



Report on
Construction Management Plan

Appletree Grove Estate - Stage 7
off Fegan Street, West Wallsend

Prepared for
Hammersmith Management Pty Limited

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Integrated Practical Solutions





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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

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Construction Management Plan – Protection of Butterfly Cave Appletree Grove Estate - Stage 7 off Fegan Street, West Wallsend

1. Introduction

Douglas Partners Pty Ltd (DP) has previously prepared a Construction Management Plan (CMP) with reference to the management and monitoring of vibrations during construction of Stage 7 Appletree Grove Estate, West Wallsend (DP, 2017a).

Subsequent to the previous CMP (DP, 2017a), a declaration has been made by the Australian Minister for the Environment in regards to the Protection of the Butterfly Cave, under the Aboriginal and Torres Strait Islander Heritage Protection Act in a Legislative Instrument prepared by the Australian Government Minister for the Environment (ME, 2019a). The declaration includes an increased area of protection (the *declared area*) around the Butterfly Cave, and as a result, the layout of Stage 7 Appletree Grove Estate has been modified to account for the *declared area*.

This revised CMP has been prepared with reference to management and monitoring of vibrations during construction of the revised Stage 7 Appletree Grove Estate, West Wallsend to effect the Protection of the Butterfly Cave and the *declared area* in accordance with Lake Macquarie City Council's (LMCC) Condition 2AA and Condition 3Z of the development consent DA/113/2011/B, dated 17 March 2017 (the consent as amended), and with reference to the recent declaration by ME (2019a).

The report was prepared for Hammersmith Management Pty Limited (Hammersmith), and in consultation with Keller Civil Engineers Pty Ltd (KCE), the Civil Contractor for Stages 1 to 6 of the project.

A copy of the declaration by the Minister for the Environment (ME, 2019a) was provided to DP by Hammersmith. In addition, Hammersmith provided a copy of the Statement of Reasons that accompanied the declaration (ME, 2019b).

The CMP has previously been revised following peer review by other consultants, LMCC's letter to Hammersmith dated 20 December 2016 and DP's response to LMCC's review dated 16 March 2017.

The CMP was further revised following LMCC's letter to Hammersmith dated 8 May 2017, consultation with LMCC, their geotechnical consultant RCA Australia (RCA), and LMCC's email dated 7 July 2017.

The Butterfly Cave was declared an Aboriginal Place in May 2013 due to its special significance to local aboriginal women. The Butterfly Cave is located north-east of Stage 7, with the construction limits previously setback a minimum of 20 m from it. The recent declaration, ME (2019a) increases the setback distances such that the *declared area* boundary is at least 45 m from the Butterfly Cave, and the limits of the Stage 7 construction are outside of the *declared area*.

The NSW DEC guideline for assessing vibration, NSW DEC (2006), classifies vibration as being:

- **Continuous:** where vibration continues uninterrupted for a defined period (usually through daytime and/or night-time);
- **Impulsive:** where vibration is a rapid build up to a peak, followed by a damped decay that may or may not involve several cycles of vibration; or
- **Intermittent:** where vibration can be defined as interrupted periods of continuous or repeated periods of impulsive vibration, or continuous vibration that varies significantly in magnitude.

It is considered that construction activities at Stage 7 Appletree Grove Estate could fall into any of the three above vibration classifications, depending on the equipment being used at any given point in time.

This CMP provides an overview identifying the likely sources of vibration, vibration criteria and monitoring, control measures, responses and mitigation measures recommended to manage the potential risks of construction-induced vibration to the Butterfly Cave. While the CMP notes a preferred approach to vibration monitoring, which will require approval of *authorised persons* to enter the *declared area* for the purpose of monitoring the condition of the Butterfly Cave prior to construction, vibrations during construction and the condition of the Butterfly Cave at the completion of construction, alternative methodologies are presented to enable vibration monitoring to occur during construction of Stage 7 in the event that the required approvals are not able to be obtained.

For the purpose of this CMP, the Butterfly Cave relates to the rock overhang area shown in red on the attached, which is sourced from a survey by ADW Johnson Project No. 37548, Rev L, dated 15 November 2011. The *declared area* relates to the area described in Section 5 of the Legislated Instrument (ME, 2019a), and as shown on the attached drawings, and as summarised in Table 1, in Section 2.1.

2. Background

2.1 Declared Area

The Legislative Instrument, ME (2019a) provides the following regarding the boundary line of the *declared area*.

Table 1: Boundary of the *Declared Area* from the Legislative Instrument, ME (2019a)

Item	Column 1	Column 2
	The line runs from this point...	thence...
1	The whole of the area bounded by a line commencing at the point MGA Zone 56 367954mE and 6358379mN	and then generally north east to the point
2	367989mE and 6358402mN	then generally north east to the point
3	368001mE and 6358415mN	then generally north east to the point
4	368007mE and 6358417mN	then generally east to the point
5	368016mE and 6358416mN	then generally north east to the point

Table 1: Boundary of the *Declared Area* from the Legislative Instrument, ME (2019a) (cont)

Item	Column 1	Column 2
	The line runs from this point...	thence...
6	368028mE and 6358420mN	then generally north east to the point
7	368034mE and 6358425mN	then generally north east to the point
8	368070mE and 6358436mN	then generally north east to the point
9	368134mE and 6358483mN	then generally north east to the point
10	368140mE and 6358494mN	then generally north east to the point
11	368170mE and 6358517mN	then generally north east to the point
12	368337mE and 6358592mN	then generally south to the point
13	368344mE and 6358480mN	then generally south west to the point
14	368332mE and 6358420mN	then generally south west to the point
15	368314mE and 6358367mN	then generally south west to the point
16	368292mE and 6358319mN	then generally south west to the point
17	368247mE and 6358237mN	then generally north west to the point
18	368176mE and 6358278mN	then generally north west to the point
19	368138mE and 6358311mN	then generally north west to the point
20	368102mE and 6358351mN	then generally north west to the point
21	368093mE and 6358358mN	then generally north west to the point
22	368084mE and 6358362mN	then generally west to the point
23	368071mE and 6358362mN	then generally west to the point
24	368064mE and 6358360mN	then generally west to the point
25	368044mE and 6358359mN	then generally south west to the point
26	368032mE and 6358353mN	then generally south west to the point
27	367985mE and 6358335mN	then generally south west to the point
28	367969mE and 6358327mN	then generally north west back to the point of commencement

Notes to Table 1:

Directions included in the table are indicative only

The Aboriginal and Torres Strait Islander Heritage Protection (Butterfly Cave, West Wallsend, NSW) Declaration 2019 states that a person must not do or act in, on or near the *declared area* that will, or is likely to, injure or desecrate the *declared area*. The legislative instrument, ME (2019a) goes on to state that an area shall be taken to be injured or desecrated if:

- (i) It is used or treated in a manner inconsistent with Aboriginal tradition;
- (ii) By reason of anything done in, on or near the area, the use or significance of the area in accordance with Aboriginal tradition is adversely affected; or
- (iii) Passage through or over, or entry upon, the area by any person occurs in a manner inconsistent with Aboriginal Tradition.

Furthermore, a person must not:

- a) pass through or over, or enter the *declared area*; or
- b) conduct any activity that will, or is likely to, damage or deface any rock or land in the *declared area*; or
- c) bulldoze, grade, drill, excavate, cut, fill, blast, clear, demolish, tunnel, burn, remove, or otherwise damage land in the *declared area*; or
- d) build or construct any road, building or structure in, or intruding into, the *declared area*; or
- e) conduct any activity that will, or is likely to, disturb soil or vegetation in the *declared area*, [except where consistent with a plan of management made under the National Parks and Wildlife Act 1974 (NSW) that has been endorsed by the Awabakal Local Aboriginal Land Council];
- f) disturb vegetation on land surrounding the *declared area* in a manner that will increase the visibility of the area.

The above, however, does not apply to acts done by an authorised person:

- (a) for the purposes of practising or observing Aboriginal traditions, observances, cultural practices, customs, or beliefs;
- (b) for the purposes of education, research, management, monitoring, revegetation, restoration or rehabilitation; or
- (c) where doing the act is authorised or required by law.

A person is an *authorised person* in relation to the doing of an act if:

- (a) the person has received permission to do the act from the Awabakal Local Aboriginal Land Council; or
- (b) the person is authorised or required by law to do the act.

The Statement of Reasons, ME (2019b), provides context to the Legislative Instrument. The Statement of Reasons suggests that the main purposes of the *declared area* are to protect the Butterfly Cave, provide seclusion and privacy for traditions to be performed by Awabakal Women (including the traditional pathway), provide an area of Native bushland resource and protect the creek that feeds into the Butterfly Cave (and its immediate catchment),

On the basis of the above, this CMP addresses the management of vibration during construction for the purpose of protecting the Butterfly Cave with reference to both the Legislative Instrument, ME (2019a), and also the Statement of Reasons, ME (2019b). This CMP does not address other construction related matters such as stormwater runoff, which are addressed by the civil engineer.

2.2 Proposed Development

Information about the proposed development has been obtained from Section 96 civil design plans by GCA Engineering Consultants (GCA), Project No 17210C, drawings C01 to C22, generally Revisions 1 or 2 and dated 18 March 2019 or earlier.

The proposed development includes bulk earthworks and construction of internal subdivision roads and drainage for Stage 7 Appletree Grove Estate, West Wallsend. The revised Stage 7 layout includes the creation of 26 residential lots (Lots 701 to 726).

The proposed cut and fill depths (existing level to design finished level) for the Stage 7 road alignments are as shown in Table 2 below.

Table 2: Proposed Cut / Fill for Stage 7 Subdivision Roads

Internal Road	Approximate Internal Pavement Length (m)	Approximate Maximum Cut to Finished Level (m)	Approximate Maximum Fill to Finished Level (m)
Baiyang Crescent (formerly referred to as Road No 10 and Fegan Street)	481 (Ch 545 – 1026)	2.9	1.4
Notley Way	45 (Ch 55 – 100)	Negligible	Negligible

The information indicates that earthworks is expected to occur across a number of the lots as follows:

- Site regrading on western side of Baiyang Crescent to include the eastern part of Lots 716 to 718. Filling assumed to generally in the order of 0.5 m or less;
- Site regrading on eastern side of Baiyang Crescent to include the western part of Lots 703, 706, 707 and 710. Filling assumed to generally in the order of 1 m or less;
- Localised filling associated with road embankment construction along the eastern frontages of Lots 718 to 724, Filling generally in the order of 0.8 m or less;
- Excavation (assumed to be up to about 3 m depth) for the temporary sediment basin to be located within Lots 701 to 703; Excavation on the eastern side of Baiyang Crescent of up to about 2.0 m across Swale 01;
- Filling of the temporary sediment basin at the completion of construction. Fill depth estimated to be up to about 3 m.
- Localised site regrading in Lots 701, 702 and 726. Filling assumed to generally be less than 0.5 m depth;

In addition, the installation of subdivision services, such as stormwater and sewer will occur. Preliminary stormwater drainage plans by GCA were provided (GCA Project No 17210C, Drawings SK1001 and SK1002, Rev 1, dated 9 April 2019). The drawings indicate the plan layout of the subdivision stormwater drainage system, and a long section for Drainage Line 1, which commences in the northern part of the site, adjacent to the part of the *declared area* that is closest to the Butterfly Cave. A copy of GCA's plan showing the proposed stormwater pipe layout is attached for reference.

The drawings by GCA indicate that stormwater trench excavation in the northern part of the site, between about Ch 810 and Ch 840 of Baiyang Crescent, is estimated to generally be between 1.0 m and 1.3 m depth. Elsewhere in Stage 7, excavation for the stormwater trench construction is expected to be required to depths of up to 2.4 m (Pit 1-8, located near Ch1005 Baiyang Crescent).

The plans prepared by GCA indicate that the Butterfly Cave is located more than 45 m north-east from the limit of works in Stage 7. The *declared area* boundary is located a few metres beyond the limit of works in Stage 7.

2.3 Background Data

Douglas Partners Pty Ltd (DP) has undertaken several assessments regarding the proposed construction in relation to the Butterfly Cave, as follows:

- Stability Assessment, 31 January 2012, DP (2012);
- Geotechnical Investigation – Stage 7, DP (2016);
- Assessment of Allowable Vibration Limits, DP (2017b);
- Vibration Monitoring Field Trials, 22 August 2016, DP (2017c).

Subsurface conditions in Stage 7 comprise predominantly clayey soils over rock at variable depth, DP (2016).

2.4 Plant Equipment

KCE provided background information to DP regarding the types of plant equipment typically used for earlier stages of the subdivision, where geotechnical conditions are generally similar. KCE indicated that, in their experience, similar plant equipment would therefore likely be used for construction of Stage 7. The range of plant equipment will depend on excavatability of rock and the volume of material to be moved.

The following table provides a list of the plant equipment that has been indicated by KCE as potentially being required for Stage 7, subject to any restrictions contained in the CMP.

Table 3: Summary of Potential Plant Equipment and Associated Activity

Plant Equipment		Activity Associated with Plant Equipment			
		Excavation Operations	Filling Operations	Driving Around Site	Other
Likely Plant Equipment	Excavators (5t - 36t)	X		X	
	Dump Trucks (20t - 30t)			X	
	Dozers (D5 – D9)	X		X	
	Smoothdrum/Padfoots (12t - 18t)		X	X	
	Compactors (815 - 825)		X	X	
	Traxcavator	X		X	
	Grader	X	X	X	
	Positrack/Bobcat	X	X	X	
	Backhoe	X	X	X	
	Truck & Dogs			X	
	Watercart			X	
	Tub grinder (Mulches Vegetation)			X	X
Possible Plant Equipment	Crusher (Crushes larger rock into smaller rock)			X	X
	Mill (grinds asphalt wearing course where existing pavements are to be remediated)			X	X
	Stabiliser (mixes stabilising agent (e.g. lime/cement) with pavement materials during pavement construction)			X	X
	Concrete pump trucks			X	
	Telehandler (carries equipment around, e.g. pipes, similar to a forklift)			X	
	Drill rig / auger	X		X	
	Small trencher	X		X	

2.5 Vibration Generating Activities

Construction activities which could generate vibration include:

- Land clearing;
- Excavations;
- Compaction of filling;
- General vehicle movements on site.

Excavations could occur under a range of different circumstances as follows:

- Bulk excavation of soil and weak rock using hydraulic excavators;
- Bulk excavation of higher strength rock using a dozer with ripper;
- Detailed excavation and trimming of higher strength rock using a hydraulic excavator equipped with a single tyne rock ripper;
- Excavations of service trenches using backhoes or hydraulic excavators, potentially equipped with single tyne rock rippers or hydraulic hammers in areas of higher strength rock.

Compaction of filling will generally occur where site levels are to be raised, and compaction of soil is required to ensure adequate structural support of road pavements, and for lot filling. Compaction of backfill of service trenches is also likely to occur.

General vehicle movements on site would be expected to include the plant equipment required for bulk earthworks (excavation and filling), and also other construction vehicles such as concrete trucks, asphalt delivery trucks, asphalt compaction equipment and other contractors vehicles.

2.6 Overview of Construction Activities in Northern Part of Stage 7

With reference to the Plan Sheet by GCA (Appendix A), and also the cross sections for construction of Baiyang Crescent in Stage 7, Figures 1 and 2 below provide a visual overview of potential earthworks in the northern part of the site, nearest to the Butterfly Cave, noting that the limit of works is more than 45 m from the Butterfly Cave. Figure 3 provides a visual overview of potential earthworks in the south-eastern part of the site, where excavations in the order of 2.9 m are proposed. It is however noted that this area is approximately 150 m or more from the Butterfly Cave.

Ch 810 (Figure 1)

Estimated to be the closest 'work' to the Butterfly Cave, with a construction limit of more than 45 m from the Butterfly Cave. Figure 1, below, indicates the following:

- Negligible filling is proposed at this location;
- Excavation to finished levels is expected to be about 0.4 m below existing levels on the northern side of Baiyang Crescent, and about 0.8 m below existing levels on the southern side of Baiyang Crescent; Excavation to box out roads to subgrade level, and filling to place road pavements will be required to about 0.46 m below design levels, at distances of greater than 45 m from the Butterfly Cave;

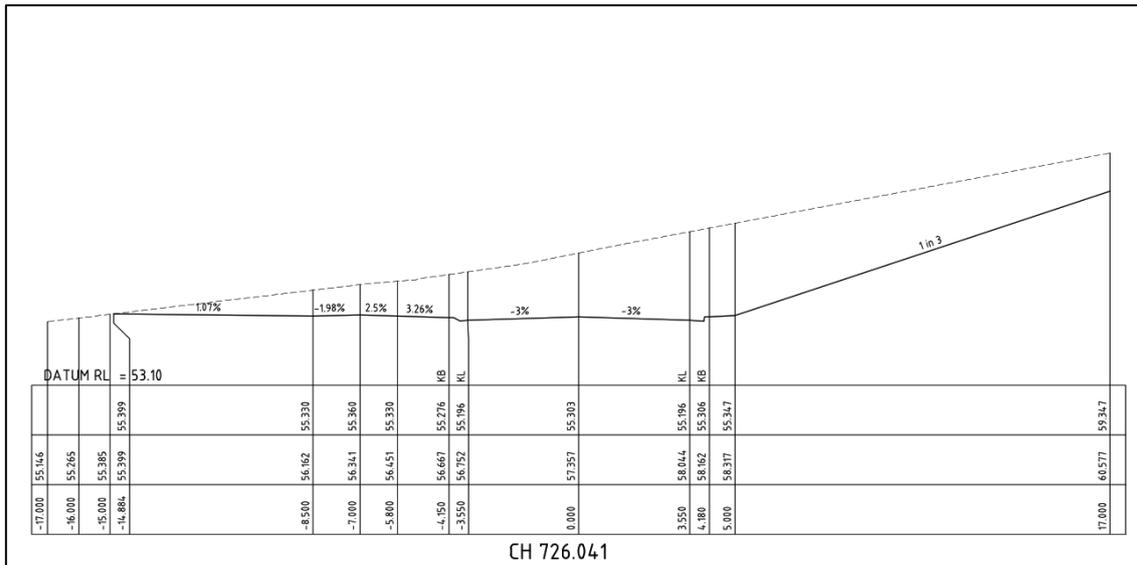


Figure 3: Overview at Ch 726.041 Baiyang Crescent

3. Construction Vibration Criteria

3.1 Vibration Limits

DP has undertaken a desktop study of allowable vibration limits, DP (2017b), and a vibration field trial, DP (2017c), as part of the process of assessing vibration criteria for the construction of Stage 7.

The desktop study recommended a maximum allowable vibration limit of 5 mm/sec peak particle velocity be adopted for the Butterfly Cave. The field vibration trial also recommended that a trigger or alarm value, lower than the allowable vibration level, be adopted for the purpose of vibration monitoring during construction, with a trigger value of 3 mm/sec recommended. The purpose of the trigger value is to provide an opportunity to review construction activities prior to the allowable level being exceeded.

The field vibration trial was undertaken for three different pieces of plant equipment which would likely be used for construction activities as follows:

- Compaction with a 13 tonne roller, operating at full vibratory mode;
- Ripping in bedrock with a single tyne fitted to a 25 tonne D6R dozer;
- Excavation with a 2000 kg rock hammer fitted to a 30 tonne excavator.

It is noted that this plant equipment was considered the most likely to cause vibration, based on the plant equipment used in earlier stages of construction of Appletree Grove Estate.

From the vibration field trial, DP (2017c), operational buffer distances from the Butterfly Cave were recommended for the nominated allowable vibration level of 5 mm/sec and the trigger / alarm value of 3 mm/sec. The distances for each of the trialled plant equipment are shown in Table 4, below.

Table 4: Minimum Buffer Distances for Vibration Management from Field Trial (Ref 4)

Plant Equipment	Minimum Buffer Distance for Vibration Management from Field Trial (m)	
	Allowable Vibration Limit ≤ 5 mm/sec	Alarm / Trigger Value ≤ 3 mm/sec
13 t pad foot roller operating in full vibratory mode	6	9
D6R dozer with ripper	6	8
30 t excavator with 2000 kg hammer	3	5

The results of the vibration field trial suggest that it will be possible for these three pieces of plant equipment to operate at distances of 45 m or more from the Butterfly Cave and maintain vibrations below both the trigger and maximum allowable levels.

In summary, the recommended vibration criteria at the Butterfly Cave for the construction of Stage 7 is as follows:

- Monitoring Trigger / Alarm Value: 3 mm/sec;
- Maximum Allowable Level: 5 mm/sec.

3.2 Access to the Declared Area During Construction

Based on the information provided in the Legislative Instrument, ME (2019a), as summarised in Section 2.1, above, it is acknowledged that access to the declared area will only be possible with the permission of the Awabakal Local Aboriginal Land Council.

In relation to undertaking a considered and thorough construction monitoring program, where the intention is to protect the Butterfly Cave, it is preferable that application be made to the Awabakal Local Aboriginal Land Council to provide permission for representatives of the Geotechnical Engineer to be *authorised persons* during the construction period, so that periodic inspections of the condition of the Butterfly Cave can be undertaken, and so that vibration monitoring can occur on the Butterfly Cave. The client may wish to consider whether other representatives (eg Council) could also need to request permission to be considered *authorised persons* during the construction period.

However, if permission for representatives of the Geotechnical Engineer to be designated as *authorised persons* for the construction period is not forthcoming, then construction of Stage 7 will need to be undertaken such that vibration monitoring occurs on the Stage 7 side of the boundary of the *declared area*. If vibration monitoring can only occur at the boundary of the *declared area*, the proximity of construction equipment to the vibration monitoring equipment could result in vibrations being recorded, which are not necessarily reflective of the vibrations being experienced at the Butterfly Cave. The location of vibration monitoring equipment is discussed further in Section 4 of this report.

DP is mindful of the significance of the Butterfly Cave and the *declared area*, and only makes this recommendation to request for permission as *authorised persons* during construction to assist all of those who are involved in the construction of Stage 7 to meet their obligations. Given that the purpose of this CMP is to manage vibration for the protection of the Butterfly Cave, some agreed and authorised access to the Butterfly Cave for the purpose of monitoring its condition and managing the construction of Stage 7 would seem prudent for all parties. However if permission to access the *declared area* is not able to be obtained, then an alternative approach to vibration monitoring is presented herein.

3.3 Damage

The Legislative Instrument, ME (2019a), does not define 'damage'.

There are few references which assist in clearly defining damage, particularly with reference to a natural structure such as the Butterfly Cave.

In 2010, the NSW Planning and Assessment Commission (PAC) published a report on the Bulli Seam Operations Project which considered mine subsidence impacts to items of aboriginal heritage, NSW PAC (2010).

NSW PAC (2010) recommends that a hierarchy of mining-induced consequences to Aboriginal cultural heritage sites be established as follows:

- *Nil* consequences, where nil has the meaning of none whatsoever;
- *Negligible* consequences, where in the context the PAC report, negligible has the meaning of small and unimportant so as not to be worth considering. The PAC Report indicated that hairline fracturing and isolated dislodgements of small pieces of ground surface or overhangs that in total do not affect more than 5% of an Aboriginal site and do not affect the physical condition of any item of aboriginal heritage or any cultural value, are indicative of the scale of impacts falling within this category;
- *Minor* consequences, where minor has the meaning of relatively small in quantity, size and degree. Isolated open cracking and rock falls of less than 2 m³ that do not affect the physical condition of any item of Aboriginal heritage or any aboriginal cultural value are indicative of the scale of impacts falling within this category.

The PAC report established a performance criteria of negligible for Aboriginal sites within the project area which had special significance status.

Notwithstanding the criteria adopted by the PAC, a more conservative approach will be adopted for the Butterfly Cave. The construction of Stage 7 should be undertaken such that it will have nil consequences to the Butterfly Cave due to construction activities.

It is important to note however that:

- The consequences need to be assessed with respect to changes in the condition of the Butterfly Cave, as measured / observed immediately prior to construction; and
- It is possible for external factors to result in impacts to the Butterfly Cave which could be considered to be greater than negligible consequences, eg weather events, erosion, mine subsidence, vandalism etc.

For the purpose of this CMP, considering the above references, and with the intention to protect the Butterfly Cave under the Legislative Instrument, and with reference to the Statement of Reasons, ME (2019b), damage is herein defined as follows, where the damage descriptions are new features that were not present at the time of the pre-construction dilapidation / condition survey:

Table 5: Damage Category Descriptions

Damage Category	Description
Nil	No visible change in condition of Butterfly Cave
Negligible	Isolated hairline or fine cracks (<1 mm width) affecting no more than 5% of the Butterfly Cave Isolated dislodged blocks of rock up to gravel sized within Butterfly Cave (<60 mm diameter) Isolated dislodged blocks of rock up to cobble size (<200 mm) in non-structural areas of the <i>declared area</i>
Minor	Hairline or fine cracks (<1 mm width) affecting more than 5% to 25% of the Butterfly Cave Fine to noticeable cracks (>1 mm width) Minor dislodged blocks of rock up to gravel sized within Butterfly Cave (<60 mm diameter) Isolated dislodged blocks of rock up to cobble sized (60 mm to 200 mm diameter) within the Butterfly Cave Isolated boulder-sized dislodged blocks of rock (>200 mm) in non-structural areas of the <i>declared area</i>

Any of the above that is observed within the Butterfly Cave overhang area is to be considered structural damage for the purpose of this CMP. Any of the above that is observed within the *declared area*, but outside of the Butterfly Cave overhang area is to be considered non-structural damage for the purpose of this CMP.

If any negligible or greater structural or non-structural damage to the Butterfly Cave and/or *declared area* is observed during the construction period, without vibration alarms having been triggered, work is to cease and a response in accordance with Section 4.5 of this report is to be followed. This will include an assessment as to whether the observed damage may have been caused by conditions other than construction works (eg weather, vandalism, mine subsidence etc).

If it is considered that the observed damage may have been the result of construction works, all work is to cease, and additional field trials may be required. Modifications to the CMP may also be required. Council approval will be required prior to the recommencement of works.

3.4 Additional Vibration Field Trials / Vibration Monitoring Considerations

Elsewhere in this CMP, the need for additional field trials is identified wherever equipment larger than that already trialled on the site is proposed, or wherever construction processes could vary from those already considered.

If permission is not granted for vibration monitoring to occur at the Butterfly Cave, as discussed above, then vibration monitoring will need to occur on the Stage 7 side of the *declared area* boundary. There is an increased risk of vibration trigger and alarm levels being exceeded if work is happening in close proximity to the vibration monitor. The available information indicates that the construction limits of Stage 7 are located within approximately 1 m at their closest point (filling embankment to be placed near Ch 825).

Therefore, in order to be able to interpret results which could be artificially high due to the proximity of the monitor to the work area, the following is recommended:

- Undertake additional monitoring of construction work when it first commences, at locations that are more remote from the Butterfly Cave, and work towards the northern part of the site from the south, where possible;
- Utilise additional vibration monitors around the work zone such that while the primary vibration monitor may be located adjacent to the Stage 7 boundary of the part of the *declared area* that is closest to the Butterfly Cave, secondary vibration monitors might be located elsewhere in Stage 7. This may require the Geotechnical Engineer to be on site to oversee the placement of secondary vibration monitors, and review of the results, during all excavation and compaction work undertaken in the northern part of the site.

The trigger / alarm and maximum allowable vibration values for the secondary vibration monitor, where it is located no more than 45 m from the construction activity being monitored, should be the same as the vibration limits identified in Section 3.1 for the Butterfly Cave (ie 3 mm/sec and 5 mm/sec).

The revised limits for the primary monitor (located at the Stage 7 boundary with the *declared area*) should be confirmed via additional field vibration trials, as discussed in Section 3.4, below, but preliminarily, based on the previous field trials undertaken by DP, the following preliminary trigger / alarm values should be considered for work within 45 m of the primary vibration monitor.

Table 6: Preliminary Trigger / Alarm Value (mm/sec) for work within 45 m of Primary Monitor

Distance from Monitor (m)	Trigger / Alarm Value (mm/sec)	Maximum Allowable Value (mm/sec)
<10	10*	15*
10-15	5*	10*
>15	3	5

Notes to Table 6:

* Subject to confirmation from additional trials at the commencement of construction

4. Compliance Management

4.1 Responsibilities

4.1.1 Hammersmith

In the context of this CMP, Hammersmith's responsibilities will include the following:

- Informing the Principal Contractor of the importance of managing vibrations and adhering to the CMP during construction;
- Requesting the Principal Contractor to confirm the plant equipment to be used and the management processes to be followed;
- To nominate one representative who will be alerted by automated SMS and/or email if the vibration trigger level is exceeded.

4.1.2 Geotechnical Engineer (DP)

The Geotechnical Engineer will be responsible for providing advice to Hammersmith and the Principal Contractor regarding the management of vibrations during construction. Responsibilities are expected to include the following:

- Initial set up of vibration monitoring equipment, including any additional pre-construction trials of plant equipment which is larger than that already trialled, if proposed to be used, or plant equipment which is expected to cause more vibration;
- Handover / train the Principal Contractor in the use of the vibration monitors;
- Regularly communicate with the Principal Contractor regarding upcoming work activities at the site, and review proposed works for adherence to the CMP;
- Review equipment proposed to be used on site with respect to this CMP and advise the contractor when additional field trials are required prior to the use of that equipment in construction activities;
- Undertake periodic inspections in response to construction activities, as outlined in Section 4.7;
- Routine checking of the vibration monitoring equipment; Downloading and review of vibration monitoring data;
- Two representatives of the Geotechnical Engineer will be nominated to receive automated SMS and/or emails if the vibration trigger level is exceeded;
- Prepare a summary report at the end of the work outlining the results of the vibration monitoring during construction, including any remedial actions taken if action criteria was triggered;

It is also preferred that the following activities also be undertaken by the Geotechnical Engineer, but it is noted that these can only occur if the Awabakal Local Aboriginal Land Council provides permission for the Geotechnical Engineer to be considered and *authorised person* for the duration of construction:

- Undertake a dilapidation / condition survey of the Butterfly Cave prior to the commencement of construction, preferably in consultation with the Awabakal Local Aboriginal Land Council;
- Provide a pre-construction Dilapidation Report on the condition of the Butterfly Cave from a geological / geotechnical perspective;
- Undertake a dilapidation / condition survey of the Butterfly Cave at completion of construction, preferably in consultation with the Awabakal Local Aboriginal Land Council;
- Provide a post-construction Dilapidation Report on the condition of the Butterfly Cave from a geological / geotechnical perspective.

4.1.3 Principal Contractor

The Principal Contractor will be engaged by Hammersmith to deliver the construction program. For the CMP, the Principal Contractor's responsibilities will include the following:

- Undertake construction in a manner which recognises the importance of managing construction vibrations and how they relate to the Butterfly Cave and the *declared area*;
- Daily set up and testing of the vibration monitor prior to commencement of construction activities, including maintaining a register recording the placement and retrieval of the monitor each day;
- Secure storage of the vibration monitor when the site is not attended;
- Maintaining the integrity of the vibration monitoring equipment, clearly documenting construction activities, recognising all vibration alerts and reporting them to the Geotechnical Engineer;
- Contacting the Geotechnical Engineer when additional advice is required, including obtaining approval from the Geotechnical Engineer prior to plant equipment being brought onto site, and/or where plant equipment can be used;
- Developing construction strategies which are aimed at reducing the potential for vibration;
- The Principal Contractor is not in any way to interfere with the operation of the vibration monitoring equipment. If detected, evidence of tampering will be reported by the Geotechnical Engineer to Hammersmith and Council for action;
- The Principal Contractor is to nominate two personnel who will be alerted by automated SMS and/or email if the vibration trigger level is exceeded. The SMS notifications to the Principal Contractor must always include one site-based person who can issue an immediate stop-work order;
- The Principal Contractor is to follow the requirements outlined in Section 4.5 if the vibration alarm is triggered, and is to immediately notify the Geotechnical Engineer. Depending on the vibration level recorded at the time of the alarm, the Geotechnical Engineer will liaise with the Principal Contractor regarding appropriate action to be taken;
- The Principal Contractor must have a procedure in place which formally advises and trains all site-based personnel, including subcontractors, of the requirements of the CMP. The Principal Contractor is responsible for the activities of all subcontractors working on the site;

- The Principal Contractor must have a clearly documented procedure and chain of command established if the designated site representative is not on site during construction activities. This must also always allow for SMS alerts triggered by the vibration monitor to be able to be received by a responsible person who is physically present on site;
- The Principal Contractor may need to modify its equipment and construction procedures to satisfy the vibration criteria; and
- The Principal Contractor is to provide Hammersmith and the Geotechnical Engineer a weekly report outlining the activities and plant equipment that is proposed to be used in the following week. These reports should be received with at least two days' notice of proposed new areas of the site being worked, or new items of plant equipment being brought on to site.

4.2 Dilapidation / Condition Survey

Prior to the commencement of construction and at the completion of construction, a dilapidation / condition survey of the Butterfly Cave is recommended. It will not be possible to objectively assess potential damage to the Butterfly Cave if a pre-construction condition survey is not undertaken. It is understood that the dilapidation / condition survey can only be undertaken with the approval from the Awabakal Local Aboriginal Land Council of the relevant consultants as *authorised persons*.

If approval as *authorised person(s)* is given, the dilapidation survey shall be undertaken by a suitably qualified geotechnical engineer / engineering geologist, and include geological mapping and photographing of the condition of the Butterfly Cave. The pre-construction dilapidation / condition surveys shall be undertaken no more than three weeks prior to the commencement of construction, so that the survey is measuring the condition of the Butterfly Cave as close to the start of construction as possible.

Prior to construction, a laser scan survey is also recommended to be undertaken of the Butterfly Cave. The purpose of the laser scan is to 'measure' the condition of the Butterfly Cave prior to construction.

The pre-construction dilapidation / condition survey should be provided to LMCC and the Awabakal Local Aboriginal Land Council.

If a significant weather event or non-local vibrations such as earth tremors or blasting at nearby mines / quarries occurs between the pre-construction survey and the commencement of construction, visual inspection of the Butterfly Cave by a geotechnical engineer is recommended to assess whether the pre-construction dilapidation / condition survey needs to be repeated prior to construction.

Additional inspections are recommended during the course of construction, as outlined in Section 4.7 of the CMP. If inspections during construction indicate visible changes to the Butterfly Cave, the geotechnical engineer may recommend additional laser scans during construction to measure and report on these changes.

A post-construction dilapidation / condition survey is recommended at the completion of the construction of the subdivision, once the earthworks contractor has demobilised from site, at the practical completion stage.

The post-construction dilapidation / condition survey is also to include comment as to whether any measurable change to the Butterfly Cave has been detected between the pre-construction survey and the post-construction survey. Where possible, an attempt shall be made to identify the likely cause of changes in condition, if any.

The post-construction dilapidation / condition survey report is to include copies of records of any additional inspections / condition surveys undertaken during construction. The post-construction dilapidation / condition survey report should be provided to LMCC and the Awabakal Local Aboriginal Land Council.

4.3 Vibration Monitoring

Continuous vibration monitoring is required during the construction of Stage 7.

The vibration monitor should include a visible alarm, such as a flashing light or similar, that can alert site personnel of an exceedance of the vibration alarm / trigger value. In addition to the visible alarm, SMS and/or email alerts should be programmed within the vibration monitor to alert key project personnel (refer Section 4.1 above) of vibration criteria being triggered. In addition to the personnel noted above, the SMS and/or email alerts will be sent to a Council representative nominated by LMCC.

The vibration monitor should be calibrated to the manufacturer's requirements. Unless otherwise required by the manufacturer, vibration monitors should arrive to site with calibration certificates that are no greater than three months old. A copy of the calibration certificate must be kept on site for vibration monitors which are in service / use. The geotechnical engineer will also be provided / retain a copy of the calibration certificate for each vibration monitor. Additional calibrations will be required if the construction period exceeds six months. The additional calibrations must be undertaken such that a vibration monitor is not to be used on site if its calibration certificate is more than twelve months old.

It is preferred that the vibration monitor be located on top of the Butterfly Cave overhang, to allow a direct measurement of vibration at the Butterfly Cave site. The geometry of the overhang is such that vibration monitoring elsewhere may not accurately measure vibration at the Butterfly Cave, if any. It is acknowledged that the placement of a vibration monitoring on the Butterfly Cave overhang will be subject to approval from the Awabakal Local Aboriginal Land Council of the relevant personnel as *authorised persons*.

If approval from the Awabakal Local Aboriginal Land Council is obtained for the purpose of vibration monitoring within the *declared area*, the vibration monitor should be placed on the Butterfly Cave using non-destructive methods. This would likely require the monitor to be placed directly onto the rock surface, with a fine bed of sand to smooth the surface, and sand bags or similar placed over the top of the monitor to hold it in place.

To the extent possible, the monitor should be positioned on a relatively flat area of rock. It is recommended that the monitor be located on the western 'wing' of the Butterfly Cave overhang such that it is located as close as practical to the construction limits. The monitor should not be located on the eastern 'wing' of the Butterfly Cave, as it may underestimate vibrations.

For information purposes, a typical vibration monitor is shown in Appendix A.

If permission from Awabakal Local Aboriginal Land Council, for the purpose of undertaking vibration monitoring within the *declared area* is not forthcoming, then multiple vibration monitors may need to be utilised, depending on where construction is occurring at any one time. If access to the *declared area* is not authorised, additional vibration trials will be needed to recommend alternative (higher) trigger and alarm values for construction within 45 m of the *declared area* boundary (ie to “mirror” the distance of the Butterfly Cave from the Stage 7 boundary with the *declared area*). One vibration monitor should be placed on a rock surface (if possible), on the Stage 7 side of the *declared area* boundary, at what is approximately the closest point to the Butterfly Cave. This primary monitor will need to monitor for exceedance of the higher / revised trigger and alarm values rather than the 3 mm/sec and 5 mm/sec values. A secondary monitoring, preferably located on rock, and located about 30 m to 40 m from the construction activities will monitor for exceedance of the 3 mm/sec and 5 mm/sec trigger and alarm values.

The vibration monitor should be stored securely when construction activities are not occurring (eg overnight / weekends).

The Principal Contractor is responsible for maintaining a daily register of the placement and retrieval of the vibration monitor, including the time that the monitor is placed and the time that the monitor is retrieved, as well as the location of the monitor.

Construction activities should not occur unless the vibration monitor is in place and has been checked to be operational.

The vibration monitor will be capable of measuring peak particle vibration to within 0.5 mm/s, and should be checked daily by the Principal Contractor.

Consideration should be given to installing security cameras / CCTV at discrete locations to monitor for external interference to the monitor during construction. It is noted that this would need to be discussed with, and approved by the Awabakal Local Aboriginal Land Council, as an authorised activity, but the intent is so that protection of the Butterfly Cave can be monitored at a time when the Butterfly Cave is not otherwise being used for traditional practices. The camera should have the capacity to be monitored remotely and its presence and location should be treated confidentially. The security cameras will also serve to verify the Principal Contractor's records of placement and retrieval of the vibration monitor, if approval is given for a monitor to be placed on the Butterfly Cave overhang. The CCTV should be monitored by the Geotechnical Engineer and LMCC, with access also offered to the Awabakal Local Aboriginal Land Council. It is recommended that any cameras / CCTV be oriented such that they can view the top of the Butterfly Cave overhang, and potentially view unauthorised people who may approach the Butterfly Cave, but it should not enable direct view into the Butterfly Cave.

Given the cultural significance of the site to local aboriginal women, consideration should be given to the gender of personnel undertaking the placement, checking and retrieval of the monitoring equipment, where possible.

4.4 Control Measures

There are a number of control measures which can be used to help reduce the risk of the vibration trigger value being reached at the Butterfly Cave, and these include:

- Clearly demarcating 'no work' or 'exclusion' zones, such that plant equipment does not accidentally encroach on the *declared area*;
- Undertake trials of plant equipment not already trialed at the commencement of construction in areas away from the *declared area*;
- Proactive selection of smaller or non-vibratory plant equipment for work where possible;
- Working in a manner which gradually approaches the *declared area*, while monitoring vibration (preferably at the Butterfly Cave, but otherwise at the *declared area* boundary), rather than commencing nearest to it and working away from it;
- Planning and sequencing of land clearing activities which controls the direction in which trees are felled (away from the *declared area*), when working in the northern part of the site, and employing measures which actively manages the height from which large trees are able to free-fall;
- Careful planning of construction traffic routes so that non-essential plant equipment is kept away from the *declared area*, unless it is required to be working in that area;
- Plant equipment which is portable in the nature of its work, ie it can perform its work anywhere (such as a tub grinder and a rock crusher), should be located as far as practical away from the *declared area* to reduce the risk that this plant equipment could cumulatively impact on total vibration;
- Careful planning of work such that multiple plant equipment with the potential to cause cumulative vibration effects are not used simultaneously.

Reference should also be made to Section 3.4 in regards to the placement of primary and secondary vibration monitors if permission is not provided to place a vibration monitor on the Butterfly Cave.

The following table provides a summary of potential control measures for each of the nominated pieces of plant equipment.

Table 7: Recommended Control Measures for Work nearest the Butterfly Cave

Plant Equipment		Control Measure
Likely Plant Equipment	Excavators (5t - 36t)	Use smaller plant equipment nearest the <i>declared area</i> ; avoid ripping while other excavation is occurring near the <i>declared area</i> boundary closest to the Butterfly Cave
	Dump Trucks (20t - 30t)	Keep trucks as far as practical away from the <i>declared area</i> boundary closest to the Butterfly Cave, and reduce speed of vehicles
	Dozers (D5 - D9)	Use smaller plant equipment nearest the <i>declared area</i> boundary closest to the Butterfly Cave; avoid ripping while other excavations are occurring near the <i>declared area</i> boundary closest to the Butterfly Cave
	Smoothdrum/Padfoots (12t - 18t)	Avoid operating in vibratory mode. Trial away from the <i>declared area</i> boundary closest to the Butterfly Cave before moving closer, and avoid compacting while other excavation / compacting activities are occurring near the <i>declared area</i> boundary closest to the Butterfly Cave
	Compactors (815-825)	Use smaller equipment and thinner layers for compaction nearest the <i>declared area</i> boundary closest to the Butterfly Cave. Avoid operating in vibratory mode unless necessary. Trial away from the <i>declared area</i> boundary closest to the Butterfly Cave before moving closer and avoid compacting while other excavation / compacting activities are occurring near the <i>declared area</i> boundary closest to the Butterfly Cave
	Traxcavator	Use smaller plant equipment nearest the <i>declared area</i> boundary closest to the Butterfly Cave
	Grader	Use smaller plant equipment nearest <i>declared area</i> boundary closest to the Butterfly Cave and reduce speed of vehicle
	Positrack/Bobcat	Low risk plant equipment due to small size
	Backhoe	Low risk plant equipment due to small size
	Truck & Dogs	Keep trucks as far as practical away from <i>declared area</i> boundary closest to the Butterfly Cave and reduce speed of vehicles
	Watercart	Low risk plant equipment; reduce speed of vehicle
	Tub grinder (Mulches Vegetation)	Portable plant equipment – Use away from the <i>declared area</i> boundary closest to the Butterfly Cave

Table 7: Recommended Control Measures for Work nearest the Butterfly Cave (Continued)

Plant Equipment		Control Measure
Possible Plant Equipment	Crusher (Crushes larger rock into smaller rock)	Portable plant equipment – Use away from the <i>declared area</i> boundary closest to the Butterfly Cave
	Mill (grinds asphalt wearing course where existing pavements are to be remediated)	Unlikely to be used near the <i>declared area</i> boundary closest to the Butterfly Cave, however if required use with caution after a trial
	Stabiliser (mixes stabilising agent (eg lime/cement) with pavement materials during pavement construction)	Unlikely to be used near the <i>declared area</i> boundary closest to the Butterfly Cave, however if required use with caution after a trial
	Concrete pump trucks	Low risk plant equipment, but use away from the <i>declared area</i> boundary closest to the Butterfly Cave if possible, and reduce speed of vehicle
	Telehandler (carries equipment around, eg pipes, similar to a forklift)	Low risk plant equipment; reduce speed of vehicle
	Drill rig / auger	Unlikely to be used near the <i>declared area</i> boundary closest to the Butterfly Cave, however if required, use with caution after trial; Risk increases if drilling through rock is required
	Small trencher	Use smaller plant equipment near <i>declared area</i> boundary closest to the Butterfly Cave; avoid trenching through rock while other excavations are occurring near the <i>declared area</i> boundary closest to the Butterfly Cave

In the event that standard construction methods are indicative of elevated vibrations, then subject to appropriate vibration trials, the following low-vibration methods could be considered for construction:

- 1) Use of rock saw and / or milling head attachment to excavate service trenches and pits in bedrock, in lieu of rock hammer or other impact method of excavation.
- 2) Larger excavator with ripper attachment for bulk excavation of bedrock in road pavement, in lieu of rock hammer or other impact method of excavation.
- 3) Compactors to be used in static mode, including switching to larger non-vibratory compactors if required, in lieu of using vibratory mode.

All plant equipment must be approved for use on the site by the Geotechnical Engineer prior to use. This may include the need for additional field trials, particularly for equipment not listed above, and also for equipment which is larger than that used for the field trials.

4.5 Response to Alarm

The response actions outlined in this section assume that vibrations are being recorded at the Butterfly Cave, subject to the required approvals from the Awabakal Local Aboriginal Land Council.

In the event that a vibration monitoring alarm is triggered (i.e. exceed 3 mm/sec trigger level at the Butterfly Cave), or damage has been observed (Refer Section 3.3), the following response is required by the Principal Contractor:

- Pause all construction activities;
- Contact the Geotechnical Engineer to attend site and download vibration data for assessment;
- In consultation with the Geotechnical Engineer, identify and isolate source of vibration, and document the event including the plant equipment working at the time, and the location of the work, relative to the Butterfly Cave and the *declared area*;
- Review construction methodology;
- Discuss proposed remedial action with the Geotechnical Engineer; and
- Provided that the event did not exceed the maximum allowable level of 5 mm/sec at the Butterfly Cave, proceed with caution, with a preference to actively reduce vibration from the source plant equipment (refer mitigation measures outlined in Section 4.6).

The results of the vibration field trials to date indicate that the distance between the Butterfly Cave and the construction activities exceeds the buffer distances to maintain vibration levels below both the allowable and trigger / alarm values.

If the construction vibration monitoring were to detect vibration exceeding the allowable 5 mm/sec level at the Butterfly Cave, all construction activities in Stage 7 are to immediately cease, and the source investigated, including whether the source of vibration could have been from non-construction related interference. Assuming that permission has been provided for the Geotechnical Engineer to be an *authorised* person, the investigation should be undertaken in a manner similar to that outlined above for a trigger value exceedance, and the Butterfly Cave should be inspected by the Geotechnical Engineer and an interim dilapidation / condition survey be undertaken. Council approval is required prior to any works recommencing if the 5 mm/sec level is exceeded at the Butterfly Cave, if measurement of vibration at the Butterfly Cave is permitted by the Awabakal Local Aboriginal Land Council.

Regardless of where the monitor is located, the vibration monitor should be checked prior to recommencing work after the alarm has been triggered.

In the event that permission is not provided for vibration monitoring to occur at the Butterfly Cave / within the *declared area*, then vibration monitoring will need to occur on the Stage 7 side of the boundary of the *declared area* and with reference to a revised (higher) trigger and alarm level at the primary monitor, as discussed in Section 4.3. If the construction vibration monitoring detects vibration exceeding the revised alarm level at the primary monitor and / or the 5 mm/sec alarm level at the secondary monitor, construction activities should cease within 45 m of the *declared area* while the source is investigated, as per the procedure above. If no construction activities are occurring within 45 m of the monitor at the time of the exceedance, then all construction activities in Stage 7 are to immediately cease. The investigation should be undertaken in a manner similar to that outlined above for a trigger value exceedance. The Geotechnical Engineer should provide an opinion as to whether the exceedance is considered significant enough to be potentially indicative of vibration exceeding the trigger and/or alarm levels at the Butterfly Cave, or whether the exceedance is considered to be reflective of the proximity of the construction activities to the monitor.

As discussed in Section 3.5, additional vibration trials should be conducted at the commencement of construction, when the work being undertaken is remote from the *declared area* boundary, so that the trigger and alarm values can be reviewed if the placement of a vibration monitor on the Butterfly Cave is not authorised, and alternative monitoring locations are to be considered.

4.6 Mitigation Measures

In the event that a vibration monitoring alarm is triggered during construction, mitigation measures are to be identified by the Principal Contractor, in consultation with the Geotechnical Engineer.

Once the source of the vibration has been identified, and the appropriate response (outlined in Section 4.5) has been followed, mitigation measures could include the following:

- Determine alternate machinery to undertake the work;
- Move the equipment further away from the *declared area*, if practical, to continue;
- Modify work sequencing to avoid multiple pieces of plant equipment operating at the same time;
- Using smaller or non-vibration compaction plant equipment;
- The use of saw cuts, judicious use of ripper tyne and/or milling attachments for excavation of rock.

The use of smaller plant equipment in some parts of the site may require modification to construction practices. For example, if smaller compaction plant equipment were to be used for filling of road embankments and/or lots, it would need to be placed in thinner layers to ensure compaction. Alternatively, a larger compactor operating in non-vibratory mode may provide adequate compaction, subject to an appropriate vibration trial away from the *declared area*.

The actual mitigation measures will depend on the results of the review of activities which led to the trigger of the alarm, but should be agreed to between the Principal Contractor and Geotechnical Engineer, before proceeding.

Mitigation measures should first include a trial, and work towards the *declared area* in a cautious manner, rather than commencing at the edge of the limit of works nearest the *declared area* and working away from it.

4.7 Inspection and Reporting

As outlined in Section 4.2, above, it is recommended that the condition of the Butterfly Cave be inspected by an appropriately qualified geotechnical engineer / engineering geologist and its condition documented prior to the commencement of construction. It is understood that the Butterfly Cave is of significance to local aboriginal women, therefore these surveys should be undertaken by appropriately qualified women, where possible, as a matter of respect.

It is acknowledged that there are a number of external factors which could potentially affect the condition of the Butterfly Cave, including natural weathering processes, mine subsidence, or “non-local” vibrations such as earth tremors or blasting at nearby mines / quarries.

Therefore, as well as inspecting the Butterfly Cave prior to the commencement of construction, it is recommended that the Butterfly Cave also be inspected if the following events were to occur during construction. In order for the Geotechnical Engineer to respond promptly to these events, it would be preferred that the Geotechnical Engineer being pre-approved, if possible, by the Awabakal Local Aboriginal Land Council an *authorised person(s)* for the duration of the construction works:

- Significant rainfall, for example 100 mm in a 48 hour period, or a rainfall intensity of about 25 mm in an hour;
- Earth tremor / earthquake in region;
- Vibration alarm triggered for a monitor located at the Butterfly Cave (as outlined in Section 4.5, above).

In addition to the above event-based inspections, periodic inspections of the Butterfly Cave are recommended during construction by an appropriately qualified geotechnical engineer / engineering geologist. Subject to the Geotechnical Engineer being considered an *authorised person* for the duration of the construction works, these inspections should generally be undertaken with reference to the following:

- Daily inspections for a minimum of three days at the commencement of constructions works which requires excavation of rock, particularly in the northern part of the site (say, within 50 m of the *declared area*);
- Daily inspections for a minimum of three days at the commencement of construction works which requires the use of compacting equipment, particularly in the northern part of the site (say, within 50 m of the *declared area*);
- Daily inspections for works which includes site clearing, the excavation of rock and/or the use of compacting equipment in the areas of the site which have been nominated in Section 4.4 for low-vibration construction methods in the northern part of the site;
- Weekly inspections for the remainder of works which includes site clearing, the excavation of rock and/or the use of compacting equipment in areas of the site away from those nominated in Section 4.4 for low-vibration construction methods;
- Fortnightly inspections for the duration of works when excavation of rock and/or the use of compacting equipment is not being used, but other subdivision construction activities are being undertaken.

As a minimum, the geotechnical engineer will provide a weekly summary report to Hammersmith, which will includes a summary of inspections which have been undertaken in the previous week, if any. It is recommended that Hammersmith consider providing copies of the inspection summaries to the Awabakal Local Aboriginal Land Council.

In the event that the Geotechnical Engineer forms the opinion that there has been a change in the condition of the Butterfly Cave between inspections, the Geotechnical Engineer will immediately notify Hammersmith and the Principal Contractor. If the Geotechnical Engineer forms the opinion that change in the condition of the Butterfly Cave is negligible or greater, as outlined in Section 3.3 of this CMP, the Geotechnical Engineer will notify Hammersmith that the Principal Contractor is to cease work and participate in an assessment process similar to that required for a response to an alarm as outlined in Section 4.5.

Furthermore, In the event that the Geotechnical Engineer forms the opinion that negligible or greater damage has been observed in the Butterfly Cave, the Geotechnical Engineer will immediately notify Hammersmith, who in turn will notify LMCC and Awabakal Local Aboriginal Land Council.

It is recommended that the Butterfly Cave also be inspected at the completion of construction, and a report prepared noting any significant / visible changes in condition during the construction period, provided that the Geotechnical Engineer has been given approval to be an *authorised person* for the duration of the construction works.

The above inspections should be undertaken by the Principal Contractor and Geotechnical Engineer, with the Awabakal Local Aboriginal Land Council in attendance if convenient.

The Geotechnical Engineer will have responsibility for collating the results of the inspections into a final report.

4.8 Review and Improvement of CMP

This CMP should be continually reviewed and improved, where required, during the construction process.

If for any reason, construction activities require a change to the CMP then these changes should be documented as part of an adaptive management process and approved by LMCC, if required.

Changes could be required due to variations in ground conditions, and/or plant equipment requirements. In general, where a change to the CMP is required due to a condition not already anticipated herein, it should include a field trial, as part of the change review process.

Changes should only occur after consultation between the Principal Contractor and Geotechnical Engineer.

5. References

DP (2012), *Stability Assessment of 'Butterfly Cave', West Wallsend Residential Subdivision, Stage 7 – Lots 103 and 105, George Booth Drive, West Wallsend*, Project 39794.05, Douglas Partners Ptd Ltd.

DP (2016), *Report on Geotechnical Investigation, Stage 7 Appletree Grove Estate, Fegan St, West Wallsend*, 81763.00.R.001.Rev1, Douglas Partners Pty Ltd.

DP (2017a), *Construction Management Plan, Protection of the Butterfly Cave, Appletree Grove Estate - Stage 7, off Fegan Street, West Wallsend*, Report 81763.02.R003.Rev2, Douglas Partners Pty Ltd.

DP (2017b), *Geotechnical Assessment of Allowable Vibration Limits for the Protection of the Butterfly Cave, Stage 7, Appletree Grove Estate, West Wallsend*, 81763.02.R.001.Rev2, Douglas Partners Pty Ltd.

DP (2017c), *Vibration Monitoring Field Trials, Stage 7, Appletree Grove Estate, Fegan St, West Wallsend*, 81763.R.002.Rev2, Douglas Partners Pty Ltd.

ME (2019a), *Aboriginal and Torres Strait Islander Heritage Protection (Butterfly Cave, West Wallsend, NSW) Declaration*, Australian Minister for the Environment.

ME (2019b), *Statement of Reasons for a Decision Under Sections 9 and 10 of the Aboriginal and Torres Strait Islander Heritage Protection Act 1984*, Department of the Environment and Energy.

NSW DEC (2006), *Assessing Vibration: A Technical Guideline, February 2006*. NSW Department of Environment and Conservation.

NSW PAC (2010), *Bulli Seam Operations, PAC Report*, NSW Government Planning Assessment Commission.

6. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Stage 7 Appletree Grove Estate in accordance with DP's letter of commission dated 13 March 2019 and acceptance received from Hammersmith Management Pty Limited dated 19 March 2019. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Hammersmith Management Pty Limited for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

DP's advice is based upon the conditions encountered during the referenced investigations. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond the sampling and/or testing locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

The contents of this report do not constitute formal design components such as are required, by the Health and Safety Legislation and Regulations, to be included in a Safety Report specifying the hazards likely to be encountered during construction and the controls required to mitigate risk. This design process requires risk assessment to be undertaken, with such assessment being dependent upon factors relating to likelihood of occurrence and consequences of damage to property and to life. This, in turn, requires project data and analysis presently beyond the knowledge and project role respectively of DP. DP may be able, however, to assist the client in carrying out a risk assessment of potential hazards contained in the Comments section of this report, as an extension to the current scope of works, if so requested, and provided that suitable additional information is made available to DP. Any such risk assessment would, however, be necessarily restricted to the geotechnical components set out in this report and to their application by the project designers to project design, construction, maintenance and demolition.

Douglas Partners Pty Ltd

Appendix A

About This Report
Information Sheet – Typical Vibration Monitoring
Plan Sheet by GCA Engineering Consultants (Dwg SK1001)

About this Report

Douglas Partners



Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

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Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;

- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

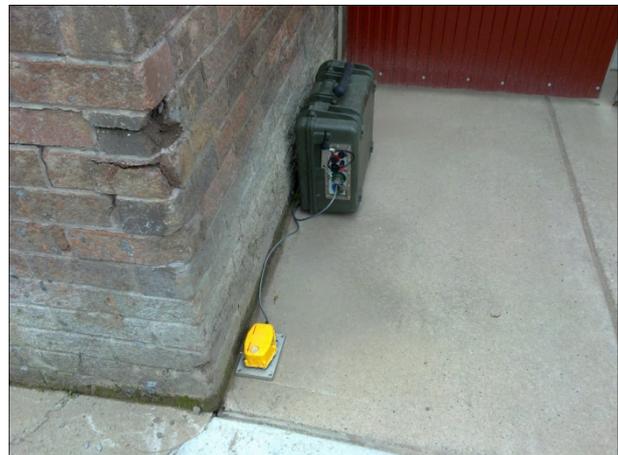
Site Inspection

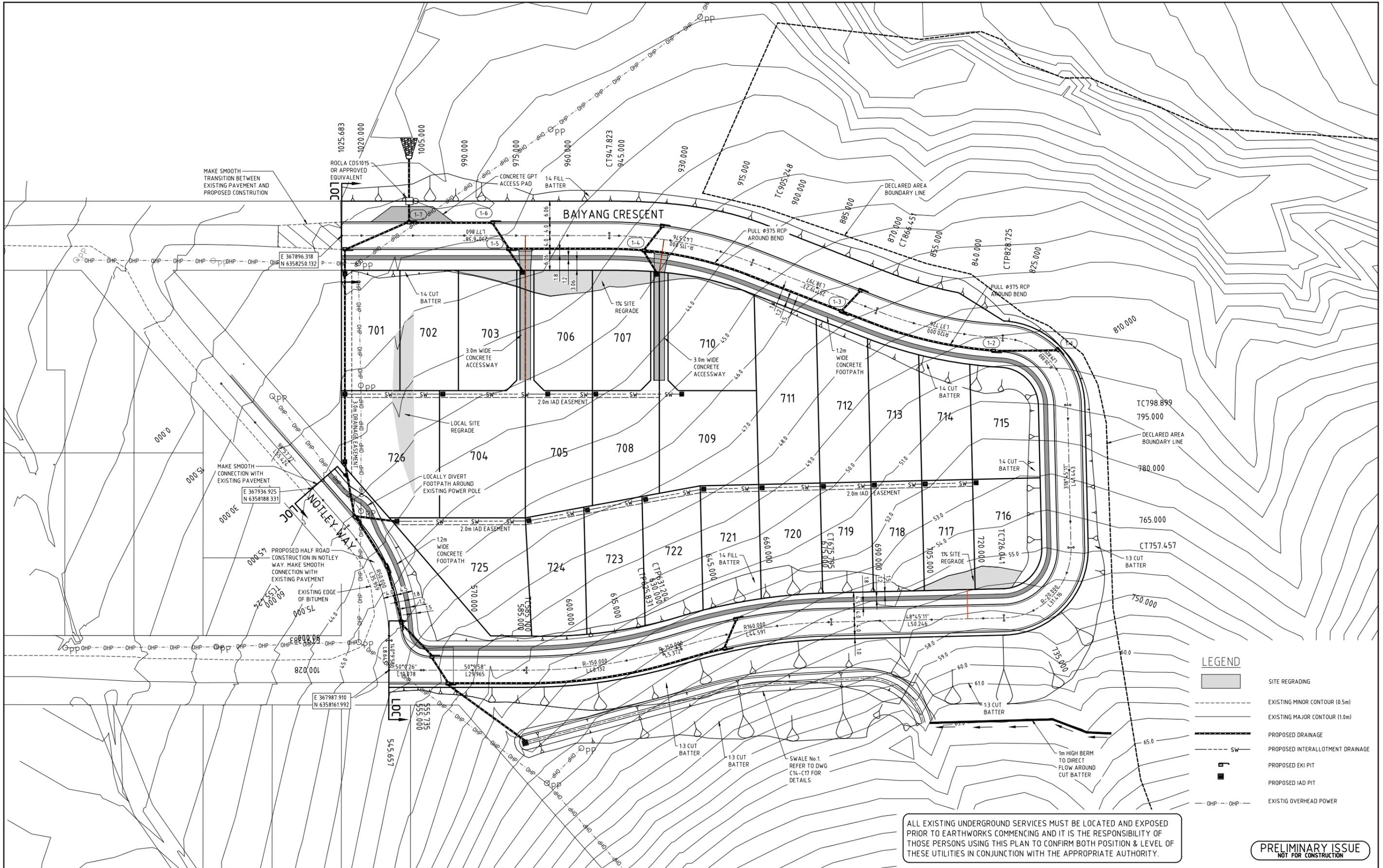
The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Typical Vibration Monitoring Equipment

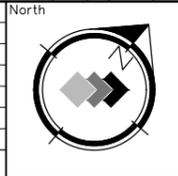
See photos below for typical setup of vibration monitoring equipment with a plasti-bond-coupled sensor (~1 kg, 150 x 100 mm) and Pelican case (~5 kg).

Typically vibration monitors would be plasti-bonded to a steel bracket which has been dynabolted to a fixed surface. Alternatively, at sensitive sites, such as the Butterfly Cave, the monitor would be set down on a level surface, and surcharged with half a sand-bag (approximately 10 kg).





Amendment	Description	Drawn	App'd	Date
1	ORIGINAL ISSUE	A.M	I.H	09.04.19



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Designed
A.M

Scale
AS SHOWN

Project Approval
IAN HILL (B.E)
Consulting Civil Engineer

Cad Reference
17210C dSK1001 r1

A1 SHEET

Client

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PROPOSED SUBDIVISION
APPLETREE GROVE - STAGE 7
WEST WALLSEND

PLAN SHEET

Project No	17210C
Drawing No	SK1001
Revision	1