REPORT TO:	**NSW Department of Planning & Infrastructure**
ATTN:	**Mr Howard Reed** **Manager Mining Projects** **Major Project Assessments**
cc:	**Mr Clay Preshaw** **Team Leader**

SUBSIDENCE IMPACT ASSESSMENT – GUJARAT NRE NO. 1 MAJOR EXPANSION PROJECT

Independent Peer Review

PART 3: Review of NRE Preferred Project Report – Subsidence Assessment

REPORT NO:	**1303/02.3**
PREPARED BY:	**BRUCE K. HEBBLEWHITE**
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1. SCOPE OF WORK

This third stage Report should be read in conjunction with, and as a sequel to my original Peer Review Report on this project, Report No. 1303/02.1, dated 20th June, 2013. This report is specifically focussed on the Preferred Project Report submitted by Gujarat NRE (undated).

For clarity, the scope of work section of my original report is repeated below:

<u>Report 1303/02.1 Scope of Work</u>

> "This report has been commissioned by the NSW Department of Planning & Infrastructure as an independent peer review of the Subsidence Impact Assessment provided by Gujarat NRE No. 1 Mine associated with their Expansion Project.
>
> The scope of this peer review has been defined as follows:
>
> *<u>"Part 1: Independent Peer Review of Subsidence Impact Assessment</u>*
> - *Review of the overall contents of the EA documentation in order to provide background and mining-related context.*
> - *Preparation of an independent peer review report specifically focussed on the Subsidence Impact Assessment contained within the project Environmental Assessment documentation. This would require development of a clear understanding of:*
>   - *the proposed mining systems and overall mining schedules and plans;*
>   - *the prevailing geological and geotechnical environment;*
>   - *the existence and nature of any particular natural or man-made surface or sub-surface features considered to require any degree of protection from adverse subsidence impacts (excluding aquifer and groundwater considerations which are understood to be being considered separately);*
> - *The peer review report would include a detailed analysis and assessment of the methodology of subsidence predictions provided, and their applicability to the environments and requirements listed above, together with assessment of the actual predictions made and the confidence levels quoted regarding such predictions.*
> - *This peer review will be provided on the basis of the knowledge and skills of the author, and experience gained in review of similar materials and project matters over recent years.*
>
> *<u>Part 2: Review of the Gujarat Response to Submissions (RtS) and possible Preferred Project Report (PPR)</u>*
> - *It is difficult to provide any further specific scope at this stage, other than to say that this Part 2 review would build on, and likely take a similar form to the Part 1 EA Review – and again it would be focused on matters pertaining to subsidence impact.""*

This third report is therefore addressing Part 2 of the above scoped process. Gujarat NRE has submitted a Preferred Project Report (PPR) to the Department, with a modified, greatly reduced "Preferred Project", compared to that envisaged in the original NRE No. 1 Mine Expansion Project that was reviewed under Part 1. A summary of the new project features is provided below (as an extract from the PPR).

1. *The estimated project life has been reduced to a maximum of 5 years.*
2. *The Wonga East Longwall (LW) layout has been extensively modified to minimise impacts to identified significant features while attempting to maximise the recovery of*

*coal reserves (see **Figure 2**, pg 11).*

3. *The Wonga Mains driveage will not be extended northwards under the south arm of the Cataract Reservoir through the known geological feature (in the Bulli Seam).*
4. *The Wonga West longwalls will be removed from this application. The Wonga West longwall layout will be revised and resubmitted as a separate application at a later date.*
5. *The Western Balgownie and Western Bulli Seam first workings will be removed from this application.*
6. *There is no change proposed to the Pit Top upgrade, 3 million tonnes per annum (Mtpa) extraction rate or peak coal transport rates as presented in the original Environmental Assessment (EA).*

Figure 1 is reproduced from Figure 2 of the PPR and provides information regarding the layout now under review. Note that there is no longer a Longwall 8 panel.

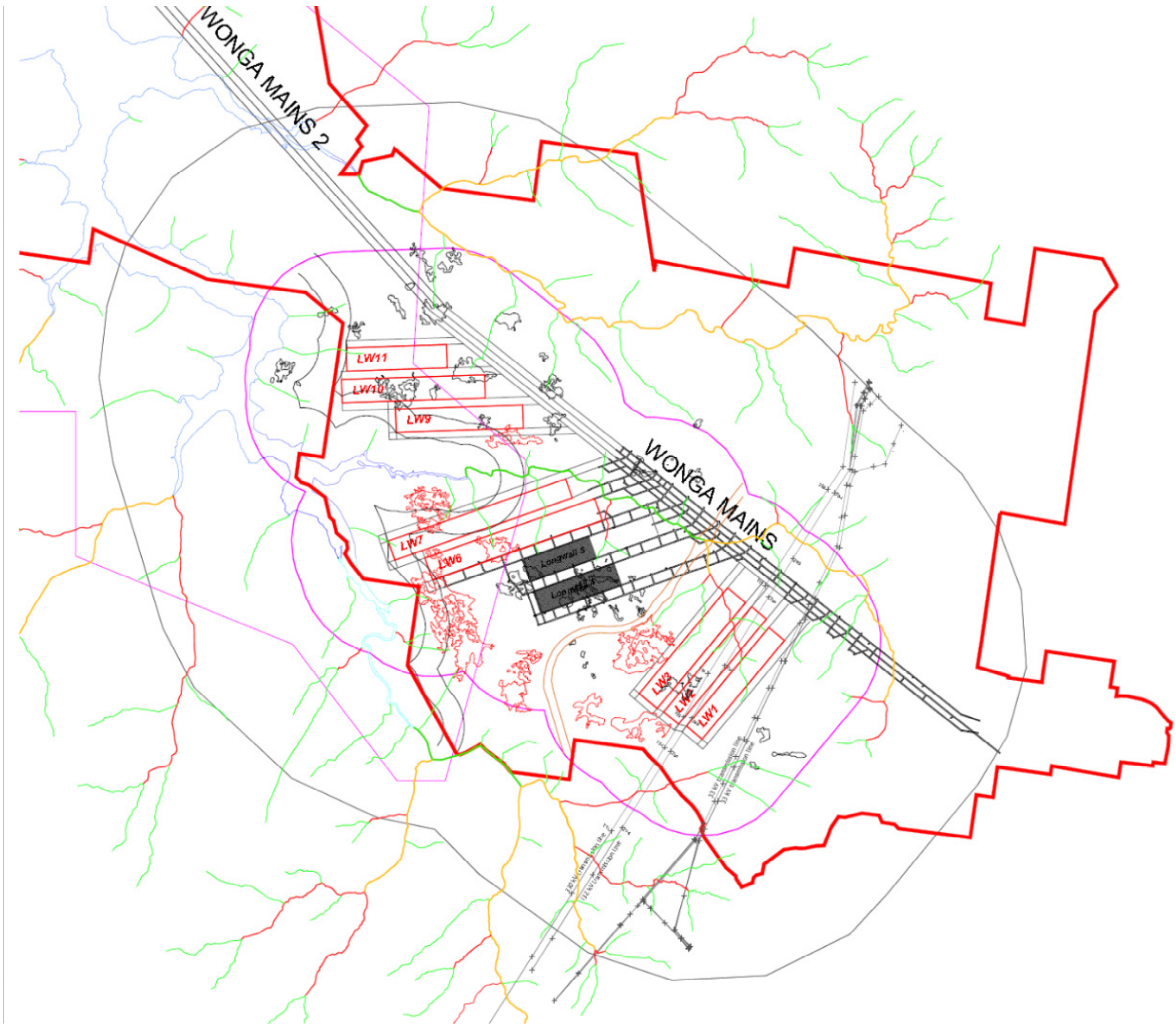

Figure 1.
(PPR Figure 2 – Wonga East Longwalls *(source: Gujarat NRE PPR)*)

Apart from the above clarification of the new, reduced mine plan under consideration, the remainder of this current review report will consist of a peer review of the specific component of the PPR documentation addressing mine subsidence prediction and assessment. This was contained in a report provided by SCT, Report No. NRE14123, authored by Dr Ken Mills, and dated 24 September, 2013. The SCT Report is titled "Subsidence Assessment for Gujarat NRE Preferred Project Russell Vale No 1 Colliery", and is contained in Attachment B of the Gujarat PPR.

2. REVIEW OF SCT REPORT NRE14123

The following represents a point-form summary of key issues or comments in relation to the prediction and assessment of subsidence, referencing the relevant section and/or page numbers from the original SCT document. The points are listed in the order that they appear in the SCT report, for easy cross-referencing. As such, the order of points does not imply any relative importance or priority of issues. It is also important to note that in reviewing the report in this manner, some issues raised in report sequence order are subsequently answered or further expanded later in the report. Therefore the report should be read in its entirety, prior to reacting to individual issues raised.

A. <u>Summary Section</u>

1) Summary, p(i) – SCT notes correctly that the presence of the old workings in the other mined overlying (Balgownie and Bulli) Seams, whilst providing some challenges, does present an advantage in the ability to project the location of known geological structures between the seams into the proposed Wongawilli workings.

2) Summary, p(ii) – SCT notes that previous Bulli Seam longwall experience will assist in understanding the subsidence mechanisms involved (for this geology), and the prediction of actual subsidence values. It is also noted that incremental subsidence and the approach of Holla and Barclay will be used for predicting tilts and strains; and that the ACARP Method (Waddington Kay & Associates (now MSEC)) will be used for predicting maximum closure. These approaches are considered valid and appropriate; furthermore, they now address the shortcomings in the previous Seedsman work which was lacking with respect to predictions in non-conventional subsidence effects such as valley closure due to surface topographic variations.

3) Summary, p(ii) – It is noted that *"subsidence behaviour is essentially predictable albeit with somewhat different characteristics to subsidence over single seam mining operations".* The term "essentially predictable" is rather vague or imprecise in meaning, presumably due to the complexity of the issue under discussion. As previously noted, it is due to the effect of multi-seam mining on subsidence behaviour. It is simply not possible to provide accurate, absolute subsidence predictions, based on such a limited database of current multi-seam experience. SCT identifies the reason for subsidence differences in a multi-seam environment as being due to *"overburden stiffness characteristics and therefore the bridging capacity across individual panels, but is otherwise essentially similar to the subsidence behaviour above single seam operations".* Whilst I agree with this statement to a point, it perhaps over-simplifies the issue of exactly how the assessment of the changed overburden stiffness characteristics can be carried out in order to predict multi-seam subsidence with any degree of certainty. It also makes no reference to the important issue of time-dependency, when previous goaf areas (particularly old partial or first workings panels) are remobilised.

4) Summary, p(ii) – SCT notes that there is potential for some localised pillar instability in the overlying Bulli Seam workings in the vicinity of Longwall 1 when mining in the Wongawilli Seam takes place.

5) Summary, pp(iii-iv) – SCT has undertaken an assessment of previous subsidence effects due to the mining of both the Bulli and Balgownie Seams. The Bulli Seam subsidence is estimated

(see later in body of report for explanation of basis for estimation technique); this has then been combined with measured data from longwall mining in the Balgownie Seam. An interesting (and considered reasonable) statement is that in the multi-seam environment *"the goaf edge subsidence profile is expected to be softer than elsewhere".*

6) Summary, p(iv) – It is noted that the PPR includes an adaptive management strategy *"based on closure monitoring and cessation of mining if there is a likelihood of significant perceptible impacts becoming apparent".* This is discussed in relation to Cataract Creek in particular, and the possible impacts of valley closure effects. Whilst this principle of adaptive management is considered reasonable, it is reliant on several factors which have not as yet been clearly defined, but which are essential to the success of such a strategy. These were identified in my initial report and include:
    a. What amount of lead time will be available in the relevant monitoring data locations, to provide meaningful data on which decisions can be made prior to the impacts occurring at Cataract Creek?
    b. What certainty will there be, that the observed surface subsidence effects and related impacts will cease immediately if mining is ceased in the area?
    c. What is the proposed management structure whereby such decisions will be made – both with regard to the interpretation of the monitoring data; and also with respect to deciding to stop the longwall, and how quickly can such a process take place?

7) Summary, p(iv) – SCT makes a significant comment and recommendations, with respect to the potential impact of mining on the identified 33 upland swamps identified by Biosis. Firstly, it is stated that mining is not expected to cause significantly different impacts to those already experienced due to earlier mining – however, such previous experience has not been well documented, to date (this is partly due to the simple lack of previous data available). It is therefore difficult to agree with, or endorse this statement, in the absence of any supporting data. Consistent with a lack of real quality data on swamp impacts, SCT then rightly argues for *"more work is required to determine the relationship between mining subsidence and the long term health of swamps".* It is stated that there is a rare opportunity within this lease area where base data, or at least experience exists over many decades, to undertake a more thorough review. SCT further recommends the formation of an ongoing monitoring and review strategy with respect to subsidence impacts on swamps and their subsequent recovery over time.

8) Such a view is strongly supported, and is in line with some of the recommendations from the Southern Coalfield Review Panel Report (2008). The issue then becomes, how is such a review and further investigation possible without mining progressing in the vicinity of such swamps in order to generate further data? It is proposed that an incremental approach be adopted, with the first stage being a summary of historical impacts and evidence of recovery; followed by more precise monitoring of subsequent impacts as mining proceeds – preferably in relation to less significant swamps in the first instance.

9) Summary, pp(iv-vi) – Further summary impacts are discussed, with conclusions that impacts on sandstone cliff formations, aboriginal sites, Mount Ousley Road, Cataract Reservoir, and the Illawarra Escarpment are likely to be minimal to negligible. This view is supported. In relation to electricity transmission towers, it is noted that some protection and remedial actions will be required. In regard to the use of a barrier between mining and the Full Supply Level (FSL) of Cataract Reservoir, a horizontal protection barrier of at least 0.7 times depth has been applied around the FSL which seems reasonable. However SCT then notes on p(vi) that *"the presence of these goafs reduces the effectiveness of the 0.7 times depth barrier".* This is referring to

goafs from old workings. If this reduction in effectiveness is real, as stated here by SCT, then surely this requires further justification of the adequacy of the 0.7 barrier, or else a modification to the barrier width or control measure for the FSL? Such an explanation is lacking, but should be provided.

10) Summary, p(vii) – Discussion of the other submissions includes comments in relation to the subsidence prediction technique(s). It is noted and agreed that prediction techniques are being continually improved, based on available data, to enable better understanding of the subsidence processes involved. The following sentence is then included in this discussion: *"Although there is somewhat greater uncertainty for subsidence predictions in a multi-seam environment, the available data indicates that the behaviour observed is repeatable and consistent with the mechanics of the processes involved".* This statement does not yet appear to be supported by a substantial body of factual data. On the evidence presented to date, there is still a reliance on hypotheses and estimates, to provide a complete understanding of the multi-seam behaviour. It is, to put it simply, early days in relation to this topic, with very little comprehensive quality data available, and I therefore find it difficult to support such a bold statement at this time.

11) Summary, p(vii) – It is noted that the presence of the old workings in other seams provides valuable data with respect to geological structures, and there are only two major structures in the area, which have been accounted for in the PPR mine design.

12) Summary, p(vii) – SCT concedes correctly that the prediction of valley closure, upsidence and far-field movements are only approximate, since these techniques are still under development. However, to their credit, SCT has made such predictions (which were absent in the earlier prediction reports), using the best available techniques and sources of data. Reference is again made, with respect to valley closure in the vicinity of Cataract Creek, to *"NRE's commitment to stop the longwalls short if closure movements become likely to cause unacceptable impacts".* As discussed above, the ability, practicality and processes for achieving such a management control require further explanation and justification.

B. Section 1. Introduction

No comments.

C. Section 2. Site Description

1) Section 2, p4 – This includes a useful summary of the subsidence constraints used in the redesign of the mine plan for the PPR. This is reproduced below:

- *The constraints of the mine lease.*
- *Geological constraints including the Corrimal Fault in the south, silling (an igneous intrusion within the seam) in the north, and coal quality considerations and its impact on mining height.*
- *Mining constraints associated with the need for main headings in the north and the legacy of previous mining extent and geometry.*
- *Surface subsidence constraints including:*
  - *Avoiding longwall extraction within 0.7 times depth (equivalent of 35° angle of draw) of the full supply level (FSL) of Cataract Reservoir including the section of the reservoir that extends up Cataract Creek.*
  - *Avoiding mining directly under the third and fourth order sections of Cataract Creek.*

- *Minimising impacts on Mount Ousley Road to tolerable levels by remaining beyond approximately half depth (equivalent to 26.5°angle of draw) from the road easement.*
- *Significant upland swamps.*

These constraints all seem reasonable and appropriate, however the constraint with respect to the significant upland swamps lacks any quantitative or measurable definition, in terms of how does this translate to a design constraint. Figure 2 is a copy of Figure 2 from the SCT report, showing both original and the revised PPR mine layouts, together with the various constraints identified above.

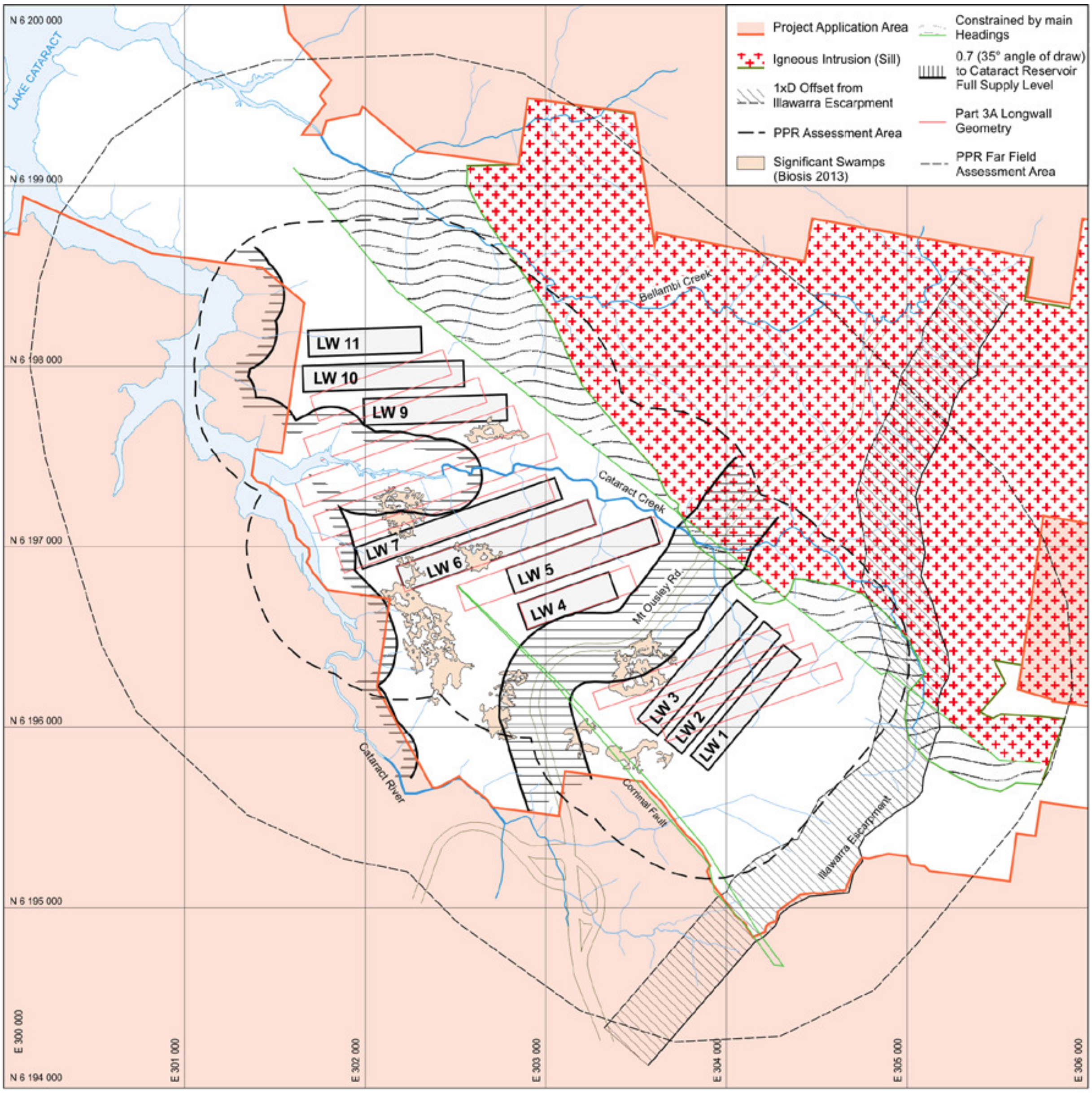

Figure 2: Plan showing the design constraints (lease, geological, mining, and surface protection) as the basis for the PPR mine layout design.

Figure 2. *(source: SCT Report NRE14123)*

2) Section 2, p6 – This provides an appropriate definition of the assessment area as extending 600m horizontally from any proposed longwall panels, and up to 1.5km to allow for far-field horizontal effects on any significant features, such as the Illawarra Escarpment.

3) Section 2, p6 – It is acknowledged that the single seam subsidence seam prediction methodology used in the original assessment was not appropriate, given the measured subsidence values over the current longwalls (LW4) being well above the predictions.

4) Section 2, Figures 6, 7 and 8 – These figures provide a useful record of the previous workings in each of the Bulli and Balgownie Seams, together with the proposed Wongawilli Seam longwall panels. The location of the major geological structures is also discussed (pp10-16), and it is noted that the major fault structure, known as the Corrimal Fault, while significant in throw towards the southern end of the lease (away from the proposed longwalls), diminishes to the northwest, to the extent that it is believed to be insignificant at the point where it will be intersected by LW6.

D. <u>Section 3. Previous Mining Activity</u>

1) Section 3, p18 – It is noted that subsidence from previous mining in the Bulli Seam has been estimated, but for the Balgownie Seam, measurements were taken at the time of mining. The recent mining of LWs 4 and 5 in the Wongawilli Seam has confirmed that observed subsidence does not match single-seam prediction behaviour, although it is claimed that the multi-seam effects are largely restricted to within the chain pillar boundaries of the currently mined panels. SCT again uses the expression "essentially predictable" when referring to multi-seam behaviour, although the basis for such a claim is yet to be substantiated.

2) Figure 3 provides a good overlay of the proposed Wongawilli longwall panels, together with the location of the previous Balgownie Seam longwalls and the areas of old Bulli Seam bord and pillar workings. This is reproduced from Figure 11 of the SCT report.

3) Section 3, p20 – SCT explains that their estimates of Bulli Seam subsidence have been obtained on the basis of previous experience *"from mining in the Bulli Seam further to the west above the T and W (200 and 300 series) longwall panels at South Bulli and subsequent pillar extraction operations".* Whilst it seems reasonable to develop an understanding of subsidence over Bulli Seam bord and pillar workings, the detail is not provided to allow any assessment of the validity or accuracy of this approach, and regardless, it would be very difficult to gain any high levels of confidence in what are no doubt a range of different mining panel geometries and extraction scenarios. This approach is therefore a reasonable one, but there must be a significant note of caution with respect to the confidence in the magnitude or variability of the predicted values, relative to the current areas of interest.

4) Section 3, p20 notes that an extensive underground inspection was undertaken on 21 June 2013 which has identified an area of pillar workings in the Bulli Seam above/adjacent to the proposed Wongawilli panels which are likely to be destabilised as a result of Wongawilli undermining. (This is backed up by evidence of pillar destabilisation caused by the previous Balgownie longwalls, in a similar area of Bulli Seam pillar workings). It is noted that such effects are likely to be localised, and confined close to the new goaf edge, but need to be taken

into consideration. This has already been discussed under section A(4), and relates to an area near Longwall 1 (further discussed on SCT Report p23).

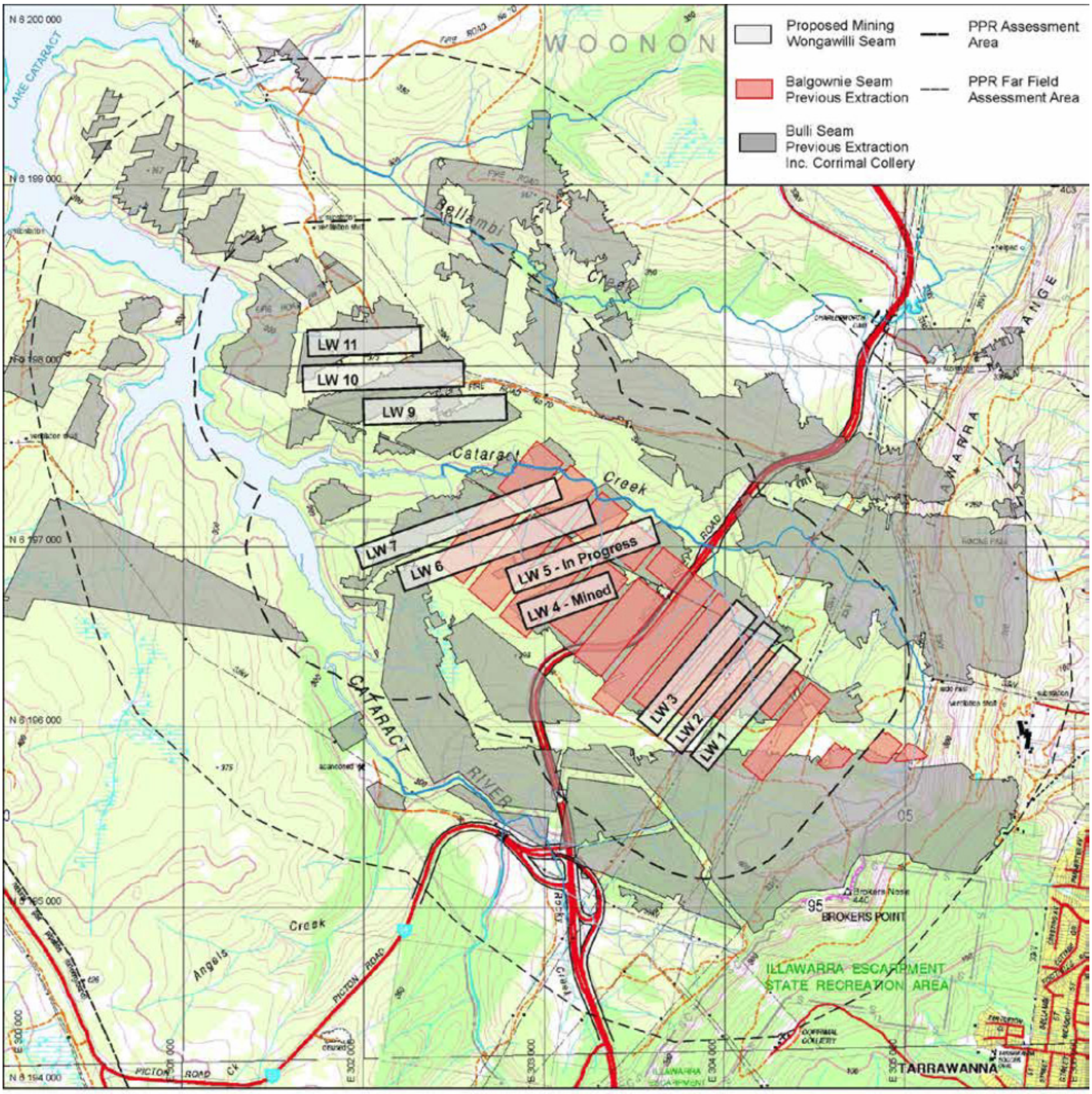

Figure 11: Plan showing extent of previous extraction in Bulli Seam (black) and Balgownie Seam (red) in the PPR Application Area.

Figure 3. Superimposed mine workings (all three seams)
(source: SCT Report NRE14123)

5) Section 3, p23 – Discussion of measured Balgownie Seam longwall-related subsidence confirms that there is evidence from the data that there was additional subsidence at the time due to associated, remobilised pillar instability.

6) Section 3, p23 – Further discussion addresses the question of pillar run potential. SCT states that such a scenario is certainly possible, in the context of localised pillar regions, as discussed above, but is unlikely to extend over any large distances, based on a combination of assessment of the old mine plans, and underground inspection. This opinion and conclusion is considered reasonable. SCT then extends the definition of "pillar run" to include the impact of additional abutment stresses on pillar regions causing, not instability, but simply an additional increment of elastic compression of the pillars, hence an additional increment (albeit small) of surface subsidence, without pillar failure. This is certainly not only feasible, but a certain outcome, where regional load transfers and abutment stresses change the loading regime on standing pillars. However, it is not considered appropriate to include this under the heading of a "pillar run" which historically has been a term used to describe large scale, dynamic pillar instability and failure. The issue of incremental elastic compression does not fall under this description and it is strongly recommended that such terminology should not be used for such behaviour.

7) Section 3, p24 and following – Section 3.2 discusses the Balgownie Seam subsidence effects. Firstly, it is noted that in areas where there was overlying Bulli Seam goaf, the measured goaf edge region subsidence extends further, but only to the extent of being a secondary effect. It is also noted (pp26-27) that where the Bulli Seam goaf areas were narrow and possibly bridging, the effect of underlying Balgownie workings is to cause a greater increment of additional subsidence, such that the resultant surface subsidence extends up to 100% (1.4m) of the Balgownie Seam mining height, i.e. the Balgownie goaf formation has reactivated the goaf above the Bulli Seam and caused this additional subsidence, over and above what would have been expected from single-seam Balgownie subsidence prediction.

8) Section 3.2 also discusses both horizontal strains and tilts, and then valley closure effects associated with Balgownie subsidence (p29). The ACARP method of predicting valley closure and upsidence is applied to these sites and compared to measured data in regions around Cataract Creek where previous Bulli Seam mining had taken place. It is found that this method provided good correlation between measured and predicted data and so is considered applicable for assessing upper bound valley closure and upsidence effects in multi-seam applications. This is a reasonable conclusion going forward, in the face of no other current methodology being available. However it is a conclusion based on a very small dataset, and should be applied with great caution, and a lower level of confidence than when working in single-seam situations.

9) Section 3, p32-35 – It is unfortunate that having discussed the Balgownie Seam subsidence data with respect to subsidence effects and impacts, strains, tilts, valley closure, surface cracking, rock falls, Cataract Creek etc, there is no discussion about the subsidence effects in the vicinity of upland swamps that were impacted by the Balgownie longwalls (such as are indicated to exist in Figure 2 in the middle of proposed Wongawilli LW6, which in reference to Figure 3, lies directly above some of the Balgownie longwall panels). It would be extremely valuable to know how much subsidence and strains, tilts etc occurred in the vicinity of those (and any other) swamps, and then to assess what was the immediate impact on the swamps, if that was recorded at the time, and what is the current state of recovery in such swamps to any

adverse impacts that occurred. Such a correlation between quantitative subsidence data and resultant impacts is the major missing element in this project assessment. If, as SCT states, such data was collected, it is essential that it be reported in the above manner to provide a valuable benchmark dataset and case study (c/f paragraph A(7) above). (Note: There is some discussion on this point later in the SCT report, and some data is included in Appendix 1 of the report, but there is no discussion of it here in the context raised above).

E. Section 4. Subsidence Prediction Methodology

1) Section 4 provides a comprehensive discussion of the methodology adopted for subsidence prediction, based on the available empirical data and understanding of subsidence mechanics behaviour. It is largely based on the experience, to date, from monitoring subsidence above Wongawilli LWs 4 and 5, where previous overlying workings exist in both the Bulli and Balgownie Seams. It is a valuable contribution to understanding the multi-seam subsidence behaviour, and is a sound, and best available source of information on which to base the future prediction methodologies for this project. However, it is important to recognise that it is still a relatively small database, and so predictions must be made with caution, whilst the database is continually expanded, and regularly re-evaluated. A critical part of the management strategy for this project moving forward must be to conduct continual high level comprehensive monitoring; regular data analysis; and regular re-evaluation of the subsidence behavioural models and hence predictions based on such models.

2) Section 4, p37 – SCT draws the appropriate conclusion that in the multi-seam environment, the effect of the overlying goaf areas is to reduce the shear stiffness and rigidity of the overburden strata. Some subsidence data is provided to support this hypothesis. On p43, the logical conclusion from this effect is stated to be *"the reduced shear stiffness leads to reduced bridging capacity of the overburden strata and significantly increased maximum subsidence for the same overburden depth and longwall panel geometry".* This is a particularly important and valid conclusion, and is significant in terms of providing forward predictions of subsidence behaviour. The challenge remains as to how to quantify the magnitude of such increases, and define the conditions under which they occur. SCT does proceed to do this in the best manner available, but the caution remains that (a) it is based on a very limited dataset, and (b) the full knowledge of the nature of the overlying workings and subsequent subsidence is based on estimates only (at least in the case of the Bulli Seam). Therefore the subsequent predictions made (see Section 5) are appropriate, but must be applied with caution.

3) Section 4, p44 – The point that has already been made about the additional subsidence due to these effects being largely confined to within the current panel geometries is an important and positive one. However, the only scenario where this may not be the case is where overlying standing pillars are destabilised, in which case the additional subsidence effects due to such pillar failures may extend to the extent of the overlying pillar regions. This point is made on p45 with respect to the region of Bulli Seam pillars in proximity to Wongawilli LW1. SCT makes some specific recommendations with respect to the length of LW1 and the need to carefully manage this situation. This opinion is strongly endorsed.

4) Section 4, p46 and following – The remainder of this section discusses specific subsidence parameters, effects and impacts – all of which are accepted as stated, based on the previous qualifications discussed above with regard to the prediction methodologies.

5) Section 4, p48 and following – SCT confirms the adoption of a purely empirically-based subsidence prediction methodology, for all of the reasons already discussed. The more traditional analytical methods using Influence or Profile Function methods, or the single seam empirical Incremental Profile methods are not considered appropriate to this type of multi-seam subsidence behaviour. This conclusion is accepted as reasonable under the circumstances of this project, albeit that the methodology adopted is in a very preliminary or prototype stage, as discussed previously.

6) Section 4, p50 – In discussing strains and tilts, it is worth emphasising the point made by SCT that it is simply not possible to predict exact locations of maximum or peak strains, and hence potential crack locations, for example. Regions where such strains might occur can be identified, but it is never going to be possible to predict in advance the actual location of actual cracks in the rock mass.

7) Section 4, pp50-52 – SCT discusses accuracy and sensitivity assessment for their prediction methodologies. This leads to the statement discussed earlier, that *"subsidence associated with multi-seam subsidence in this area is essentially similar to the subsidence behaviour in a single seam".* Once again, although it is only semantics, it is hard to see what is essentially similar about the behaviour predicted. SCT has just discussed significant changes in behaviour due to changes in the overburden characteristics, rendering traditional prediction relationships invalid. This statement is therefore not considered an appropriate description of a quite different world of multi-seam subsidence behaviour, the understanding of which is still relatively embryonic. SCT's own excellent approach to understanding this is still only based on data from two current longwalls (LWs 4 and 5).

8) Section 4, p52 – SCT makes a very important and valid conclusion, having discussed the impact of softened overburden leading to a change in bridging characteristics and potential increased subsidence. It is noted that in spite of this changed behaviour, all of the proposed panels within the PPR are of a reduced panel width such that there remains a significant subsidence-limiting control factor present due to the panel widths, such that full subsidence will not develop above these panels, compared to if they were wider, under the multi-seam environment.

F. <u>Section 5. Predicted Subsidence</u>

1) This section simply presents the factual predictions for the full range of scenarios and features present – based on all of the assumptions already discussed. These predictions are all accepted at face value, together with the various caveats already mentioned, especially with regard to confidence levels.

G. <u>Section 6. Subsidence Impacts</u>

1) Section 5, p61-62 – This section returns to the issue of upland swamps and refers to the data contained within the Appendix regarding past estimates, and future predicted subsidence effects. However it still does not address any detail with respect to either previous impacts or future likely impacts (accepting that some of these issues fall outside of the brief of SCT). The most relevant and pertinent statements made on these issues are:

- *"It is unclear how sensitive swamps are to mining subsidence"*
- *"the swamps located within the PPR Assessment Area appear to be thriving despite having been previously subsided to levels that are of the same order as the subsidence expected above future longwall panels"*
- *"the drop in piezometric pressure observed when some swamps are mined under may not have a significant impact on their long term condition"*
- *"It is considered that more work is required to determine the relationship between mining subsidence and the long term health of swamps".*

Clearly there is a need for a more quantitative and comprehensive assessment of these relationships between the swamps and the impact factors – both immediately, based on the known and estimated subsidence data reported here; and also through further work in the future.

H. <u>Section 7. Management Strategies</u>

1) The recommended strategies discussed here are all considered of value and worth pursuing. These include the adoption of a higher standard of survey monitoring, including use of three dimensional GPS arrays, in support of conventional survey data, and also high precision point to point measurement of valley closure.

2) The concept of an adaptive management strategy discussed earlier is not specifically referenced in this section, but is an essential process that brings together the data from various sources of monitoring data and analysis, in order to inform operational mine management and planning decisions. It is critical that an appropriate management system is established to handle this in an effective manner, as previously discussed under paragraph A(6) and elsewhere. This system needs to be developed well in advanced, and clearly enunciated, including answers to the questions posed in A(6).

I. <u>Section 8. Response to Submissions</u>

1) The issues raised in this section are all ones that have been discussed in earlier sections of the report, and as such, do not warrant further review or comment.

Bruce Hebblewhite
17th November, 2013