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CONFIDENTIAL

REVIEW of the DRAFT REPORT ENTITLED "HORNSBY QUARRY and ASSOCIATED LAND", Prepared by Pells Sullivan Meynink Pty Ltd (PSM), Dated 17th January 2007, and Numbered PSM1059.TR1

1. INTRODUCTION

The review of this report is based on an understanding of what Hornsby Council would desire as outcomes.

This would be to conduct "best practice" geological and geotechnical investigations and to use the resultant data to enable Council to make "best practice" decisions on the future use of the quarry and associated lands that;

- **did not expose the Council, citizens, or visitors of Hornsby to unacceptable risks, in the short, medium, and longer terms and**
- **were estimated to have the greatest benefit to cost ratio, this always being considerably subjective because of the difficulty of valuing some community benefits in strict dollar terms.**

The PSM report succeeds, to some extent, to provide these outcomes and brief examples of this are given in a Section below, entitled "Agreed Findings".

In some cases, either the point being made by PSM, or its basis, is unclear. These cases are listed below, in the Section entitled "Questions for Clarification".

However, there are both major and minor deficiencies in some aspects of the methodology and reporting of the study and these are given below in the Sections entitled "Major Criticisms" and "Minor Criticisms". In the view of this reviewer, the Major Criticisms are important enough to potentially change the decisions that Council may have made on the basis of only taking account of the material in the PSM report.

This review perforce concentrates on the areas of apparent deficiency and/or question, given the stipulated requirement for brevity

2. AGREED FINDINGS

There are many points of agreement between the points made in the PSM report and the opinions of this reviewer. The following are a few illustrative examples.

2.1 **Section 1 of the PSM report, INTRODUCTION, is particularly relevant in drawing attention to the much greater level of risk accepted in quarrying operations as compared to civil engineering construction.**

2.2 **The division of the Quarry into five distinct areas by PSM is a constructive way to develop consideration of futures land use**

2.3 **The conclusion is sound that, "most of the quarry itself should be quarantined from the public unless the walls are stabilised by backfilling" (see Section 3.2, page 8).**

2.4 PSM point out that one option for stabilising the quarry walls would be to use a "combination of drainage holes, rock bolts, shotcrete, mesh, and scaling" (see Section 4.2, pages 11/12). This reviewer agrees with the PSM assessment of this option as being relatively high cost, requiring a high contingency amount to cover the considerable uncertainties relating to engineering geology, and yet still only providing limited public access

2.5 For the South Western Area, the PSM conclusion is sound that there are severe constraints on the development of buildings or facilities (see Section 4.5, pages 15/16)

3. QUESTIONS for CLARIFICATION

3.1 Part 5 of the Quarry (Section 3.2, page7), is described as "The area of natural bushland in the western part of the site, an area that is understood to remain undisturbed for environmental / heritage reasons".

Has Council made a final decision that it would not consider the possible returns from developing this land as an offset to the costs of stabilising the quarry?

If not, the possible development of this area should have been considered by PSM.

3.2 With regard to groundwater levels, PSM note In Section 2.1.4, that one piezometer showed, "the current water level is virtually the same as .... in 1990. What, if anything, is concluded from this?

For example, it would not be valid to assume that this one result shows that groundwater conditions throughout the quarry site have not changed since 1990.

4. MAJOR CRITISISMS

These are important issues that, in the opinion of this reviewer, are likely to impact on the decisions that Council makes, and should have been contained in summary form in the "Findings" Section of the PSM report, with full detail in the Appendices.

4.1 Issues Relating to Estimates of Slope Instability

These estimates are essential data for Council decision-making in relation to the future uses of the quarry and associated land.

What is required is a matrix of estimates of slope failure data, including;

- probabilities of failure expressed in numerical form, so as to allow an informed understanding of the level of risk being undertaken
- the likely scales of the range of possible instabilities, including the volumes of materials likely to be involved. For large scale failures, an essential estimate is the horizontal distance that the failure is likely to extend back from the quarry face, and
- the increase in the probability of slope instability with time, over the range of scales.

In the PSM report some components of this essential data is inadequate and other components are absent.

Specifically, PSM make no qualification for the increased risk of instability as the time horizon is extended.

There are a number of factors that increase the risk of slope instability with increased time horizon and some of these are interactive. These factors include;

- seismic activity,
- air conditions including pollutants,
- weathering and/or softening of materials contained within the slopes,
- rainfall and runoff,
- groundwater conditions,
- nearby construction and/or excavation,
- micro ground movements that can over time link to facilitate the development of failure surfaces, etc.

The fact that instances of major instability have not occurred at the quarry since operations ceased about 10 years ago is cold comfort when Council has to make decisions that are likely to have a time horizon of at least 50 years into the future. For example, there have been significant factors that have varied over the period since cessation;

- the level of runoff has been at historically low values. What will be the impact on slope instability when normal and above normal conditions again prevail?

- the gradual filling of the quarry that continues to occur, from a zero value at the cessation of quarry operations, to a current depth in excess of 20metres. This is having a major impact on groundwater conditions in the materials at the base of the quarry and these materials would be involved in any future slope instability event of major consequence.

The above discussion in turn spotlights for deeper consideration the PSM recommendation (last paragraph of Section 4.2 on page 13) that "if the quarry is not backfilled, the water level should be controlled at about RL 30" ie approximately the current level. Hopefully, this recommendation is based on more than, 'if it hasn't fallen down yet it will never fall down'.

The terms used by PSM to express different levels of the risk of slope instability are not numerical and hence do not allow the decision-maker to understand the odds he/she is accepting.

For example, in numerical terms, what are meant be the PSM descriptors of "Low", "Moderate", and "High"? Does "Low" mean, say, a 2 to 4% chance of instability over 5 years and a 5 to 15% chance of instability over 50 years?

An acceptable expression of the probability of slope instability would be, for example, "that for the Northern Face, within the next 10 years, there is a 2% to 5% chance of a failure extending horizontally up to 100 metres from the lip of the quarry. Taken over 100 years this probability will increase to 5% to 10%".

PSM show their zones of "Low", "Moderate", and "High" risk of slope instability on Drawing PSM 1059-18. Apart from the deficiency of not expressing these risks in numerical form, this diagram does not appear to differentiate between different scales of slope instability, or give an indication as to how far back from the lip of the quarry large-scale failures may extend.

Within the PSM report there are several examples of where the way of treating the probability of slope instability is questionable;

(a) The Northern Face

The PSM report (Section 3.3, page 8) contains the statement, "There is no risk of deep seated sliding of the northern face of the quarry affecting existing buildings and infrastructure to the north of the quarry". The unconditional nature of this statement is questionable in the context of geotechnical uncertainties. Such uncertainties are significantly high at this site for the reasons expressed in the engineering geology sections of the PSM report. Also, the majority of the most recent instances of slope instability at the quarry have occurred in the Northern face. Despite the high level of geotechnical uncertainty and the record of recent failures,

PSM did not take the opportunity to gain engineering geological data from behind the Northern face through the drilling a of a borehole similar to the one they drilled behind the Southern face.

The PSM statement is that no "existing" buildings or infrastructure would be affected. Since Council are seeking to decide land use at the quarry site for at least 50 years, this PSM statement begs the question of future developments that Council may allow on land outside the quarry boundaries to the north of the Northern face. Should such further development be quarantined? If so, there is no apparent recommendation from PSM to Council to this effect. Hopefully, the PSM statement does not indicate an assumption that, 'if it is OK today, it will be OK forever'.

Despite the PSM statement regarding the Northern face, referred to above, their Drawing of "Risk of Instability Associated with the Quarry Slopes", PSM 1059-18, shows considerable potential slope instability in the Northern face. This drawing indicates a zone of at least "Moderate" risk extending along the Northern boundary of the Quarry site for a distance exceeding 250 metres. The question arises as to why this potential instability may not extend over the boundary at any point along this 250 metre length? This raises another question as to whether adjoining lands to the north should be compulsorily acquired by Council. The PSM report is silent on this issue.

Further with regard to the possibility of slope failures in the Northern face propagating to and beyond the Northern boundary of the quarry, it is of interest to note that from the RL 20 contour near the base of the quarry, a failure wedge would outcrop outside the quarry boundary if it had an intersection inclination of not less than 30 degrees.

The formation of such a failure wedge has a non-zero probability, particularly since there is documentary evidence that inclined and intersecting planar veins of slippery fatty clays exist behind the Northern wall/face. It has also been documented that such intersections have previously produced slope failures, albeit on a moderate, rather than a massive, scale.

(b) The Crusher Area

An example of a PSM statement that requires very close revision, particularly from the viewpoint of facilitating land-use decisions, relates to the Crusher Area. The PSM report (Section 4.4.1 on page 14) states, "the area available is essentially unaffected by the risk of quarry slope instability". In fact, the data that is required for a rational decision to be made is, "what range of percentages expresses the risk that this area may be affected by slope instability some time within the next 50 years?" Given such data, a rational decision could then be made as to whether the risk of damage to any proposed development on the site is acceptable.

(c) The South-East Corner

Quarry plans and anecdotal evidence suggest that in the past an unplanned and uncontrolled major event of slope instability occurred in the South-East corner of the quarry. It appears that the possibility of future instability in this area has not been specifically addressed in the "Interpretation" and "Findings" Sections of the PSM report.

(d) The Viewing Platform

The approach of PSM to the probability of slope instability related to the Viewing Platform is questionable. In Section 4.7, page 18, they state;

- "no localised instability issues are present"
- "no bench scale wedge on (or?) sliding type failures can occur"
- "erosion of the rock face below the location will not cause any instability".

All three of these statements suggest an unqualified absence of the risk of failure. In reality, the risk of failure must be non-zero in each case. For each of the three cases, what level of failure risk does PSM suggest would be acceptable to Council in the short (5years), medium (40 years), and long term (100 years)?

(e) Costing of the Do-Nothing Option

In the case of the Do-Nothing option, the questionable approach of PSM to the consequences of the risk of major slope instability causes a pronounced distortion to the cost estimates that they provide (see page 20). For this they do not include the potential cost of remediation of slope instability events occurring over an appropriate time frame, say 50 years. For the sake of example, consider the scale of slope instability to be divided into three quantitatively defined categories; small(S), medium(M), and large(L). The respective costs of remediation are Cs, Cm, and Cl, and the probability that they will occur over a 50 year time span are Ps, Pm, and Pl.

The remediation cost that should be allowed in the Do-Nothing option is,

$$\text{Do-Nothing Remediation Cost} = Cs \times Ps + Cm \times Pm + Cl \times Pl .$$

This total remediation cost may well be very high and have a major impact on Council decision-making.

4.2 Issues Relating to the Future Possible Uses of the Quarry

For example, one of the most obvious possible future uses of the quarry is that of a recreational lake that also acts as a stormwater water retention basin. However, this specific use is not one the 16 listed in Section 4.1.

PSM, however, do imply the possibility of a recreational lake / stormwater basin in the discussion in the last two paragraphs of Section 4.2. They conclude correctly that allowing the quarry to fill with water would result "in an overall decrease in the factor of safety".

Such a decrease would not apply if the quarry was partially filled with "engineered" solid fill to an appropriate height before the water was allowed to rise to the creek exit level.

The possible use of the quarry as a stormwater retention basin, as indirectly suggested by PSM in the first dot point of Section 3.4, may allow the exit level for the creek to be lowered. This possibility, and its pros and cons, do not appear to be considered by PSM.

There are a number of other variations of possible land-use that are worthy of consideration.

4.3 Issues Relating to Backfilling Options for the Quarry

The possible alternatives relating to the option of backfilling the quarry do not appear to have received comprehensive consideration from PSM.

For example, in the consideration of the backfilling option (see Section 4.2 and page 20) there is no allowance for the revenue that could be generated by Council by accepting waste as backfill material. Such waste would need to be strictly defined, with appropriate protocols for its acceptance and placement.

Further there is no discussion as to the reduction of the estimated 850,000 (presumably off-site to on-site) truck movements that would occur if on-site materials were used for backfilling.

The only sources of possible on-site backfilling materials, identified by PSM, are from the eastern and south western areas. The Northern face and other sources, indicated in the example below, appear to have been ignored by PSM.

There is no doubt that the surest way of producing a long term and major improvement of the stability of the quarry walls is to;

(a) backfill the quarry in an "engineered" fashion up to an appropriate level, and
(b) decrease the slope of the quarry walls above that level of backfilling.

There are many possible ways of achieving these twin objectives but it appears that only (a) of these has been considered by PSM.

Set out below is one possible example of how the twin stability objectives could be met, It involves;

- **the development of a recreational lake, which doubles as a stormwater retention basin, and**
- **the on-site generation of all of the required backfill materials.**

PSM have estimated that to backfill the quarry to RL90 would require 3.3 million cubic metres. However, if the backfilling was only carried out to RL 80 the requirement is estimated to be reduced to about 2.6 million cubic metres. If the creek exit was fixed at RL 85, a recreational lake / stormwater basin of 5m depth would thereby be created.

PSM also state (Section 4.2) that there is almost 0.7 million cubic metres of fill in the South-western and Eastern areas. Including these materials in the backfilling of the quarry, means that the shortfall is reduced to 1.9 million cubic metres.

It is almost certain that all of this volume can be produced on-site by battering back all four quarry faces above RL 80. This would produce a very significant increase in the stability of all four faces and not a single noisy haul truck would have to pass over Hornsby roads!

Also, the Northern and Southern buttresses proposed by PSM in Section 4.2, page 12 would no longer be necessary. This is because the battering back of the Northern and Southern walls/faces would provide the required levels of stability.

The proposed battering back of the Southern face would significantly improve the stability of the Crusher Area (see above Section 4.1(b) in this review).

4.4 Issues Relating to the Monitoring Program

In the opinion of this reviewer it is essential to immediately implement a monitoring program to warn of the development of conditions of incipient major slope instability. In this way Council can be seen to be taking responsible and effective action to manage the risks of slope instability at the quarry site.

It is not clear as to what level of importance has been placed on monitoring by PSM. This is because the specific topic of monitoring does not appear to be mentioned in the "Interpretation" or "Findings" Sections of their report. In fact, the only apparent mention of monitoring, apart from brief discussion in the Appendices, is in the Summary of Cost Estimates, Section 5, pages 20/21 of the PSM report.

This reviewer considers that a minimal monitoring program would include;

- **a cased deep piezometer behind each of the four quarry faces**
- **facilities to monitor subsurface ground movements down each of the four casings**
- **an array of surface movement monitoring points**
- **inspections of quarry faces to discern changes in structural geology that may be indicative of incipient slope instability.**

PSM proposals appear to fall well short of this level and are hence considered by this reviewer to be inadequate.

The monitoring program has in impact on the comparative budgets for the future uses of the quarry site. If the Do-Nothing option is selected then monitoring needs to be continued on an ongoing basis. However, if the backfilling option is taken then the monitoring program can be wound back at the rate that backfilling occurs. Hence, monitoring costs will be much greater for the Do-Nothing option than for the Backfilling option. This differentiation of monitoring costs, according to the whether the Do-Nothing or Backfilling option is selected, does not appear to be reflected in the PSM report. This provides an invalid advantage for the Do-Nothing option when compared to the Backfilling option (a further invalid cost distortion in favour of the Do-Nothing option is discussed above in Section 4.1(e) of this review).

5. MINOR CRITISISMS

5.1 Having separate Sections of the Report dealing with "3. Interpretation", and "4. Findings" is confusing and leads to repetition, such as occurs with the material given in Section 3.4 on page 10 and repeated in Section 4.2 on page 13.

According to the Macquarie Dictionary, the difference between "Interpretation" and "Finding" is essentially academic;

Interpretation = the act of setting forth the meaning of
Finding = that which is found or ascertained.

It would be much easier to follow the material presented in the PSM report if there was a section for "Interpretation and Findings" and a separate section for "Recommendations".

5.2 On page 3, and in Appendix C, the value of the reference to the breccia in East Kalimantan is of uncertain value since no explanation appears to have been given explaining its relevance to the Hornsby Quarry materials.

5.3 On page 11, Section 4.2 the "findings of this study" that small scale instability is more frequent than large scale instability is in fact the general principle that applies to the geotechnical stability of excavations.'

5.4 PSM state in Section 4.2, page 12, that the Eastern area could be the source of 0.37 million cubic metres of fill for the quarry. However, this possibility, and its potential impact on the options for the development of the Eastern Area do not appear to be mentioned in Section 4.3, pages 13 and 14. Perhaps the removal of the fill from the Eastern area, to be placed in the quarry, could mean that the foundation conditions in the Eastern area were improved so that any subsequent development of the area would not require the relatively expensive foundation options proposed by PSM.

5.5 The plan location of boreholes and test pits is important information and should be contained in the first part of the report, ie the part excluding the Appendices. It does not appear to be there.

5.6 In Section 4.2 (eg last paragraph) PSM indicate that they have a degree of confidence in predicting the extent of deep seated failures. If this is correct then the extent of such failures should be shown in the first part of the report in plan and cross-section.

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