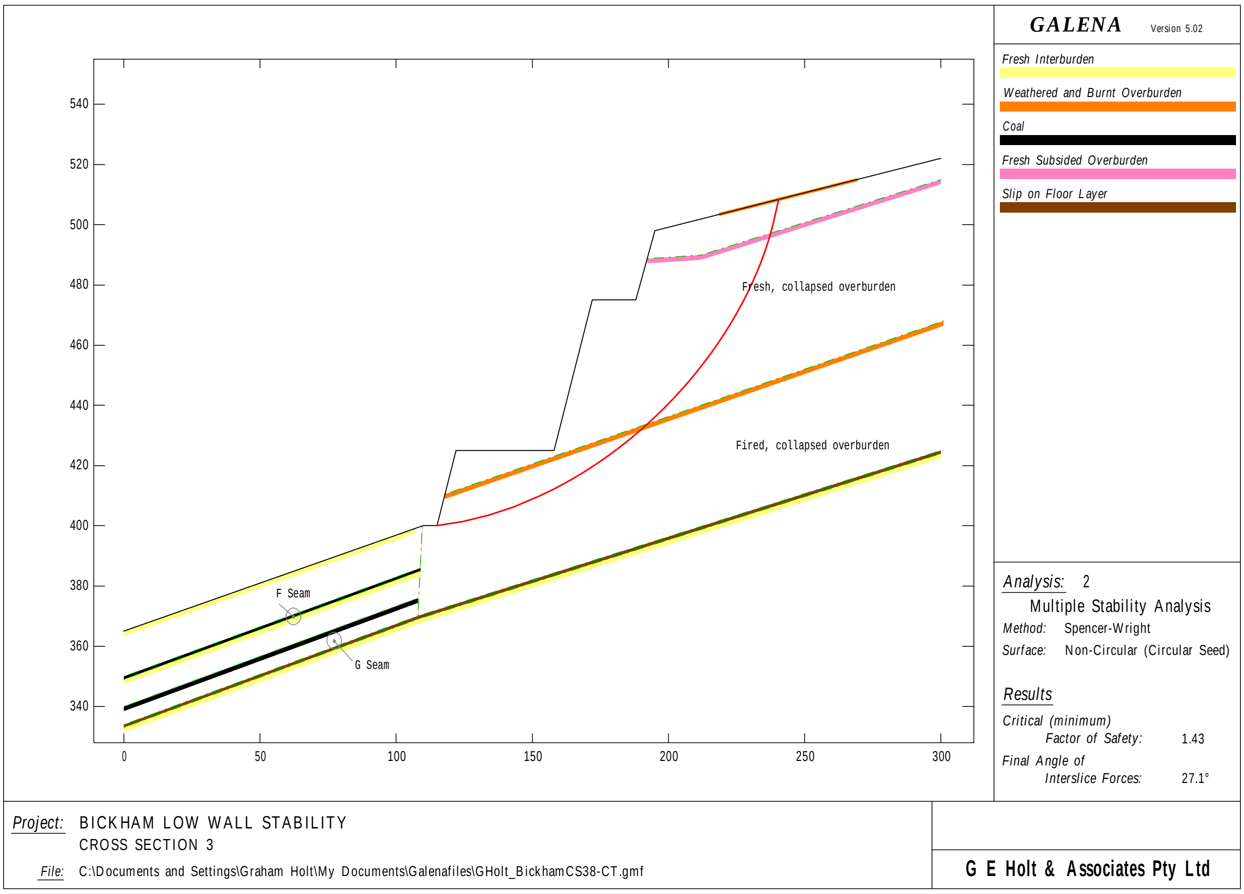

Figure 7: **Galena model result for cross section 3 through western end of proposed pit. Pit floor is at E seam level. There is no buttress in fresh overburden above the E seam level.**

Conclusions

Slip circle modelling has been undertaken on three cross sections through the pit shell of the proposed Bickham open cut mine. In updating the stability modelling of the low wall side of the pit, the same material properties as were used in earlier modelling were adopted.

Refinement of the pit location, coupled with changes to the proposed pit floor levels means that slip on the pit floor is less likely at the eastern and western ends since the floor will be at a higher level. This potential failure of the wall through a combination of tensile failure on steep joints, fracture across multiple joints coupled with some slip at the pit floor was simulated through selection of non-circular failure surfaces in the three cross sections. In the central part of the pit where slip of the G seam floor might be a mechanism for failure, reduction in the shear strength of a weak layer beneath the floor resulted in a slight drop in the factor of Safety from 1.4 to 1.3.

A key feature of the strata at the Bickham site is the increased strength as a result of folding and low grade dynamic metamorphism that is a result of such folding, and in the case of coal fired rock east of the pit, the increase in strength due to firing by the burning coal seams.

The data set on which modelling work has been undertaken is limited to the eastern end as this is the end of the pit closest to the Pages River. More information will be required in time to confirm the findings presented here for the remainder of the pit.

It is evident that increasing the distance between the Pages River and the open cut, coupled with more accurate delineation of minable coal reserves, has led to increased Factors of Safety against failure of the low wall compared with preliminary work that assumed the G Seam would be the floor of the whole pit. Modelling indicates the likelihood of long term stability. Using the data presently available from laboratory testing the low wall has long term stability. Regular review of low wall stability should be built into the Slope Stability Management Plan for the proposed mining operation.

Yours faithfully

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