ENVIRONMENTAL IMPACT STATEMENT

SAND, CLAY & PEBBLE EXTRACTION

LOT 1 & 2, DP 228308, LOT 2, DP 312327

MAROOTA

VOLUME I - TEXT

November, 1999

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TABLE OF CONTENTS

APPENDICES

VOLUME II

VOLUME III

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Form 2

Submission of
environmental impact statement (EIS)
prepared under the Environmental Planning and Assessment Act 1979
Section 78A(8)

EIS prepared by

name	Neil Richard Kennan
qualifications	B.A., Dip. Urb. & Reg. Plan., Dip. Cart., Ord 4.
address	PO Box 212 **CONCORD NSW 2137**

in respect of

development application

applicant name	L S Martin
applicant address	584 Old Northern Road **DURAL NSW 2158**
land to be developed: address lot no., DPMPS, vol/fol etc	Lot 2, DP 312327, Lots 1 & 2, DP 228308 Roberts Road **Maroota NSW**
proposed development	Sand Extraction

or

☐ map(s) attached

environmental impact statement

☑ an environmental impact statement (EIS) is attached

certificate

I certify that I have prepared the contents of this Statement and to the best of my knowledge

- it is in accordance with clauses 54A and 55 of the Environmental Planning and Assessment Regulation 1994, and
- it is true in all material particulars and does not, by its presentation or omission of information, materially mislead.

Signature Neil Kennan
name NEIL KENNAN
date 3.11.99

EXECUTIVE SUMMARY

This Environmental Impact Statement (EIS) has been prepared on behalf of L S Martin (the Applicant) in support of a Development Application pursuant to the Environmental Planning and Assessment Act, 1979.

By Declaration contained within the New South Wales Government Gazette No.102 of 3 September, 1999 (refer **Appendix 1**), the Minister for Urban Affairs and Planning (the Minister), pursuant to section 76A(7) of the Environmental Planning and Assessment Act, 1979, declared the following development to be State significant development:

> *"**An extractive industry**, if in the opinion of the consent authority:*
>
> *1. the resource has been identified as being of State or regional significance in a strategic plan adopted by the Director-General; or*
>
> *2. the total resource (the subject of the development application) is greater than 5 million tonnes; or*
>
> *3. the proposed extraction rate is greater than 200,000 tonnes per annum; or*
>
> *4. the project is to be located in an "environmentally sensitive area of State significance"."*

Notwithstanding points 1, 2 and 4 of that above Declaration, the proposed development, as described in this EIS, will involve the extraction of greater than 200,000 tonnes of material per annum and as such is State significant development for the purposes of the Environmental Planning and Assessment Act, 1979.

The Applicant seeks the approval of the Minister to establish a sand extraction operation on land at Maroota. **Figures 1 & 2** show the regional and site location respectively.

The objectives of the proposal are:

- To establish a commercially viable sand extraction operation which is capable of providing sand to the Sydney building market;
- To provide an environmentally acceptable process for the extraction of sand from the site so as to minimise any environmental impacts of the extraction process;
- To progressively rehabilitate the site as it is extracted in order to produce a stable and attractive landform with a large water supply dam; and
- To establish an environmentally responsible industry which will create employment and become a major environmentally sustainable industry.

The EIS is divided into a number of parts. The EIS continues at **Part 2** with a description of the site and the general planning controls applying to the site. The existing environment is described in **Part 3**; **Part 4** contains a description of the proposed development; **Part 5** provides a justification of the proposal and the alternatives to that which is proposed and **Part 6** details the net impact of the proposed development. **Part 7** describes the mitigation measures which are to be put in place to contain any potential adverse impacts of the proposed development. **Part 8** contains an outline of the Environmental Management and Rehabilitation Plan for the facility and **Part 9** is the conclusion to the EIS.

Site Location

The site forms part of the Maroota area which is located some 50 km north west of the Sydney Central Business District and about 10 km south of Wisemans Ferry.

Legal Description

The site comprises three parcels of land on the corner of Roberts Road and Old Northern Road, Maroota, being:

Lot 2, DP 312327 and Lots 1 & 2, DP 228308.

The area of the entire site is approximately 30 ha. As part of the preparation of this EIS, a topographic survey of the site was undertaken. **Figure 4** is a reduced copy of that survey. Scale versions of the survey have been submitted with the Development Application. The site is accessed by way of an existing entrance of Roberts Road approximately 290 m from the intersection of Old Northern Road with Roberts Road.

Operational History of the Site

The site has previously been used for agriculture and in particular as an orchard and plant nursery. The north western corner of the site remains in use by the Applicant as a plant nursery. The Applicant is presently undertaking the construction of a dam on the site which is located on the northern boundary of the site, again as shown on the plan at **Figure 4**. That dam construction commenced in or around 1970 and its continued construction is being undertaken pursuant to the 29 May, 1991 Orders of the Land and Environment Court, a copy of which are at **Appendix 3**.

Land Tenure

The site is in the ownership of Leonard Stanley Martin (the Applicant). Copies of Certificates of Title for the parcels which make up the site are contained at **Appendix 5**.

Zoning and Planning Controls

The site is zoned Rural 1(b) pursuant to Baulkham Hills Local Environmental Plan (LEP), 1991. The proposed development is permissible with the consent of the Council, and in this case the Minister, in the Rural 1(b) Zone.

Sydney Regional Environmental Plan No.9 - Extractive Industry (No.2)

The site is subject to the provisions of Sydney Regional Environmental Plan (SREP) No.9 - Extractive Industry (No.2). Sub-clause 7 (2) of SREP No.9 states that:

> *"(2) A person may, with the consent of the council, carry out development for the purpose of an extractive industry on land to which this clause applies."*

Sub-clause 4 (1) of SREP No.9 states that:

> *"(1) This plan prevails to the extent of any inconsistency between it and another environmental planning instrument, except a State environmental planning policy."*

Sydney Regional Environmental Plan No.20, Hawkesbury-Nepean River (No.2 -1997)

The site is located within the catchment of the Hawkesbury River. As such the land is subject to the provisions of Sydney Regional Environmental Plan (SREP) No.20, Hawkesbury-Nepean River (No.2 -1997).

Clause 4 of SREP No.20 states, inter alia:

> *"(1) The general planning considerations set out in clause 5, and the specific planning policies and related recommended strategies set out in clause 6 which are applicable to the proposed development, must be taken into consideration:*
>
> *(a) by a **consent authority** determining an application for consent to the carrying out of development on land to which this plan applies,"*

The "General planning considerations" detailed in clause 5 which are applicable to the subject development application are:

> *"(a) the aim of this plan, and*
>
> *(d) the relationship between the different impacts of the development or other proposal and the environment, and how those impacts will be addressed and monitored."*

Of the "Specific planning policies and recommended strategies" listed in clause 6, the following are considered applicable to the subject development application:

> *"(1) Total catchment management*
>
> *(2) Environmentally sensitive areas*

(3) Water quality

(4) Water quantity

(6) Flora and fauna."

The aim of the plan is:

> *"... to protect the environment of the Hawkesbury-Nepean River system by ensuring that the impacts of future land uses are considered in a regional context."*

The preparation of this EIS has involved the undertaking of a number of specific planning and technical studies of the site. The results and recommendations of those studies have formed the basis for the selection of that part of the total site which is suitable for sand extraction and indeed in the preparation of the plan of extraction for those areas. It has been the intention of the Applicant from the outset to plan the extraction having regard to the environmental constraints which have been identified in the relevant studies. All studies are reproduced in **Volumes II & III** of this EIS

State Environmental Planning Policy (SEPP) No.33 - Hazardous and Offensive Development

State Environmental Planning Policy (SEPP) No.33 - Hazardous and Offensive Development aims, inter alia:

> *"(d) to ensure that in determining whether a development is a hazardous or offensive industry, any measures proposed to be employed to reduce the impact of the development are taken into account; and*
>
> *(e) to ensure that in considering any application to carry out potentially hazardous or offensive development, the consent authority has sufficient information to assess whether the development is hazardous or offensive and to impose conditions to reduce or minimise any adverse impact."*

If a licence is required by the EPA, then it is safe to assume that the proposed development is "Potentially Offensive Industry". The EPA has indicated that Approval is required to operate the proposed extractive industry, and as such it is concluded that the proposed development is "Potentially Offensive Industry".

The technical studies which were undertaken as part of the EIS process, and concerned with noise, air quality, flora and fauna, archaeology, groundwater, hydrology, and stormwater management, have clearly demonstrated that the impact of the proposed development will not be significant.

The EIS has demonstrated that the consent authority can be satisfied that:

> *"... there are adequate safeguards to ensure emissions from a facility can be*

controlled to a level at which they are not significant"

and as such the proposed development, although always remaining "Potentially Offensive Industry" is not "Offensive Industry".

State Environmental Planning Policy No.44 - Koala Habitat Protection

The site has an area of more than one (1) hectare and as such is subject to the provisions of State Environmental Planning Policy (SEPP) No.44 - Koala Habitat Protection. The general aim of SEPP No.44 is to:

> *"... encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala population decline ...."*

The flora and fauna assessment of the site which has been undertaken as part of the EIS process (refer **Appendix 8)** has concluded that:

> *"The land is not potential koala habitat as Grey Gum the only listed feed tree on site comprises less than 15% of the total number of trees present on the site."*

As such, the remaining provisions of SEPP No.44 do not apply.

State Environmental Planning Policy No.11 - Traffic Generating Development

State Environmental Planning Policy No.11 (SEPP 11) applies to the site. In this regard, clause 7(3) of the Policy states:

> *"(3) Where a consent authority receives a development application to carry out development specified in Schedule 1, the consent authority shall, within 7 days of its receipt of the application, forward a copy of the application to the Traffic Authority."*

Item (m) within Schedule 1 of the Policy details development for the purpose of:

> *"(m) extractive industry or mining."*

As such, the development falls within the Schedule 1 definition. The traffic impact report which has been prepared as part of the EIS process addresses all the concerns of the Roads and Traffic Authority (RTA). The RTA will be provided with a copy of the development application and will have the opportunity to make comment on the proposed development.

The Rivers and Foreshores Improvement Act, 1948

Part 3A of the Act requires approval from the Department of Land and Water Conservation for certain activities including excavation or removal of material from protected lands in or within 40 metres of rivers as defined in the Act.

As the proposed development will incorporate development which may require a permit under Part 3A of the Act, the application will be forwarded to the Department of Land and Water Conservation for comment.

Surrounding Land Uses

Land surrounding the site is generally developed for rural purposes consistent with the rural zone which applies to the area. Land uses in the immediate area include market gardens, rural residential development, service industries and extractive industries which have developed in the SREP No.9 area.

The location of adjoining buildings and their distance from the site have been surveyed as part of this EIS process. The resultant plan is at **Figure 5** .

THE EXISTING ENVIRONMENT

Topography

The area's landscape is formed on a Hawkesbury Sandstone plateau and reflects the characteristic morphology of this formation, with steep valleys flanked by massive cliff faces. The relief ranges from 170 m AHD, south of the project area, to 240.7 m AHD at the Maroota Trig Station. Within the site, elevations range from 226 m AHD at the southwestern end along Old Northern Road to 178 m AHD at the base of the dam excavation.

The original drainage pattern of the area was in a northerly direction, to eventually join a tributary of Coopers Creek approximately 2 km to the north, however, runoff along this line is captured by a number of dams, two of which are located inside the property boundaries. Those dams provide a water supply to the existing nursery operations on the site. The rest of the site is internally draining, with all runoff directed towards the central dam construction operation.

Geology

The Maroota area is known for the production of sand, which represents a valuable resource to the building industry. The sand is obtained from two main sources, the Maroota Sand and the weathered profiles of the Hawkesbury Sandstone. The occurrence of the Maroota Sand has, in the past, been systematically mapped by the Department of Minerals and Energy of New South Wales (Etheridge, 1980) and its distribution over the area is well documented. Figure 1 of the Groundwater Impact Report at **Appendix 6**, adapted from Etheridge, shows the occurrence of the Maroota Sand in relation to the site.

Maroota Sand

The Maroota Sand comprises a sequence of interbedded and poorly sorted sands, gravels, clayey gravels, gravelly sands, pebbly sands, clayey/silty sands and clay which range from compacted to partly consolidated materials. The bulk of these sediments, however, consists of sand sized material. Ferricrete bands are common and occur at a number of levels within the Maroota Sand.

The formation unconformably overlies the Hawkesbury Sandstone. It was deposited on the

exposed and scarred surface of the Hawkesbury Sandstone and its base corresponds with, and is delimited by, that surface which was characterised by sharp relief and broad meandering palaeochannels and depressions. The sediments making up the Maroota Sand derive from eroded and re-worked material of the Hawkesbury Sandstone and of Permian conglomerates.

As a consequence of their origin and mode of deposition in meandering palaeochannels, the Maroota Sand sediments are characterised by rapid lateral and vertical face changes. The Maroota Sand units occur as a channel system of fluvial and alluvial origin and were deposited by an old Tertiary age river system cut into the Triassic sandstone bedrock, giving rise to a highly irregular surface on the Hawkesbury Sandstone. Two main components of this old river system have been identified:

- a major north-south channel aligned with and to the west of the current Maroota Ridge, and

- a meandering, generally east to west orientated channel, which enters the site in a central position along the northern boundary and exits just north of Roberts Road.

The confluence of these two palaeochannels appears to have been west of the site and in the northwestern portion of the present Haerses Road ridge (Etheridge, 1980).

Due to the irregular surface of the Hawkesbury Sandstone bedrock, the thickness of the Maroota Sand is not directly related to the present topography. According to Etheridge, the Maroota Sand formation attains a maximum thickness of 39 m at the Maroota Trig Station, just west of the now mostly eroded north-south palaeochannel. North of Maroota, the thickness is variable and commonly not more than 5 m.

Clay beds, deposited by the meandering of the palaeochannels, are common throughout the Maroota Sand formation. These clay layers were probably deposited as overbank deposits and abandoned channel fill deposits. A significant and extensive clay bed outcrops around the Maroota Trig Station and in the southwestern portion of the site and lenses out towards the north and east. The clay, which is composed of kaolinite and silica, reaches a thickness of 13.4 m under the Trig area. In other areas to the southwest and north, this clay has been extracted in the past for use as a ceramic clay in the manufacture of cream-burning bricks.

Hawkesbury Sandstone

The Hawkesbury Sandstone is a widespread formation occupying a large portion of the Sydney Basin. It comprises a thick sequence of sub-horizontal, massive, cemented quartz sandstone, with well developed cross-bedding and intercalations of shale and siltstone beds. Grain size is generally in the range of fine to medium sand, but sorting is generally poor with some silt and pebble grains. Shale layers and bands and occasional carbonaceous beds are also common within the Hawkesbury Sandstone. Shale beds have been identified at various locations at the contact between the Maroota Sand and the underlying Hawkesbury Sandstone bedrock.

The weathered profile of the Hawkesbury Sandstone, which is the primary target of other quarrying operations in the area, is of variable thickness and can be as much as 15 m deep. It is represented by a soft and friable rock ranging in colour from white to red-brown, the latter

resulting from the presence of variable iron oxides. Where this weathered zone is consistently above water table, it has been leached by infiltrating rainwater and is present as weakly cemented, white sandy soil, referred to as eluvial sand (Etheridge, 1980).

Existing Air Quality

The proposed development will be a variation on the existing operations of the site. Present concentration and deposition levels will therefore include contributions from existing operations. The existing case has been modelled to obtain an estimate of how these operations currently impact on the nearby sensitive receptors. These results have been taken into account when determining the increases due to the proposed extraction activities.

This section details a description of the modelling exercise and the dust monitoring program put in place to monitor existing levels. Further details are contained in the air quality impact assessment at **Appendix 10** of this EIS.

Two deposition monitoring programs have been undertaken and provide information for this assessment. The first was undertaken as part of another sand extraction operation west of the proposed operation (Colin Donges & Associates, 1996) and the deposition levels were measured at three locations during 1997. These sites are named as follows:

- Site 1: Maroota Public School
- Site 2: Vucko's House
- Site 3: Jurd's Property

The second program was undertaken specifically for this EIS. Measurements have been made at three locations on the boundaries of the site. These sites are named as follows:

- Site 4: North Fence
- Site 5: Entrance
- Site 6: East Corner

All dust gauge locations are shown in **Figure 10** and the results of the both monitoring programs are summarised in Tables 4 and 6 of the air quality impact assessment at **Appendix 10**.

Acoustic Environment

A report addressing the acoustic impact of the proposed development has been prepared as part of this EIS. That report, a copy of which is at **Appendix 11**, details the existing acoustic environment. Existing background noise levels for the site were measured at the following locations (refer **Figure 11**):

Location A: Residence at 155 Roberts Road, Maroota. This residence is approximately 15 m north of the northern boundary of the site. The logger was placed adjacent to the northern boundary of the site and in line with the facade of the residential dwelling.

Location B: Residence at 2a Roberts Road, Maroota. This residence is located approximately 60 m east of the eastern boundary of the site. The logger was positioned on the resident's northern boundary, approximately 5 m from the residential facade.

Location C: Residence at 156 Old Northern Road, Maroota. This residence is located approximately 140 m north of the northern boundary of the site. The logger was positioned approximately 10 m from the facade of the residential dwelling.

Existing traffic noise levels along Old Northern Road and Wisemans Ferry Road were measured at the following two locations:

Location D: Premises at Maroota Motors Pty Ltd, Corner of Old Northern Road and Roberts Road, Maroota. The premises are setback approximately 20 m from Old Northern Road. The logger was placed within 0.5 m of the front facade of the building.

Location E: Residence at the corner of Wisemans Ferry Road and Haerses Road, Maroota. This residence is setback approximately 25 m from Wisemans Ferry Road. The logger was positioned within 0.5 m of the front facade of the building.

The results obtained from the noise loggers at Location A, B and C are presented in **Tables 3.6, 3.7** and **3.8** of the EIS. The purpose of the monitoring at Locations A, B and C was to assess existing ambient noise levels during the period of proposed operations on the site.

The results obtained from the noise loggers at Location D and E are presented in **Table 3.9** of the EIS. The purpose of the noise monitoring at Locations D and E was to determine existing road traffic noise levels.

The results of the acoustic monitoring are shown graphically in the attachments to the acoustic impact assessment at **Appendix 11**.

Measured ambient L_{A90} noise levels exceed NSW Environment Protection Authority (EPA) recommended planning levels at Locations A and B. The graphical presentation of the results for these two locations show that noise levels fluctuate considerably throughout the day. Observations during logger establishment and retrieval found that the dam construction and processing activities were clearly audible at both locations.

The ambient noise levels at Locations A and B increase significantly during the daytime, approximately during the times that the existing extraction operations are undertaken on the site. Ambient noise levels at these locations are also influenced by intermittent road traffic noise along Roberts Road.

Measured ambient L_{A90} noise levels at Location C were below the NSW EPA recommended planning levels. The site was inaudible during logger establishment and retrieval. The graphical presentation of the results are typical of a location in a rural residential environment.

Measured noise levels at Locations D and E were primarily influenced by road traffic noise.

Transport and Traffic

A transport and traffic report has been prepared as part of the preparation of this EIS. A copy of that report is at **Appendix 15**.

Old Northern Road/Roberts Road Intersection.

To determine the highest hourly volumes and turning movements at the intersection, twelve hour traffic volume and classification counts were made at the intersection of Old Northern Road with Roberts Road. These counts were used to confirm the extent and type of improvements necessary to meet Roads and Traffic Authority (RTA) and Austroad Standards.

The 12 hour traffic volume was low (251) in Roberts Road and thirty one percent (31%) of the total volume (78) were heavy trucks. It is relevant to note that the number of heavy truck movements permitted by the Court Orders for the existing activity on the site is 50 trucks per day.

The am and pm peak hours were from 7:00 am - 8:00 am and 4:30 pm - 5:30 pm. The two way through traffic volumes in Old Northern Road ranged from 71 vehicles per hour to 168 vehicles per hour between 6:00 am and 6:00 pm. The twelve hour count showing:

- cars and light vehicles,
- heavy trucks, and
- the two peak hour counts

are shown in Figures 3A and 3B respectively of the transport and traffic report at **Appendix 15**.

Weekday and Weekend Volumes on State Arterial Roads

Automatic counters were placed at two locations (refer to **Figure 23**) on the haul road network from the subject site to determine the time pattern and volumes of light vehicle and heavy truck movements over a full 7 days including a weekend.

Light vehicles are cars and 2 axle trucks, vans etc., and heavy vehicles are three or more axle trucks such as the fleet used for the transport of sand from extractive operations in the Maroota area. A classification chart is included in Appendix D of the transport and traffic report at **Appendix 15**. The average weekday and weekend two way daily traffic volumes at Stations 3 and 4 were as detailed in **Table 3.10** of the EIS.

Road Inventory

Old Northern Road has a sealed pavement about 6.4 metres wide and unsealed gravel shoulders which vary in width from about 1.5 to 2.5 metres. Wisemans Ferry Road is of a similar standard to Old Northern Road. The edges of the sealed pavement are subject to higher loading by heavy vehicles travelling near the edges of the road pavement and require higher maintenance to repair the broken edges. The road pavement is generally in reasonable condition.

Based upon Table 4.1 in Austroads Rural Road Design, the desirable sealed pavement width in Old Northern Road and Wisemans Ferry Road is 7.0 metres because the AADT traffic volumes

are well in excess of 1,000 vehicles per day. Roberts Road is a sealed local road and has a pavement width of 5.7 metres. The pavement condition, geometric alignment and line marking are shown in Photograph P5 of **Appendix 15**.

Operation of the Roberts Road/Old Northern Road Intersection.

This intersection has been up-graded recently to provide a sheltered right turn bay in Old Northern Road as shown in Photograph P4 of **Appendix 15**. The pavement striping continues on the northern side of Roberts Road as shown in Photograph P6. The full extent of pavement markings south and north of Roberts Road can be seen in Photograph P1.

A layout of the Roberts Road and Old Northern Road intersection has been compiled from site measurements and is drawn to scale in **Figure 24.**

An analysis of the performance of the intersection under existing am and pm peak hour volumes has been made using INTANAL Version 3.17. The intersection is operating at Level of Service A in both peak hours as shown in **Table 3.11** of the EIS.

Vehicle Access to Site

The site entry gate is on the northern side of Roberts Road and is located some 290 metres east of Old Northern Road. The sight distance from the entry road is excellent in both directions along Roberts Road. The entry road is an unsealed gravel road.

Surface Water and Existing Water Quality

The general drainage pattern of the site is in the northerly direction along a natural creek line which joins a tributary of Coopers Creek approximately 2 km to the north, which eventually flows into the Hawkesbury River. Drainage within the site is characterised by two separate catchments which are identified on **Figure 6**. The western catchment (some 8.9 ha) contains two dams which provide a water supply to the existing nursery operations. The eastern catchment (some 20.7 ha) drains the remaining area of the site with generally all runoff directed into the existing dam construction area. The dam construction area also collects runoff from the small catchment to the east of Roberts Road (approximately 10.5 ha). Runoff from this catchment enters the site via a road culvert beneath Roberts Road, located some 60 m north of the site entrance. The total catchment area of the current dam construction area is 31.1 ha.

The current dam construction area is located at the lowest point within the site and it is possible that, during exceptionally high rainfall periods, the excavation area could overfill. During such events, overflow from the construction area would occur via a natural low point in the pit northern wall into the existing natural watercourse.

Existing Water Quality

As part of the preparation of the EIS, a strategy for surface water management was prepared, a copy of which is at **Appendix 7**. To assess the stormwater impacts of the proposed development, the computer program AUSQUAL was used to model pollutant generation for undeveloped and developed catchment scenarios. Details of the existing model results are contained in section 2.2

of the report at **Appendix 7**.

Flora and Fauna

An assessment of the impact of the proposed sand extraction activity on the flora and fauna of the site has been undertaken as part of this EIS, with particular reference to threatened species. A copy of the assessment is at **Appendix 8** of the EIS.

Description of the Existing Environment

Flora

Vegetation Description

Most of the site is fully cleared and solely vegetated with introduced pasture grasses and herbs, however, there are a few small areas of remnant vegetation.

In the north of the site just to the west of the existing dam construction area, is a stand of trees including Blue-leaved Stringybark (*Eucalyptus agglomerata*), Thin-leaved Stringybark (*E.eugenioides*), Smooth-barked Apple (*Angophora costata*) and Black She-oak (*Allocasuarina littoralis*). Groundcover species include Bracken (*Pteridium esculentum*), Hedgehog Grass (*Echinopogon caespitosus*), Kangaroo Grass (*Themeda australis*) and the introduced Crofton Weed (*Ageratina adenophora*).

There is a strip of remnant trees along a fence line in the south of the site. Species present are White Stringybark, Grey Gum (*Eucalyptus punctata*), Blue Mountains Mahogany (*E. notabilis*), Red Bloodwood (*Corymbia gummifera*), Rough-barked Apple (*Angophora floribunda*) and Black She-oak.

North of the existing entrance to the site is another stand of White Stringybark, a few Blue Mountains Mahoganies and White Mahogany (*E.acmenoides*). Just north of this is a degraded scrubby area dominated by Yellow Tea-tree (*Leptospermum polygalifolium*), Tick Bush (*Kunzea ambigua*), Scale-rush (*Lepyrodia scariosa*) and the introduced Kikuyu (*Penniseteum clandestinum*) and Whisky Grass (*Andropogon virginicus*).

Conservation Significance of the Vegetation

The treed areas of the site would have been part of Shale-Sandstone Transition Forest, now recognised as an Endangered Ecological Community. Shale-Sandstone Transition Forest probably covered much of the ridges and ridge-slopes along and beside Old Northern Road, but has been removed for agricultural and rural residential development. Given their small size, highly disturbed nature, low species diversity, and low likelihood of regeneration, it is considered that the treed areas of the site do not constitute viable remnants of Shale-Sandstone Transition Forest.

The scrub area was probably previously heath/woodland of the Maroota Sands complex as described by Ryan *et al* (1996). Due to clearing, altered fire regimes and disturbance of the site, the scrub's floristics and structure have been modified allowing the dominance by Yellow Tea Tree, Tick Bush and Whisky Grass. Some previously existing species have persisted though

diversity is far lower than in comparable undisturbed areas of heath/woodland nearby. Its only significance is as habitat for a small number of the threatened plant *Acacia bynoeana* .

Threatened Plant Species

Six individuals of the small, prostrate shrub *Acacia bynoeana* were found in the scrubby area near Roberts Road. **Figure 7** shows the location of this species. This species is currently listed as Vulnerable under the TSC Act but has been preliminarily determined as Endangered, which is a higher risk code. Impacts on this species are dealt with in **Part 6.9** of this EIS.

Regionally Significant Species

One of the remnant trees on site, Blue Mountains Mahogany (*Eucalyptus notabilis*), has some regional conservation significance. Populations of this species in the Maroota area are significant as they are an outlier of the larger Blue Mountains population and it is not well represented in nearby Marramarra National Park. Blue Mountains Mahogany is not listed as endangered or vulnerable in the TSC Act.

Fauna

Fauna Habitat

Fauna habitats on the site broadly correspond to the vegetation described above. Specific habitat features which influence the range and abundance of fauna species are:

- the modified nature of the site which makes it more suitable for introduced species (eg Common Myna, Spotted Turtledove) and those native species which are highly adaptable (eg Australian Magpie).

- tree hollows of a size suitable for use by bats, arboreal mammals and avifauna are absent.
- farm dams on site provide habitat for a range of waterfowl and frog species, none of which are threatened.

Threatened Fauna

Table 3.12 of the EIS lists those threatened fauna species which have been detected within a 5 km radius of the site. Apart from the Glossy Black-Cockatoo and Turquoise Parrot, all of the above species require intact bushland or specific habitat features which are not present on site. Likely impacts on these two threatened fauna species are discussed in **Part 6.9** of this EIS.

Archaeology

An archaeological survey of the site was undertaken as part of the preparation of this EIS. A copy of the survey report is at **Appendix 9**. No Aboriginal archaeological sites or areas of potential archaeological deposit were identified.

The ridge on which the site is located is thought to be part of a major north-south Aboriginal pathway between the Parramatta River valley and the Hawkesbury and thence on to the Hunter

Valley. This ridge may also have been a language boundary between the Darug speakers to the west and the Kuringgai to the east, however, no localities particularly suitable for camping or activities likely to result in significant quantities of archaeological material appear to be present on the area surveyed. The absence of local surface water on this section of the ridge top is a particular constraint.

Extensive horticultural activity over many years, levelling of surfaces, dam construction and extraction of sand have left virtually no surface within the survey area undisturbed. There is no outcropping rock other than a few small sections in some areas. These rocks are iron-rich and coarse-grained and are unsuitable for engraving or grinding.

Therefore, the lack of old trees, extensive cultivation and lack of outcropping sandstone, eliminate scarred trees, engravings, rock shelters and wells from any site prediction model, leaving the rare categories of artefact scatters (Open Camp Sites) and stone arrangements as the most likely archaeological remains.

Generally high levels of grass cover made it difficult to identify artefact scatters which may have been present. As these appear to be rare in this type of landscape, and considering the general level of surface disturbance, it is unlikely that any *in situ* artefacts are present. There may be occasional stone artefacts on the surface which have been obscured by vegetation or mechanical disturbance, as Aboriginal people are likely to have used this area in the past for foraging and hunting.

No original food plants were identified on the ridge top, those that were likely to have been present in the past having been cleared. Only a few regrowth eucalypts are present near fence lines and three regrowth casuarinas are present below the wall of the dam nearest Old Northern Road.

Groundwater

A groundwater assessment of the site has been undertaken as part of the EIS process. A copy of the complete groundwater report is at **Appendix 6** of this EIS.

According to the Baulkham Hills Shire Council Development Control Plan No.500, the position of the water table in that aquifer determines the depth to which the excavation can be carried out.

The three monitoring bores were drilled at the locations shown in **Figure 8**. The sites were chosen on the basis of existing available information in order to intersect the greatest thickness of the Maroota Sand. The geological and construction logs of the bores are presented in Appendix A of the groundwater impact assessment at **Appendix 6**, and relevant details are given in **Table 3.13** of the EIS.

Upon completion of drilling, construction and development, the bores were purged and sampled. The samples were submitted to Australian Laboratory Services under chain of custody procedures. Of the three bores, bore PT84MW2 could not be adequately sampled because of both the small volume of water which could be obtained and its slow rate of recovery observed during purging.

The full laboratory analytical reports are presented in Appendix B of the Groundwater impact assessment at **Appendix 6** as are the field measurements and the analytical results. Salinity values are included in **Table 3.13** of the EIS.

The groundwater from the two sampled bores is somewhat similar in nature although bore PT84MW1 has a lower ionic concentration, reflecting its perched nature, its shallower depth, higher elevation and consequent rainfall recharge effects. The analyses reveal that a small amount of nutrients are present in the groundwater, particularly in bore PT84MW1, in the form of ammonia, nitrate and phosphate, most likely the result of the agricultural pursuits of the area. Nutrients have also been found in several bores during the DLWC Maroota Groundwater Study, Stage 2.

The water samples were also analysed for the presence of Total Petroleum Hydrocarbons (TPH), a broad test which includes an array of organic compounds, not all necessarily associated with petroleum products. This was done in the event that the dredging operations at the site may have had an impact on the groundwater, although, in consideration of the geology encountered during drilling, and of the low permeability of the formation, this was considered unlikely. A small amount of TPH was recorded in the results. Upon further checks, the chromatographs of the analyses (Appendix B of the report at **Appendix 6**) indicated that the recorded peaks related to chlorinated products. The results are explained with the use of chlorinated breakdown agents used to disperse the drilling mud during development of the bores.

Hydraulic Tests

The completed bores were subjected to a falling head test in order to evaluate the hydraulic conductivity of the formation around each bore. Plots of the tests are presented in Appendix C of the groundwater impact assessment and the applicable values included in **Table 3.13** of the EIS.

The results indicate hydraulic conductivity values ranging from 0.25 m/day to 0.05 m/day, with a most probable average value of 0.14 m/day. These values, which are typical of clayey sands, together with the small saturated thickness of the Maroota Sand indicate that this aquifer has only a limited water supply capacity.

Automatic Data Loggers

The three monitoring bores have been equipped with Dataflow Systems Pty Ltd automatic data loggers of the same type used in the area by the DLWC.

Hydrogeology

The formations present in the Maroota area have dissimilar hydrogeological characteristics. The high degree of lithological variability (i.e., sands, clays, shale, sandstone, etc.) often results in the establishment of perched water tables in both the Maroota Sand and in the Hawkesbury Sandstone and, possibly within the latter, between the weathered profile and the fresher sandstone.

Under these conditions, three separate aquifers can be identified, although the extent of their hydrogeological separation or, conversely, interconnection, is sometimes uncertain. These aquifer

units are:

- the Maroota Sand;
- the eluvial/weathered profile of the underlying Hawkesbury Sandstone, and
- the fresh Hawkesbury Sandstone.

The more significant aquifers are the Maroota Sand and the deeper Hawkesbury Sandstone. The description of the hydrogeological characteristics of the two aquifers presented in this EIS is based on records held by Woodward-Clyde, by the Department of Land and Water Conservation (DLWC) and others contained in EIS documents available in the Maroota area. A review of the bore records held by the DLWC for the Maroota area is summarised in Table 4 and their location plotted in Figure 1 of the groundwater impact assessment at **Appendix 6**.

The Maroota Sand, where it occurs below water table (such as in the deeper section of sands along the palaeochannels), constitutes an unconfined, or water table aquifer. It is open to direct rainfall infiltration and, as a consequence, is subject to seasonal variations in response to rainfall patterns and climatic cycles. The aquifer derives its permeability (its ability to store and transmit groundwater), from the open pore spaces between its constituent sand grains. The permeability of the Maroota Sand aquifer is variable and is limited by its clay content, the degree of cementation of the ferricrete and ferruginous bands and the presence of substantial clay layers. Although the storativity[1] of the Maroota Sand aquifer is considered greater than that of the underlying Hawkesbury Sandstone, its total storage capacity is reduced by its limited saturated thickness, particularly north of Maroota, and by its relatively small areal extent.

The natural groundwater flow (underflow) within the Maroota Sand aquifer is dictated by its position at the top of the Maroota Ridge along Old Northern Road and Wisemans Ferry Road. The underflow, therefore, follows the topographic relief pattern and, where this relief intersects the base of the aquifer, seepages can be expected to occur at the contact with the less permeable underlying material. These seepage points, identified by Etheridge at the margins of the Maroota Sand outcrop, supply water to a number of perennial creeks at the margin of the Maroota Sand outcrop.

Where the water table in the Maroota Sand aquifer is at a higher elevation than that of the underlying Hawkesbury Sandstone, a potential exists for groundwater flow and recharge to the Hawkesbury Sandstone aquifer to occur from this source.

The commercial extraction of groundwater from the Maroota Sand aquifer requires large diameter excavations and dams, due to the relatively low permeability and storage capacity of the aquifer, even in the deeper sections of the buried palaeochannels. Irrigation supplies to orchards and market gardens in the area are drawn in this manner.

In addition to the regional water table within the Maroota Sand aquifer, perched water tables occur above the extensive clay layers and ferricrete bands present within the formation.

[1] The volume of water an aquifer releases or takes into storage per unit surface per unit change in head.

From a resource viewpoint, the perched water tables have limited value due to their small extent and storage, but they may be significant in the maintenance of vegetation capable of tapping this source. Where sand mining will take place, however, by necessity the vegetation will be removed and the local aquifer excavated, so that the vegetation-perched water table interdependence will no longer be an issue.

Similar geological conditions as described above for the regional area were also encountered during the investigations at the subject site.

Small aquifer zones have developed in the eluvial sand, which comprises the leached and weathered profile of the Hawkesbury Sandstone. These zones often form perched aquifer systems above the deeper regional water level of the Hawkesbury Sandstone.

In the majority of cases, these perched aquifer systems have limited resource value because, like the Maroota Sand, they have small extent and storage. They act as temporary storage of groundwater prior to release to streams or leakage to underlying aquifers. Dams and large diameter wells constructed into this material can provide a source of farm water supplies, but generally the permeability is too low to yield significant supplies to small diameter boreholes.

The Hawkesbury Sandstone is generally an impermeable rock, due to the large degree of grain cementation resulting from the development of secondary minerals in the interpore spaces, such as kaolinitic clay and iron oxides. The presence of these minerals in the groundwater gives the characteristic red-brown staining of the rock visible in road cuttings and building stone. Although the rock has negligible primary permeability, fracturing and jointing, where open and interconnected, provide secondary permeability and storativity.

Estimates of transmissivity (i.e. permeability times aquifer thickness) for the Hawkesbury Sandstone, calculated from the available bore records by Australian Groundwater Consultants (now AGC Woodward-Clyde) and more recently by Woodward-Clyde, range from 0.06 m^2/day to 3.6 m^2/day. These values support the overall low permeability characteristics of this formation as understood from geological interpretation. Storativity is estimated to be in the order of 0.001, due to the secondary permeability characteristics of the aquifer.

Available records show that different water tables are intersected during drilling into the Hawkesbury Sandstone, due to the different degree of fracturing and the presence of confining layers (such as the shale lenses) within the rockmass. Because most bores in the Hawkesbury Sandstone are completed open hole, however, an equilibrium water table is eventually established with time, often coinciding with the deeper water table intersection, through drainage from the upper strata.

Groundwater Quality

The quality of the groundwater in the Maroota Sand aquifer in the area within and around the proposed development is dependent upon direct rainwater infiltration and the chemical processes and exchanges occurring with the minerals contained in the formation. This process is reflected in the generally low salinity of the groundwater, as shown in the data of Table 4 of the groundwater impact assessment at **Appendix 6**.

Water quality in the Hawkesbury Sandstone in the Maroota area is generally good. Because the

Hawkesbury Sandstone is not in outcrop in the subject site, this formation is not discussed in greater detail here.

Groundwater Levels

Maroota Sand

Table 5 of the groundwater impact assessment at **Appendix 6**, shows a summary of water levels obtained from a number of bores completed in the Maroota Sand. The data available from the DLWC Stage 2 Study, the present study and the EIS completed by PF Formation in the land to the west of the proposed development, indicate a high degree of variability in the Maroota Sand aquifer. Such variability is the result of geological conditions which cause perching of water bearing strata above substantial clay layers.

Water levels in the groundwater monitoring bores on the site recorded by the automatic data loggers are presented in Figures 3, 4 and 5 of the groundwater impact assessment at **Appendix 6**. With the exclusion of the perched levels, it appears that the water table within the Maroota Sand aquifer ranges between 178.58 m AHD to 183.59 m AHD, with an average of around 180 m AHD.

Visual Aspects

The topography of the site is such that it falls away from Old Northern Road, and hence affords extensive vistas of large portions of the site when viewed from various vantage points along both Old Northern and Roberts Roads. As a result, the current dam construction and sections of the future proposed extraction works would be visible to public and private view. The visual impact generated by these works is currently, and will in the future, be caused by the colour contrast of exposed soils.

While these visual impacts are temporary, and will be totally eliminated once rehabilitation works have been undertaken, strategic bund wall construction and planting works along the boundaries of the subject property, will provide a visual screen for the current, and in particular, the future extraction works within the site. This aspects are discussed further in **Part 4** of this EIS.

THE PROPOSED DEVELOPMENT

The development proposal involves the extraction of sand and clay from approximately 29.5 ha. The general operational constraints of the site are outlined in Development Control Plan No.500 adopted by Baulkham Hills Shire Council in December, 1996. Based on groundwater level monitoring data presented in the groundwater impact assessment, it appears that the water table within the Maroota Sand aquifer in the area ranges between 178.58 m AHD to 183.59 m AHD, with an average of around 180 m AHD. These values have been used in the operations plan to calculate the final level to which extraction will be allowed on the site.

The depth of Maroota Sand available for extraction will vary across the site depending on the location of the underlying shallow groundwater level and the presence of peaks and rises in the sandstone bedrock. The predicted maximum depth of extraction is some 35 m below existing surface, located adjacent to Old Northern Road. The average extraction depth over the site is predicted to be approximately 10 m.

The Resource

As part of a previous determination of the resource contained on the site, a drilling program was undertaken in August, 1991 to assist in the identification and quantification of resources on the site. The report resulting indicates that reserves of three (3) specific resource types were calculated, firstly by assuming complete extraction to the boundaries, secondly by invoking reasonable environmental, geotechnical and safety parameters and thirdly by excluding the north-western area containing the nursery and dams. The last consideration was adopted as the most realistic and the reserves calculated were:

Maroota Sand	2.25 million tonnes
Clay	1.25 million tonnes
Friable Sandstone	2.70 million tonnes.

The above drilling program did not, however, take into account the requirement that extraction is to not be undertaken below a level which is 2 m above the groundwater table in the shallow aquifer. A copy of the text of the investigation report is at **Appendix 12**.

Work undertaken in the design of the conceptual mine plan for the proposed extraction of the site has included the land in the north-western area of the site and has accounted for the need to not extract within 2 m of the groundwater table. It has determined that a total resource **3.43 million tonnes** of product is available within 2 m of the confines of the shallow aquifer, and within the setback requirements of DCP No.500. Of that product, **2.4 million tonnes** is Maroota Sand, product which represents 70% of the material which would be extracted from the site. The remaining 30% (**1.03 million tonnes**) of the material won during the extraction process would be clay and pebble material.

Rate of Extraction

The Applicant seeks approval for fifty (50) laden truck movements from the site per day with extraction to occur 5.5 days per week. In recent times, load limits for individual trucks have been increased significantly to allow a maximum of 33.5 tonnes per load. Thus, under existing maximum load limit regulations, it is expected that a maximum of **1,675 t/day** of extracted material will be taken from the site per day which equals **479,050 t/annum**. As such, with this maximum rate of product leaving the site daily, the resource on the site could be extracted in a period of 8-9 years allowing for time for commencement of operations.

The above estimate, due to inclement weather, fluctuations in the demand for product and other limiting factors, may not occur each and every day during the life of the extraction. As such, a conservative average production of thirty (30) laden truck movements per day is anticipated over the life of the extraction which, with an average load of 33.5 tonne per load, represents **1,000 t/day** or **286,000 tonnes per annum**. On the basis of this rate of extraction, the total extraction of the resource could take up to 12-13 years to complete.

On the basis of the above, the applicant seeks approval to complete the extraction at the rate of 50 laden trucks per day (**479,050 tonnes/annum**) and it is this figure upon which the impact of the proposed development has been assessed. For the purposes of determining the life of the extraction, however, and hence the life of any approval for that extraction, the above conservative estimate of 30

trucks per day is adopted. Allowing for contingencies and delays in the processing of approvals and the like after the initial consent has been given, an **approval for a 15 year period is sought**.

The Proposed Development Process

The extraction of sand in the Maroota area is generally dependant upon a quality water supply in order that the clay within the extracted material can be washed from the sand. The applicant is currently constructing a water supply dam on the site. It is proposed to utilise the work already undertaken in the construction of that dam to provide for a water supply for the proposed extraction of the total site.

The development of the site will be undertaken as follows:

1. Construction of the process water dam for the washing of sand in conjunction with Stage 1 extraction of material from the site;

2. Stage 2 extraction of material from the site, and

3. Extraction of the resource under the existing processing plant and the access road utilising mobile extraction equipment.

Full details of the proposed process water dam are contained in **Part 4** of the EIS.

The Proposed Sand Extraction Process

Future extraction operations will involve the excavation, washing and screening of the Maroota Sand using the same process plant as per the existing operation. The proposed excavation will cover the majority of the site, some 23 ha, allowing for boundary buffer zones as described in **Part 4.1** of this EIS. Future extraction operations are to involve the following:

- Materials are to be excavated using a self-loading scraper and transported to the process plant. In areas where the underlying material cannot be effectively excavated using the scraper, the surface would be initially ripped using an excavator and in exceptional circumstances using a dozer.

- Process water for washing/screening will be primarily sourced from a water dam constructed at the location of the existing excavation pit (adjacent to the northern boundary). The existing pump-out facility will be utilised.

- Processed material is to be stockpiled adjacent to the plant area prior to transportation off-site generally using articulated trucks. A front-end loader is to be used to load the trucks.

- The residue clay/silt slurry is to be delivered by pipeline to designated drying areas in the previously extracted cell where it is spread in thin layers to dry. Liberated water will be drained into the water dam for re-use in the process plant. The clay materials will be used for the rehabilitation of the extracted areas.

- The materials are to be sequentially extracted in "cells" commencing along the northern boundary (adjacent to the process water dam) and working towards the southern boundary (to

Old Northern Road). Each cell will be approximately 200 m x 50 m wide (1 ha in area) which provides sufficient area for the machinery to load and manoeuvre within each cell. The extraction process will minimise the disturbed area (i.e. the area exposed to erosive processes) and enable rehabilitation procedures to commence during operations.

- Each cell will be progressively rehabilitated (following extraction of the sand materials) involving surface contouring and replacement of a suitable growth medium/topsoil layer to enhance revegetation.

Extraction within the site will be undertaken in two stages as follows:

Stage 1 Area located to the east of the catchment divide (i.e. the process water dam catchment), occupying a total area of approximately 16.5 ha, and

Stage 2 Area located to the west of the catchment divide (i.e. the catchment of the two existing water dams for the nursery), occupying a total area of approximately 6.5 ha.

The staging will enable the existing nursery operation to continue during the initial Stage 1 extraction operation and for most of Stage 2 and as required by the owner. The operation will use the existing process plant and sand stockpile area including the existing site entrance, weighbridge and offices.

The conceptual extraction strategy for the Stage 1 and 2 areas is that three cells will be subject to work as follows:

- only one cell will be extracted at any one time,
- the clay from the processing plant will be piped to the previously extracted cell where it will be spread in a thin layer for drying, and
- the vegetation and topsoil from the new cell will be stockpiled in the third cell which has been extracted and now contains a layer of "dried" clay. This third cell in the sequence is to undergo rehabilitation. The topsoil from the current extraction cell will be mixed with the "dried" clay materials and used for rehabilitation of the cells.

The mining strategy is illustrated in **Figures 15 to 20** of the EIS as described in **Part 4** of the EIS.

The predicted final layout (and contours) following extraction operations at the site and a cross-section of the final landform are presented in **Figure 21**.

Processing Plant

The processing plant will be that which is currently on the site and being utilised for the processing of extracted material as part of the approved dam construction on the site. Material won from the extraction faces will be transported by scrapper to the receiving hopper which is part of the existing processing plant.

The extracted material is transferred by conveyor from the receiving hopper to the sand washing

section of the plant where clay is washed from the primary material. Sand is screened according to a predetermined size and stockpiled by use of a conveyor system according to product size.

Clay washed from the sand is piped as slurry to the clay drying area from where water is drained from the slurry and gravity fed back to the process water dam.

Processed material is to be transported from the site by large, generally articulated vehicles. These trucks access the processing area by way of the internal haul road. Trucks are loaded by Front End Loader.

A weighbridge has been located at the entrance of the site as part of the approved dam construction on the site. The weighbridge will remain in that location as part of the proposed extraction Here all material leaving the site is recorded. The applicant has established a computer recording system in conjunction with the establishment of the weighbridge on the site. All trucks entering the site are weighed and their weight recorded. Upon leaving the site, each truck is again weighed and the weight of the load it is carrying is calculated and recorded by the weighbridge computer.

Rehabilitation

Rehabilitation of the site will be undertaken progressively on the completion of extraction within the individual cells. A detailed rehabilitation plan is at **Appendix 14**.

Component Requirements

The proposed development will require a number of components, many of which are already located on the site as part of the current dam construction. The key elements of the proposal are as follows:

- Administrative office, weighbridge and associated amenities. The existing facilities will be utilised.
- Stockpile areas for processed material. Existing facility to be used.
- Processing plant. The existing plant will be utilised.
- One Caterpillar Self-loading Scrapper. Existing plant to be used.
- One Leibherr 850 Front End Loader. Existing plant to be used.
- One Terex Front Loader. Existing plant to be used.
- One water cart for watering haul road and internal working areas. Existing plant to be used.
- Water storage ponds. These are based on the existing dam construction on the site.
- Water pumps. Existing pumps to be used.
- Above ground fuel storage tank. Existing facility to be used.

- Car parking spaces for visitors and employees adjacent to administrative office. Existing facility to be used.

Stormwater Management

As part of the preparation of the EIS, a strategy for surface water management was prepared, a copy of which is at **Appendix 7**.

To minimise sediment build up in the dam, a sedimentation pond will be used to remove coarse sediment from surface waters before entering the process water dam. It will be constructed to approximate dimensions of 30 x 50 x 1.5 metres, located as shown on **Figure 12**.

Water Requirements and Recycling of Runoff

The objective of water cycle management is to maximise the conservation of available water and minimise requirements for other water sources. To achieve this:

- surface runoff will be captured and stored within the process water dam for reuse;
- additional water will be supplied from bore(s) which will access water from the Hawkesbury Sandstone aquifer, and
- water will be separated from the clay slurry within clay drying areas and returned to the Process Water Dam for subsequent reuse.

Access

Access to the proposed development will be from the existing access from Roberts Road approximately 290 metres from the intersection of Old Northern Road with Roberts Road.

Distribution of Trucks to Main Road System

Trucks leaving the site will be distributed onto the main road system as follows:

- 40 per cent will travel south along Old Northern Road. These trucks will pass through survey counting Station 4 in Old Northern Road.
- 60 percent will travel west on Wisemans Ferry Road and pass through counting Station 3.

Fire Control

Fixed and portable fire services are provided over the whole of the site as required by the relevant governing bodies.

Workforce

The personnel required for the operation of the development would include the following:

- One (1) scrapper operator
- One (1) front end loader operator
- One (1) process plant manager
- One (1) office worker
- One (1) site manager/general maintenance engineer

Services

Water to service the office complex is currently supplied from a rain water tank. That supply will remain as part of this development. The office amenities are connected to a septic system. No change to the existing system is proposed. Integral Energy has installed an underground high voltage electricity supply to the site. The location of that supply is generally along the alignment of the access road from Roberts Road to the processing plant. The electricity supply has been installed to convert the processing plant from diesel to electric power. In the event of power failure, the existing diesel generators will be utilised to ensure the integrity of the processing plant.

A 1,000 amp supply is available to the processing plant with a transformer located adjacent to the processing plant.

Fuel Storage

The scrapper, front end loaders and bulldozer (when required) will require diesel fuel for their operation. A 14,000 litre capacity overhead fuel tank is located on site adjacent to the processing plant. That tank is bunded so that the bunding will retain 110% of the capacity of the above ground tank. No alteration is proposed to the fuel storage as part of this application.

Hours of Operation

The proposed daily operating hours are as follows:

6:00 am to 6:00 pm Monday to Friday

6:00 am to 1:00 pm Saturday

Heavy machinery activity on the site will normally cease at 4:30 pm on weekdays.

Site Landscaping

The aims of the site landscaping and rehabilitation are to:

- Initially establish, within the boundary setback areas, extensive screen planting, supplemented with earth bunding where required, to provide for visual screening and noise control of the proposed extraction works.

- Ensure the extraction site is fully rehabilitated in an "orderly, progressive and controlled manner".

- Ensure that the proposed rehabilitation processes facilitate the successful establishment and on-going performance of the nominated end land-use for each disturbed area, namely:

  - Indigenous native vegetation to the majority (70 %) of the site

  - Unimproved pasture/existing facilities to remain (23 %)

  - Dams (7 %).

- Ensure that the progressively rehabilitated areas of the site are protected and monitored for the life of the development.

At the beginning of the project, and within the boundary setback zones, earth bunds shall be established. These bund walls and the remaining boundary setback areas will then be permanently mass planted with appropriate native plants for visual screening and noise attenuation purposes. Plan MP-01A of the rehabilitation report at **Appendix 14** shows the location and intent of these works.

Proposed bund walls - within the 30 metre setback zone to Old Northern Road and Roberts Road - are typically 23m wide, up to 3m high, and have a profile which portrays a 1 in 4 grade to the road frontage and a 1 in 3 interior grade. Service and maintenance access routes are proposed at the base of both the front and rear of these bund walls.

Nominated bund walls with the 10 metre setback zone along the northern property boundary, shall achieve a 2 metre height, as required for noise attenuation, and will therefore have 1 in 2 finished batter grades.

The bund walls will be constructed using overburden from the existing dam works, and capped with a 250 mm layer of site topsoil.

Within the extraction works areas, additional earth bunding will be provided around nominated works areas to provide additional visual screening and noise attenuation. These internal bunds will be temporary and as such, shall be stabilised with a grass cover crop.

Other aspects of the rehabilitation of the site, including:

- Protection of Existing Vegetation;

- Native Seed Collection;

- Removal of Vegetation;

- Topsoil Stripping and Storage;

- Treatment of Final Excavated Surfaces, and

- Maintenance

are discussed in detail in the rehabilitation report at **Appendix** 14.

Approvals Required

All relevant authorities were contacted with regard to approvals which have to be obtained as part of the development process. The following information is supplied:

EPA

The EPA has advised that a licence will be required under the Protection of the Environment Operations Act.

Department of Land and Water Conservation

The Department has advised that if water supply is intended to be obtained from surface or groundwater, a licence under the Water Act (1912) may be needed from the Department.

IMPACT OF THE PROPOSED DEVELOPMENT

The proposed facility is to be located on land to which Sydney Regional Environmental Plan No.9 - Extractive Industry applies. The proposed use is permitted, with consent. The proposed facility is consistent with the long term land use planning for the site as indicated by the provisions of SREP No.9.

Air Quality

Impacts on Air Quality Due to Existing Activities

Sand materials are currently being excavated to construct the dam near the northern site boundary. This material is being excavated using dredging methods. The dredged slurry is pumped to the processing plant where the sand is separated (washed and screened) and stockpiled. This material is then loaded into trucks and transported off-site. The residue clay slurry is pumped from the plant into sedimentation ponds and then into drying beds. The clay soils are collected and stockpiled and then transferred by front-end loader to the cut-off trenches for dam construction.

The main dust generating activities of those described above, include:

- bulldozers and front-end loaders on the clay drying area
- front-end loaders picking up stockpiled clay and dumping it to the cut-off trenches
- loading product sand to trucks

- transporting product sand off-site
- wind erosion from exposed clay drying areas and stockpiles
- wind erosion from sand stockpiles.

Appendix A of the air quality impact assessment at **Appendix 10** provides a detailed description of the calculations carried out in determining the emissions from each activity, and these are summarised in **Table 6.3** of the EIS. A modelling exercise was undertaken to estimate the contribution made by these existing operations to the background dust levels around the site. The emissions rates in **Table 6.3** were used, and the predicted concentrations and deposition rates due to these emissions, are shown in Figures 4 to 7 of the air quality impact assessment report at **Appendix 10**.

The highest levels for both short- and long-term predictions, occur in the north-eastern corner of the site. This is currently the main area of activity, where the clay is dried and then picked up to be relocated. It is also where most of the wind erosion would occur. Although there is not a high volume of material moved around on site, the triple handling of the clay and its high silt content make those operations particularly dusty. Emissions from these activities will be eliminated in the proposed operations as the clay will be piped to the clay drying areas in a slurry and will be spread in thin layers for drying. The clay will not be relocated elsewhere on the site as it will be utilised in the rehabilitation of the area within which it is dried..

The following paragraphs contain discussion about "background" levels, so it is necessary to briefly describe here what is meant by this term. Background concentrations or deposition levels refer to those levels which are due to all other sources except those being assessed. For example, in the area around the project site there will be other dust generating activities. These will include farming and ploughing of land, the spreading of fertilisers, other extractive industry sites, wind erosion of farmland, bushfires and emissions from local traffic (particularly heavy vehicles). All these sources will produce particulate emissions which will contribute in varying degrees to the existing levels in the area, regardless of whether this project is operational. These levels are defined as "background" levels.

The locations where the dust deposition gauges are positioned are estimated to receive approximately 1 – 1.5 g/m^2/month due to the current activities. If the contribution from those activities is removed from the average of 3 g/m^2/month measured at those gauges, the background level due to other sources is likely to be of the order of 1.5 – 2 g/m^2/month. This is a typical background level expected in a rural environment where farming and other such activities are taking place. The allowable increase due to the proposed operations is therefore estimated to be approximately 2 – 2.5 g/m^2/month, before the 4 g/m^2/month is reached.

There are no monitoring data for airborne particulate matter to use in determining the background PM_{10} and TSP levels. The deposition monitoring discussed in the previous paragraph showed that approximately half of the current levels are due to emissions from the existing activities at the site. In the absence of particulate concentration monitoring it has been assumed that a similar value would apply for annual average PM_{10} and TSP levels. This is a conservative assumption as it is likely that the contribution from the existing activities is more than half at the closest residences (meaning a lower background).

It is estimated that the existing activities at the site contribute approximately 10 $\mu g/m^3$ and 15 $\mu g/m^3$

to the current annual average PM_{10} and TSP levels, respectively, at the nearest residences on Roberts Road. As discussed above, it has been conservatively assumed that half of the current levels are due to existing operations. In other words, the current annual average PM_{10} concentration would be of the order of 20 $\mu g/m^3$, 10 $\mu g/m^3$ of which is due to the existing operations at the project site. For TSP the argument is the same, meaning a current level of approximately 30 $\mu g/m^3$ (15 $\mu g/m^3$ contributed from existing activities at the site). The annual average background concentrations of PM_{10} and TSP would be of the order of 10 $\mu g/m^3$ and 15 $\mu g/m^3$, respectively.

Background levels for a 24-hour averaging period are more difficult to determine, as the maximum 24-hour PM_{10} concentrations will depend on the presence of nearby sources of particulate matter such as bushfire or remote sources such as dust storms. There is no reason to suppose that the highest concentrations produced from these sources will correlate with the worst-case conditions for the proposal. The dispersion modelling showed that the maximum 24-hour PM_{10} concentrations predicted for the most affected residences are approximately 50 $\mu g/m^3$, due to existing operations at the site. These levels are not unusual, given the closeness of these receptors to the existing operations, and as will be shown in the following sections of the EIS, the levels are not significantly different from those anticipated for the proposed operations.

Estimated Emissions from the Proposed Operation

Dust emissions have been estimated by analysing the proposed extraction operations. It is not anticipated that the level of activity or the mode of operation will change substantially over the life span of the project once maximum production levels have been reached.

The operations which apply at the site have been combined with emission factors developed, both locally and by the US EPA, to estimate the amount of total suspended particulate (TSP) produced by each activity. Estimated emission totals are presented in **Table 6.4** of the EIS, and details of the calculations are presented in Appendix A of the air quality assessment report at **Appendix 10**. It has been assumed that the extraction operation will be operating at a production rate of 286,000 tonnes of sand per year.

Concentration

Short-term concentration

The predicted maximum 24-hour $PM_{2.5}$ concentrations due to proposed operations at the extraction site, are shown in Figure 8 of the air quality assessment report at **Appendix 10**. Predicted levels at all residences are expected to be below 10 $\mu g/m^3$. This is well below the short-term US EPA goal of 65 $\mu g/m^3$.

Figure 9 of the air quality assessment report at **Appendix 10** shows the predicted maximum 24-hour PM_{10} concentration in the area around the proposed site. The predicted 24-hour PM_{10} concentrations at the nearest residences are slightly less than 50 $\mu g/m^3$. As discussed in **Part 6** of this EIS, it is impossible to determine a 24-hour average background PM_{10} concentration without monitoring data. Without contemporaneous meteorological and monitoring data it is also impossible to determine whether or not the maximum predicted 24-hour PM_{10} concentration will occur under conditions which produce the worst-case background levels. The best that can be done is to show that the levels which are predicted to occur for the proposed operations are

almost identical to those estimated for existing activities.

It must also be remembered that this is a worst-case assessment for these residences, since the active extraction cell will not always be in the northeast corner of the site. At other times during the year, and throughout the life of the project, the main dust producing activities will be occurring further away from these residences.

The US EPA short-term goal of 150 $\mu g/m^3$ is not predicted to be exceeded at any residence. This is the most appropriate goal for this assessment. Background concentrations would need to be of the order of 100 $\mu g/m^3$ or more for the US EPA short-term PM_{10} goal to be exceeded, and this is unlikely to be the case.

The NEPM 24-hour goal on which the NSW EPA goal is based, allows five exceedances of 50 $\mu g/m^3$ per year. Figure 10 of the air quality assessment report at **Appendix 10** shows the predicted sixth highest 24-hour PM_{10} concentration due to proposed on-site operations. It is shown that all residences lie outside the 50 $\mu g/m^3$ contour.

Figure 11 of the air quality impact assessment at **Appendix 10** shows a time series of 24-hour average PM_{10} concentrations at the most affected residence, indicating that the majority of predicted levels are below 30 $\mu g/m^3$. The sixth highest predicted PM_{10} level at this residence is approximately 31 $\mu g/m^3$. A background of 19 $\mu g/m^3$ would therefore be required to cause an exceedance of the NSW EPA goal. It is likely that this could occur under worst-case conditions, but as discussed previously, the more appropriate goal for assessing this proposal is the US EPA 24-hour goal of 150 $\mu g/m^3$. It should also be remembered that when the operations move away from the northeast corner, 24-hour concentrations due to on-site operations will be reduced significantly.

Long-term concentration

Predicted annual average $PM_{2.5}$ levels are shown in Figure 12 of the air quality assessment report at **Appendix 10** to be well below the US EPA goal of 15 $\mu g/m^3$. The highest $PM_{2.5}$ prediction at the most affected residence is less than 2 $\mu g/m^3$.

Figure 13 of the air quality assessment report at **Appendix 10** shows that predicted PM_{10} levels, due to the proposed operations, are expected to remain well below the US EPA annual goal of 50 $\mu g/m^3$, with the concentration at the most affected residence estimated to be approximately 10 $\mu g/m^3$. When added to an estimated background level of 10 $\mu g/m^3$, the proposal is not anticipated to exceed the annual goal.

Figure 14 of the air quality assessment report at **Appendix 10** shows the predicted annual average TSP concentrations due to emissions from the site. The most affected residence is predicted to experience an increase in annual TSP concentration of approximately than 20 $\mu g/m^3$. This is well below the NHMRC annual goal of 90 $\mu g/m^3$ and this goal is not expected to be exceeded even when added to estimated existing levels of 15 $\mu g/m^3$.

Deposition

Annual average dust deposition rates of approximately 4 g/m^2/month are currently experienced

at the Maroota Public School and areas to the west. This allows for almost no contribution to deposition levels in those areas from the proposed operations. As shown in Figure 15 of the air quality assessment report at **Appendix 10**, the levels predicted for areas north of the current study area are negligible.

It is argued that an appropriate background deposition level (excluding existing operations on the site), would be approximately 1.5 - 2 g/m^2/month, which would allow for an increase in the order of 2 - 2.5 g/m^2/month. Figure 15 of the air quality assessment report at **Appendix 10** shows that the levels predicted at the nearest residences are approximately 2 g/m^2/month. The EPA annual average goal of 4 g/m^2/month is therefore not expected to be exceeded due to emissions from the proposed operations. Levels are expected to be similar to those which are currently experienced at the site. It must also be remembered that as the excavation operations move further to the south and west, most of the emission sources will also be relocated. The deposition levels at these residences on Roberts Road are therefore likely to decrease significantly as this occurs.

The assessment has shown that the operations are predicted to comply with both the long-term and short-term concentration goals, as well as the deposition goals. Indeed, in some cases, it may be that the dust levels decrease with the proposed development, as the activities move further away from Roberts Road during the life of the project.

Noise

The results presented in **Table 6.8** of the EIS demonstrate that, following the construction of the proposed earth berms, noise emissions will be significantly attenuated. Whilst the predicted levels do not comply with the design objectives for several scenarios, the objective is only exceeded by 1 – 2 dBA for the majority of these cases. There are several points which should also be considered:

(a) the modelling scenarios for maximum operations are based on all equipment operating at peak output. This would only occur on rare occasions and, therefore, designing for compliance with the L_{A10} noise objective may be overly stringent.

(b) The modelling results for existing operations with no controls demonstrated that the model is conservative. The results of the unattended monitoring show that the predicted L_{A10} noise levels are only reached occasionally. Therefore, the predicted noise levels for the proposed operations may also be considered as conservative and actual noise levels may only reach the predicted values occasionally.

(c) The predicted noise levels show that the total noise impact from the site will be significantly reduced when compared to existing. Discussions with residents have found that they are not annoyed by noise emissions from the current operations. Although the design objectives may be slightly exceeded, a reduction in noise levels will ensure that potential for annoyance is further minimised.

(d) As detailed in Table 5.2 of the acoustic study at **Appendix 11**, a dozer was included in each of the maximum operation scenarios. Analysis of the model outputs has found that the dozer contributes significantly to the combined predicted level. For example, in Scenario 3A, the predicted combined noise level was 54.7 dBA at Location B; the highest predicted

noise level of all scenarios, however, the predicted noise level from the dozer alone was 53.6 dBA. All other sources were below 46 dBA. The dozer will only be used when the material cannot be excavated using a scraper or excavator. Discussions with site management have found that this will be rare.

The results of the modelling for the 6:00 am to 7:00 am period comply with the design objective. The modelling assumes that a truck and front end loader will operate during this period only. The plant and other mobile equipment will not commence operations until after 7:00 am.

The maximum daily laden truck movements from the site will be 50 (100 total movements). The average daily laden truck movements from the site will be 30 (60 total movements).

The traffic noise computer model - TNOISE which is based on the "Calculation of Road Traffic Noise" by the UK Department of Transport, 1988, was utilised to predict the impact of proposed increases in truck movements along the two proposed routes. The predicted impact is based on modelling of semi-trailer trucks, which are typical for the transport of sand. Traffic noise levels have been predicted based on the measured traffic flows at the two residential locations where existing traffic noise levels were monitored. These are:

Location D: Residence at Maroota Motors Pty Ltd, Corner of Old Northern Road and Roberts Road, Maroota.

Location E: Residence at the corner of Wisemans Ferry Road and Haerses Road, Maroota.

The modelling was carried out based on the maximum anticipated truck movements. Average truck movements would generate lower road traffic noise levels. The results of the modelling show that the increase in hourly L_{Aeq} noise levels is well below 2 dBA for both location D and E.

It should be noted that there are no residential premises located in Roberts Road between the site entrance and Old Northern Road. The traffic noise assessment has therefore been limited to residences along Old Northern Road and Wisemans Ferry Road.

The assessment which has been undertaken has found that the use of earth berms and the implementation of a noise management plan would provide significant noise control. The mobile equipment in use generates noise levels free of tonal or other annoying characteristics. The predicted noise emissions, with noise controls in place, represent a significant improvement in current noise emissions from the site. There have been no known complaints lodged with management of the site regarding excessive noise from the current operations. Furthermore, discussions with residents at the most potentially affected locations have found that they are not annoyed by noise from the site and are generally supportive of the site management. Following the implementation of controls and a comprehensive noise management plan, it is considered unlikely that noise levels at the residents will cause concern.

Visual Impacts

The extraction areas will be progressively rehabilitated so that vegetative cover is established at the earliest possible opportunity, thus minimising the extent of disturbed land within each extraction cell, and ensuring that any potential visual impact has a limited life. The Environmental

Management and Rehabilitation Plan will provide detailed staging plans for the excavation and progressive rehabilitation of the works.

The extraction process will entail operating in cells approximately 1 ha in area. It is intended that 3 cells will be open at any one time as follows:

- The newest cell will be extracted
- The previous cell will be used for clay drying
- The oldest cell will be rehabilitated.

It is proposed that, as part of the progress rehabilitation process and the on-going maintenance of these works, management plans will be prepared and updated on a yearly basis. These management plans will outline what has been achieved in the previous year and what is proposed in the upcoming year. It is proposed that if the methods outlined in the rehabilitation report at **Appendix 14** are followed, then:

- The nominated extraction areas can be successfully rehabilitated, re-establishing an extensive native vegetation cover.
- The rehabilitation process can be staged in a progressive manner to limit possible visual impacts resulting from the excavation works.
- Appropriate standards will be set for the on-going monitoring of the rehabilitation process and maintenance works to ensure the successful establishment and on-going performance of these rehabilitation areas.

Traffic Impacts

The internal access road will extend from the site entrance in Roberts Road to the existing processing plant. The existing access road is in poor condition and needs to be upgraded. Off road type vehicles such as scrapers do not use this road and therefore the road pavement should be designed for heavy trucks. On an average weekday over the estimated 15 year life of the project, the number of heavy truck movements will be 60 per day. Although the future total traffic volumes will be less than 100 vehicles per day, the percentage of heavy trucks will be around 60 per cent and therefore a pavement width of 7 metres should be provided based upon Austroads Table 4.1 Traffic Lane Widths for Undivided Sealed Roads.

It is desirable that the road pavement be sealed with a hot flush bitumen seal to eliminate dust. A suitable typical cross section for the internal haul road is shown in Figure 10 of the traffic and transport report at **Appendix 15**. It is recommended that the road be signposted for 20 km/hour operation for safety and environmental reasons.

Traffic counts over a number of years show that Annual Average Daily Traffic Volumes in Old Northern Road at Maroota are increasing at 2 per cent per annum. The estimated intersection turning volumes at the intersection of Roberts Road with Old Northern Road on a weekday after 15 years are shown in Figure 8 of the traffic and transport report and reproduced as **Figure 25**

of this EIS.

An INTANAL analysis shows that the current intersection, which has been upgraded recently to include a sheltered right turn bay, will continue to operate at Level of Service A to the end of the project. The sight distance in Old Northern Road and south of Roberts Road are considered satisfactory for a speed of 100 km/hour. No intersection improvements, except for double centreline markings in Roberts Road for 30 metres from Old Northern Road, are required.

The increase in heavy truck traffic generated by this development is estimated to be 30 truck movements per day (Monday to Friday) in Wisemans Ferry Road west of Old Northern Road and 20 truck movements per day in Old Northern Road south of Roberts Road. These increases amount to 14.25 per cent and 9.37 percent respectively. These increases are relatively small and will not reduce the Level of Service at either the intersection of Roberts Road with Old Northern Road or in Wisemans Ferry Road and Old Northern Road.

Social and Economic Impacts

The impact of the proposed development upon the local community has been carefully considered and measures devised to protect the local amenity. These include:

- provision of noise attenuation measures including the location of earth berms at locations suggested in the Acoustic Study at **Appendix 11**.
- control of pollution at all stages of development.
- the provision of landscaping and visual barriers to provide a screen to the proposed development and provide a more attractive vista. In this regard, a perimeter landscape plan has been devised by Scott Murray and Associates to assist in the mitigation of the visual impact of the existing dam construction on the site. That plan has been submitted to Baulkham Hills Shire Council as a Development Application separate to this application process. At time of writing, no decision had been made by the Council on that application.
- the establishment of quality groundwater monitoring bores which will provide information to the Department of Land and Water Conservation in its continuing groundwater monitoring in the Maroota.

The proposed development will have the following economic benefits:

- the creation of employment in the Maroota area.
- payment of section 94 contributions for the continued maintenance of Old Northern Road and Wisemans Ferry Road.
- the provision of additional income to local businesses and suppliers.
- a continuation of the supply of quality sand products to the Sydney market at reasonable prices.
- continued employment of truck drivers and those employed in landscaping businesses and

the like which will utilise the extracted product.

Groundwater

From a surface and groundwater viewpoint, potential adverse impacts could be considered to be:

- reduced groundwater availability to users.
- aquifer contamination.
- reduced flow to streams.
- increased turbidity to streams.
- water table lowering.

No mitigation measures against reduced groundwater availability will be required because sand mining will not be carried out below the water table, the aquifer will not be disturbed and no groundwater will be extracted from the shallow aquifer for the purpose of extraction. Because no additional groundwater pumping will occur, no additional effects above the present conditions can be expected. On the contrary, the increased potential for groundwater recharge to the shallow aquifer means that a potential benefit may be derived by nearby users.

Under the current approval, sand extraction at the site is carried out by a floating dredge which breaks down the sides of the excavation by high pressure water jetting. The sand and water slurry is then pumped to the plant, where sand and water are separated and the water returned to the dam. The potential for aquifer contamination exists via infiltration of contaminated water to the aquifer, which can occur from every excavation in the shallow aquifer in the Maroota area. At the subject site, the existing potential contaminant is considered to be fuel spillages from the operating dredge. The dredge will not be used as part of the now proposed dry extraction process and as such this potential source of groundwater contamination will be removed.

Potential fuel spillages from machinery to be used on the site need to be addressed as part of the site management plan. With proper remedial measures, it is considered that the potential for aquifer contamination is negligible.

Perched water tables in the Maroota Sand and in the weathered profile of the Hawkesbury Sandstone are capable of providing contributions to stream flows where these streams have been eroded to the level of the bedrock. This is particularly the case along the perimeter of the Maroota Sand outcrop. Seepage zones have been identified at some distance from the site and drainage or removal of perched groundwater bodies could cause a reduction of stream flow. It is not known what percentage of stream flow is due to natural drainage of perched water tables, to bank storage and to catchment run-off.

The increased amount of recharge to the shallow aquifer, which will occur as excavation progresses, is likely to create a mound in the water table under and around the site. This mound will dissipate within the rock mass at a rate dictated by the permeability of the formation and the new hydraulic gradients. It is considered that no mitigation measures are required to be

implemented for the maintenance of stream flow. The regional shallow water table, which is considered to be the main contributor to stream flow after run-off, will be unaffected by the extraction operations.

The proposed development is entirely internally draining. Run-off is currently directed to the two large dams on the site and into the existing excavation. Release of turbid water from the site is most unlikely to occur even following heavy storms.

Mitigation measures to prevent and offset the release of turbid water from the site are contained in the Strategy for Surface Water Management at **Appendix 7** and will be reported upon in the annual Environmental Management and Rehabilitation Plan for the site.

Extraction will not be taken within two metres of the water table and no groundwater from the shallow aquifer will be utilised. In these circumstances, no lowering of the water table will occur as a result of extraction. On the contrary, the removal of vegetation and the creation of an internally draining basin will have the effect of increasing the recharge to the aquifer to the benefit of surrounding users. The principle of improved recharge to the shallow aquifer has been accepted by the DLWC in its Maroota Groundwater Study Stage 1 report (Section 4.2.1).

No mitigation measures are considered necessary with regards to the possibility of the lowering of the existing water table levels. Monitoring of groundwater levels will be performed as part of the Environmental Management and Rehabilitation Plan for the development.

Not all impacts are, potentially, of an adverse nature. Some beneficial effects are also likely to be derived from the operation. These include more direct (increased) groundwater recharge to the shallow and deep aquifers from the site storages and rainfall via the exposed surfaces. Aquifer recharge from beneath the site would be enhanced also by the removal of clay lenses present within the Maroota Sand over the site.

These beneficial effects answer to the principles of an ecologically sustainable groundwater development, whereby current groundwater resources will be maintained to existing users and future generations will not be affected by the present activities.

The environmental impact of the proposed development upon the groundwater in the known aquifers in the area is likely to be negligible after the recommended mitigation and monitoring procedures have been implemented.

The change in the landform and the removal of soil material above the shallow and deep aquifers is likely to result, on balance, in beneficial long term effects to those aquifers, represented by increased groundwater recharge rates.

Surface water quality should be maintained by the prevention of releases of turbid water to the natural drainage system due to the internally draining design of the development.

Although the proposed development is likely to have some and varying impacts on the existing groundwater environment, it is considered that the implementation of proper design and management measures and procedures, would reduce these impacts to a manageable level.

A programme of groundwater monitoring will be carried out at the three bores established at the site.

The three groundwater monitoring bores have been equipped with automatic data recorders. The loggers will be downloaded at three monthly intervals and the data graphed and prepared for inclusion in the annual Environmental Management and Rehabilitation Plan.

Soil Erosion

A comprehensive Soil and Water Management Plan has been prepared for the site and is contained within **Appendix 16**. The implementation of the plan will ensure that no sediment laden water will be discharged from the site.

IMPACT MITIGATION MEASURES

Noise

The impact of noise generated from the proposed development will not have a significant adverse impact on the environment. As discussed in the acoustic impact assessment report at **Appendix 11**, there will be a requirement that earth berms be constructed in certain sections of the site to mitigate any acoustic impact to adjoining residences. Those bunds are to be located as follows:

- A 3 m permanent earth berm around the north-western boundary corner and extending along the western boundary to the site entrance;
- A 2 m permanent earth berm along the north-western section of the northern boundary, and
- A 3 m temporary earth berm around the active extraction cell.

The location of these proposed earth berms is shown on **Figure 22**.

The berms will be stabilised and seeded in accordance with the Landscape Plan for the site as detailed in the rehabilitation report prepared by Scott Murray and Associates a copy of which is at **Appendix 14**.

Soil and Water Management

To ensure the integrity of water quality both on the site and for any water which is discharged from the site, a detailed and integrated soil and water management system has been designed to provide facilities to:

- Conserve and effectively manage the sustainability of water supplies and resources in the Baulkham Hills Shire, and
- Protect downstream drainage patterns including location, quantity and quality of waters.

In order to achieve those objectives, the following strategies have been developed for the

proposed development:

- A soil and water management plan (refer to **Appendix 16**);
- A surface water management strategy (refer to **Appendix 7**), and
- A rehabilitation strategy from an erosion and sediment control perspective (refer to **Appendix 14**).

The implementation of those strategies will ensure that no sediment laden waters enter the downstream waters of the area.

Visual Aspect

The topography of the site and its environs is such that the site is visible from surrounding areas. It is proposed to form significant landscaped bunds around the boundaries of the site where there is a potential to view the extraction process from outside the site. The landscaping and planting will be undertaken as part of the site establishment and will ensure that long term views to the site are minimised.

The rehabilitation plan (refer **Appendix 14**) will ensure that progressive rehabilitation will be undertaken during the life of the extraction to ensure that limited site area is disturbed at any one time. This will ensure limited visual impact to areas outside the outside the site.

Dust

As part of the proposed development, the following mitigation measures are proposed:

- Areas on which vehicle activity takes place will be watered so dust suppression can be maximised.
- Construction of wind breaks of natural vegetation around the boundary of the site.
- Ensure that potentially dusty material is processed and stored in a damp condition.
- Control of vehicles speeds on the site.
- Construction of a bund around the current extraction cell to assist in dust suppression and mitigation of any acoustic impact.
- Ensure that trucks leaving the site have their loads covered.

Flora and Fauna

Overall, it is considered that the impact of the proposed extractive industry would not be significant on the ecology of the area. Nevertheless, to ameliorate likely impacts, it is considered that the following measures should be undertaken:

- inclusion of Blue Mountains Mahogany and other Shale-Sandstone Transition Forest species in the landscaping/rehabilitation plan for the site, and

- appropriate management of the area containing the remaining *Acacia bynoeana* plants. The viability of this species within the scrub near Roberts Road could be enhanced by periodic slashing or burning.

The above have been included in the rehabilitation plan for the site as contained in **Appendix 14**.

Traffic

The research undertaken as part of this EIS has concluded that there will not be a need to upgrade the intersection of Roberts Road with Old Northern Road apart from some additional line marking.

There will, however, be a requirement for internal haul roads to be upgraded as part of the establishment of the site and that the entrance to the site also be upgraded. Details of the measures proposed to effect those upgrading works are contained in the report of Lyle Marshall and Associates at **Appendix 15**.

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Part One
INTRODUCTION

1.1 Statement of the Proposal

This Environmental Impact Statement (EIS) has been prepared on behalf of L S Martin (the Applicant) in support of a Development Application pursuant to the Environmental Planning and Assessment Act, 1979.

By Declaration contained within the New South Wales Government Gazette No.102 of 3 September, 1999, (refer **Appendix 1**), the Minister for Urban Affairs and Planning (the Minister), pursuant to section 76A(7) of the Environmental Planning and Assessment Act, 1979, declared the following development to be State significant development:

> *"**An extractive industry**, if in the opinion of the consent authority:*
>
> *1. the resource has been identified as being of State or regional significance in a strategic plan adopted by the Director-General; or*
>
> *2. the total resource (the subject of the development application) is greater than 5 million tonnes; or*
>
> *3. the proposed extraction rate is greater than 200,000 tonnes per annum; or*
>
> *4. the project is to be located in an "environmentally sensitive area of State significance"."*

Notwithstanding points 1, 2 and 4 of that above Declaration, the proposed development, as described in this EIS, will involve the extraction of greater than 200,000 tonnes of material per annum and as such is State significant development for the purposes of the Environmental Planning and Assessment Act, 1979.

The Applicant seeks the approval of the Minister to establish a sand extraction operation on land at Maroota. **Figures 1 & 2** show the regional and site location respectively.

The objectives of the proposal are:

- To establish a commercially viable sand extraction operation which is capable of providing sand to the Sydney building market;
- To provide an environmentally acceptable process for the extraction of sand from the site so as to minimise any environmental impacts of the extraction process;
- To progressively rehabilitate the site as it is extracted in order to produce a stable and attractive landform with a large water supply dam; and

- To establish an environmentally responsible industry which will create employment and become a major environmentally sustainable industry.

1.2 Background to Proposal

Sydney Regional Environmental Plan No.9 was gazetted in October, 1986 with the aim of helping the development of extractive resources close to the Sydney metropolitan area so that the cost of supplying materials to the community could be kept to a reasonable level.

The Maroota area is one of the areas to which Sydney Regional Environmental Plan (SREP) No.9 applies and has long been recognised as a major source of sand for the Sydney construction industry. **Figure 3** shows the land within the Maroota area to which SREP No.9 applies.

It is the intention of the Applicant to utilise the provisions of SREP No.9 to extract sand, pebble and clay resources from the site within the environmental constraints which have been identified on the site.

1.3 EIS Requirements

In addition to being State significant development, the proposed development is Designated Development pursuant to Schedule 3 of the Environmental Planning and Assessment Regulation, 1994, and as such an EIS must accompany the Development Application to the consent authority.

The EIS identifies and assesses the potential environmental impacts of the proposal and provides information on the measures which will be implemented to mitigate any potential adverse impact.

1.4 Consultations

Written consultations were made with the following authorities seeking both comments on the development proposal and any requirements for the content of the EIS:

- Department of Urban Affairs and Planning
- Baulkham Hills Shire Council
- Department of Mineral Resources
- National Parks and Wildlife Service
- Hawkesbury Nepean Catchment Management Trust
- Department of Land and Water Conservation
- Environment Protection Authority
- Roads and Traffic Authority
- Integral Energy

Copies of all replies are contained in **Appendix 2** to this EIS.

1.5 Structure of the EIS

The EIS is divided into a number of parts. The EIS continues at **Part 2** with a description of the site and the general planning controls applying to the site. The existing environment is described in **Part 3**; **Part 4** contains a description of the proposed development; **Part 5** provides a justification of the proposal and the alternatives to that which is proposed and **Part 6** details the net impact of the proposed development. **Part 7** describes the mitigation measures which are to be put in place to contain any potential adverse impacts of the proposed development. **Part 8** contains an outline of the Environmental Management and Rehabilitation Plan for the facility and **Part 9** is the conclusion to the EIS.

Part Two

SITE INFORMATION

2.1 Site Location

The site forms part of the Maroota area which is located some 50 km north west of the Sydney Central Business District and about 10 km south of Wisemans Ferry. **Figures 1 & 2** show the regional and site location respectively.

2.2 Legal Description

The site comprises three parcels of land on the corner of Roberts Road and Old Northern Road, Maroota, being:

Lot 2, DP 312327 and Lots 1 & 2, DP 228308.

The area of the entire site is approximately 30 ha. As part of the preparation of this EIS, a topographic survey of the site was undertaken. **Figure 4** is a reduced copy of that survey. Scale versions of the survey have been submitted with the Development Application.

The site is accessed by way of an existing entrance of Roberts Road approximately 290 m from the intersection of Old Northern Road with Roberts Road.

2.3 Operational History of the Site

The site has previously been used for agriculture and in particular as an orchard and plant nursery. The north western corner of the site remains in use by the Applicant as a plant nursery, the location of which is shown on the survey plan at **Figure 4**.

The Applicant is presently undertaking the construction of a dam on the site which is located on the northern boundary of the site, again as shown on the plan at **Figure 4**. That dam construction commenced in or around 1970 and its continued construction is being undertaken pursuant to the 29 May, 1991 Orders of the Land and Environment Court, a copy of which are at **Appendix 3**.

By Notice of Determination dated 7 November, 1990, Baulkham Hills Shire Council (the Council) notified the Applicant that it had consented to Development Application No.90/108 for the operation of an extractive industry on the site, subject to a number of conditions. A copy of the Notice of Determination is at **Appendix 4**.

The Executive Summary to the Environmental Impact Statement which accompanied Development Application No.90/108 states, inter alia:

"The landholders, Dr Martin and the Warrah School Society now require to extract the Maroota Sand deposit within an approximately rectangular area of about 16 ha. This area comprises the easternmost two thirds of the subject lands.

Although there is in excess of 2 million cubic metres of commercial sand on the total site this application, which is partly aimed at regularising past operations addresses only the first stage of extraction. In this stage a total volume of about 300,000 m^3 of Maroota sand will be removed, processed into construction sand and aggregate and transported from the site over a 5 year period."

It had been the intention of the Applicant to extract sand in accordance with the abovementioned approval such that sufficient funds could be generated to effect the preparation of a second EIS and Development Application which would seek the approval of the Council for the extraction of the remaining sand resource on the site. The commencement of the approved extraction operation was, however, dependant upon the completion of the water supply dam which was the subject of the 29 May, 1991 Court Orders. The water supply was required in order to sustain sufficient water supply on the site to wash the clay from the material won from the approved extractive operation.

In the years which followed, a number of events occurred which led the Council to conclude, rightly or wrongly, that Consent No.90/108 had not been commenced and as such the consent had lapsed. Following protracted discussions with the Council, the Applicant indicated to the Council that he would not, at this point in time, pursue that Consent further pending approval of the subject Development Application. At no time did the Applicant agree that Consent No.90/108 had lapsed. Nor did he agree to surrender that consent, Rather, the Applicant indicated that he would commence the necessary tasks involved in the preparation of the second EIS which was to seek approval for the extraction of the total sand resource on the site. This EIS has been prepared to accompany the Development Application for that total extraction of the site.

2.4 Land Tenure

The site is in the ownership of Leonard Stanley Martin (the Applicant). Copies of Certificates of Title for the parcels which make up the site are contained at **Appendix 5**.

2.5 Zoning and Planning Controls

2.5.1 Baulkham Hills Local Environmental Plan, 1991

The site is zoned Rural 1(b) pursuant to Baulkham Hills Local Environmental Plan (LEP), 1991. The proposed development is permissible with the consent of the Council, and in this case the Minister, in the Rural 1(b) Zone.

Clause 9(3) of LEP, 1991 states:

"Except as otherwise provide by this plan, the Council shall grant consent to the carrying out of development on land to which this plan applies only if the Council is of the opinion that the carrying out of the development is generally consistent with one or more of the aims and objectives of this plan or with one or more of the objectives of the zone within which the development is proposed to be carried out."

The objectives of the Rural 1(b) Zone are:

"(a) to ensure that existing or potentially productive agricultural land is not withdrawn unnecessarily from agricultural production; and

(b) to ensure that development is carried out in a manner that minimises risks from natural hazards and does not unreasonably increase demand for public services and public facilities; and

(c) to provide for urban support functions; and

(d) to protect and enhance those areas of particular scenic and environmental value; and

(e) to maintain the rural character of the area without adversely affecting the carrying out of agricultural activities; and

(f) to make provision for tourist facilities in appropriate locations."

Clause 34 of the LEP, 1991relates specifically to extractive industries and states:

"(1) In respect of extractive industry development, the Council must aim

(a) to ensure that extractive industries are not carried out in areas of particular environmental sensitivity; and

(b) to ensure that extractive industries are undertaken in accordance with management and planning provisions as contained in any plan of management adopted by the Council; and

(c) to permit extractive industry development which is of regional significance without burdening the Council with the costs for the provision of services and roads.

(2) Before granting consent to an application to carry out extractive industry development the Council must take into consideration whether the development is in accordance with:

(a) the provisions of any management plan adopted by the Council; and

(b) any staging and rehabilitation plan adopted by the Council."

2.5.2 Sydney Regional Environmental Plan No.9 - Extractive Industry (No.2)

The site is subject to the provisions of Sydney Regional Environmental Plan (SREP) No.9 - Extractive Industry (No.2). Sub-clause 7 (2) of SREP No.9 states that:

"(2) A person may, with the consent of the council, carry out development for the purpose of an extractive industry on land to which this clause applies."

Sub-clause 4 (1) of SREP No.9 states that:

"(1) This plan prevails to the extent of any inconsistency between it and another environmental planning instrument, except a State environmental planning policy."

2.5.3 Sydney Regional Environmental Plan No.20, Hawkesbury-Nepean River (No.2 - 1997)

The site is located within the catchment of the Hawkesbury River. As such the land is subject to the provisions of Sydney Regional Environmental Plan (SREP) No.20, Hawkesbury-Nepean River (No.2 -1997).

Clause 4 of SREP No.20 states, inter alia:

"(1) The general planning considerations set out in clause 5, and the specific planning policies and related recommended strategies set out in clause 6 which are applicable to the proposed development, must be taken into consideration:

*(a) by a **consent authority** determining an application for consent to the carrying out of development on land to which this plan applies,"*

The "General planning considerations" detailed in clause 5 which are applicable to the subject development application are:

"(a) the aim of this plan, and

(d) the relationship between the different impacts of the development or other proposal and the environment, and how those impacts will be addressed and monitored."

Of the "Specific planning policies and recommended strategies" listed in clause 6, the following are considered applicable to the subject development application:

> *"(1) Total catchment management*
>
> *(2) Environmentally sensitive areas*
>
> *(3) Water quality*
>
> *(4) Water quantity*
>
> *(6) Flora and fauna."*

The aim of the plan is:

> *"... to protect the environment of the Hawkesbury-Nepean River system by ensuring that the impacts of future land uses are considered in a regional context."*

The preparation of this EIS has involved the undertaking of a number of specific planning and technical studies of the site. The results and recommendations of those studies have formed the basis for the selection of that part of the total site which is suitable for sand extraction and indeed in the preparation of the plan of extraction for those areas. It has been the intention of the Applicant from the outset to plan the extraction having regard to the environmental constraints which have been identified in the relevant studies.

The above-mentioned studies and reports relate to:

- Flora and Fauna
- Archaeology
- Groundwater
- Soil & Water Management (Surface Water)
- Hydrology
- Traffic and Transport
- Acoustics
- Air Quality
- Scenic Quality and Landscape Planning
- Rehabilitation.

All studies are reproduced in **Volume II** of this EIS, with much of the text of those documents being used in **Volume I** of the EIS. It can be seen from the results of the reports and studies that the impact on the Hawkesbury River system as a result of the proposed extraction will be manageable.

It is considered that the proposed development accords with the provisions of SREP No.20.

2.5.4 State Environmental Planning Policy (SEPP) No.33 - Hazardous and Offensive Development

State Environmental Planning Policy (SEPP) No.33 - Hazardous and Offensive Development aims, inter alia:

> *"(d) to ensure that in determining whether a development is a hazardous or offensive industry, any measures proposed to be employed to reduce the impact of the development are taken into account; and*
>
> *(e) to ensure that in considering any application to carry out potentially hazardous or offensive development, the consent authority has sufficient information to assess whether the development is hazardous or offensive and to impose conditions to reduce or minimise any adverse impact."*

The proposed development is not a "Hazardous Industry", "Potentially Hazardous Industry" or "Hazardous Storage Establishment" as defined in SEPP No.33 as it will not pose a significant risk in relation to the locality to human health, life or property, or to the biophysical environment.

The proposed development is, however, "Potentially Offensive Industry" and as such SEPP No.33 does apply.

When determining an application for Potentially Offensive Industry, the consent authority must, pursuant to clause 13 of SEPP No.33, consider:

> *"(a) current circulars or guidelines published by the Department of Planning relating to hazardous or offensive development; and*
>
> *(b) whether any public authority should be consulted concerning any environmental and land use safety requirements with which the development should comply; and*
>
> *(c) ....., and*
>
> *(d) any feasible alternatives to the carrying out of the development, and the reasons for choosing the development the subject of the application (including any feasible alternatives for the location of the development and the reasons for choosing the location of the subject application); and*
>
> *(e) any likely future use of the land surrounding the development."*

With regard to current circulars and guidelines, the then Department of Planning has prepared Circular B27 and the publication *"Applying SEPP 33 Hazardous and Offensive Development Application Guidelines"*. It is the information contained within these Guidelines which has been used to determine that the subject development is not "Hazardous Industry", "Potentially Hazardous Industry" or a "Hazardous Storage Establishment", but is "Potentially Offensive Industry".

With regard to "Potentially Offensive Industry", the Guidelines, at pages 13 & 14, give guidance to the consent authority with regard to the information which should be provided with a Development Application. This EIS provides sufficient detail in this regard.

As indicated in the guidelines, if a licence is required by the EPA, then it is safe to assume that the proposed development is "Potentially Offensive Industry". The EPA has indicated that Approval is required to operate the proposed extractive industry, and as such it is concluded that the proposed development is "Potentially Offensive Industry".

With regard to assessing a "Potentially Offensive Industry", the guidelines state that:

> *"The key consideration in the assessment of a potentially offensive industry is that the consent authority is satisfied there are adequate safeguards to ensure emissions from a facility can be controlled to a level at which they are not significant. An important factor in making this judgement is the view of the EPA (for those proposals requiring a pollution control licence under EPA legislation). If the EPA considers that its licence requirements can be met, then the proposal is not likely to be "offensive industry"."*

The technical studies which were undertaken as part of the EIS process, and concerned with noise, air quality, flora and fauna, archaeology, groundwater, hydrology, and stormwater management, have clearly demonstrated that the impact of the proposed development will not be significant.

The EIS has demonstrated that the consent authority can be satisfied that:

> *"... there are adequate safeguards to ensure emissions from a facility can be controlled to a level at which they are not significant"*

and as such the proposed development, although always remaining "Potentially Offensive Industry" is not "Offensive Industry".

With regard to any likely future use of the land surrounding the development, the environs of the site are zoned for rural activity, however, SREP No.9 is based on the potential use of land in the Maroota area for extractive industry in conjunction with "normal" agricultural and rural land uses. The proposed use is consistent with this objective.

2.5.5 State Environmental Planning Policy No.44 - Koala Habitat Protection

The site has an area of more than one (1) hectare and as such is subject to the provisions of State Environmental Planning Policy (SEPP) No.44 - Koala Habitat Protection. The general aim of SEPP No.44 is to:

> *"... encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas to ensure a permanent free-living population over their present range and reverse the current trend of koala*

population decline ...."

SEPP No.44 provides a number of Steps which must be followed in the determination of a Development Application on land to which the Policy applies. Step 1 is a determination of whether the land is potential koala habitat. In this regard the SEPP states:

> *"7 (1) Before a council may grant consent to an application for consent to carry out development on land to which this Part applies, it must satisfy itself whether or not the land is a potential koala habitat.*
>
> *(2) A council may satisfy itself as to whether or not land is a potential koala habitat only on information obtained by it, or by the applicant, from a person who is qualified and experienced in tree identification.*
>
> *(3) If the council is satisfied:*
>
> *(a) that the land is not a potential koala habitat, it is not prevented, because of this Policy, from granting consent to the development application;"*

The flora and fauna assessment of the site which has been undertaken as part of the EIS process (refer **Appendix 8)** has concluded that:

> *"The land is not potential koala habitat as Grey Gum the only listed feed tree on site comprises less than 15% of the total number of trees present on the site."*

As such, the remaining provisions of SEPP No.44 do not apply.

2.5.6 State Environmental Planning Policy No.11 - Traffic Generating Development

State Environmental Planning Policy No.11 (SEPP 11) applies to the site. In this regard, clause 7(3) of the Policy states:

> *"(3) Where a consent authority receives a development application to carry out development specified in Schedule 1, the consent authority shall, within 7 days of its receipt of the application, forward a copy of the application to the Traffic Authority."*

Item (m) within Schedule 1 of the Policy details development for the purpose of:

> *"(m) extractive industry or mining."*

As such, the development falls within the Schedule 1 definition. The traffic impact report which has been prepared as part of the EIS process addresses all the concerns of the Roads and Traffic Authority (RTA). The RTA will be provided with a copy of the development application and will have the opportunity to make comment on the proposed development.

2.5.7 The Rivers and Foreshores Improvement Act, 1948

Part 3A of the Act requires approval from the Department of Land and Water Conservation for certain activities including excavation or removal of material from protected lands in or within 40 metres of rivers as defined in the Act.

As the proposed development will incorporate development which may require a permit under Part 3A of the Act, the application will be forwarded to the Department of Land and Water Conservation for comment.

2.5.8 Baulkham Hills Shire Council Development Control Plan No.500

Development Control Plan No.500 has been prepared by Council to supplement the provisions of the Baulkham Hills Local Environmental Plan, 1991. It contains a detailed description of the environmental assessment and management process which should be undertaken in the establishment of an extractive industry in the Shire.

2.6 Surrounding Land Uses

Land surrounding the site is generally developed for rural purposes consistent with the rural zone which applies to the area. Land uses in the immediate area include market gardens, rural residential development, service industries and extractive industries which have developed in the SREP No.9 area.

The location of adjoining buildings and their distance from the site have been surveyed as part of this EIS process. The resultant plan is at **Figure 5** .

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Part Three

THE EXISTING ENVIRONMENT

3.1 Topography

The proposed development site is located approximately 50 km north of Sydney, at the junction of Old Northern Road and Roberts Road, Maroota. The area's landscape is formed on a Hawkesbury Sandstone plateau and reflects the characteristic morphology of this formation, with steep valleys flanked by massive cliff faces.

The relief ranges from 170 m AHD, south of the project area, to 240.7 m AHD at the Maroota Trig Station. Within the site, elevations range from 226 m AHD at the southwestern end along Old Northern Road to 178 m AHD at the base of the dam excavation.

The original drainage pattern of the area was in a northerly direction, to eventually join a tributary of Coopers Creek approximately 2 km to the north, however, runoff along this line is captured by a number of dams, two of which are located inside the property boundaries. Those dams provide a water supply to the existing nursery operations on the site. The rest of the site is internally draining, with all runoff directed towards the central dam construction operation.

3.2 Geology

The Maroota area is known for the production of sand, which represents a valuable resource to the building industry. The sand is obtained from two main sources, the Maroota Sand and the weathered profiles of the Hawkesbury Sandstone. The occurrence of the Maroota Sand has, in the past, been systematically mapped by the Department of Minerals and Energy of New South Wales (Etheridge, 1980) and its distribution over the area is well documented. Figure 1 of the Groundwater Impact Report at **Appendix 6**, adapted from Etheridge, shows the occurrence of the Maroota Sand in relation to the site. The general stratigraphy of the area is as shown in the table below:

Table 3.1
Stratigraphic Sequence

AGE	UNIT	LITHOLOGY
Quaternary	Soils	Variable
Tertiary	Unnamed Maroota Sand	Basalt Sand, gravel, clayey sand and clay
Triassic	Ashfield Shale Hawkesbury Sandstone	Shale and laminite Quartzose sandstone with shale lenses

Maroota Sand

The Maroota Sand comprises a sequence of interbedded and poorly sorted sands, gravels, clayey gravels, gravelly sands, pebbly sands, clayey/silty sands and clay which range from compacted to partly consolidated materials. The bulk of these sediments, however, consists of sand sized material. Ferricrete bands are common and occur at a number of levels within the Maroota Sand.

The formation unconformably overlies the Hawkesbury Sandstone. It was deposited on the exposed and scarred surface of the Hawkesbury Sandstone and its base corresponds with, and is delimited by, that surface which was characterised by sharp relief and broad meandering palaeochannels and depressions. The sediments making up the Maroota Sand derive from eroded and re-worked material of the Hawkesbury Sandstone and of Permian conglomerates.

As a consequence of their origin and mode of deposition in meandering palaeochannels, the Maroota Sand sediments are characterised by rapid lateral and vertical face changes. The Maroota Sand units occur as a channel system of fluvial and alluvial origin and were deposited by an old Tertiary age river system cut into the Triassic sandstone bedrock, giving rise to a highly irregular surface on the Hawkesbury Sandstone. Two main components of this old river system have been identified:

- a major north-south channel aligned with and to the west of the current Maroota Ridge, and

- a meandering, generally east to west orientated channel, which enters the site in a central position along the northern boundary and exits just north of Roberts Road.

The confluence of these two palaeochannels appears to have been west of the site and in the northwestern portion of the present Haerses Road ridge (Etheridge, 1980).

Due to the irregular surface of the Hawkesbury Sandstone bedrock, the thickness of the Maroota Sand is not directly related to the present topography. According to Etheridge, the Maroota Sand formation attains a maximum thickness of 39 m at the Maroota Trig Station, just west of the now mostly eroded north-south palaeochannel. North of Maroota, the thickness is variable and commonly not more than 5 m.

Clay beds, deposited by the meandering of the palaeochannels, are common throughout the Maroota Sand formation. These clay layers were probably deposited as overbank deposits and abandoned channel fill deposits. A significant and extensive clay bed outcrops around the Maroota Trig Station and in the southwestern portion of the site and lenses out towards the north and east. The clay, which is composed of kaolinite and silica, reaches a thickness of 13.4 m under the Trig area. In other areas to the southwest and north, this clay has been extracted in the past for use as a ceramic clay in the manufacture of cream-burning bricks.

Hawkesbury Sandstone

The Hawkesbury Sandstone is a widespread formation occupying a large portion of the Sydney Basin. It comprises a thick sequence of sub-horizontal, massive, cemented quartz

sandstone, with well developed cross-bedding and intercalations of shale and siltstone beds. Grain size is generally in the range of fine to medium sand, but sorting is generally poor with some silt and pebble grains. Shale layers and bands and occasional carbonaceous beds are also common within the Hawkesbury Sandstone. Shale beds have been identified at various locations at the contact between the Maroota Sand and the underlying Hawkesbury Sandstone bedrock.

The weathered profile of the Hawkesbury Sandstone, which is the primary target of other quarrying operations in the area, is of variable thickness and can be as much as 15 m deep. It is represented by a soft and friable rock ranging in colour from white to red-brown, the latter resulting from the presence of variable iron oxides. Where this weathered zone is consistently above water table, it has been leached by infiltrating rainwater and is present as weakly cemented, white sandy soil, referred to as eluvial sand (Etheridge, 1980).

3.3 Temperature, Rainfall, Humidity & Evaporation

Temperature

Temperature is measured at Glenorie, south of the site by the Bureau Of Meteorology. From data collected over ten (10) years, the annual average maximum and minimum temperatures experienced are 22.7°C and 11.2°C respectively. The maximum monthly average temperature is recorded in January at 27.6°C. July is the coldest month, with an average temperature of 5.3°C.

Rainfall

The nearest rainfall station to the site is at the Maroota Bush Fire Brigade Station (No.067014), located opposite the junction of Old Northern Road with Roberts Road. Records at this station are available from 1925 to present, and show that the average rainfall for Maroota is 884.8 mm/year. Records also show that rainfall is highly variable, with a maximum of 1,637 mm in 1990 and a minimum of 354 mm in 1953.

Humidity

The annual average humidity reading from eight (8) years of data collected at 9:00 am is 71%. The month with the highest 9:00 am humidity on average is June with 80%. The annual average humidity at 3:00 pm is lower at 54%. The month with the highest 3:00 pm humidity on average is June with 64%.

Evaporation

Evaporation data are available from station No.067033 at Richmond AMO/MO, located some 30 km southwest of Maroota. Although this station is located in a different topographic setting, in the absence of other data, the records are considered applicable to Maroota for the purpose of the EIS. Mean daily pan evaporation ranges from 1.8 mm in June to 7.0 mm in December, with the annual average of 4.2 mm per day.

Tables 3.2, 3.3, 3.4 & 3.5 below presents a summary of climatic statistics for the area.

Table 3.2
Monthly Rainfall

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
Mean	101.5	104.8	103.9	90.5	61.2	89.9	46.6	55.2	53.9	64.7	76.9	76.4	884.8
Median	73.6	75.9	84.0	58.8	41.9	50.8	26.0	22.8	40.3	53.7	66.6	69.1	869.2
Highest	395.5	464.9	437.7	467.2	370.1	445.4	250.6	497.4	174.0	220.3	208.3	375.0	1636.6
Lowest	0.0	0.0	2.1	0.0	1.5	0.0	0.0	0.0	0.4	0.6	0.5	0.0	353.9

Table 3.3
Mean Daily Pan Evaporation (mm)

Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Year
6.3	5.4	4.4	3.3	2.1	1.8	2.0	3.1	4.3	5.4	5.9	7.0	4.2

Table 3.4
Temperature

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Maximum Temperature (C) (10 years of record)													
Mean	27.6	27.2	26.4	23.7	19.8	16.7	16.6	17.8	20.7	23.4	24.9	27.4	22.7
Daily Minimum Temperature (C) (10 Years of record)													
Mean	16.3	16.5	15.0	12.0	8.6	6.8	5.3	6.5	8.4	11.4	12.8	15.1	11.2

Table 3.5
Humidity

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Maximum Relative Humidity (%) (8 years of record)													
9 am	69	75	74	72	75	80	73	70	70	69	63	67	71
Daily Minimum Relative Humidity (%) (8 Years of record)													
3 pm	52	59	54	52	55	64	53	50	51	53	50	55	54

As detailed in the air quality impact assessment at **Appendix 10**, the dispersion model which is used to predict ground level concentrations of dust requires information about the dispersion

characteristics of the area.

Hourly data for a typical year has been collected at Kurrajong (Blaxland Ridge) approximately 15 km directly west of the site and this forms the basis on which meteorological conditions at Maroota are assessed. These data provide information on the frequency of winds from each direction and their speed, and have been used to created the wind roses in the air quality study, copies of which are reproduced as **Figure 9** of this EIS.

Wind speed and direction and stigma-theta (standard deviation of wind direction) were measured at Kurrajong using highly sensitive instruments. The Kurrajong site is similar to the Maroota site in vegetative cover, but also in that both sites are towards the top of ridges of similar heights. The Kurrajong meteorological station and the proposed extraction areas are separated by approximately 15 km of undulating land.

On an annual basis, winds from the northwest quadrant are slightly more dominant than those from other directions although the winds are quite evenly distributed. These north westerlies become more dominant in winter. Winds from east-northeast to south (in a clockwise direction) prevail in summer, while autumn and spring show winds from all quadrants.

3.4 Existing Air Quality

The proposed development will be a variation on the existing operations of the site. Present concentration and deposition levels will therefore include contributions from existing operations. The existing case has been modelled to obtain an estimate of how these operations currently impact on the nearby sensitive receptors. These results have been taken into account when determining the increases due to the proposed extraction activities.

This section details a description of the modelling exercise and the dust monitoring program put in place to monitor existing levels. Further details are contained in the air quality impact assessment at **Appendix 10** of this EIS.

3.4.1 Monitoring the Existing Air Quality

Two deposition monitoring programs have been undertaken and provide information for this assessment. The first was undertaken as part of another sand extraction operation west of the proposed operation (Colin Donges & Associates, 1996) and the deposition levels were measured at three locations during 1997. These sites are named as follows:

- Site 1: Maroota Public School
- Site 2: Vucko's House
- Site 3: Jurd's Property

The second program was undertaken specifically for this EIS. Measurements have been made at three locations on the boundaries of the site. These sites are named as follows:

- Site 4: North Fence
- Site 5: Entrance
- Site 6: East Corner

All dust gauge locations are shown in **Figure 10** and the results of the both monitoring programs are summarised in Tables 4 and 6 of the air quality impact assessment at **Appendix 10**.

Dust monitoring was also undertaken in the latter half of 1995 at the Maroota Public School and showed average levels of approximately 1.7 g/m^2/month. Although there are only six months of data from 1995, it is clear that these values are lower than those measured in 1997. An inspection of the area indicated that the school is relatively unsheltered from operations to the south, but surrounding trees provide protection from other existing quarrying operations to the west. It is likely therefore, that while the school has not historically shown significant deposition levels despite the extensive quarrying activity that occurs in the area, the relatively unsheltered activities to the south have caused noticeable increases.

The results indicate that the area to the north of the site experiences annual average deposition levels of around 4 g/m^2/month. The current monitoring data suggest that background deposition levels range from 2.8 g/m^2/month to 5.7 g/m^2/month (annual average). The high reading of 5.7 g/m^2/month (Site 4) is likely to be due to the agricultural activities adjacent to that particular gauge, and it has since been recommended that the gauge at Site 4 be relocated for the remainder of the monitoring period. The remaining gauges record existing deposition levels near the current proposal of approximately 3 g/m^2/month on average.

3.5 Acoustic Environment

A report addressing the acoustic impact of the proposed development has been prepared as part of this EIS. That report, a copy of which is at **Appendix 11**, details the existing acoustic environment.

Existing background noise levels for the site were measured at the following locations (refer **Figure 11**):

Location A: Residence at 155 Roberts Road, Maroota. This residence is approximately 15 m north of the northern boundary of the site. The logger was placed adjacent to the northern boundary of the site and in line with the facade of the residential dwelling.

Location B: Residence at 2a Roberts Road, Maroota. This residence is located approximately 60 m east of the eastern boundary of the site. The logger was positioned on the resident's northern boundary, approximately 5 m from the residential facade.

Location C: Residence at 156 Old Northern Road, Maroota. This residence is located approximately 140 m north of the northern boundary of the site. The logger

was positioned approximately 10 m from the facade of the residential dwelling.

Existing traffic noise levels along Old Northern Road and Wisemans Ferry Road were measured at the following two locations:

Location D: Premises at Maroota Motors Pty Ltd, Corner of Old Northern Road and Roberts Road, Maroota. The premises are setback approximately 20 m from Old Northern Road. The logger was placed within 0.5 m of the front facade of the building.

Location E: Residence at the corner of Wisemans Ferry Road and Haerses Road, Maroota. This residence is setback approximately 25 m from Wisemans Ferry Road. The logger was positioned within 0.5 m of the front facade of the building.

At all of the above locations, measurements were carried out using a statistical Environmental Noise Logger, type EL-215. The loggers were set to monitor noise levels continuously over 15 minute statistical intervals for a period of seven days.

The results obtained from the noise loggers at Location A, B and C are presented in **Tables 3.6, 3.7** and **3.8** below. The purpose of the monitoring at Locations A, B and C was to assess existing ambient noise levels during the period of proposed operations on the site. Therefore, the statistical analysis includes measured L_{A10} and L_{A90} noise levels during the daytime period, 7:00 am to 6:00 pm, and the shoulder period, 6:00 am to 7:00 am.

Table 3.6
Measured Background Noise Levels - Location A

Date	Shoulder Period (6am - 7am)		Daytime Period (7am - 6pm)	
	Average L_{A10}	90th Percentile L_{A90}	Average L_{A10}	90th Percentile L_{A90}
Mon 19/7/99	-	-	61.8	50.3
Tues 20/7/99	48.5	41.4	62.5	54.8
Wed 21/7/99	50.8	42.3	60.0	52.6
Thur 22/7/99	53.3	46.5	59.6	52.0
Fri 23/7/99	50.1	42.1	58.1	50.1
Sat 24/7/99	46.6	38.3	57.0	48.2
Sun 25/7/99	46.9	36.6	55.4	45.7
Mon 26/9/99	50.3	43.0	58.2	48.8
Median[1]	**50.1**	**42.1**	**58.9**	**50.2**

[1] Median values are calculated for Mon to Sat only as the site will not operate on Sundays.

Table 3.7
Measured Background Noise Levels - Location B

Date	Shoulder Period (6am - 7am)		Daytime Period (7am - 6pm)	
	Average L_{A10}	90th Percentile L_{A90}	Average L_{A10}	90th Percentile L_{A90}
Mon 19/7/99	-	-	52.0	42.3
Tues 20/7/99	47.1	37.6	59.9	51.8
Wed 21/7/99	47.8	38.4	62.3	51.2
Thur 22/7/99	51.0	42.4	61.4	52.9
Fri 23/7/99	47.8	35.3	57.0	48.3
Sat 24/7/99	45.8	33.5	51.3	40.6
Sun 25/7/99	42.8	31.9	51.3	40.5
Mon 26/9/99	49.1	37.6	56.0	46.3
Median[1]	**47.8**	**37.6**	**56.5**	**47.3**

[1] Median values are calculated for Mon to Sat only as the site will not operate on Sundays.

Table 3.8
Measured Background Noise Levels - Location C

Date	Shoulder Period (6am - 7am)		Daytime Period (7am - 6pm)	
	Average L_{A10}	90th Percentile L_{A90}	Average L_{A10}	90th Percentile L_{A90}
Mon 19/7/99	-	-	53.0	41.4
Tues 20/7/99	53.9	40.1	60.0	48.5
Wed 21/7/99	55.3	40.5	56.9	46.8
Thur 22/7/99	57.1	46.4	55.8	46.0
Fri 23/7/99	56.0	43.4	52.7	42.4
Sat 24/7/99	50.9	38.1	50.1	37.7
Sun 25/7/99	43.6	30.8	55.8	42.9
Mon 26/9/99	53.4	42.0	52.6	42.1
Median[1]	**53.9**	**40.5**	**54.4**	**43.0**

[1] Median values are calculated for Mon to Sat only as the site will not operate on Sundays.

The results obtained from the noise loggers at Location D and E are presented in **Table 3.9** below.

The purpose of the noise monitoring at Locations D and E was to determine existing road traffic noise levels. Therefore the statistical analysis includes $L_{Aeq,9hr}$, $L_{Aeq,15hr}$, and $L_{Aeq,1hr}$ noise levels.

Table 3.9
Measured Road Traffic Noise Levels - Locations D & E

Measured Road Traffic Noise Level (dBA)						
Date	$L_{Aeq,9hr}$		$L_{Aeq,15hr}$		$L_{Aeq,24hr}$	
	D	E	D	E	D	E
Fri 20/11/98	48.7	44.3	54.0	53.5	52.7	51.2
Sat 21/11/98	48.1	47.4	56.5	55.2	53.4	52.3
Sun 22/11/98	47.3	45.2	55.4	54.6	52.3	51.0
Mon 23/11/98	49.4	47.1	56.2	55.3	53/7	52.2
Tues 24/11/98	50.4	46.8	55.9	54.8	53.8	51.8
Wed 25/11/98	50.1	46.9	55.3	55.1	53.3	52.0
Thur 26/11/98	51.0	48.9	56.2	56.2	54.2	53.5
Fri 27/11/98	49.2	47.5	55.4	56.4	53.0	53.1
Sat 28/11/98	49.1	48.9	54.4	55.9	52.4	53.3
Sun 29/11/98	44.5	46.7	54.8	54.3	50.9	51.5
Mon 30/11/98	47.8	47.2	54.5	55.1	52.0	52.1
Tues 1/12/98	47.6	48.4	-	-	47.6	48.4
Median[1]	**48.9**	**47.1**	**55.3**	**55.1**	**52.9**	**52.1**

[1] Median values have been calculated for the entire monitoring period in order to assess the traffic noise model calibrations.

The results of the acoustic monitoring are shown graphically in the attachments to the acoustic impact assessment at **Appendix 11**.

Measured ambient L_{A90} noise levels exceed NSW Environment Protection Authority (EPA) recommended planning levels at Locations A and B. The graphical presentation of the results for these two locations show that noise levels fluctuate considerably throughout the day. Observations during logger establishment and retrieval found that the dam construction and processing activities were clearly audible at both locations.

The ambient noise levels at Locations A and B increase significantly during the daytime, approximately during the times that the existing extraction operations are undertaken on the site. Ambient noise levels at these locations are also influenced by intermittent road traffic noise along Roberts Road.

While the site is the most significant contributor to ambient noise levels, discussions with the residents found that they are generally not annoyed by the noise emissions, however, noise design objectives for the proposed operations should aim at reducing the overall noise emissions from the site.

Measured ambient L_{A90} noise levels at Location C were below the NSW EPA recommended planning levels. The site was inaudible during logger establishment and retrieval. The graphical presentation of the results are typical of a location in a rural residential environment.

Measured noise levels at Locations D and E were primarily influenced by road traffic noise. The median noise levels are well below the objectives for arterial roads, however, the noise logger graphs presented in the attachments to the acoustic impact assessment show that the measured L_{Aeq} regularly exceeds 55 dBA during the 7:00 am – 6:00 pm period. The criterion for local roads, as outlined in the NSW EPA Environmental Criteria for Road Traffic Noise, is an $L_{Aeq,1hr}$ of 55 dBA during the daytime. While neither Old Northern Road nor Wisemans Ferry Road could be considered local roads, measured L_{Aeq} noise levels exceeding 55 dBA for extended periods of time could have the potential for annoyance. The potential for annoyance is amplified by the prevalence of low background noise levels resulting in minimal masking of traffic noise.

These assumptions are verified by discussions with residents which revealed traffic noise is a major concern.

The criteria contained in the NSW EPA guidelines involves averaging noise levels over 15 hour periods during the daytime. This criteria may not adequately protect the amenity of residents along Old Northern Road and Wisemans Ferry Road where traffic volumes are high during the 6:00 am to 6:00 pm period only. Therefore, the objective which will be used to assess traffic noise impacts for this study will be to limit the hourly increase in L_{Aeq} noise levels to not more than 2 dBA above existing L_{Aeq} noise levels.

3.6 Transport and Traffic

A transport and traffic report has been prepared as part of the preparation of this EIS. A copy of that report is at **Appendix 15**. The following information is taken from the transport and traffic study.

3.6.1 Existing Traffic Volumes

Old Northern Road/Roberts Road Intersection.

To determine the highest hourly volumes and turning movements at the intersection, twelve hour traffic volume and classification counts were made at the intersection of Old Northern Road with Roberts Road. These counts were used to confirm the extent and type of improvements necessary to meet Roads and Traffic Authority (RTA) and Austroad Standards.

The 12 hour traffic volume was low (251) in Roberts Road and thirty one percent (31%) of the total volume (78) were heavy trucks. It is relevant to note that the number of heavy truck movements permitted by the Court Orders for the existing activity on the site is 50 trucks per day.

The am and pm peak hours were from 7:00 am - 8:00 am and 4:30 pm - 5:30 pm. The two way through traffic volumes in Old Northern Road ranged from 71 vehicles per hour to 168 vehicles per hour between 6:00 am and 6:00 pm. The twelve hour count showing:

- cars and light vehicles,
- heavy trucks, and
- the two peak hour counts

are shown in Figures 3A and 3B respectively of the transport and traffic report at **Appendix 15**.

Weekday and Weekend Volumes on State Arterial Roads

Automatic counters were placed at two locations (refer to **Figure 23**) on the haul road network from the subject site to determine the time pattern and volumes of light vehicle and heavy truck movements over a full 7 days including a weekend.

Light vehicles are cars and 2 axle trucks, vans etc., and heavy vehicles are three or more axle trucks such as the fleet used for the transport of sand from extractive operations in the Maroota area. A classification chart is included in Appendix D of the transport and traffic report at **Appendix 15**.

The average weekday and weekend two way daily traffic volumes at Stations 3 and 4 were as detailed in **Table 3.10** below:

Table 3.10
Average Two Way Traffic Volumes

Average Daily Vehicles	Old Northern Road MR 120 Station 4	Wisemans Ferry Road MR 181 Station 3
Average Weekday		
Total Vehicles	1923	1706
Light Vehicles	1710	1495
Heavy Vehicles	213	211
Average Weekend		
Total Vehicles	2285	1927
Light Vehicles	2178	1824
Heavy Vehicles	107	103

3.6.2 Pattern of Truck Movements on Transport Routes in Maroota

The complete counts of light and heavy vehicles for each hour of the day by direction for one week in October 1997 at survey Stations 3 and 4 are included in Appendix B of the transport and traffic report at **Appendix 15**.

The average number of heavy truck movements Monday to Friday by hour of day from 6:00 am to 6:00 pm and for the 24 hour period at each survey location are contained in Table C1 in Appendix C of the transport and traffic report at **Appendix 15**.

Similar data for Saturdays are contained in Table C4 in Appendix C of the transport and traffic report at **Appendix 15**.

The main findings were:

Station 3 Wisemans Ferry Road

Total heavy truck movements over 24 hours on weekdays averaged 109.4 eastbound and 101.2 westbound, however, the average truck movements over 12 hours were significantly higher westbound (95.8) compared with eastbound (70.8). The peak hourly movement westbound (average over 5 days) was 14.0 between 6:00 am and 7:00 am, whereas the peak hourly movement eastbound (average over 5 days) was 9.0 between 8:00 am and 9:00 am.

Station 4 Old Northern Road

The average weekday heavy truck volumes northbound were higher than southbound over 24 hours (112 compared with 101.4) and also over 12 hours between 6:00 am and 6:00 pm. The peak hourly volume was 17.2 (average over 5 days) southbound from 6:00 am to 7:00 am. The peak hourly volume northbound (average over 5 days) was 12.8 from 10:00 am to 11:00 am.

The counts show that about 80 percent and 91.5 percent of the 24 hour daily truck movements occurred between 6:00 am and 6:00 pm at survey locations 3 and 4 respectively. The total number of truck movements on Saturdays was 75 percent of the daily Monday to Friday total at Station 3 and 64 percent at Station 4, however, the number of light vehicles was significantly greater on Sundays at Station 4 than on other days.

3.6.3 Road Inventory

Old Northern Road has a sealed pavement about 6.4 metres wide and unsealed gravel shoulders which vary in width from about 1.5 to 2.5 metres. Wisemans Ferry Road is of a similar standard to Old Northern Road. The edges of the sealed pavement are subject to higher loading by heavy vehicles travelling near the edges of the road pavement and require higher maintenance to repair the broken edges. The road pavement is generally in reasonable

condition.

Based upon Table 4.1 in Austroads Rural Road Design, the desirable sealed pavement width in Old Northern Road and Wisemans Ferry Road is 7.0 metres because the AADT traffic volumes are well in excess of 1,000 vehicles per day.

Roberts Road is a sealed local road and has a pavement width of 5.7 metres. The pavement condition, geometric alignment and line marking are shown in Photograph P5 of **Appendix 15**.

3.6.4 Operation of the Roberts Road/Old Northern Road Intersection.

This intersection has been up-graded recently to provide a sheltered right turn bay in Old Northern Road as shown in Photograph P4 of **Appendix 15**. The pavement striping continues on the northern side of Roberts Road as shown in Photograph P6. The full extent of pavement markings south and north of Roberts Road can be seen in Photograph P1.

A layout of the Roberts Road and Old Northern Road intersection has been compiled from site measurements and is drawn to scale in **Figure 24.**

An analysis of the performance of the intersection under existing am and pm peak hour volumes has been made using INTANAL Version 3.17. The intersection is operating at Level of Service A in both peak hours as shown in **Table 3.11**

Tale 3.11
INTANAL Results - Existing Conditions

Peak Hour	DoS[1]	LoS[2]	Max Delay (sec/veh)	Critical Movement
AM	0.01	A	7.7	Right turn from Roberts Rd
PM	0.02	A	7.0	Right turn from Roberts Rd

[1] DoS - Degree of Saturation
[2] LoS - Level of Service

3.6.5 Vehicle Access to Site

The site entry gate is on the northern side of Roberts Road and is located some 290 metres east of Old Northern Road. The sight distance from the entry road is excellent in both directions along Roberts Road.

The entry road is an unsealed gravel road.

3.7 Surface Water and Existing Water Quality

3.7.1 Existing Drainage Pattern

The general drainage pattern of the site is in the northerly direction along a natural creek line which joins a tributary of Coopers Creek approximately 2 km to the north, which eventually flows into the Hawkesbury River. Drainage within the site is characterised by two separate catchments which are identified on **Figure 6**. The western catchment (some 8.9 ha) contains two dams which provide a water supply to the existing nursery operations. The eastern catchment (some 20.7 ha) drains the remaining area of the site with generally all runoff directed into the existing dam construction area. The dam construction area also collects runoff from the small catchment to the east of Roberts Road (approximately 10.5 ha). Runoff from this catchment enters the site via a road culvert beneath Roberts Road, located some 60 m north of the site entrance. The total catchment area of the current dam construction area is 31.1 ha.

The current dam construction area is located at the lowest point within the site and it is possible that, during exceptionally high rainfall periods, the excavation area could overfill. During such events, overflow from the construction area would occur via a natural low point in the pit northern wall into the existing natural watercourse.

3.7.2 Existing Water Quality

As part of the preparation of the EIS, a strategy for surface water management was prepared, a copy of which is at **Appendix 7**. To assess the stormwater impacts of the proposed development, the computer program AUSQUAL was used to model pollutant generation for undeveloped and developed catchment scenarios. Details of the existing model results are contained in section 2.2 of the report at **Appendix 7**.

3.8 Flora and Fauna

An assessment of the impact of the proposed sand extraction activity on the flora and fauna of the site has been undertaken as part of this EIS, with particular reference to threatened species. A copy of the assessment is at **Appendix 8** of the EIS.

3.8.1 Methodology

Fieldwork was undertaken on 3 May, 1999 and 2 July, 1999. It was considered that the level of survey outlined below was appropriate as the site does not contain significant areas of bushland, nor is it directly adjacent to any.

Flora

The vegetation communities on the site were described based on the dominant tree species and the height and cover of the uppermost stratum (following Specht, 1970). The site was surveyed for plant species and those species not readily identified in the field were collected for identification using standard texts. Checks were made against the Schedules of the Threatened Species Conservation (TSC) Act, Briggs & Leigh, (1995) and other literature for any species of conservation significance.

Fauna

The vegetation community descriptions were used to describe the different fauna habitats which occur on the site. The habitat surrounding the site was also investigated to gain an appreciation of the relative importance of the habitat which occurs on the site.

A search was undertaken for specific sources of native fauna food and shelter, such as dense shrubs, flowering trees, tree hollows and rock outcrops. The presence, or lack, of particular fauna habitat requirements was noted to enable predictions of species which would be likely to utilise the site. National Parks and Wildlife Service (NPWS) database records, and the results of previous surveys carried by AES Environmental Consultancy in the area (AES 1998, 1996) were used to predict which species would use the site.

3.8.2 Description of the Existing Environment

Flora

Vegetation Description

Most of the site is fully cleared and solely vegetated with introduced pasture grasses and herbs, however, there are a few small areas of remnant vegetation.

In the north of the site just to the west of the existing dam construction area, is a stand of trees including Blue-leaved Stringybark (*Eucalyptus agglomerata*), Thin-leaved Stringybark (*E.eugenioides*), Smooth-barked Apple (*Angophora costata*) and Black She-oak (*Allocasuarina littoralis*). Groundcover species include Bracken (*Pteridium esculentum*), Hedgehog Grass (*Echinopogon caespitosus*), Kangaroo Grass (*Themeda australis*) and the introduced Crofton Weed (*Ageratina adenophora*).

There is a strip of remnant trees along a fence line in the south of the site. Species present are White Stringybark, Grey Gum (*Eucalyptus punctata*), Blue Mountains Mahogany (*E.*

notabilis), Red Bloodwood (*Corymbia gummifera*), Rough-barked Apple (*Angophora floribunda*) and Black She-oak.

North of the existing entrance to the site is another stand of White Stringybark, a few Blue Mountains Mahoganies and White Mahogany (*E.acmenoides*). Just north of this is a degraded scrubby area dominated by Yellow Tea-tree (*Leptospermum polygalifolium*), Tick Bush (*Kunzea ambigua*), Scale-rush (*Lepyrodia scariosa*) and the introduced Kikuyu (*Penniseteum clandestinum*) and Whisky Grass (*Andropogon virginicus*).

Conservation Significance of the Vegetation

The treed areas of the site would have been part of Shale-Sandstone Transition Forest, now recognised as an Endangered Ecological Community. Shale-Sandstone Transition Forest probably covered much of the ridges and ridge-slopes along and beside Old Northern Road, but has been removed for agricultural and rural residential development. Given their small size, highly disturbed nature, low species diversity, and low likelihood of regeneration, it is considered that the treed areas of the site do not constitute viable remnants of Shale-Sandstone Transition Forest.

The scrub area was probably previously heath/woodland of the Maroota Sands complex as described by Ryan *et al* (1996). Due to clearing, altered fire regimes and disturbance of the site, the scrub's floristics and structure have been modified allowing the dominance by Yellow Tea Tree, Tick Bush and Whisky Grass. Some previously existing species have persisted though diversity is far lower than in comparable undisturbed areas of heath/woodland nearby. Its only significance is as habitat for a small number of the threatened plant *Acacia bynoeana* .

Threatened Plant Species

Six individuals of the small, prostrate shrub *Acacia bynoeana* were found in the scrubby area near Roberts Road. **Figure 7** shows the location of this species. This species is currently listed as Vulnerable under the TSC Act but has been preliminarily determined as Endangered, which is a higher risk code. Impacts on this species are dealt with in **Part 6.9** of this EIS.

Regionally Significant Species

One of the remnant trees on site, Blue Mountains Mahogany (*Eucalyptus notabilis*), has some regional conservation significance. Populations of this species in the Maroota area are significant as they are an outlier of the larger Blue Mountains population and it is not well represented in nearby Marramarra National Park. Blue Mountains Mahogany is not listed as endangered or vulnerable in the TSC Act.

Fauna

Fauna Habitat

Fauna habitats on the site broadly correspond to the vegetation described above. Specific habitat features which influence the range and abundance of fauna species are:

- the modified nature of the site which makes it more suitable for introduced species (eg Common Myna, Spotted Turtledove) and those native species which are highly adaptable (eg Australian Magpie).

- tree hollows of a size suitable for use by bats, arboreal mammals and avifauna are absent.
- farm dams on site provide habitat for a range of waterfowl and frog species, none of which are threatened.

Threatened Fauna

Table 3.12 lists those threatened fauna species which have been detected within a 5 km radius of the site.

Table 3.12
Locally Occurring Threatened Fauna Species

Scientific Name	Common Name	Comments
Heleioporus australiacus	Giant Burrowing Frog	no breeding habitat present; unlikely
Pseudophryne australis	Red-crowned Toadlet	no breeding habitat present; unlikely
Burhinus grallarius	Bush Stone-curlew	rare vagrant to local area; recorded in cleared land adjacent to bushland 2km north of site; unlikely
Calyptorhynchus lathami	Glossy Black-Cockatoo	feeds on she-oaks which are present on site; likely
Neophema pulchella	Turquoise Parrot	grassland and wooded edges; likely
Ninox strenua	Powerful Owl	open forest and woodland; not likely
Tyto novaehollandiae	Masked Owl	open forest and margins; not likely
Tyto tenebricosa	Sooty Owl	rainforest and dense forest; not likely
Xanthomyza phrygia	Regent Honeyeater	rare vagrant feeds on ironbarks & winter-flowering eucalypts: unlikely
Dasyurus maculatus	Tiger Quoll	prefers dense forest; sometimes preys on domestic fowl; unlikely
Phascolarctos cinereus	Koala	feed tree (Grey Gum) present; unlikely due to fragmented habitat
Petaurus australis	Yellow-bellied Glider	requires forest for movement; unlikely
Myotis adversus	Large-footed Myotis	forages over water bodies near bushland; unlikely
Mormopterus norfolcensis	Eastern Little Mastiff-bat	forages above canopy or forest edge; unlikely
Miniopterus schreibersii	Common Bent-wing Bat	requires extensive canopy; unlikely

Apart from the Glossy Black-Cockatoo and Turquoise Parrot, all of the above species require intact bushland or specific habitat features which are not present on site. Likely impacts on these two threatened fauna species are discussed in **Part 6.9** of this EIS.

3.9 Archaeology

An archaeological survey of the site was undertaken as part of the preparation of this EIS. A copy of the survey report is at **Appendix 9**.

The field survey took place on 3 March, 1999. Present were archaeologists Tessa Corkill and John Edgar. Allen Madden and Andrew Roberts represented the interests of the Metropolitan Local Aboriginal Land Council (LALC).

No Aboriginal archaeological sites or areas of potential archaeological deposit were identified.

The ridge on which the site is located is thought to be part of a major north-south Aboriginal pathway between the Parramatta River valley and the Hawkesbury and thence on to the Hunter Valley. This ridge may also have been a language boundary between the Darug speakers to the west and the Kuringgai to the east, however, no localities particularly suitable for camping or activities likely to result in significant quantities of archaeological material appear to be present on the area surveyed. The absence of local surface water on this section of the ridge top is a particular constraint.

Extensive horticultural activity over many years, levelling of surfaces, dam construction and extraction of sand have left virtually no surface within the survey area undisturbed. There is no outcropping rock other than a few small sections in some areas. These rocks are iron-rich and coarse-grained and are unsuitable for engraving or grinding.

Therefore, the lack of old trees, extensive cultivation and lack of outcropping sandstone, eliminate scarred trees, engravings, rock shelters and wells from any site prediction model, leaving the rare categories of artefact scatters (Open Camp Sites) and stone arrangements as the most likely archaeological remains.

Generally high levels of grass cover made it difficult to identify artefact scatters which may have been present. As these appear to be rare in this type of landscape, and considering the general level of surface disturbance, it is unlikely that any *in situ* artefacts are present. There may be occasional stone artefacts on the surface which have been obscured by vegetation or mechanical disturbance, as Aboriginal people are likely to have used this area in the past for foraging and hunting.

No original food plants were identified on the ridge top, those that were likely to have been present in the past having been cleared. Only a few regrowth eucalypts are present near fence lines and three regrowth casuarinas are present below the wall of the dam nearest Old Northern Road.

Ground Surface Visibility

There was a general background surface visibility ranging from zero to 5% in each of the paddocks except in Area K, (refer to Archaeological Survey Report at **Appendix 9**), in which the surface has been removed to a considerable depth or otherwise totally disturbed.

Area K has been excluded from the calculation because of the total destruction of surface area as has the area of the existing two dams. The inclusion of these large areas (relative to the total area) would artificially skew the visibility figures.

Total ground surface visibility was calculated at 6% of the total survey area.

Given the current and past extractive activities, previous clearing and other horticultural practices over the whole of the survey area, and its relatively small size, the Archaeological report concludes that there are unlikely to be any significant undetected, undisturbed Aboriginal sites or areas of Potential Archaeological Deposit in the area surveyed.

3.10 Groundwater

A groundwater assessment of the site has been undertaken as part of the EIS process. A copy of the complete groundwater report is at **Appendix 6** of this EIS.

The scope of the groundwater investigations was:

- a review of the existing groundwater environment;
- the establishment of three groundwater monitoring bores at selected locations;
- the performance of falling head tests at these bores to assess the hydraulic conductivity of the formation surrounding the bores;
- the collection of groundwater samples for analysis of a number of parameters, and
- the collation and assessment of these data and the preparation of a report to be included in the EIS document.

Additional to this work, was the setting out of a groundwater monitoring program. For this purpose, automatic data loggers were installed in the three bores to record fluctuations in the water table in the Maroota Sand aquifer, the principal geological unit underlying the property.

According to the Baulkham Hills Shire Council Development Control Plan No.500, the position of the water table in that aquifer determines the depth to which the excavation can be carried out.

3.10.1 Monitoring Bores

The three monitoring bores were drilled at the locations shown in **Figure 8**.

The sites were chosen on the basis of existing available information in order to intersect the greatest thickness of the Maroota Sand. The geological and construction logs of the bores are presented in Appendix A of the groundwater impact assessment at **Appendix 6**, and relevant details are given in **Table 3.13** below.

Bore PT84MW1 was located near the nursery building at the northern corner of the property and at the apex of a triangle formed with the two other bores to provide hydraulic gradients and geological confirmation of the expected thickness of the Maroota Sand formation.

Bore PT84MW2 was drilled at the site of the Department of Land and Water Conservation (DLWC) Maroota Groundwater Study, Stage 2 monitoring bores (Nos.75003 & 75004) in order to supplement data on the Maroota Sand from that location. The results of the drilling indicate that the Maroota Sand at this location may be of a greater thickness than initially estimated by Etheridge (Etheridge, 1980).

Bore PT84MW3 was located in a central position within the property and at a location along the palaeochannel identified by Etheridge where the thickest section of Maroota Sand is found. The bore was drilled to a depth comparable with the depth of the current excavation within the property.

Table 3.13
Bore Statistics

Bore No.	East.	North.	Surface Elevation m AHD	Top of Casting Elevation m AHD	Total Depth m b.g.	Screened Interval m b.g.	SWL m b.g.	TDS mg/L	Hydraulic Conduct. m/sec
PT84MW1	9422.49	6132.88	213.43	214.24	11.89	4.9-10.9	5.34	186	$6.7x10^{-7}$
PT84MW2	9637.10	5698.76	226.80	227.63	26.50	18.6-24.6	24.52	NA	$1.4x10^{-6}$
PT84MW3	9802.78	5916.37	202.43	203.25	21.90	14.9-20.9	18.84	266	$2.9x10^{-6}$

Drilling has confirmed the presence of substantial clay layers within the Maroota Sand, which may give rise to perched water tables at different levels within the formation.

3.10.2 Groundwater Sampling and Analysis

Upon completion of drilling, construction and development, the bores were purged and sampled. The samples were submitted to Australian Laboratory Services under chain of custody procedures.

Of the three bores, bore PT84MW2 could not be adequately sampled because of both the small volume of water which could be obtained and its slow rate of recovery observed during purging.

The full laboratory analytical reports are presented in Appendix B of the Groundwater impact assessment at **Appendix 6** as are the field measurements and the analytical results. Salinity values are included in **Table 3.13** above.

The groundwater from the two sampled bores is somewhat similar in nature although bore PT84MW1 has a lower ionic concentration, reflecting its perched nature, its shallower depth, higher elevation and consequent rainfall recharge effects.

The analyses reveal that a small amount of nutrients are present in the groundwater, particularly in bore PT84MW1, in the form of ammonia, nitrate and phosphate, most likely the result of the agricultural pursuits of the area. Nutrients have also been found in several bores during the DLWC Maroota Groundwater Study, Stage 2.

The water samples were also analysed for the presence of Total Petroleum Hydrocarbons (TPH), a broad test which includes an array of organic compounds, not all necessarily associated with petroleum products. This was done in the event that the dredging operations

at the site may have had an impact on the groundwater, although, in consideration of the geology encountered during drilling, and of the low permeability of the formation, this was considered unlikely. A small amount of TPH was recorded in the results. Upon further checks, the chromatographs of the analyses (Appendix B of the report at **Appendix 6**) indicated that the recorded peaks related to chlorinated products. The results are explained with the use of chlorinated breakdown agents used to disperse the drilling mud during development of the bores.

3.10.3 Hydraulic Tests

The completed bores were subjected to a falling head test in order to evaluate the hydraulic conductivity of the formation around each bore. The tests are performed by the injection of a slug of water in the bore, which causes a rise in the water level, and in the measurement of the rate of fall of that level with time. Water level data were recorded using a Solinst automatic data logger and pressure transducer.

The tests results were analysed by the Bower and Rice method using the computer program "Aquitest" developed by Waterloo Hydrogeologic. Plots of the tests are presented in Appendix C of the groundwater impact assessment and the applicable values included in **Table 3.13** above.

The results indicate hydraulic conductivity values ranging from 0.25 m/day to 0.05 m/day, with a most probable average value of 0.14 m/day. These values, which are typical of clayey sands, together with the small saturated thickness of the Maroota Sand indicate that this aquifer has only a limited water supply capacity.

3.10.4 Automatic Data Loggers

The three monitoring bores have been equipped with Dataflow Systems Pty Ltd automatic data loggers of the same type used in the area by the DLWC. Details of these units are given in Appendix D of the groundwater impact assessment at **Appendix 6**.

Data collected in this manner from these bores will help in the delineation of the water table in the Maroota Sand and, hence, in the determination of the allowable depth of mining.

3.11 Hydrogeology

The formations present in the Maroota area have dissimilar hydrogeological characteristics. The high degree of lithological variability (i.e., sands, clays, shale, sandstone, etc.) often results in the establishment of perched water tables in both the Maroota Sand and in the Hawkesbury Sandstone and, possibly within the latter, between the weathered profile and the fresher sandstone.

Under these conditions, three separate aquifers can be identified, although the extent of their hydrogeological separation or, conversely, interconnection, is sometimes uncertain. These aquifer units are:

- the Maroota Sand;
- the eluvial/weathered profile of the underlying Hawkesbury Sandstone, and
- the fresh Hawkesbury Sandstone.

The more significant aquifers are the Maroota Sand and the deeper Hawkesbury Sandstone. The description of the hydrogeological characteristics of the two aquifers presented in this EIS is based on records held by Woodward-Clyde, by the Department of Land and Water Conservation (DLWC) and others contained in EIS documents available in the Maroota area.

3.11.1 Department of Land and Water Conservation (DLWC) Bore Records

A review of the bore records held by the DLWC for the Maroota area is summarised in Table 4 and their location plotted in Figure 1 of the groundwater impact assessment at **Appendix 6**. The table and figure include observation bores recently established by the DLWC during its Stage 2 Maroota Groundwater Study, by other sand mining companies, and by the applicant during the preparation of this EIS.

3.11.2 Maroota Sand

The Maroota Sand, where it occurs below water table (such as in the deeper section of sands along the palaeochannels), constitutes an unconfined, or water table aquifer. It is open to direct rainfall infiltration and, as a consequence, is subject to seasonal variations in response to rainfall patterns and climatic cycles.

The aquifer derives its permeability (its ability to store and transmit groundwater), from the open pore spaces between its constituent sand grains. The permeability of the Maroota Sand aquifer is variable and is limited by its clay content, the degree of cementation of the ferricrete and ferruginous bands and the presence of substantial clay layers. Although the storativity[1] of the Maroota Sand aquifer is considered greater than that of the underlying Hawkesbury Sandstone, its total storage capacity is reduced by its limited saturated thickness, particularly north of Maroota, and by its relatively small areal extent.

The natural groundwater flow (underflow) within the Maroota Sand aquifer is dictated by its position at the top of the Maroota Ridge along Old Northern Road and Wisemans Ferry Road. The underflow, therefore, follows the topographic relief pattern and, where this relief intersects the

[1] The volume of water an aquifer releases or takes into storage per unit surface per unit change in head.

base of the aquifer, seepages can be expected to occur at the contact with the less permeable underlying material. These seepage points, identified by Etheridge at the margins of the Maroota Sand outcrop, supply water to a number of perennial creeks at the margin of the Maroota Sand outcrop.

Where the water table in the Maroota Sand aquifer is at a higher elevation than that of the underlying Hawkesbury Sandstone, a potential exists for groundwater flow and recharge to the Hawkesbury Sandstone aquifer to occur from this source.

The commercial extraction of groundwater from the Maroota Sand aquifer requires large diameter excavations and dams, due to the relatively low permeability and storage capacity of the aquifer, even in the deeper sections of the buried palaeochannels. Irrigation supplies to orchards and market gardens in the area are drawn in this manner.

In addition to the regional water table within the Maroota Sand aquifer, perched water tables occur above the extensive clay layers and ferricrete bands present within the formation.

From a resource viewpoint, the perched water tables have limited value due to their small extent and storage, but they may be significant in the maintenance of vegetation capable of tapping this source. Where sand mining will take place, however, by necessity the vegetation will be removed and the local aquifer excavated, so that the vegetation-perched water table interdependence will no longer be an issue.

Similar geological conditions as described above for the regional area were also encountered during the investigations at the subject site.

In bore PT84MW1, the Maroota Sand attains a thickness of approximately 9.5 m and the aquifer is represented by a thin layer of gravelly material. It is considered that the aquifer at this location is perched above the Hawkesbury Sandstone.

In bore PT84MW2, the Maroota Sand was expected to be between 20 m and 25 m thick, with substantial clay layer in the upper sequence. The aquifer was found below a thick sequence of clay at a depth of approximately 24.5 m.

In bore PT84MW3, the Maroota Sand was also represented by a sequence of clays and sands and mixes of both.

The overall nature of the Maroota Sand aquifer has been summed up in the conclusions of the recently completed Maroota Groundwater Study, Stage 2 Final Draft Report, in which the DLWC has stated that: *"The Maroota Sand aquifer has limited water supply potential, based upon the saturated thickness of the formation at the time of the investigation"*.

3.11.3 Eluvial Sand/Weathered Sandstone Profile

Small aquifer zones have developed in the eluvial sand, which comprises the leached and weathered profile of the Hawkesbury Sandstone. These zones often form perched aquifer systems above the

deeper regional water level of the Hawkesbury Sandstone.

In the majority of cases, these perched aquifer systems have limited resource value because, like the Maroota Sand, they have small extent and storage. They act as temporary storage of groundwater prior to release to streams or leakage to underlying aquifers. Dams and large diameter wells constructed into this material can provide a source of farm water supplies, but generally the permeability is too low to yield significant supplies to small diameter boreholes.

3.11.4 Hawkesbury Sandstone

The Hawkesbury Sandstone is generally an impermeable rock, due to the large degree of grain cementation resulting from the development of secondary minerals in the interpore spaces, such as kaolinitic clay and iron oxides. The presence of these minerals in the groundwater gives the characteristic red-brown staining of the rock visible in road cuttings and building stone. Although the rock has negligible primary permeability, fracturing and jointing, where open and interconnected, provide secondary permeability and storativity.

Estimates of transmissivity (i.e. permeability times aquifer thickness) for the Hawkesbury Sandstone, calculated from the available bore records by Australian Groundwater Consultants (now AGC Woodward-Clyde) and more recently by Woodward-Clyde, range from 0.06 m^2/day to 3.6 m^2/day. These values support the overall low permeability characteristics of this formation as understood from geological interpretation. Storativity is estimated to be in the order of 0.001, due to the secondary permeability characteristics of the aquifer.

Available records show that different water tables are intersected during drilling into the Hawkesbury Sandstone, due to the different degree of fracturing and the presence of confining layers (such as the shale lenses) within the rockmass. Because most bores in the Hawkesbury Sandstone are completed open hole, however, an equilibrium water table is eventually established with time, often coinciding with the deeper water table intersection, through drainage from the upper strata.

3.12 Groundwater Quality

3.12.1 Maroota Sand

The quality of the groundwater in the Maroota Sand aquifer in the area within and around the proposed development is dependent upon direct rainwater infiltration and the chemical processes and exchanges occurring with the minerals contained in the formation. This process is reflected in the generally low salinity of the groundwater, as shown in the data of Table 4 of the groundwater impact assessment at **Appendix 6**.

Water quality data presented in the DLWC Stage 2 Final Draft report indicate TDS values between 76 mg/L and 195 mg/L for the Maroota Sand aquifer to the northeast and to the southwest of the

subject site. During the DLWC Stage 2 investigations at site 3, located within the subject site, the Maroota Sand aquifer was considered to be dry and no monitoring bore was constructed at this site.

Data collected during the current investigations indicate TDS values of 186 mg/L for bore PT84MW1 and 266 mg/L for bore PT84MW3 and thus fall within the upper end of the observed range of values for this formation. A water sample could not be collected from bore PT84MW2 because of the low yield of this bore.

3.12.2 Hawkesbury Sandstone

Water quality in the Hawkesbury Sandstone in the Maroota area is generally good. Because the Hawkesbury Sandstone is not in outcrop in the subject site, this formation is not discussed in greater detail here.

3.13 Groundwater Levels

3.13.1 Maroota Sand

The determination of the position of the water table in the Maroota Sand (the shallow aquifer of the DLWC report) and in the Hawkesbury Sandstone has been the focus of the recent studies conducted in the area. A generally agreed position of the water table in the shallow aquifer under the subject property will be the basis for the final level to which extraction will be allowed in the future. The DLWC has recommended and adopted as its policy in the Stage 1 of the Maroota Groundwater study that:

> *"the base of the excavations made for the purpose of sand mining should be maintained at least 2 m above the seasonally highest elevation of the shallow water table."*

The report did not provide guidelines for the recognition of the seasonally highest elevation of the shallow water table.

The Extractive Industries Development Control Plan No. 500 adopted by Baulkham Hills Shire Council in December, 1996 states that:

> *"Extraction should not occur within 2 m of the wet weather high groundwater level or otherwise to the requirements of the Department of Land and Water Conservation."*

Again, no method of determining the wet weather high water table was provided.

Table 5 of the groundwater impact assessment at **Appendix 6**, shows a summary of water levels obtained from a number of bores completed in the Maroota Sand. The data available from the

DLWC Stage 2 Study, the present study and the EIS completed by PF Formation in the land to the west of the proposed development, indicate a high degree of variability in the Maroota Sand aquifer. Such variability is the result of geological conditions which cause perching of water bearing strata above substantial clay layers.

Water levels in the groundwater monitoring bores on the site recorded by the automatic data loggers are presented in Figures 3, 4 and 5 of the groundwater impact assessment at **Appendix 6**.

Bore PT84MW1 is shallow with a Maroota Sand thickness in the order of 9.5 m. Groundwater in the bore has been found in a gravelly layer at around 6 m below ground and above a clay base.

Bore PT84MW2 shows a water level which, based on the geological log of the DLWC bores next to it, may be also considered perched above a significant clay layer. The recent records show that the water table at this site is deeper than originally anticipated and deeper than the depth of the bore (25.6 m) as the flat plot of the data shows that the water level in the bore is at the top of the casing sump (202.2 m AHD) or at the base of the screens.

Bore PT84MW3 is considered representative of the water table in the deeper Maroota Sand. The data plot shows that the water level in this bore has moved within a 0.6 m range, possibly in response to weather patterns.

Outside the subject site, bore PF166MW1 is also considered to display a perched water table.

With the exclusion of the above perched levels, it appears that the water table within the Maroota Sand aquifer ranges between 178.58 m AHD to 183.59 m AHD, with an average of around 180 m AHD.

The licensed dam in Portion 167, excavated to the base of the Maroota Sand, reportedly has a water level close to 180 m AHD, which is considered a representative shallow aquifer level as it is located in the palaeochannel and was excavated to the top of the Hawkesbury Sandstone initially.

A surveyed peg has been placed in the excavation of the current pit at the site and a water level of 180.29 m AHD was measured in February 1999. A regular program of water level monitoring has been initiated.

In summary, it appears that the Maroota Sand aquifer, in its deeper sequence, has a water table mostly at or below 180 m AHD, with perched water tables at various locations depending on elevation and geology. The data show the high degree of variability in aquifer thickness and water table depth in the Maroota Sand.

Several of the bores in the area tapping both aquifers are located at high elevations along the Maroota Ridge, which represents both a surface divide and a groundwater divide. The low density and the distribution of the groundwater monitoring points on either side of a surface and groundwater divide makes the production of a reliable water table contour map difficult. Groundwater gradients measured in recent investigations in closely spaced bores are variable and steep in places due to the low permeability of the rockmass, particularly in the Hawkesbury Sandstone. Groundwater flow directions are expected to be generally to the northwest, east and south, away from the main axis of the groundwater divides, which coincide with the main surface

divides. In specific areas, the presence of excavations and dams in the Maroota Sand used for irrigation is likely to cause local distortion of hydraulic gradients.

3.14 Visual Aspects

The topography of the site is such that it falls away from Old Northern Road, and hence affords extensive vistas of large portions of the site when viewed from various vantage points along both Old Northern and Roberts Roads.

As a result, the current dam construction and sections of the future proposed extraction works would be visible to public and private view. The visual impact generated by these works is currently, and will in the future, be caused by the colour contrast of exposed soils.

While these visual impacts are temporary, and will be totally eliminated once rehabilitation works have been undertaken, strategic bund wall construction and planting works along the boundaries of the subject property, will provide a visual screen for the current, and in particular, the future extraction works within the site. This aspects are discussed further in **Part 4** of this EIS.

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Part Four

THE PROPOSED DEVELOPMENT

4.1 Introduction

The development proposal involves the extraction of sand and clay from approximately 29.5 ha.

The general operational constraints of the site are outlined in Development Control Plan No.500 adopted by Baulkham Hills Shire Council in December, 1996. The relevant constraints associated with the extraction operation and layout are stated as follows:

1. The area of land disturbed for the purpose of extraction shall not exceed the overall extraction site as identified in the EIS.

2. Extraction activities are not to approach within the following setbacks:

   - 30 m from Old Northern Road and Roberts Roads, and

   - 10 m from all property boundaries not associated with the extraction operation.

3. Excavation depths may increase to no more than two (2) metres above the wet weather high groundwater level to the requirements of the Council and the Department of Land and Water Conservation (DLWC).

The determination of the position of the water table in the Maroota Sand (the shallow aquifer of the DLWC report) and in the Hawkesbury Sandstone has been the focus of the recent studies conducted in the area (refer to **Parts 3.11-3.14** of this EIS and to the groundwater impact assessment at **Appendix 6**). A generally agreed position of the water table in the shallow aquifer will be the basis for the final level to which extraction will be allowed in the future.

Based on groundwater level monitoring data presented in the groundwater impact assessment, it appears that the water table within the Maroota Sand aquifer in the area ranges between 178.58 m AHD to 183.59 m AHD, with an average of around 180 m AHD. These values have been used in the operations plan to calculate the final level to which extraction will be allowed on the site.

The depth of Maroota Sand available for extraction will vary across the site depending on the location of the underlying shallow groundwater level and the presence of peaks and rises in the sandstone bedrock. The predicted maximum depth of extraction is some 35 m below existing surface, located adjacent to Old Northern Road. The average extraction depth over the site is predicted to be approximately 10 m.

4.2 The Resource

As part of a previous determination of the resource contained on the site, a drilling program was

undertaken in August, 1991 to assist in the identification and quantification of resources on the site.

Following a topographic survey of the site, a triangular grid was devised for the purposes of drilling, that grid conforming to the general shape of the site.

The wide spaced, slightly distorted grid resulted in 13 drill sites approximately 140 m apart. No drill sites were within 50 m of the external boundaries of the site as it was recognised that limited extraction would be permitted in these areas.

Drilling contractors were engaged to drill 13 holes of average anticipated depth of about 20 m, using the reverse circulation air drilling method. This method of drilling is relatively rapid, virtually free of contamination and allows continuous sampling, through a cyclone, without loss of any intersected materials.

Drilling was undertaken in the period 5th to 8th August, 1991. Samples were collected in a large bucket as underflow from the cyclone and laid out in rows near the drill site. Each sample was inspected, described, logged and sub-sampled for laboratory analysis.

Investigation results

The report resulting from the abovementioned drilling program indicates that reserves of three (3) specific resource types were calculated, firstly by assuming complete extraction to the boundaries, secondly by invoking reasonable environmental, geotechnical and safety parameters and thirdly by excluding the north-western area containing the nursery and dams. The last consideration was adopted as the most realistic and the reserves calculated were:

Maroota Sand	2.25 million tonnes
Clay	1.25 million tonnes
Friable Sandstone	2.70 million tonnes.

The above drilling program did not, however, take into account the requirement that extraction is to not be undertaken below a level which is 2 m above the groundwater table in the shallow aquifer. A copy of the text of the investigation report is at **Appendix 12**.

Work undertaken in the design of the conceptual mine plan for the proposed extraction of the site has included the land in the north-western area of the site and has accounted for the need to not extract within 2 m of the groundwater table. It has determined that a total resource **3.43 million tonnes** of product is available within 2 m of the confines of the shallow aquifer, and within the setback requirements of DCP No.500. Of that product, **2.4 million tonnes** is Maroota Sand, product which represents 70% of the material which would be extracted from the site. The remaining 30% (**1.03 million tonnes**) of the material won during the extraction process would be clay and pebble material. The Applicant has indicated that whilst the clay material is often in demand in the marketplace, it will be utilised in the progressive rehabilitation of the site. The pebble material is also in demand in the market place and will be transported from the site as product.

4.3 Rate of Extraction

The Applicant seeks approval for fifty (50) laden truck movements from the site per day with extraction to occur 5.5 days per week. During preparation of many of the technical reports which form the appendices of this EIS, it has been conservatively assumed that an average load of 20 tonnes will leave the site and as such the maximum volume of product leaving the site would be 1,000 t/day or 286,000 t/annum. In recent times, however, load limits for individual trucks have been increased significantly to allow a maximum of 33.5 tonnes per load. Thus, under existing maximum load limit regulations, it is expected that a maximum of **1,675 t/day** of extracted material will be taken from the site per day which equals **479,050 t/annum**. As such, with this maximum rate of product leaving the site daily, the resource on the site could be extracted in a period of 8-9 years allowing for time for commencement of operations.

The above estimate, due to inclement weather, fluctuations in the demand for product and other limiting factors, may not occur each and every day during the life of the extraction. As such, a conservative average production of thirty (30) laden truck movements per day is anticipated over the life of the extraction which, with an average load of 33.5 tonne per load, represents **1,000 t/day** or **286,000 tonnes per annum**. On the basis of this rate of extraction, the total extraction of the resource could take up to 12-13 years to complete.

On the basis of the above, the applicant seeks approval to complete the extraction at the rate of 50 laden trucks per day (**479,050 tonnes/annum**) and it is this figure upon which the impact of the proposed development has been assessed. For the purposes of determining the life of the extraction, however, and hence the life of any approval for that extraction, the above conservative estimate of 30 trucks per day is adopted. Allowing for contingencies and delays in the processing of approvals and the like after the initial consent has been given, an **approval for a 15 year period is sought**.

4.4 The Proposed Development Process

The extraction of sand in the Maroota area is generally dependant upon a quality water supply in order that the clay within the extracted material can be washed from the sand. The applicant is currently constructing a water supply dam on the site. It is proposed to utilise the work already undertaken in the construction of that dam to provide for a water supply for the proposed extraction of the total site.

The development of the site will be undertaken as follows:

1. Construction of the process water dam for the washing of sand in conjunction with Stage 1 extraction of material from the site;

2. Stage 2 extraction of material from the site, and

3. Extraction of the resource under the existing processing plant and the access road utilising mobile extraction equipment.

The following sections describe the processes which will be undertaken to effect each of the above steps.

4.5 Process Water Dam

The proposed process water dam is to be constructed to include the existing excavation pit located along the central northern boundary of the site. It is intended that the existing stockpiles of clay residue within the site will be used to construct the storage lining and perimeter embankments.

The general design criteria for the process water dam are as follows:

- to provide a reliable source of process water for current and future extraction operations, and
- to be suitably located to maximise the quantity of sand available for extraction and to maximise surface runoff inflows from the surrounding catchment.

4.5.1 Storage Design Requirements

The water supply dam has been sized for future extractive operations at the site which is to involve conventional dry excavation methods. Process water for washing and screening of the sand would be sourced from the dam.

The following storage requirements and assumptions regarding the future operation process/layout have been adopted:

- a sand production rate up to 1000 t/day is assumed plus 430 t/day of clay and pebble materials, but will vary depending on supply and demand during the life of the operation;
- operations will be carried out on 5.5 days per week for the life of the operation;
- the proportion of clay and pebbles is approximately 30% on average;
- the washing/screening process will be a closed system with free water returning to the dam storage for re-use;
- no discharge of water off the site is intended;
- sand is stockpiled nearby the plant with any free water able to be drained into the water dam;
- clay residue materials are discharged to nearby drying areas with free water able to be drained into the water dam;

- water from the dam will not be used to supplement the existing water ponds for use in the existing nursery operations

- water from the existing dams may be used to supplement the extraction process.

Based on the above, water inputs to the storage would be direct rainfall and surface runoff from the surrounding catchment, with outputs comprising evaporation and seepage losses from the storage and general process (i.e. stockpile) losses. The components to the overall water balance of the storage are discussed further below.

4.5.2 Water Balance Modelling

A monthly water balance was undertaken for the proposed process water dam to simulate storage level fluctuations during operation and to predict the likelihood and frequency of overflow from the storage. The objective of the storage is to provide a reliable water source based on adopted future operation process requirements.

The model simulated the response in the storage of the water dam based on catchment yield (surface runoff) and storage losses (eg. evaporation, seepage and process outputs). The criteria, assumptions and data which were used in the model are detailed in section 5.3 of the process water dam design report at **Appendix 13** of this EIS.

Based on those criteria, process water (i.e. stockpile) losses for a range of average sand production rates used in the model are summarised in the **Table 4.1** below:

Table 4.1
Stockpile Water Losses

Average Sand Production Rate (t/day)	Average Clay Production Rate (t/day)	Sand Stockpile Water Loss (m^3/day)	Clay Stockpile Water Loss (m^3/day)	Total Stockpile Water Loss	
				(m^3/day)	(ML/month)
600	257	30	90	120	2.6
800	343	40	120	160	3.5
1000	429	50	150	200	4.4

The water balance was run with average sand production rates of 600, 800 and 1000 t/day for the extraction operation. For each production rate, the number of "shortfall" months were recorded (i.e. the number of months when storage losses exceeded the dam storage volume for the month) and subsequently the storage "reliability" was calculated over the 63 year rainfall sequence.

The predicted storage volume versus time over the 63 year rainfall sequence for each of the production rates is provided in Appendix A of the process water dam design report at **Appendix 13**.

The water balance modelling results are summarised in **Table 4.2**.

Table 4.2
Water Balance Modelling Results

Average Sand Production Rate (t/day)	Number of Shortfall Months	Storage Reliability (%)	Frequency of Additional Water Requirements (%)	Average Monthly Shortfall Volume (ML)	Average Storage Depth (m)
600	214	75	25	2.0	0.8
800	356	60	40	2.7	0.6
1000	460	40	60	3.4	0.5

The above modelling results (based on 63 years of rainfall record) indicate the following:

- for an average sand production rate of 1000 t/day, a storage reliability of 40% is predicted to supply water for the washing/screening process;
- for an average sand production rate of 600 t/day, the storage reliability predicted increases to 75%;
- when "shortfall" is predicted within the storage, the average monthly shortfall volume is predicted to be 2.0 ML (or 0.8 L/sec) and 3.4 ML (or 1.3 L/sec) for 600 and 1000 t/day average production rates respectively, and
- average storage depths should range between 0.5 to 0.8 m for the range of sand production rates modelled.

Since the preparation of the process water dam report, the Applicant has sunk two (2) bores into the Hawkesbury Sandstone aquifer which are generating 1.9 L/sec and 1.3 L/sec respectively which is more than the "shortfall".

The sensitivity of the model on storage area and capacity with respect to the storage reliability was also examined by increasing the storage area and depth by 50% and re-running the model to predict the storage reliability. The results indicated that for an increase in storage area of 50% (i.e. resulting in a modelled storage area of 30, 000 m^2), the storage reliability is decreased by an average of 25% for the range of sand production rates modelled. This is due to a substantial increase in evaporation loss from the storage as a result of the increase in the storage surface area, thus reducing the overall storage reliability.

Also, for an increase in storage depth by 50% (i.e. resulting in a storage depth of 4.5 m), the storage reliability only increases by an average of 4% for the range of sand production rates modelled. This is due to the relatively low predicted frequency of overflow occurring from the storage in the "base" case and, therefore, the effects of additional storage capacity on storage reliability would only be minimal.

The above model sensitivity analysis indicates that substantially increasing the storage area and capacity has only minimal (or negative) impact on the predicted storage reliability.

The storage reliability could be increased by dividing the storage area into separate cells and transferring water from one cell to the other during periods of low inflow. In this manner, the surface area would be reduced and the evaporation minimised, thus increasing the reliability factor. Such a water management scheme will be investigated more thoroughly during detail design. Surface evaporation will also be reduced by covering of the surface area with floating plastic spheres.

Based on the water balance modelling results, the following conclusions are provided:

- a nominal 60 ML water storage (approximate dimensions of 140 x 140 x 3 m deep) should provide a storage reliability of at least 40% assuming an average (maximum) sand production rate of 1000 t/day is achieved during the extraction operation;
- the storage reliability increases to around 60 to 75% if average sand production rates between 600 and 800 t/day are achieved during the extraction operation;
- substantially increasing the storage area and capacity has only minimal (if not negative) impact on the predicted storage reliability;
- an alternative water supply source would, therefore, be required to supplement the process water dam between 25 to 60% of the months (for the range of sand production rates modelled) during extended periods of low or no rainfall. For example, 2 deep groundwater bores constructed into the Hawkesbury Sandstone with a combined capacity of 2.5 L/sec could supply up to 6.5 ML/month, which is above the calculated total stockpile water loss of 4.4 ML/month outlined in **Table 4.1**. As indicated above, these bores have now been sunk on the site with a combined capacity of 3.2 L/sec, and
- storage reliability could be increased by the adoption of appropriate water management strategies at the dam, including the introduction of possible evaporation control measures.

4.5.3 Preliminary Engineering Design

The proposed preliminary dam design has been carried out based on the results of the above water balance modelling. The main objectives of the design were to provide details on:

- liner properties and thickness;
- required batter slopes for pond perimeter embankments and pit batter slopes;
- constructability, and
- surface water control measures.

The proposed dam design is presented on **Figures 12, 13 and 14** and outlined in Section 6.3 of the

process water dam design report at **Appendix 13**.

The following criteria have been adopted for preliminary design of the water storage dam:

- a storage capacity of approximately 60 ML (approximate dimensions 140 x 140 x 3 m deep);
- the base level of the dam (top of liner) to be at 180 m AHD (this ensures that there is always a net outward water pressure gradient from the pond and that the potential leakage from the pond acts as a local source of recharge to the Maroota Sand, i.e. no groundwater loss from the Maroota Sand);
- full supply level in the dam to be at 183 m AHD;
- a 2.0 m exclusion zone above the water table for extraction operations;
- maximum use of on site materials, and
- design and construction of the dam in accordance with good engineering practice.

To enable the approved sand production to continue during construction of the process water dam, it is proposed to adopt a two stage construction method.

Stage 1 (approximate dimensions = 110 x 110 x 2.5 m) will comprise the construction of the first portion of the storage dam to a clay liner top level of 181 m AHD (**Figures 12 and 13**), whilst the existing dam continues to supply water to the processing plant. The Stage 1 dam will have a temporary northern wall with batters of 3(H):1(V). Once completed, the Stage 1 dam will be filled by pumping from the existing dam and used for continued supply to the processing plant during construction of the Stage 2 portion of the dam.

Stage 2 (approximate dimensions = 100 x 100 x 3 m) will comprise the construction of the remainder of the dam and will start with emptying the existing dam into Stage 1. The clay liner will be constructed to a top level of 180 m AHD.

Upon completion of overall construction, the temporary wall separating the two portions of the dam could be breached to form one large storage, however, it may be preferable to retain two separate dams during the quarry life to improve the storage efficiency and for water management purposes.

4.6 The Proposed Sand Extraction Process

Future extraction operations will involve the excavation, washing and screening of the Maroota Sand using the same process plant as per the existing operation. The proposed excavation will cover the majority of the site, some 23 ha, allowing for boundary buffer zones as described in **Part 4.1** of this EIS.

Production objectives are demand related, however, a maximum sand production rate of 1000 t/day

has been used for the extraction plan.

Future extraction operations are to involve the following:

- Materials are to be excavated using a self-loading scraper and transported to the process plant. In areas where the underlying material cannot be effectively excavated using the scraper, the surface would be initially ripped using an excavator and in exceptional circumstances using a dozer.

- Process water for washing/screening will be primarily sourced from a water dam constructed at the location of the existing excavation pit (adjacent to the northern boundary). The existing pump-out facility will be utilised.

- Processed material is to be stockpiled adjacent to the plant area prior to transportation off-site generally using articulated trucks. A front-end loader is to be used to load the trucks.

- The residue clay/silt slurry is to be delivered by pipeline to designated drying areas in the previously extracted cell where it is spread in thin layers to dry. Liberated water will be drained into the water dam for re-use in the process plant. The clay materials will be used for the rehabilitation of the extracted areas.

- The materials are to be sequentially extracted in "cells" commencing along the northern boundary (adjacent to the process water dam) and working towards the southern boundary (to Old Northern Road). Each cell will be approximately 200 m x 50 m wide (1 ha in area) which provides sufficient area for the machinery to load and manoeuvre within each cell. The extraction process will minimise the disturbed area (i.e. the area exposed to erosive processes) and enable rehabilitation procedures to commence during operations.

- Each cell will be progressively rehabilitated (following extraction of the sand materials) involving surface contouring and replacement of a suitable growth medium/topsoil layer to enhance revegetation.

Extraction within the site will be undertaken in two stages as follows:

Stage 1 Area located to the east of the catchment divide (i.e. the process water dam catchment), occupying a total area of approximately 16.5 ha, and

Stage 2 Area located to the west of the catchment divide (i.e. the catchment of the two existing water dams for the nursery), occupying a total area of approximately 6.5 ha.

The staging will enable the existing nursery operation to continue during the initial Stage 1 extraction operation and for most of Stage 2 and as required by the owner. The operation will use the existing process plant and sand stockpile area including the existing site entrance, weighbridge and offices.

The conceptual extraction strategy for the Stage 1 and 2 areas is that three cells will be subject to work as follows:

- only one cell will be extracted at any one time,

- the clay from the processing plant will be piped to the previously extracted cell where it will be spread in a thin layer for drying, and

- the vegetation and topsoil from the new cell will be stockpiled in the third cell which has been extracted and now contains a layer of "dried" clay. This third cell in the sequence is to undergo rehabilitation. The topsoil from the current extraction cell will be mixed with the "dried" clay materials and used for rehabilitation of the cells.

The mining strategy is illustrated in **Figures 15 to 20** and is described as follows:

- The existing processing plant, weighbridge and office facilities will remain at their current location until the end of extraction of Stage 2.

- Extraction will initially commence in Cell 1A (within Stage 1 area), located immediately to the west of the process water dam. Prior to extraction, vegetation and topsoil will be stripped and stockpiled at a suitable location near the processing plant for rehabilitation of the final stage of extraction. The latter will be the area comprising the processing plant, the offices and the weighbridge. The existing clay drying beds will also be used. Surface runoff from the upslope catchment and from the active cell area will be diverted (via diversion drains) into the sedimentation pond prior to discharging into the process water dam to minimise on-going siltation of the water storage dam.

- Following completion of the Cell 1A area, excavation will continue within Cell 1B, located to the east of the process water dam. The clay drying area will be located in the previously mined Cell 1A area. The clay materials will be gravity fed from the plant to the designated drying area. Runoff and free water from the drying area would discharge (via formed drains or pipes) into the process water dam's sedimentation pond.

- The remaining cells within Stage 1 (Cells 1B to 1K) will be progressively excavated as described above. Prior to extraction, each cell area will be stripped of vegetation and topsoil which will be transported to the third cell in the sequence which is to undergo rehabilitation, as described earlier. Surface runoff from upslope catchments and from the active cell areas will also be progressively diverted (via diversion drains) into the dam's sedimentation pond prior to discharging into the process water dam.

- Final maximum rehabilitated batter slopes of 3(H):1(V) are envisaged. Temporary batter slopes adjacent to the Stage 1/Stage 2 boundary would be approximately 2(H):1(V).

- Following completion of the Stage 1 area, excavation of the Stage 2 area will then commence. The operation will be similar to the Stage 1 operation using the Stage 1 process plant and sand stockpile pad layout. Prior to extraction, each cell area will also be stripped of topsoil which will be transported to a previously extracted cell for use in rehabilitation as described earlier. Surface runoff from upslope catchments and from the active cell areas will be progressively diverted (via diversion drains) into the sediment pond prior to discharging into the process water dam.

- Following completion of excavation of the Stage 2 area, final rehabilitation of Cell 2D and the process plant and sand stockpile pad area (within Stage 1) will be undertaken. The existing

processing plant will be dismantled and removed from the site. It is envisaged that sand extraction beneath the plant and stockpile pad will be processed using a mobile plant unit.

The predicted final layout (and contours) following extraction operations at the site and a cross-section of the final landform are presented in **Figure 21**.

A preliminary extraction schedule for the site based on the proposed extraction strategy of Maroota Sand only is provided in **Table 4.3** below. The schedule is based on the following assumptions and criteria:

- future maximum sand production rate of 1000 t/day on average;
- a total excavation rate of approximately 1,430 t/day (assuming 70% is sand and 30% is clay/silt reject materials);
- production continuous for 5.5 days per week;
- an average bulk density of sand/clay materials of 1.6 t/m^3, and
- progressive extraction in a series of "cells" for Stage 1 and 2 areas.

Table 4.3
Preliminary Extraction Schedule (Maroota Sand)

Stage Area	Cell Number	Approximate Cell Volume (m^3)	Approximate Completion Time Following Commencement[1] (years)
Stage 1	Cell 1A	89,500	0.4
	Cell 1B	38,500	0.5
	Cell 1C	122,200	1.1
	Cell 1D	144,400	1.7
	Cell 1E	83,100	2.0
	Cell 1F	196,200	2.9
	Cell 1G	131,500	3.4
	Cell 1H	265,700	4.5
	Cell 1I	193,900	5.4
	Cell 1J	89,700	5.7
	Cell 1K	102,700	6.2
Stage 2	Cell 2A	103,100	6.6
	Cell 2B	183,800	7.4

	Cell 2C	208,500	8.3
	Cell 2D	138,600	8.9
Plant and Stockpile Pad Area	-	52,600	9.1
Total		**2,144,00**	**9.1**

[1] Assumes constant extraction of 1,000 t/day for the life of the project.

4.7 Noise Control Measures

As discussed in the acoustic impact assessment report at **Appendix 11**, there will be a requirement that earth berms be constructed in certain sections of the site to mitigate any acoustic impact to adjoining residences. Those bunds are to be located as follows:

- A 3 m permanent earth berm around the north-western boundary corner and extending along the western boundary to the site entrance;
- A 2 m permanent earth berm along the north-western section of the northern boundary, and
- A 3 m temporary earth berm around the active extraction cell which will assist in noise attenuation in the early stage of the extraction of each cell.

The location of these proposed earth berms is shown on **Figure 22**.

The berms will be stabilised and seeded in accordance with the Landscape Plan for the site.

4.8 Processing Plant

The processing plant will be that which is currently on the site and being utilised for the processing of extracted material as part of the approved dam construction on the site. Material won from the extraction faces will be transported by scrapper to the receiving hopper which is part of the existing processing plant.

The extracted material is transferred by conveyor from the receiving hopper to the sand washing section of the plant where clay is washed from the primary material. Sand is screened according to a predetermined size and stockpiled by use of a conveyor system according to product size.

Clay washed from the sand is piped as slurry to the clay drying area from where water is drained from the slurry and gravity fed back to the process water dam.

Processed material is to be transported from the site by large, generally articulated vehicles. These trucks access the processing area by way of the internal haul road. Trucks are loaded by Front End

Loader.

A weighbridge has been located at the entrance of the site as part of the approved dam construction on the site. The weighbridge will remain in that location as part of the proposed extraction Here all material leaving the site is recorded. The applicant has established a computer recording system in conjunction with the establishment of the weighbridge on the site. All trucks entering the site are weighed and their weight recorded. Upon leaving the site, each truck is again weighed and the weight of the load it is carrying is calculated and recorded by the weighbridge computer.

4.9 Rehabilitation

Rehabilitation of the site will be undertaken progressively on the completion of extraction within the individual cells. A detailed rehabilitation plan is at **Appendix 14**.

4.10 Component Requirements

The proposed development will require a number of components, many of which are already located on the site as part of the current dam construction. The key elements of the proposal are as follows:

- Administrative office, weighbridge and associated amenities. The existing facilities will be utilised.
- Stockpile areas for processed material. Existing facility to be used.
- Processing plant. The existing plant will be utilised.
- One Caterpillar Self-loading Scrapper. Existing plant to be used.
- One Leibherr 850 Front End Loader. Existing plant to be used.
- One Terex Front Loader. Existing plant to be used.
- One water cart for watering haul road and internal working areas. Existing plant to be used.
- Water storage ponds. These are based on the existing dam construction on the site.
- Water pumps. Existing pumps to be used.
- Above ground fuel storage tank. Existing facility to be used.
- Car parking spaces for visitors and employees adjacent to administrative office. Existing facility to be used.

4.11 Stormwater Management

As part of the preparation of the EIS, a strategy for surface water management was prepared, a copy of which is at **Appendix** 7. To assess the stormwater impacts of the proposed development, the computer program AUSQUAL was used to model pollutant generation for undeveloped and developed catchment scenarios. Details of the existing model results are contained in section 2.2 of the report at **Appendix** 7.

The modelling shows that the development of the proposed area for extractive industry will increase the pollutant loadings if water quality controls are not implemented. Based on average year rainfall data, it shows increases occur in suspended solids, total nitrogen and total phosphorus loadings by 6,008, 14.4 and 2.4 kilograms per year respectively from the pre-development to the peak development scenarios. Once the site has been rehabilitated, pollutants loads will be lower than the pre-development levels.

4.11.1 Water Quality Treatment

Management of pollutant levels during peak development will be achieved through the construction of a sedimentation pond and the process water dam.

Sedimentation Pond

To minimise sediment build up in the dam, a sedimentation pond will be used to remove coarse sediment from surface waters before entering the process water dam. It will be constructed to approximate dimensions of 30 x 50 x 1.5 metres, located as shown on **Figure 12**.

A solid (e.g. concrete or steel) baffle will be placed in the sedimentation pond to help in the sedimentation process. This will capture 0.05 mm particles and coarser (about two thirds of all sediment).

The pond will not be clay-lined so some water is expected to be lost through infiltration. Contamination of the groundwater system with suspended solids or nutrients is unlikely to occur due to the physical process of water filtering through the soil to groundwater, which is approximately two metres below the base of the earth basin. A layer of settled clay particles is expected to deposit quickly within the base of the pond and provide an impermeable barrier.

Water will drain from the sedimentation pond to the Process Water Dam through a 500 mm diameter HPDE pipe. A 2 metre wide by 0.3 metre deep concrete spillway will be installed at an elevation of 183.7 metres AHD to minimise scouring of the wall should the capacity of the HPDE pipe be exceeded.

Process Water Dam

The Process Water Dam will provide a dual role of water storage for processing operations (lower section), and extra capacity to meet pollution control requirements for *Type F* soils (upper section).

The dam will be non-draining, and lined at least to the top of the zone used for pollution control.

The capacity required:

(1) For processing operations is 60 ML. The reliability for storing the 60 ML of water is 40 per cent, assuming a maximum sand production rate of 1,000 tonnes per day during the extraction operation. As a result, additional water will be provided by pumping from the Hawkesbury Aquifer, expected to achieve a pumping rate of 2 litres per second, and

(2) For stormwater capture or surcharge is 8.88 ML (**Table 4.4 below**). This is based on a non-draining sediment basin using the 90th percentile, 5-day rainfall event of 47.6 mm at Wilberforce.

Table 4.4
Capacity of Process Water Dam and Sediment Basin

Dam Components	Depth (mm)	Capacity (ML)	AHD (m)
Spillway	na	na	192
Surplus storage capacity	8.5	166	183.5-192
Sediment basin storage	0.5	8.88	183.5
Process water dam storage	3.0	60.00	180-183

The volume of the dam not required for water requirements or surcharge storage is essentially surplus capacity. The surplus capacity is calculated to be 166 ML, which is far more than the required volume of 8.88 ML. A rainfall event which would result in the surplus capacity filling up, and subsequently overflowing to the watercourse is equivalent to a 5-day rainfall event of 800 mm, which is almost equal to the average annual rainfall of 840 mm. As a result, overflows to Coopers Creek are not expected. By comparison, the 1 per cent AEP is 140 mm.

Nevertheless, as a precautionary measure, a 20 metre wide and 1 metre deep spillway channel will be provided on the northern wall of the dam to allow flow into the existing natural watercourse at approximately 192 m AHD.

If water is to be discharged into the natural watercourse intentionally, it will be flocculated (if required) to reduce the load of suspended solids to below 50 milligrams per litre. This will only be required once the water level has reached peak capacity, which would be shown as a marker within the dam.

To meet the Department of Land and Water Conservation requirements, the floor of the dam will be lined to prevent accession from the Maroota Sand aquifer. The aquifer has been found between 177.7 metres AHD and 183.59 metres AHD, with an average of around 180 metres AHD.

Management strategies will ensure that:

- the capacity to capture the 1% AEP storm is always available in each catchment.
- the qualities of discharge waters are maintained at existing levels by trapping sediment and flocculating suspended solids as required by the site conditions.

- discharge waters are monitored to ensure that water quality objectives are met.

4.11.2 Temporary Earth Diversion Banks and Catch Drains

Temporary earth diversion banks and catch drains will be used to capture runoff which is consequently recycled in the managed water cycle. Table 2.6 of the surface water management report at **Appendix 7** identifies the required earth banks and drains to manage this process. The design will ensure that:

- diversion banks and collector drains will be stable in the 1 in 20 year AEP storm event with a minimum 1 metre flood freeboard margin, and

- diversion drains will be located to discharge water direct to the sedimentation pond which has a capacity to capture the runoff from the 1% AEP storm event.

Diversion banks will ensure that flood flows are contained on the site and that no downstream properties are affected.

The framework for the water management strategies will include the following risk management strategies:

- monitoring of the water retention structures and sediment detention basin will be carried out to ensure structural stability and available stormwater capacity;

- inward draining design will ensure that any spillages are contained within the site, and

- contingency plans will include chemical flocculation of suspended solids (if required or necessary) in extreme storm events where flows may exceed the design storm event.

4.11.3 Water Requirements and Recycling of Runoff

The objective of water cycle management is to maximise the conservation of available water and minimise requirements for other water sources. To achieve this:

- surface runoff will be captured and stored within the process water dam for reuse;

- additional water will be supplied from bore(s) which will access water from the Hawkesbury Sandstone aquifer, and

- water will be separated from the clay slurry within clay drying areas and returned to the Process Water Dam for subsequent reuse.

4.12 Access

Access to the proposed development will be from the existing access from Roberts Road approximately 290 metres from the intersection of Old Northern Road with Roberts Road.

4.13 Estimated Daily Truck Movements

Processed material will be transported to the market in rigid 3 axle trucks, 3 axle rigid trucks with dog trailers, and tri-axle semi trailers. Based upon previous records, it has been conservatively estimated that the average laden truck leaving the site will carry a 20 tonne payload of processed material. As indicated elsewhere in this EIS, however, recent changes to the regulations governing load limits are such that a maximum load of 33.5 tonne is now permissible.

The proposed daily operating hours at the site will be:

- 6:00 am to 6:00 pm Monday to Friday and
- 6:00 am to 1:00 pm on Saturday.

A maximum of 50 laden truck movements per day is proposed. This will amount to an annual maximum total of 479,050 tonnes of product transported from the site. As detailed in **Part 4.3** of this EIS, due to unforeseen circumstances, it is most likely that an average of 30 laden trucks per day would leave the site which would account for 286,000 tonnes of product being transported from the site per annum. For the purposes of this EIS, however, it is assumed that the maximum 50 laden truck movements per day will occur.

4.14 Distribution of Trucks to Main Road System

Trucks leaving the site will be distributed onto the main road system as follows:

- 40 per cent will travel south along Old Northern Road. These trucks will pass through survey counting Station 4 in Old Northern Road.
- 60 percent will travel west on Wisemans Ferry Road and pass through counting Station 3.

The number of laden and unladen trucks travelling on Wisemans Ferry Road and Old Northern Road has been estimated for each hour of the day Monday to Friday between 6:00 am and 6:00 pm and on Saturdays between 6:00 am and 1:00 pm, based upon the 60/40 split.

The increased hourly truck movements from and to the site are as detailed in **Table 4.5** below.

Table 4.5
Increased Truck Movements

Monday to Friday	Increase	Saturday	Increase
6:00 am - 7:00 am	6	6:00 am - 7:00 am	6
7:00 am - 8:00 am	6	7:00 am - 8:00 am	4
8:00 am - 5:00 pm	4	8:00 am - 11:00 am	4
5:00 pm - 6:00 pm	2	11:00 am - 12 noon	2
Total	50	12 noon - 1:00 pm	1
		Total	**25**

The increased trucks volumes are shown in Table C2 (Monday to Friday) and Table C5 (Saturday) of the traffic and transport report at **Appendix 15**. Existing and increased truck volumes are shown in Table C3 (Monday to Friday) and Table C6 (Saturday) of that report.

4.15 Projected Increase in Hourly and Daily Truck Movements on Main Road Network

As shown in Table C3 of the traffic and transport report, the maximum hourly generation rates inbound and outbound through Roberts Road on an average weekday will be between 3:00 am and 4:00 pm Monday to Friday. The truck movements are expected to be lower in the peak direction of flow during the normal 7:00 am to 8:00 am peak hour and in both directions in the 4:30 pm to 5:30 pm commuter peak hour.

During busy times, the site could generate up to a maximum of 50 laden and 50 unladen truck movements per day and the corresponding peak hourly rate would be 10 laden out and 10 unladen returning between 6:00 am and 7:00 am on weekdays as shown in **Table 4.6** below, however, since the applicant currently has approval for a maximum of 25 laden and 25 unladen trucks daily, the estimated maximum daily increase will be 25 laden and 25 unladen trucks.

The generation rates for Saturdays will be lower than weekdays. There will be no truck traffic generated on Sundays.

The existing trucks, estimated increased trucks and total trucks by direction by hour of the day, are shown in Tables C1, C2 and C3 for weekdays and in Tables C4, C5 and C6 for Saturdays in the traffic and transport report at **Appendix 15**.

The number of existing daily truck movements Monday to Friday (averaged) and Saturdays, increase generated by the proposed Development and total heavy truck movements are shown in Table 4.6 of the traffic and transport study and are summarised in **Table 4.7** below.

Since pavement design thicknesses are based upon the expected number of equivalent standard axle loadings it is relevant to consider the increase in heavy truck movements.

The figures have been totalled to show the increase for a full week (7 days) at each counting station location and the percentage increase compared with existing heavy truck volumes at each location.

Table 4.6
Maximum Hourly Truck Movements

Time	In (Empty)	Out (Loaded)
6 - 7 am	10	10
7 - 8 am	8	8
8 - 9 am	5	5
9 - 10 am	3	3
10 - 11 am	3	3
11 - 12 am	3	3
12 - 1 pm	3	3
1 - 2 pm	3	3
2 - 3 pm	3	3
3 - 4 pm	3	3
4 - 5 pm	3	3
5 - 6 pm	3	3
Total	50	50

Note: Maximum 20 movements per hour in any hour after 7:00 am

Table 4.7
Increased Heavy Truck Traffic on Weekdays and Saturdays

Route	Daily Increase in Heavy Trucks			
	Monday to Friday		Saturday	
	Number	Percent	Number	Percent
Roberts Rd	50	64.1	25	208.3
Wisemans Ferry Road west of Old Northern Road	30	14.25	15	9.49
Old Northern Road south of Roberts Road	20	9.37	10	7.46

4.16 Operation of Roberts Road / Old Northern Road Intersection

Allowing for variations in weather and market demand, the resource extraction is likely to be completed within fifteen years. Based upon an annual growth rate of 2 percent in Old Northern Road, through traffic volumes could increase by 34.6 per cent over fifteen years. Assuming a similar pattern to the existing site and hourly limits, the maximum hourly distribution of trucks to and from the site are listed in Table C2 for Mondays to Fridays and Table C5 for Saturdays in the traffic and transport report at **Appendix 15**.

The estimated maximum future peak hour volumes in 15 years, expressed in passenger car units (pcu's), at the intersection of Roberts Road with Old Northern Road are shown in Figure 8 of the traffic and transport report at **Appendix 15**.

Using INTANAL, it has been determined that the intersection will continue to operate at Level of Service A . The results are as detailed in **Table 4.8** below.

Table 4.8
INTANAL Analysis of Old Northern Road and Roberts Road Intersection

Scenario	Peak Hour	DoS	LoS	Max Delay (Sec/Veh)	Critical Movement
Future	am	0.02	A	8.2	Right Turn From Roberts
	pm	0.02	A	7.2	Right Turn From Roberts

Note: Each truck factored by 2 to achieve equivalent passenger units for analysis purpose.

4.17 Internal Access Road

Based upon Section 2.3 Transport in the Baulkham Hills Shire Council DCP No. 500, the standard of construction of the Internal Access Road should have a carriageway width of 12 metres as shown in Figure 4 of that document. A carriageway width of 10 metres is recommended as discussed in **Part 6.6.1** of this EIS.

4.18 Fire Control

Fixed and portable fire services are provided over the whole of the site as required by the relevant governing bodies.

4.19 Workforce

The personnel required for the operation of the development would include the following:

- One (1) scrapper operator
- One (1) front end loader operator
- One (1) process plant manager
- One (1) office worker
- One (1) site manager/general maintenance engineer

4.20 Services

Water to service the office complex is currently supplied from a rain water tank. That supply will remain as part of this development.

The office amenities are connected to a septic system. No change to the existing system is proposed.

Integral Energy has installed an underground high voltage electricity supply to the site. The location of that supply is generally along the alignment of the access road from Roberts Road to the processing plant. The electricity supply has been installed to convert the processing plant from diesel to electric power. In the event of power failure, the existing diesel generators will be utilised to ensure the integrity of the processing plant.

A 1,000 amp supply is available to the processing plant with a transformer located adjacent to the processing plant.

4.21 Fuel Storage

The scrapper, front end loaders and bulldozer (when required) will require diesel fuel for their operation. A 14,000 litre capacity overhead fuel tank is located on site adjacent to the processing plant. That tank is bunded so that the bunding will retain 110% of the capacity of the above ground tank. No alteration is proposed to the fuel storage as part of this application.

4.22 Hours of Operation

The proposed daily operating hours are as follows:

6:00 am to 6:00 pm Monday to Friday

6:00 am to 1:00 pm Saturday

Heavy machinery activity on the site will normally cease at 4:30 pm on weekdays.

4.23 Site Landscaping

The aims of the site landscaping and rehabilitation are to:

- Initially establish, within the boundary setback areas, extensive screen planting, supplemented with earth bunding where required, to provide for visual screening and noise control of the proposed extraction works.
- Ensure the extraction site is fully rehabilitated in an "orderly, progressive and controlled manner".
- Ensure that the proposed rehabilitation processes facilitate the successful establishment and on-going performance of the nominated end land-use for each disturbed area, namely:
  - Indigenous native vegetation to the majority (70 %) of the site
  - Unimproved pasture/existing facilities to remain (23 %)
  - Dams (7 %).
- Ensure that the progressively rehabilitated areas of the site are protected and monitored for the life of the development.

At the beginning of the project, and within the boundary setback zones, earth bunds shall be established. These bund walls and the remaining boundary setback areas will then be permanently mass planted with appropriate native plants for visual screening and noise attenuation purposes. Plan MP-01A of the rehabilitation report at **Appendix 14** shows the location and intent of these works.

Proposed bund walls - within the 30 metre setback zone to Old Northern Road and Roberts Road - are typically 23m wide, up to 3m high, and have a profile which portrays a 1 in 4 grade to the road frontage and a 1 in 3 interior grade. Service and maintenance access routes are proposed at the base of both the front and rear of these bund walls.

Nominated bund walls with the 10 metre setback zone along the northern property boundary, shall achieve a 2 metre height, as required for noise attenuation, and will therefore have 1 in 2 finished batter grades.

The bund walls will be constructed using overburden from the existing dam works, and capped with a 250 mm layer of site topsoil.

Within the extraction works areas, additional earth bunding will be provided around nominated works areas to provide additional visual screening and noise attenuation. These internal bunds will be temporary and as such, shall be stabilised with a grass cover crop.

Other aspects of the rehabilitation of the site, including:

- Protection of Existing Vegetation;
- Native Seed Collection;
- Removal of Vegetation;
- Topsoil Stripping and Storage;
- Treatment of Final Excavated Surfaces, and
- Maintenance

are discussed in detail in the rehabilitation report at **Appendix 14**.

4.24 Approvals Required

All relevant authorities were contacted with regard to approvals which have to be obtained as part of the development process. The following information is supplied:

EPA

The EPA has advised that a licence will be required under the Protection of the Environment Operations Act.

Department of Land and Water Conservation

The Department has advised that if water supply is intended to be obtained from surface or groundwater, a licence under the Water Act (1912) may be needed from the Department.

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Part Five

DEVELOPMENT JUSTIFICATION AND ALTERNATIVES

5.1 Development Alternatives

Alternatives to the proposed development have been considered as follows:

5.1.1 Location

The Applicant has only one holding in the Maroota area and as such there is no alternative than the subject land. The site has distinct advantages over and above other sites in the Sydney area as follows:

- The site is located within the area designated by the NSW State Government as containing significant extractive resources. The Government has considered the resource to be of such significance to include the Maroota area within its Sydney Regional Environmental Plan No.9 - Extractive Industry.
- There is limited development in the vicinity of the site which will be effected by the proposed development.

5.1.2 Production Method

The proposed method of extraction is by use of a scrapper and occasionally an excavator or bulldozer. The processing of the material will be undertaken using the existing wet processing plant on the site. This extraction method is far superior, in terms of environmental impact, than other methods such as blasting.

5.1.3 Non Development

The "do-nothing" option has been rejected on the following grounds:

- to do nothing would disregard the economic potential of the resource.
- an avenue for employment in the Maroota area would be lost.
- an opportunity to rehabilitate the entire site to close to its original bushland state would be lost.
- no significant environmental benefit would be gained by non-development whereas

significant environmental, social and economic benefit would be gained through concentrating extractive industry in the Maroota area as envisaged by the State Government when developing its Regional Environmental Plan - Extractive Industry.

5.2 Development Need and Justification

As detailed in the Planning Report which forms part of the documentation of Sydney Regional Environmental Plan No.9 - Extractive Industry (No.2):

> *"Sydney Regional Environmental Plan No.9 Extractive Industry (SREP No.9) was gazetted in October 1986. It aimed to help develop extractive industry resources close to the Sydney metropolitan area so that the cost of supplying materials to the community can be kept to a reasonable level. The plan identified and protected existing and potential extractive resource areas of regional significance."*

> *"The making of this plan will help to ensure that extractive resources continue to be made available for the construction and landscaping industries which is so important for our city's continued development."*

The above provides sufficient justification of the need for the resource and the location of the proposed extractive industry.

5.3 The Principles of Ecologically Sustainable Development

The Sydney metropolitan area will continue to demand resources for mortar sand, landscaping supplies and construction sand in general.

Schedule 2 of the Environmental Planning and Assessment Regulation, 1994 states that for the purposes of justification of a development having regard to the principles of ecologically sustainable development, the principles are:

(a) The precautionary principle - namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

(b) Inter-generational equity - namely, that the present generation should ensure that the health, diversity and productivity of the environmental is maintained or enhanced for the benefit of future generations.

(c) Conservation of biological diversity and ecological integrity.

(d) Improved valuation, pricing and incentive mechanisms - namely, that environmental factors should be included in the valuation of assets, and services.

The Precautionary Principle

The proposed development is for extraction of sand from a site where extraction has been occurring as part of the construction of a large dam. There will be no activities occurring on the site as part of the proposed development which have not occurred during the life of the dam construction. Indeed, management practices which will be employed as part of the proposed development will provide an improved extraction operation when compared to that which is currently operating on the site.

The only aspect of the proposed development which is irreversible is the depletion of the sand resource on the site. The State government has, through Sydney Regional Environmental Plan No.9 identified the sand resource in the Maroota area as being of regional significance to the construction industry in the Sydney metropolitan area. The scientific studies which have been undertaken as part of this EIS have demonstrated that the extraction of sand from the site will not provide a threat of serious environmental damage and the long term consequences of the extraction process will not provide irreversible damage to the environment.

Inter Generational Equity

The subject proposal has been designed to ensure that current and future generations in the Maroota area will not be adversely impacted by the proposed extraction. The plan of proposed extraction has been devised to ensure that groundwater utilised by market gardeners in the Maroota area will not be impacted by the proposed extraction.

Future generations will benefit from the resource which has been extracted, though the provision of quality construction and landscaping sand which is in demand in the Sydney construction market place in the long term.

The proposed progressive rehabilitation of the site will ensure that future generations will be left with a visually pleasing landscape. That landscape will be such that no evidence of extraction will be apparent.

Concerns of local residents have been addressed in the design of the proposed development and will be continually addressed through the environmental monitoring process which has been established on the site.

Conservation of Biodiversity and Ecological Integrity

The proposed extraction will have no impact either directly or indirectly on any species of fauna or its habitat. Indeed, the planned rehabilitation to bushland will provide habitat in an area of Maroota where little habitat remains.

One flora species has been identified on the Roberts Road boundary of the site as being worthy of preservation. That species has been preserved from extraction and the rehabilitation plan has incorporated that species into the bushland regeneration which will occur progressively over the site as the extraction progresses.

Improved valuation, pricing and incentive mechanisms

The content of this EIS provides details of the comprehensive studies which have been undertaken to ensure that the environmental values of the site and the environs of the site have been accounted for in the assessment of the value of the resource on the site. Those studies have identified that the groundwater resource on the site and one flora species are resources which should be valued in the development of the site as proposed. Those aspects of the environment have been preserved and in the long term will be enhanced as part of the development of the site.

In summary, the proposed development will provide:

- Increased access to sand resources in the regionally significant Maroota area;
- A means by which the land can be rehabilitated following extraction to provide for regenerated bushland and hence improve the environmental value of the site;
- Economic benefits to the Sydney construction and landscaping industries through the supply of quality sand resources in keeping with the regional significance of the area as recognised by the State Government;
- An avenue by which the economic value of the resource can be improved, and
- A resource based industry which will provide benefits to future generations.

5.4 Environmental Impact

The proposed development can be further justified as it will not cause any significant detrimental impacts on either the surrounding environment or local residents. These aspects are addressed in **Part 6** of the EIS.

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Part Six

IMPACT OF THE PROPOSED DEVELOPMENT

6.1 Planning Issues

The proposed facility is to be located on land to which Sydney Regional Environmental Plan No.9 - Extractive Industry applies. The proposed use is permitted, with consent.

The proposed facility is consistent with the long term land use planning for the site as indicated by the provisions of SREP No.9.

6.2 Air Quality

6.2.1 Air Quality Goals

As indicated elsewhere in this EIS, an air quality impact assessment has been prepared as part of this EIS, a copy of which is at **Appendix 10**. The following information is extracted from that study.

This section discusses air quality goals which currently apply in NSW. These goals are used to assess air quality impacts, but they are not formal standards in NSW, that is, they are not legally binding standards.

Concentration

In the following discussion, reference will be made to three classes of dust, $PM_{2.5}$, PM_{10} and Total Suspended Particulate matter (TSP). $PM_{2.5}$ refers to dust in the fine particle size range 0 to 2.5 µm. This dust can be inhaled into the deepest areas of the lung. PM_{10} dust relates to particles less than 10 µm aerodynamic size and TSP relates to all suspended particles (which are usually in the size range 0 to 50 µm, larger particles settling out too rapidly to be considered a significant air quality issue).

TSP concentration measurements therefore include PM_{10} particles and PM_{10} particles included $PM_{2.5}$ particles. Particles in the $PM_{2.5}$ and PM_{10} size range have recently become the focus of considerable scientific attention because of the strong correlation between excess mortality and fine particle concentration that has been noted in the Six Cities Study undertaken by Dockery et al. (1993) in the United States, and other studies. The correlation is weaker with TSP concentrations, presumably because a substantial fraction of TSP particles are too large to enter the sensitive areas of the respiratory system.

PM_{10} particle concentrations are of interest because these particles can reach the lower parts of the respiratory system by inhalation and can have health impacts as well as nuisance impacts. $PM_{2.5}$ particles are those which show the strongest association with health effects and it is possible

that in the future the air quality goals for the protection of human health will be expressed in terms of the concentrations of $PM_{2.5}$ rather than PM_{10} or TSP concentrations. The US EPA has recently reformulated its air quality standards for particulate matter to include concentration limits for $PM_{2.5}$.

In Australia, the National Environment Protection Council (NEPC) has determined a 24-hour PM_{10} goal of 50 $\mu g/m^3$, which is part of the National Environment Protection Measure (NEPM). It allows for five exceedances of the goal per year. The NSW EPA has historically noted the US EPA 24-hour standard of 150 $\mu g/m^3$ and an annual average standard of 50 $\mu g/m^3$ for PM_{10}. It has now adopted the NEPM 24-hour standard of μ50 g/m^3 and refers to a new annual average of 30 $\mu g/m^3$ as a long-term reporting goal. The NSW EPA goals are designed as regional goals and are therefore not intended to apply at the boundary of any particular development.

In assessing the impacts of the current proposal it is perhaps then more appropriate to use the US EPA goals at the lease boundary, in conjunction with their $PM_{2.5}$ goals of 65 $\mu g/m^3$ (24-hour) and 15 $\mu g/m^3$ (annual mean).

The NSW EPA also continues to note the NHMRC's 90 $\mu g/m^3$ annual average goal for total suspended particulate matter (TSP). This level is recommended as the maximum permissible level in urban environments.

$PM_{2.5}$ particles in the atmosphere are generally the result of combustion processes in motor vehicles, bushfire and industrial processes. Some $PM_{2.5}$ particles are generated by evaporation of sea-spray and from vegetation. Most quarrying dust is composed of coarser particles with a tendency to cause nuisance effects rather than pose a threat to human health. Work undertaken on behalf of the SPCC (1983), shows that close to dust sources on open cut mines the mass fraction of the $PM_{2.5}$, and PM_{10} in the TSP fraction of dust is approximately 6 per percent and 40 to 50 per cent respectively. These ratios are likely to apply for most operations where the dust is generated by the mechanical disturbance of dusty materials. **Table 6.1** summarises the goals discussed above.

Table 6.1
Air quality Standards/Goals for Particulate Matter Concentrations

Pollutant	Standard	Agency
Total Suspended particulate matter (TSP)	90 $\mu g/m^3$ (annual mean)	NHMRC
Particulate matter < 10 μm (PM_{10})	50 $\mu g/m^3$ (annual mean) 30 $\mu g/m^3$ (annual mean) 150 $\mu g/m^3$ (24-hour)[1] 50 $\mu g/m^3$ (24-hour)[2]	US EPA NEPM US EPA NEPM, NSW EPA
Particulate matter < 2.5 μm ($PM_{2.5}$)	15 $\mu g/m^3$ (annual mean) 65 $\mu g/m^3$ (24-hour)[2]	US EPA US EPA

[1] 99th percentile averaged over three years

[2] May be exceeded on five (5) occasions per year

Deposition

The EPA considers that residential areas begin to experience dust related nuisance impacts when annual average dust (insoluble solids) deposition levels exceed 4 g/m^2/month, and that dust impacts would be at unacceptable levels when they reach 10 g/m^2/month. In the early 1990s, the EPA refined these criteria. They are now expressed in terms of an acceptable increase in dust deposition over the existing background. **Table 6.2** shows the maximum acceptable increase in dust deposition over the existing dust levels.

For example, in residential areas with annual average deposition levels of between 0 and 2 g/m^2/month, an increase of up to 2 g/m^2/month would be permitted before it is considered that a significant degradation of air quality has occurred.

Table 6.2
EPA Criteria for Dust Fallout

Existing dust fallout level (g/m^2/month)	Maximum acceptable increase over existing fallout levels (g/m^2/month)	
	Residential	Other
2	2	2
3	1	2
4	0	1

6.2.2 Impacts on Air Quality Due to Existing Activities

Sand materials are currently being excavated to construct the dam near the northern site boundary. This material is being excavated using dredging methods. The dredged slurry is pumped to the processing plant where the sand is separated (washed and screened) and stockpiled. This material is then loaded into trucks and transported off-site. The residue clay slurry is pumped from the plant into sedimentation ponds and then into drying beds. The clay soils are collected and stockpiled and then transferred by front-end loader to the cut-off trenches for dam construction.

The main dust generating activities of those described above, include:

- bulldozers and front-end loaders on the clay drying area
- front-end loaders picking up stockpiled clay and dumping it to the cut-off trenches
- loading product sand to trucks
- transporting product sand off-site
- wind erosion from exposed clay drying areas and stockpiles

- wind erosion from sand stockpiles.

Appendix A of the air quality impact assessment at **Appendix 10** provides a detailed description of the calculations carried out in determining the emissions from each activity, and these are summarised in **Table 6.3** below.

Table 6.3
Estimated Dust Emissions for Existing Operations

Activity	TSP Emission Rate (kg/year)
Dozers on clay drying area	19,968
Transferring clay to cut-off trenches	88
Conveyer stacking stockpiles	13
Loading product to trucks	200
Hauling product off-site	96
Wind erosion from exposed areas	4,746
Wind erosion from stockpiles and processing area	803
Total	**25,914**

A modelling exercise was undertaken to estimate the contribution made by these existing operations to the background dust levels around the site. The emissions rates in **Table 6.3** were used, and the predicted concentrations and deposition rates due to these emissions, are shown in Figures 4 to 7 of the air quality impact assessment report at **Appendix 10**.

The estimate of dust concentrations and deposition rates have been made over an area of 6 km by 6 km, using ISCST3, the US EPA Industrial Source Complex model. The ISCST3 model makes predictions of dust concentration and deposition at a set of user specified grid points. For this study a grid spacing of 200 m has been used.

The highest levels for both short- and long-term predictions, occur in the north-eastern corner of the site. This is currently the main area of activity, where the clay is dried and then picked up to be relocated. It is also where most of the wind erosion would occur. Although there is not a high volume of material moved around on site, the triple handling of the clay and its high silt content make those operations particularly dusty. Emissions from these activities will be eliminated in the proposed operations as the clay will be piped to the clay drying areas in a slurry and will be spread in thin layers for drying. The clay will not be relocated elsewhere on the site as it will be utilised in the rehabilitation of the area within which it is dried..

The following paragraphs contain discussion about "background" levels, so it is necessary to briefly describe here what is meant by this term. Background concentrations or deposition levels refer to those levels which are due to all other sources except those being assessed. For example, in the area around the project site there will be other dust generating activities. These will include farming and ploughing of land, the spreading of fertilisers, other extractive industry sites, wind erosion of farmland,

bushfires and emissions from local traffic (particularly heavy vehicles). All these sources will produce particulate emissions which will contribute in varying degrees to the existing levels in the area, regardless of whether this project is operational. These levels are defined as "background" levels.

The locations where the dust deposition gauges are positioned are estimated to receive approximately 1 – 1.5 g/m^2/month due to the current activities. If the contribution from those activities is removed from the average of 3 g/m^2/month measured at those gauges, the background level due to other sources is likely to be of the order of 1.5 – 2 g/m^2/month. This is a typical background level expected in a rural environment where farming and other such activities are taking place. The allowable increase due to the proposed operations is therefore estimated to be approximately 2 – 2.5 g/m^2/month, before the 4 g/m^2/month is reached.

There are no monitoring data for airborne particulate matter to use in determining the background PM_{10} and TSP levels. The deposition monitoring discussed in the previous paragraph showed that approximately half of the current levels are due to emissions from the existing activities at the site. In the absence of particulate concentration monitoring it has been assumed that a similar value would apply for annual average PM_{10} and TSP levels. This is a conservative assumption as it is likely that the contribution from the existing activities is more than half at the closest residences (meaning a lower background).

It is estimated that the existing activities at the site contribute approximately 10 µg/m^3 and 15 µg/m^3 to the current annual average PM_{10} and TSP levels, respectively, at the nearest residences on Roberts Road. As discussed above, it has been conservatively assumed that half of the current levels are due to existing operations. In other words, the current annual average PM_{10} concentration would be of the order of 20 µg/m^3, 10 µg/m^3 of which is due to the existing operations at the project site. For TSP the argument is the same, meaning a current level of approximately 30 µg/m^3 (15 µg/m^3 contributed from existing activities at the site). The annual average background concentrations of PM_{10} and TSP would be of the order of 10 µg/m^3 and 15 µg/m^3, respectively.

Background levels for a 24-hour averaging period are more difficult to determine, as the maximum 24-hour PM_{10} concentrations will depend on the presence of nearby sources of particulate matter such as bushfire or remote sources such as dust storms. There is no reason to suppose that the highest concentrations produced from these sources will correlate with the worst-case conditions for the proposal. The dispersion modelling showed that the maximum 24-hour PM_{10} concentrations predicted for the most affected residences are approximately 50 µg/m^3, due to existing operations at the site. These levels are not unusual, given the closeness of these receptors to the existing operations, and as will be shown in the following sections of the EIS, the levels are not significantly different from those anticipated for the proposed operations.

6.2.3 Estimated Emissions from the Proposed Operation

Dust emissions have been estimated by analysing the proposed extraction operations. It is not anticipated that the level of activity or the mode of operation will change substantially over the life span of the project once maximum production levels have been reached.

The operations which apply at the site have been combined with emission factors developed, both

locally and by the US EPA, to estimate the amount of total suspended particulate (TSP) produced by each activity. Estimated emission totals are presented in **Table 6.4**, and details of the calculations are presented in Appendix A of the air quality assessment report at **Appendix 10**. It has been assumed that the extraction operation will be operating at a production rate of 286,000 tonnes of sand per year, from the 408,890 tonnes per year excavated. This is assuming a maximum excavation rate of 1,430 tonnes per day for 5.5 days per week, 30% of which is "reject" clay material.

Table 6.4
Estimated Dust Emissions For Extraction Operations

Activity	TSP Emission Rate (kg/year)
Scraper excavating material	11,860
Scraper transporting material to processing plant	2,340
Conveyer stacking screened material	449[1]
Loading product to trucks	7,150
Hauling product off-site	8,580
Wind erosion from exposed extraction area	4,746
Wind erosion from stockpiles and processing area	803
Total	**34,742**

[1] This is an approximate value for the year and will vary from hour to hour depending on the wind speed.

6.2.4 Assessment of Impact of Proposed Operations

The ISCST3 model has been used to predict dust concentrations and deposition levels for each grid receptor and residence near the site to determine whether or not the EPA short-term PM_{10} goals are met by the proposed operations. Dust deposition has been averaged over the year and expressed as monthly deposition levels. Results are presented in Figures 8 to 15 of the air quality assessment report at **Appendix 10** and discussed below with reference to the individual goals.

Concentration

Short-term concentration

The predicted maximum 24-hour $PM_{2.5}$ concentrations due to proposed operations at the extraction site, are shown in Figure 8 of the air quality assessment report at **Appendix 10**. Predicted levels at all residences are expected to be below 10 $\mu g/m^3$. This is well below the short-term US EPA goal of 65 $\mu g/m^3$.

Figure 9 of the air quality assessment report at **Appendix 10** shows the predicted maximum 24-

hour PM_{10} concentration in the area around the proposed site. The predicted 24-hour PM_{10} concentrations at the nearest residences are slightly less than 50 $\mu g/m^3$. As discussed in **Part 6** of this EIS, it is impossible to determine a 24-hour average background PM_{10} concentration without monitoring data. Without contemporaneous meteorological and monitoring data it is also impossible to determine whether or not the maximum predicted 24-hour PM_{10} concentration will occur under conditions which produce the worst-case background levels. The best that can be done is to show that the levels which are predicted to occur for the proposed operations are almost identical to those estimated for existing activities.

It must also be remembered that this is a worst-case assessment for these residences, since the active extraction cell will not always be in the northeast corner of the site. At other times during the year, and throughout the life of the project, the main dust producing activities will be occurring further away from these residences.

The US EPA short-term goal of 150 $\mu g/m^3$ is not predicted to be exceeded at any residence. This is the most appropriate goal for this assessment. Background concentrations would need to be of the order of 100 $\mu g/m^3$ or more for the US EPA short-term PM_{10} goal to be exceeded, and this is unlikely to be the case.

The NEPM 24-hour goal on which the NSW EPA goal is based, allows five exceedances of 50 $\mu g/m^3$ per year. Figure 10 of the air quality assessment report at **Appendix 10** shows the predicted sixth highest 24-hour PM_{10} concentration due to proposed on-site operations. It is shown that all residences lie outside the 50 $\mu g/m^3$ contour.

Figure 11 of the air quality impact assessment at **Appendix 10** shows a time series of 24-hour average PM_{10} concentrations at the most affected residence, indicating that the majority of predicted levels are below 30 $\mu g/m^3$. The sixth highest predicted PM_{10} level at this residence is approximately 31 $\mu g/m^3$. A background of 19 $\mu g/m^3$ would therefore be required to cause an exceedance of the NSW EPA goal. It is likely that this could occur under worst-case conditions, but as discussed previously, the more appropriate goal for assessing this proposal is the US EPA 24-hour goal of 150 $\mu g/m^3$. It should also be remembered that when the operations move away from the northeast corner, 24-hour concentrations due to on-site operations will be reduced significantly.

Long-term concentration

Predicted annual average $PM_{2.5}$ levels are shown in Figure 12 of the air quality assessment report at **Appendix 10** to be well below the US EPA goal of 15 $\mu g/m^3$. The highest $PM_{2.5}$ prediction at the most affected residence is less than 2 $\mu g/m^3$.

Figure 13 of the air quality assessment report at **Appendix 10** shows that predicted PM_{10} levels, due to the proposed operations, are expected to remain well below the US EPA annual goal of 50 $\mu g/m^3$, with the concentration at the most affected residence estimated to be approximately 10 $\mu g/m^3$. When added to an estimated background level of 10 $\mu g/m^3$, the proposal is not anticipated to exceed the annual goal.

Figure 14 of the air quality assessment report at **Appendix 10** shows the predicted annual average TSP concentrations due to emissions from the site. The most affected residence is predicted to

experience an increase in annual TSP concentration of approximately than 20 $\mu g/m^3$. This is well below the NHMRC annual goal of 90 $\mu g/m^3$ and this goal is not expected to be exceeded even when added to estimated existing levels of 15 $\mu g/m^3$.

Deposition

Annual average dust deposition rates of approximately 4 g/m^2/month are currently experienced at the Maroota Public School and areas to the west. This allows for almost no contribution to deposition levels in those areas from the proposed operations. As shown in Figure 15 of the air quality assessment report at **Appendix 10**, the levels predicted for areas north of the current study area are negligible.

It is argued that an appropriate background deposition level (excluding existing operations on the site), would be approximately 1.5 - 2 g/m^2/month, which would allow for an increase in the order of 2 - 2.5 g/m^2/month. Figure 15 of the air quality assessment report at **Appendix 10** shows that the levels predicted at the nearest residences are approximately 2 g/m^2/month. The EPA annual average goal of 4 g/m^2/month is therefore not expected to be exceeded due to emissions from the proposed operations. Levels are expected to be similar to those which are currently experienced at the site. It must also be remembered that as the excavation operations move further to the south and west, most of the emission sources will also be relocated. The deposition levels at these residences on Roberts Road are therefore likely to decrease significantly as this occurs.

The assessment has shown that the operations are predicted to comply with both the long-term and short-term concentration goals, as well as the deposition goals. Indeed, in some cases, it may be that the dust levels decrease with the proposed development, as the activities move further away from Roberts Road during the life of the project.

6.3 Noise

6.3.1 Acoustic Criteria

As indicated in **Part 3** of this EIS, an acoustic impact assessment has been undertaken as part of the assessment process, a copy of which is at **Appendix 11**. The following information draws from that study.

The noise emissions from the sand extraction and processing operations are required to satisfy specific Baulkham Hills Shire Council and NSW EPA acoustic criteria.

Baulkham Hills Shire Council DCP No. 500

Section 2.9 of DCP No.500 outlines the acoustic criteria for extractive industries. The objectives of the criteria are:

"• *To maintain the acoustic quality of the Shire;*

• *To protect and maintain the acoustic environment of residents, Public & Community facilities and other receivers in the Shire; and*

• *To limit the potential offensiveness of noise from specific sources."*

The key prescriptive measures outlined in Section 2.9 include:

"• *Proponents should ensure that the maximum average noise emission level of extraction is no more than 5 dBA above maximum average background noise levels;*

• *Extraction activities should not occur within 100 metres of a residence not associated with the activities;*

• *Proponents should ensure that noise emissions meet all minimum acoustic standards defined in Chapters 19, 20 and 21 of the Environmental Noise Control Manual, 1994."*

Existing NSW EPA Assessment Criteria

The EPA has overall responsibility for setting noise quality objectives from industrial premises. The primary aim of environmental noise control is to minimise the occurrence of offensive noise in the community. It is considered that to be both effective and equitable, the determination and application of environmental noise control must take into account many factors, including:-

- the variation in response between individuals to any noise;
- the inherently noisy characteristics of many activities;
- the circumstances within which noise occurs;
- potential for annoyance and reduction in acoustic amenity;
- the technical and economic feasibility for noise control, and
- social worth of the activity.

The noise emissions from the proposed extraction and processing operations are required to satisfy specific EPA acoustic criteria. The broad environmental noise objectives are two-fold:

(i) that noise from any single source does not intrude greatly above the prevailing background noise level, and

(ii) that the background noise level does not exceed the level appropriate for a particular locality or land use.

The normal EPA noise criteria for continuous industrial type noise which are most relevant to the proposed extraction are stated in **Table 6.6**.

Table 6.6
Recommended Outdoor Background Noise Levels

Predominant Land Use Receiver	Time Period	L_{A90} Background Acceptable Level	Noise Level(dBA) Extreme Limit
Residential, Rural	Day Night	45 35	50 40

From Monday to Saturday, day time is defined as 7:00 am to 10:00 pm and night time 10:00 pm to 7:00 am and night time is 10:00 pm to 7:00 am.

Recommended planning levels, sleep disturbance criteria, construction noise criteria and traffic noise criteria are discussed in more detail in Section 3 of the acoustic study at **Appendix 11**.

6.3.2 Design Objectives

Current ambient noise levels at Locations A and B exceed recommended planning levels. Therefore, noise design objectives shall aim to reduce overall noise emissions from the site, however, the design objectives should not be so low as to be practically unachievable. The restriction of activities so as to make the proposal not economically viable would be against the objectives of the NSW EPA guidelines.

The results of the noise modelling presented in the acoustic study show that current noise emissions from the site are approximately 60 dBA at Locations A and B. This is supported by the unattended noise monitoring results and the observations during logger establishment and retrieval.

An L_{A10} noise design objective of 45 dBA at the nearest residences during the 7:00 am to 6:00 pm period and 40 dBA at the nearest residences during the 6:00 am to 7:00 am period will provide

a significant improvement in the ambient noise environment. These objectives are expected to ensure that the potential for residential annoyance is minimal.

The noise emissions from the site are a primary contributor to noise levels at the residential locations. Therefore, maintaining the objectives presented above shall ensure that the NSW EPA planning levels are not exceeded. The noise management plan for the site shall also aim at maintaining ambient noise levels below the planning levels.

6.3.3 Predicted Noise Levels

The proposed operations on site include the extraction and processing of sand as well as the construction of a water storage dam. There are several operations with the potential to generate excessive noise.

The plant, when the acoustic impact assessment report was undertaken, was powered by a diesel generator, however, the plant has been modified to support electrical power which is now operational.

Noise source data were obtained from each of the mobile and stationary sources during normal operations. Noise source levels for the extraction operations were measured at similar sand quarries. The measurements were carried out using a Rion NA27E Precision Sound Level Meter. The instrument was calibrated before and after use with a Rion calibrator. There were no significant variances between pre and post measurement reference signals. Weather conditions were satisfactory for noise measurement.

The noise source data is summarised in Table 5.1 of the acoustic study at **Appendix 11**. The data has been used to model noise emissions from the site at the nearest sensitive receivers.

The predicted noise levels have been calculated on the following basis:

- Use of the environmental noise model ENM Version 3.06. This model is recommended by the NSW EPA for noise modelling.

- Ground contours developed from the site survey plans included in the Conceptual Mine Plan and the CMA Topographic Map for Lower Portland (1:25,000).

- L_{A10} octave band noise source data presented in Table 5.1 of the acoustic study at **Appendix 11**.

- Meteorological conditions consisting of:

- still wind;
- moderate relative humidity and moderate air temperature, and
- stability class D,

providing neutral to slightly adverse conditions.

Several scenarios were modelled with the aim of providing a comprehensive assessment of all likely situations during the development of the quarry. Furthermore, extraction scenarios were modelled with mobile equipment operating at the natural surface level (designated "A" in **Table 6.7**) and at depth (designated "B" in **Table 6.7**). Extraction scenarios include operations at various areas of the site. The cells were developed in the extraction plan. Extraction will only occur in one cell at a time.

Modelling was carried out for typical normal operations and maximum operations. Whilst it is unlikely that all noise sources will be operating at peak capacity and simultaneously, it is necessary to assess this situation.

The details of each scenario are presented in Table 5.2 of the acoustic study at **Appendix 11**.

The results of the point to point modelling are presented in **Table 6.7** below.

The results shown shaded in **Table 6.7** exceed the noise design objectives. Although the modelling scenarios are based on peak operations and conservative modelling factors have been used, the results demonstrate that there is potential for adverse noise emissions if the operations are not adequately managed.

The predicted noise levels for the existing operations are close to the measured noise levels during the unattended monitoring at each location, however, the predicted levels are only reached on some occasions. This demonstrates the conservative nature of the modelling.

In order to reduce predicted noise emissions, the design of noise controls have been carried out. Using the ENM model, the effect of constructing several permanent earth berms along the site boundaries and temporary earth berms around active extraction cells has been assessed.

The following earth berms have been included in the noise model:

- a 3 m permanent earth berm around the north-eastern boundary corner and extending along the eastern boundary to the site entrance.
- a 2 m permanent earth berm along the north-eastern section of the northern boundary.
- a 3 m temporary earth berms around the active extraction cell.

Figure 22 shows the location of the proposed earth berms.

Table 6.7
Predicted Noise Levels from Site Operations

Scenario	Location A	Location B	Location C
Daytime Design Objective	45	45	45
1	54.4	64	45.4
2A	64.5	69.3	48.1
2B	51.4	52.9	40.9
3A	66.9	73	50.2
3B	52.9	54.1	42.2
4A	58.8	65	48.3
4B	52.4	64.2	42.5
5A	61.2	66.1	51.3
5B	52.5	64.2	44.4
6A	55.5	64.2	41.7
6B	52.2	61.2	42.3
7A	62	66	48.6
7B	52.2	61.2	43
8A	56.5	64.5	46.5
8B	50.9	64.2	42
9A	58.9	65	49.2
9B	51.2	65.4	43.7
Shoulder Period Design Objective	40	40	40
10	37.4	51.5	35

Furthermore, the diesel generator used on the site during the undertaking of the acoustic study will no longer be used following commencement of extraction operations. Electrical power will be used for the plant and, therefore, the diesel generator has been removed from this second round of modelling.

Point to point calculations were again carried out using the ENM model with the inclusion of the

noise controls. The results of the revised modelling are presented in **Table 6.8** below.

Table 6.8
Predicted Noise Levels from Site Operations with Controls in Place

Scenario	Location A	Location B	Location C
Daytime Design Objective	45	45	45
1	43.2	45.2	43.1
2A	43.6	46.4	37.5
2B	42.8	44.8	36
3A	45.8	54.7	43.8
3B	44.8	49.6	39.2
4A	45.5	47.8	47.6
4B	40.7	43.3	38.7
5A	47.9	52.2	51.1
5B	42.4	45.2	42.5
6A	41.1	45.8	36.8
6B	40.8	42.5	36.5
7A	42.8	47.9	39.7
7B	42.4	45.6	39.3
8A	45.4	45.1	45.4
8B	40.5	42.3	38.4
9A	48	48.5	48.7
9B	42.4	45.5	41.2
Shoulder Period Design Objective	40	40	40
10	34.6	39.7	34.3

The shaded results exceed the design objectives.

The results presented in **Table 6.8** demonstrate that, following the construction of the earth berms, noise emissions will be significantly attenuated. Whilst the predicted levels do not comply with the design objectives for several scenarios, the objective is only exceeded by 1 – 2 dBA for the majority of these cases. There are several points that should also be considered:

(a) the modelling scenarios for maximum operations are based on all equipment operating at peak output. This would only occur on rare occasions and, therefore, designing for compliance with the L_{A10} noise objective may be overly stringent.

(b) The modelling results for existing operations with no controls demonstrated that the model is conservative. The results of the unattended monitoring show that the predicted L_{A10} noise levels are only reached occasionally. Therefore, the predicted noise levels for the proposed operations may also be considered as conservative and actual noise levels may only reach the predicted values occasionally.

(c) The predicted noise levels show that the total noise impact from the site will be significantly reduced when compared to existing. Discussions with residents have found that they are not annoyed by noise emissions from the current operations. Although the design objectives may be slightly exceeded, a reduction in noise levels will ensure that potential for annoyance is further minimised.

(d) As detailed in Table 5.2 of the acoustic study at **Appendix 11**, a dozer was included in each of the maximum operation scenarios. Analysis of the model outputs has found that the dozer contributes significantly to the combined predicted level. For example, in Scenario 3A, the predicted combined noise level was 54.7 dBA at Location B; the highest predicted noise level of all scenarios, however, the predicted noise level from the dozer alone was 53.6 dBA. All other sources were below 46 dBA.

The dozer will only be used when the material cannot be excavated using a scraper or excavator. Discussions with site management have found that this will be rare.

The results of the modelling for the 6:00 am to 7:00 am period comply with the design objective. The modelling assumes that a truck and front end loader will operate during this period only. The plant and other mobile equipment will not commence operations until after 7:00 am.

6.3.4 Road Traffic Noise

This section details the predicted impact of road traffic noise from the proposed quarry. Details of the proposed transport movements and routes were extracted from the traffic investigation carried out by Lyle Marshall & Associates Pty Ltd.

The maximum daily laden truck movements from the site will be 50 (100 total movements). The average daily laden truck movements from the site will be 30 (60 total movements).

The maximum and average hourly truck movements are presented in **Table 6.9**.

Table 6.9
Maximum and Average Hourly Truck Movements

Time	Average Movements		Maximum Movements	
	In (empty)	Out (loaded)	In (empty)	Out (loaded)
6am - 7am	7	7	10	10
7am - 8am	3	3	8	8
8am - 9am	2	2	5	5
9am - 10am	2	2	3	3
10am - 11am	2	2	3	3
11am - 12pm	2	2	3	3
12pm - 1pm	2	2	3	3
1pm - 2pm	2	2	3	3
2pm - 3pm	2	2	3	3
3pm - 4pm	2	2	3	3
4pm - 5pm	2	2	3	3
5pm - 6pm	2	2	3	3
Total	**30**	**30**	**50**	**50**

The main transport routes for the proposed operations are as follows :

- Trucks will exit the site onto Roberts Road (heading west).
- At the intersection of Roberts Road with Old Northern Road, approximately 40% of trucks will turn left and travel along Old Northern Road (heading south).
- The remaining 60% of trucks will turn right at old Northern Road and then left at Wisemans Ferry Road to head west.

Traffic counts have been undertaken as part of the preparation of this EIS and are contained in the report of Lyle Marshall & Associates at **Appendix 15**.

TNOISE Modelling

The traffic noise computer model - TNOISE which is based on the "Calculation of Road Traffic Noise" by the UK Department of Transport, 1988, was utilised to predict the impact of proposed increases in truck movements along the two proposed routes. The predicted impact is based on

modelling of semi-trailer trucks, which are typical for the transport of sand. Traffic noise levels have been predicted based on the measured traffic flows at the two residential locations where existing traffic noise levels were monitored. These are:

Location D: Residence at Maroota Motors Pty Ltd, Corner of Old Northern Road and Roberts Road, Maroota.

Location E: Residence at the corner of Wisemans Ferry Road and Haerses Road, Maroota.

The purpose of the traffic noise modelling for existing flows is to calibrate the model. Several site specific factors need to be calibrated for each location. Predicted $L_{Aeq(15hr)}$, $L_{Aeq(9hr)}$ and $L_{Aeq,24hr}$ noise levels were used to assess the calibration against the measured noise levels. The results of the calibration are presented in Table 5.7 of the acoustic study at **Appendix 11**. A reasonably accurate calibration of the traffic noise model has been achieved. All modelled noise levels are within 3 dBA of the measured noise level.

The TNOISE model can now be used to predict the hourly increase in L_{Aeq} noise levels due to the increase in traffic movements from the site. The existing hourly L_{Aeq} noise level was modelled for each location using the calibrated TNOISE model. The hourly L_{Aeq} noise levels were then modelled again with the inclusion of the anticipated truck movements from the site. The maximum hourly movements have been used in the modelling in order to provide a conservative assessment. The results are presented in **Tables 6.10 and 6.11**.

Table 6.10
Modelled Hourly L_{Aeq} Noise Levels (dBA) - Location D

Period	Modelled Existing L_{Aeq}	Modelled Proposed L_{Aeq}	Increase
6am - 7am	53.7	54	0.3
7am - 8am	54.6	54.9	0.3
8am - 9am	54.7	55	0.3
9am - 10am	54.2	54.3	0.1
10am - 11am	54.3	54.4	0.1
11am - 12pm	54.6	54.8	0.2
12pm - 1pm	54.3	54.4	0.2
1pm - 2pm	54.7	54.8	0.1
2pm - 3pm	55.1	55.2	0.1
3pm - 4pm	55.2	55.3	0.1
4pm - 5pm	55.9	56	0.1
5pm - 6pm	55.5	55.6	0.1

Table 6.11
Modelled Hourly L_{Aeq} Noise Levels (dBA) - Location E

Period	Modelled Existing L_{Aeq}	Modelled Proposed L_{Aeq}	Increase
6am - 7am	52.4	52.9	0.5
7am - 8am	53.6	53.9	0.3
8am - 9am	53.1	53.3	0.2
9am - 10am	53.0	53.1	0.1
10am - 11am	52.3	52.5	0.2
11am - 12pm	52.3	52.5	0.2
12pm - 1pm	52.6	52.8	0.2
1pm - 2pm	52.3	52.5	0.2
2pm - 3pm	52.6	52.8	0.2
3pm - 4pm	53.3	53.4	0.1
4pm - 5pm	53.8	54.0	0.2
5pm - 6pm	53.6	53.7	0.1

The modelling was carried out based on the maximum anticipated truck movements. Average truck movements would generate lower road traffic noise levels. The results of the modelling show that the increase in hourly L_{Aeq} noise levels is well below 2 dBA for both location D and E.

It should be noted that there are no residential premises located in Roberts Road between the site entrance and Old Northern Road. The traffic noise assessment has therefore been limited to residences along Old Northern Road and Wisemans Ferry Road.

The assessment which has been undertaken has found that the use of earth berms and the implementation of a noise management plan would provide significant noise control. The mobile equipment in use generates noise levels free of tonal or other annoying characteristics.

The predicted noise emissions, with noise controls in place, represent a significant improvement in current noise emissions from the site. There have been no known complaints lodged with management of the site regarding excessive noise from the current operations. Furthermore, discussions with residents at the most potentially affected locations have found that they are not annoyed by noise from the site and are generally supportive of the site management. Following the implementation of controls and a comprehensive noise management plan, it is considered unlikely that noise levels at the residents will cause concern.

6.4 Visual Impacts

The extraction areas will be progressively rehabilitated so that vegetative cover is established at the earliest possible opportunity, thus minimising the extent of disturbed land within each extraction cell, and ensuring that any potential visual impact has a limited life.

The Environmental Management and Rehabilitation Plan will provide detailed staging plans for the excavation and progressive rehabilitation of the works.

The extraction process will entail operating in cells approximately 1 ha in area. It is intended that 3 cells will be open at any one time as follows:

- The newest cell will be extracted
- The previous cell will be used for clay drying
- The oldest cell will be rehabilitated.

It is proposed that, as part of the progress rehabilitation process and the on-going maintenance of these works, management plans will be prepared and updated on a yearly basis. These management plans will outline what has been achieved in the previous year and what is proposed in the upcoming year.

It is proposed that if the methods outlined in the rehabilitation report at **Appendix 14** are followed, then:

- The nominated extraction areas can be successfully rehabilitated, re-establishing an extensive native vegetation cover.
- The rehabilitation process can be staged in a progressive manner to limit possible visual impacts resulting from the excavation works.
- Appropriate standards will be set for the on-going monitoring of the rehabilitation process and maintenance works to ensure the successful establishment and on-going performance of these rehabilitation areas.

6.5 Waste Impacts

The proposed facility will not generate significant waste. That waste which will be generated includes the general waste from the office complex and staff amenities, and reject material for the

extraction process.

All waste from the amenities complex and office will be collected in a commercial waste bin and taken to landfill either through the Council garbage collection or by private contractor.

Waste material from the extraction process will be used as fill material during the rehabilitation of the site.

6.6 Traffic Impacts

6.6.1 Internal Access Road

The internal access road will extend from the site entrance in Roberts Road to the existing processing plant. The existing access road is in poor condition and needs to be upgraded. Off road type vehicles such as scrapers do not use this road and therefore the road pavement should be designed for heavy trucks. On an average weekday over the estimated 15 year life of the project, the number of heavy truck movements will be 60 per day. Although the future total traffic volumes will be less than 100 vehicles per day, the percentage of heavy trucks will be around 60 per cent and therefore a pavement width of 7 metres should be provided based upon Austroads Table 4.1 Traffic Lane Widths for Undivided Sealed Roads.

It is desirable that the road pavement be sealed with a hot flush bitumen seal to eliminate dust. A suitable typical cross section for the internal haul road is shown in Figure 10 of the traffic and transport report at **Appendix 15**. It is recommended that the road be signposted for 20 km/hour operation for safety and environmental reasons.

6.6.2 Operation of Roberts Road/Old Northern Road Intersection

Traffic counts over a number of years show that Annual Average Daily Traffic Volumes in Old Northern Road at Maroota are increasing at 2 per cent per annum. The estimated intersection turning volumes at the intersection of Roberts Road with Old Northern Road on a weekday after 15 years are shown in Figure 8 of the traffic and transport report and reproduced as **Figure 25** of this EIS.

An INTANAL analysis shows that the current intersection, which has been upgraded recently to include a sheltered right turn bay, will continue to operate at Level of Service A to the end of the project.

The sight distance in Old Northern Road and south of Roberts Road are considered satisfactory for a speed of 100 km/hour.

No intersection improvements, except for double centreline markings in Roberts Road for 30 metres from Old Northern Road, are required.

6.6.3 Increased Truck Traffic in Main Road System

The increase in heavy truck traffic generated by this development is estimated to be 30 truck movements per day (Monday to Friday) in Wisemans Ferry Road west of Old Northern Road and 20 truck movements per day in Old Northern Road south of Roberts Road. These increases amount to 14.25 per cent and 9.37 percent respectively.

These increases are relatively small and will not reduce the Level of Service at either the intersection of Roberts Road with Old Northern Road or in Wisemans Ferry Road and Old Northern Road.

6.7 Social and Economic Impacts

The Baulkham Hills DCP No.500, at its Section 2.13, provides details of the Social and Economic Impact Assessment which might be undertaken as part of the preparation of an EIS for extraction. The objectives of the DCP in this regard are:

- to facilitate and encourage Community participation, and

- to encourage and promote employment associated with or linked to Extractive Industries.

In order to ascertain the concerns of the local community, a 3 March, 1999 site meeting was held to discuss the proposed development which was then in its concept development stage and to seek the input from both the Community and Statutory Authorities. Those invited to attend the meeting included:

- Wisemans Ferry & District Progress Association
- Streamwatch Co-ordinator, Little Cattai/Glenorie School Stream Watch
- Glenorie Progress Association
- Maroota Planning Group
- Maroota and District Residents Association Inc.
- Annangrove Progress Association

- Maroota Public School Parents and Citizens Association
- The Principal Maroota Public School
- Cattai Catchment Management Committee
- Hornsby Shire Council
- NSW Department of Urban Affairs and Planning
- Baulkham Hills Shire Council
- Hawkesbury Nepean Catchment Management Trust
- National Parks and Wildlife Service
- Roads and Traffic Authority
- Environment Protection Authority
- Department of Land and Water Conservation.

All consultants undertaking studies relating to the EIS preparation were in attendance to provide information to those who attended the meeting and to answer any questions which arose. The main concerns which were raised at the meeting related to:

- Traffic impact
- Uncovered loads
- The number of trucks
- The visual impact of the existing dam construction
- The impact of extraction on groundwater
- Dust and other impacts at the Maroota School
- Final rehabilitated landform
- The lack of knowledge with regard to the existing dam construction.

The impact of the proposed development upon the local community has been carefully considered and measures devised to protect the local amenity. These include:

- provision of noise attenuation measures including the location of earth berms at locations suggested in the Acoustic Study at **Appendix 11**.

- control of pollution at all stages of development.

- the provision of landscaping and visual barriers to provide a screen to the proposed development and provide a more attractive vista. In this regard, a perimeter landscape plan has been devised by Scott Murray and Associates to assist in the mitigation of the visual impact of the existing dam construction on the site. That plan has been submitted to Baulkham Hills Shire Council as a Development Application separate to this application process. At time of writing, no decision had been made by the Council on that application.

- the establishment of quality groundwater monitoring bores which will provide information to the Department of Land and Water Conservation in its continuing groundwater monitoring in the Maroota.

The proposed development will have the following economic benefits:

- the creation of employment in the Maroota area.
- payment of section 94 contributions for the continued maintenance of Old Northern Road and Wisemans Ferry Road.
- the provision of additional income to local businesses and suppliers.
- a continuation of the supply of quality sand products to the Sydney market at reasonable prices.
- continued employment of truck drivers and those employed in landscaping businesses and the like which will utilise the extracted product.

6.8 Groundwater

From a surface and groundwater viewpoint, potential adverse impacts could be considered to be:

- reduced groundwater availability to users.
- aquifer contamination.
- reduced flow to streams.
- increased turbidity to streams.
- water table lowering.

6.8.1 Reduced Groundwater Availability

Baulkham Hills Shire Council Development Control Plan No 500 - Extractive Industries, dictates that any excavation in the area must remain 2 m above the high wet weather water table.

It is possible that the original excavation on the property was taken initially to below the water table in the Maroota Sand, however, the proposed development will operate on the basis of a closed water circuit.

The water level in the operating dam appears to fluctuate substantially in response to rainfall events, as the property is almost entirely internally draining, with the exclusion of the western portion where run-off is captured by the two existing large dams. The water level appears to be maintained at high levels for several days following rainfall events. During these periods at least, a potential for groundwater recharge exists via the walls of the excavations by the maintenance of a positive groundwater gradient away from the pond.

No mitigation measures against reduced groundwater availability will be required because sand mining will not be carried out below the water table, the aquifer will not be disturbed and no groundwater will be extracted from the shallow aquifer for the purpose of extraction. Because no additional groundwater pumping will occur, no additional effects above the present conditions can be expected. On the contrary, the increased potential for groundwater recharge to the shallow aquifer means that a potential benefit may be derived by nearby users.

At present, the only data on groundwater users and bores in the area are those obtainable from the Department of Land and Water Conservation (DLWC) record section. During Stage 1 of the Maroota Groundwater Study, the DLWC carried out a survey of all surface water and groundwater users in the area and the results of the survey were appended to that report. No further assessment of those data was carried out as part of the Stage 2 report and no attempt was made to estimate the groundwater component of the water stored in dams and excavations which also receive run-off from rainfall.

6.8.2 Aquifer Contamination

Under the current approval, sand extraction at the site is carried out by a floating dredge which breaks down the sides of the excavation by high pressure water jetting. The sand and water slurry is then pumped to the plant, where sand and water are separated and the water returned to the dam.

The potential for aquifer contamination exists via infiltration of contaminated water to the aquifer, which can occur from every excavation in the shallow aquifer in the Maroota area. At the subject site, the existing potential contaminant is considered to be fuel spillages from the operating dredge. The dredge will not be used as part of the now proposed dry extraction process and as such this potential source of groundwater contamination will be removed.

Potential fuel spillages from machinery to be used on the site need to be addressed as part of the site management plan. With proper remedial measures, it is considered that the potential for aquifer contamination is negligible.

6.8.3 Reduced Flow to Streams

Perched water tables in the Maroota Sand and in the weathered profile of the Hawkesbury Sandstone are capable of providing contributions to stream flows where these streams have been eroded to the level of the bedrock. This is particularly the case along the perimeter of the Maroota Sand outcrop. Seepage zones have been identified at some distance from the site and drainage or removal of perched groundwater bodies could cause a reduction of stream flow. It is not known what percentage of stream flow is due to natural drainage of perched water tables, to bank storage and to catchment run-off.

The increased amount of recharge to the shallow aquifer, which will occur as excavation progresses, is likely to create a mound in the water table under and around the site. This mound will dissipate within the rock mass at a rate dictated by the permeability of the formation and the new hydraulic gradients.

It is considered that no mitigation measures are required to be implemented for the maintenance of stream flow. The regional shallow water table, which is considered to be the main contributor to stream flow after run-off, will be unaffected by the extraction operations.

6.8.4 Increased Turbidity to Streams

The proposed development is entirely internally draining. Run-off is currently directed to the two large dams on the site and into the existing excavation. Release of turbid water from the site is most unlikely to occur even following heavy storms.

Mitigation measures to prevent and offset the release of turbid water from the site are contained in the Strategy for Surface Water Management at **Appendix 7** and will be reported upon in the annual Environmental Management and Rehabilitation Plan for the site.

6.8.5 Water Table Lowering

It has been mentioned in previous parts of this EIS that extraction will not be taken within two metres of the water table and no groundwater from the shallow aquifer will be utilised. In these circumstances, no lowering of the water table will occur as a result of extraction. On the contrary, the removal of vegetation and the creation of an internally draining basin will have the effect of increasing the recharge to the aquifer to the benefit of surrounding users. The principle of improved recharge to the shallow aquifer has been accepted by the DLWC in its Maroota Groundwater Study Stage 1 report (Section 4.2.1).

No mitigation measures are considered necessary with regards to the possibility of the lowering of the existing water table levels. Monitoring of groundwater levels will be performed as part of the Environmental Management and Rehabilitation Plan for the development.

6.8.6 Beneficial Effects

Not all impacts are, potentially, of an adverse nature. Some beneficial effects are also likely to be derived from the operation. These include more direct (increased) groundwater recharge to the shallow and deep aquifers from the site storages and rainfall via the exposed surfaces. Aquifer recharge from beneath the site would be enhanced also by the removal of clay lenses present within the Maroota Sand over the site.

These beneficial effects answer to the principles of an ecologically sustainable groundwater development, whereby current groundwater resources will be maintained to existing users and future generations will not be affected by the present activities.

The environmental impact of the proposed development upon the groundwater in the known aquifers in the area is likely to be negligible after the recommended mitigation and monitoring procedures have been implemented.

The change in the landform and the removal of soil material above the shallow and deep aquifers is likely to result, on balance, in beneficial long term effects to those aquifers, represented by increased groundwater recharge rates.

Surface water quality should be maintained by the prevention of releases of turbid water to the natural drainage system due to the internally draining design of the development.

Although the proposed development is likely to have some and varying impacts on the existing groundwater environment, it is considered that the implementation of proper design and management measures and procedures, would reduce these impacts to a manageable level.

A programme of groundwater monitoring will be carried out at the three bores established at the site.

The three groundwater monitoring bores have been equipped with automatic data recorders. The loggers will be downloaded at three monthly intervals and the data graphed and prepared for inclusion in the annual Environmental Management and Rehabilitation Plan.

6.9 Flora and Fauna

A comprehensive flora and fauna study has been undertaken as part of the preparation of this EIS. That study, a copy of which is at **Appendix 8**, provides an assessment of the impact of the proposed development having regard to the relevant legislation. The following extracts are taken from that study.

6.9.1 Threatened Species Conservation Act 1995 - Eight Part Test Of Significance

One threatened flora species, *Acacia bynoeana* was found on the site. Two threatened fauna species, being the Turquoise Parrot and the Glossy Black-cockatoo, are likely to occur.

The 8-part test in relation to each species is included in the flora and fauna study at **Appendix 8**. The following conclusions have been drawn:

Acacia bynoeana

It is concluded that the proposed development will not have a significant impact on *Acacia bynoeana* or its habitat.

Turquoise Parrot

There is unlikely to be a significant impact on the Turquoise Parrot or its habitat.

Glossy Black Cockatoo

There is unlikely to be a significant impact on the Glossy Black-cockatoo or its habitat.

6.9.2 State Environmental Planning Policy No. 44 - Koala Habitat Protection

An assessment of the proposed extraction site was undertaken to ascertain its suitability as koala habitat. The procedures involved in such an assessment are outlined in SEPP 44. The land is not potential koala habitat as Grey Gum the only listed feed tree on site comprises less than 15% of the total number of trees present. Therefore, the development application may proceed without a plan of management in respect of koalas.

6.9.3 Sydney Regional Environmental Plan No.20 - Hawkesbury-Nepean River (No.2 - 1997)

Under this plan the policy with regard to flora and fauna is to:

> *"manage flora and fauna communities so that the diversity of species and genetics within the catchment is conserved and enhanced."*

Relevant general strategies are detailed below in italics with comments as appropriate:

"(a) Conserve, and where appropriate, enhance flora and fauna communities, particularly threatened species, populations and ecological communities, aquatic habitats, wetland flora, rare flora and fauna, riverine flora, flora with heritage value, habitats for indigenous and migratory species of fauna, and existing or potential fauna corridors."

Only a small amount of habitat for threatened species occurs on site. Most of the area containing the vulnerable plant species *Acacia bynoeana* will be retained within the buffer zoned to Roberts Road.

"(b) Locate structures where possible in areas which are already cleared or disturbed instead of clearing or disturbing further land."

The proposed development will occur within already cleared and disturbed land.

"(c) Minimise adverse environmental impacts, protect existing habitat and where appropriate, restore habitat values by the use of management practices."

As the site is already highly modified there will be little adverse impact in regard to flora and fauna. Simply slashing and possible burning of the scrub area will protect habitat for *Acacia bynoeana*.

"(d) Consider the impact on ecological processes such as waste assimilation and nutrient cycling."

Due to the modified nature of the site, natural ecological processes have been substantially modified to a point where consideration of processes such as waste assimilation and nutrient cycling is not applicable.

"(e) Consider the range of flora and fauna inhabiting the site of development concerned and the surrounding land, including threatened species and migratory species, and the impact of the proposal on the survival of threatened species, populations and ecological communities, both in the short and long terms."

Consideration of the range of flora and fauna has been detailed in **Part 3** of this EIS and in **Appendix 8**. There is unlikely to be a significant effect on threatened species, populations and ecological communities.

"(f) Consider the need to provide and manage buffers, adequate fire radiation zones and building setbacks from significant flora and fauna."

The *Acacia bynoeana* population on the site will be naturally protected within the buffer zone to Roberts Road. It can be managed through appropriate slashing and/or burning to encourage germination and perpetuation of the site population.

"(g) Consider the need to control access to flora and fauna habitat areas."

No specific measures are considered necessary in this regard.

"(h) Consider the need to maintain corridors for fish passage, and protect spawning grounds and gravel beds."

Not relevant in this case.

On the basis of the above discussion, it is considered that the requirements of the SREP are met by the proposed development.

6.9.4 Sydney Regional Environmental Plan No.9 Extractive Industry (No.2)

Clause 11 of this plan requires that in relation to extractive industry operations at Maroota, Council (or the Minister in this instance) be satisfied that the proposed development adhere to a number of conditions. In relation to flora and fauna issues, the relevant section is:

"(b) [that the proposed development] will conserve the environmentally sensitive and significant features of the Maroota locality, including the environment of threatened species, populations and ecological communities."

Habitat for the threatened plant *Acacia bynoeana* will be conserved within the buffer to Roberts Road. Replacement planting with locally-occurring eucalypt species will ameliorate the loss of some of these trees from the site.

6.9.5 Extractive Industries Development Control Plan No.500

The Performance Criteria of the Flora and Fauna Element (Clause 2.6) of the DCP are presented in italics below followed by appropriate comment:

"Proponents should identify and assess the impacts upon all threatened species, populations and ecological communities within the sites proposed for extraction."

The appropriate assessment has been undertaken and is contained within **Part 3** and **Appendix 8** of this EIS. It was found that the proposed development would not have a significant effect on any of the threatened species identified as inhabiting, or likely to inhabit, the site.

"Extractive operation should provide an effective buffer capable of protecting habitats of threatened species, populations or ecological communities."

The buffer to Roberts Road will provide sufficient habitat for the retention of *Acacia bynoeana* on the site. The modified nature of surrounding land and the presence of intervening roads means that there is no need to set aside further areas specifically dedicated for habitat protection.

"Proponents should outline a set of contingencies capable of ameliorating the impact of an Extractive Industry upon the habitats of threatened species, populations or ecological communities."

Specific measures recommended for ameliorating impact are appropriate management of the *Acacia bynoeana* and the inclusion of certain species in landscape planting around the extraction area.

"Proponents should ensure that extractive operations do not result in the regional loss of:

- *significant native vegetation and fauna communities;*
- *threatened species, populations and ecological communities."*

The site is highly modified and only contains small areas of remnant vegetation. Retention and suitable management of the remaining *Acacia bynoeana* plants will avoid significant loss of habitat. Replanting of component eucalypt species including Blue Mountain Mahogany in landscape areas will ensure that there is no regional loss of significant native vegetation

6.10 Water Quality

6.10.1 Water Quality Modelling

Existing water quality on the site and the proposed means of protecting and indeed the means by which the integrity of that water quality will be maintained during extraction are discussed in the strategy for surface water management at **Appendix 7**.

In order to assess the stormwater impacts of the proposed development, the computer program AUSQUAL was used to model the pollutant generation of both the undeveloped and developed catchment scenarios.

The modelling shows that the development of the proposed areas for extraction will increase the pollutant loadings if water quality controls are not implemented. Based on average year rainfall data, it shows increases occur in suspended solids, total nitrogen and total phosphorus loadings by 6,008, 14.4 and 2.4 kilograms per year respectively from the pre-development to the peak development scenarios. Once the site has been rehabilitated, pollutants loads will be lower than the pre-development levels. Full details are contained in Section 2.2 of the strategy for surface water management at **Appendix 7**.

Impact mitigation measures designed to manage the pollutant levels during peak development are discussed in **Part 7** of this EIS and in Section 2.2 of the strategy for surface water management at **Appendix 7**.

6.10.2 Hydrologic Modelling

This section contains storm flow calculations for the existing site and the post development land use and the AUSQUAL modelling results to find out the hydrological effects on Coopers Creek.

Stormflow

Stormflow analysis has been carried out for the area to be developed for sand extraction which includes the eastern and western sub-catchments. Under the present drainage pattern, the western sub-catchment drains to the natural watercourse, however, once the western sub-catchment is developed in Stage 2, it will also drain to the process water dam.

Peak storm flows are expected to decrease downslope of the site once the western sub-catchment is developed, due to the collection of runoff in the process water dam.

Catchment Yield

The existing landuse within the eastern and western sub-catchments is natural pasture. At the completion of the development process it is proposed to rehabilitate most of the site to native vegetation.

The 40.1 ha catchment includes the eastern and western sub-catchments of the property, and the sub-catchment on the adjoining property east of Roberts Road. A summary of the catchment yield is shown in **Table 6.12** below.

Table 6.12
Summary of Catchment Yields

Site	Catchment Area (ha)	Pre-development Catchment Yield (ML/yr)	Peak Development Catchment Yield (ML/yr)	Post Development Catchment Yield (ML/yr)
Western sub-catchment	8.9	20.4	23.4	20.3
Eastern sub-catchment	20.7	47.5	54.4	47.3
Total catchment to be developed	29.6	67.9	77.8	67.6
Sub-catchment east of Roberts Rd	10.5	22.9	26.3	22.8
Total Catchment	**40.1**	**90.8**	**104.1**	**90.4**

It is expected that about 26 per cent of average annual rainfall will runoff the catchment for the pre-development current land use, 29 per cent at the peak of development and 26 per cent once the site has been rehabilitated (post development). The overall decreases in runoff from pre-development to post development site conditions from the catchment to be developed is expected to be 0.4 ML.

Under the existing drainage pattern, all runoff from the eastern sub-catchment and east of Roberts Road sub-catchment is captured by the excavation. Consequently, the only significant change to downstream water flows will occur from the western sub-catchment being diverted to the process water dam. This will decrease water flow to the natural watercourse by 20.4 ML per annum, although some of this would be expected to return to the hydrologic cycle via groundwater infiltration within the earth banks and catch drains.

The change in catchment surface cover is not expected to affect average annual runoff from the site, either during the extraction phase or post extraction. As 26 per cent of rainfall is expected to run off, 74 per cent is expected to infiltrate and provide flow to groundwater and consequently return to the natural watercourse downslope of the dam by way of natural seepage from springs.

Since the depth of excavation will not exceed 183 metres AHD, the excavation will not affect the groundwater table, groundwater flow rates, or groundwater quality because the extraction operations will not be carried out below the groundwater table. Contamination of the groundwater system with suspended solids is highly unlikely to occur due to the low velocity of the groundwater, the excellent

filtering qualities of the soils, and the high concentration of iron in the soil. The low vertical permeability of the infiltrating soils makes it difficult for fine particles to migrate into the groundwater system. Therefore, the effects on the quality of the groundwater will be negligible.

6.11 Climate

The proposed development will not generate emissions into the atmosphere which will have an impact on the climate of the area.

6.12 Soil Erosion

A comprehensive Soil and Water Management Plan has been prepared for the site and is contained within **Appendix 16**.

The implementation of the plan will ensure that no sediment laden water will be discharged from the site.

6.13 Archaeology

The site has been survey for items of Aboriginal significance (refer report at **Appendix 9**). The report concludes that:

"There are no constraints on archaeological grounds resulting from the current investigation to the proposed development proceeding as planned."

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Part Seven

IMPACT MITIGATION MEASURES

7.1 Introduction

Potential impacts associated with the proposed development of an extractive industry have been identified as part of this EIS.

This part of the EIS provides details of the measures which are to be employed to mitigate those potential impacts.

7.2 Noise

The impact of noise generated from the proposed development will not have a significant adverse impact on the environment.

As discussed in the acoustic impact assessment report at **Appendix 11**, there will be a requirement that earth berms be constructed in certain sections of the site to mitigate any acoustic impact to adjoining residences. Those bunds are to be located as follows:

1. A 3 m permanent earth berm around the north-western boundary corner and extending along the western boundary to the site entrance;

2. A 2 m permanent earth berm along the north-western section of the northern boundary, and

3. A 3 m temporary earth berm around the active extraction cell.

The location of these proposed earth berms is shown on **Figure 22**.

The berms will be stabilised and seeded in accordance with the Landscape Plan for the site as detailed in the rehabilitation report prepared by Scott Murray and Associates a copy of which is at **Appendix 14**.

7.3 Soil and Water Management

To ensure the integrity of water quality both on the site and for any water which is discharged from the site, a detailed and integrated soil and water management system has been designed to provide facilities to:

- Conserve and effectively manage the sustainability of water supplies and resources in the Baulkham Hills Shire, and

- Protect downstream drainage patterns including location, quantity and quality of waters.

In order to achieve those objectives, the following strategies have been developed for the proposed development:

- A soil and water management plan (refer to **Appendix 16**);
- A surface water management strategy (refer to **Appendix 7**), and
- A rehabilitation strategy from an erosion and sediment control perspective (refer to **Appendix 14**).

The implementation of those strategies will ensure that no sediment laden waters enter the downstream waters of the area.

7.4 Visual Aspect

The topography of the site and its environs is such that the site is visible from surrounding areas. It is proposed to form significant landscaped bunds around the boundaries of the site where there is a potential to view the extraction process from outside the site. The landscaping and planting will be undertaken as part of the site establishment and will ensure that long term views to the site are minimised.

The rehabilitation plan (refer **Appendix 14**) will ensure that progressive rehabilitation will be undertaken during the life of the extraction to ensure that limited site area is disturbed at any one time. This will ensure limited visual impact to areas outside the outside the site.

7.5 Fire Control

Both portable and fixed fire fighting devices are currently installed as part of the dam construction development in accordance with the requirements of the relevant authority. These devices will service the now proposed development.

7.6 Dust

As part of the proposed development, the following mitigation measures are proposed:

- Areas on which vehicle activity takes place will be watered so dust suppression can be maximised.
- Construction of wind breaks of natural vegetation around the boundary of the site.
- Ensure that potentially dusty material is processed and stored in a damp condition.

- Control of vehicles speeds on the site.
- Construction of a bund around the current extraction cell to assist in dust suppression and mitigation of any acoustic impact.
- ensure that trucks leaving the site have their loads covered.

7.7 Flora and Fauna

Overall, it is considered that the impact of the proposed extractive industry would not be significant on the ecology of the area. Nevertheless, to ameliorate likely impacts, it is considered that the following measures should be undertaken:

- inclusion of Blue Mountains Mahogany and other Shale-Sandstone Transition Forest species in the landscaping/rehabilitation plan for the site, and
- appropriate management of the area containing the remaining *Acacia bynoeana* plants. The viability of this species within the scrub near Roberts Road could be enhanced by periodic slashing or burning.

The above have been included in the rehabilitation plan for the site as contained in **Appendix 14**.

7.8 Traffic

The research undertaken as part of this EIS has concluded that there will not be a need to upgrade the intersection of Roberts Road with Old Northern Road apart from some additional line marking.

There will, however, be a requirement for internal haul roads to be upgraded as part of the establishment of the site and that the entrance to the site also be upgraded. Details of the measures proposed to effect those upgrading works are contained in the report of Lyle Marshall and Associates at **Appendix 15**.

---------- OOO ----------

Part Eight

OUTLINE ENVIRONMENTAL MANAGEMENT AND REHABILITATION PLAN

8.1 Introduction

The Department of Urban Affairs and Planning document *Extractive Industries Quarries - EIS Guidelines*, when discussing the preparation of an Environmental Management and Rehabilitation Plan for such facilities, states:

> *"An Environmental Management and Rehabilitation Plan (EMRP) is a document designed to ensure that the commitments in the EIS, subsequent assessment reports, and approval or licence conditions are fully implemented. It is a comprehensive technical document which is usually finalised during or following detailed design of the proposal after approval of the development application."*
>
> *"Although the level of detail required for an EMRP is usually not considered necessary for the EIS or SEE, the documents should contain a comprehensive outline of the structure of the EMRP, including the environmental management principles which would be followed when planning, designing, constructing and operating the proposal."*
>
> *"Two sections should be included, one setting out the program from managing the proposal and the other outlining the monitoring program with a feedback loop to the management program."*

8.2 Environmental Management and Rehabilitation Outline

It is envisaged that the following management measures will form part of the EMRP for the development:

8.2.1 Dust Control

Objectives

- To ensure minimal dust generation as a result of the extraction operation.
- To maintain dust levels below the EPA goals detailed in the site licence.

Tasks/Actions

- The moisture content of extracted material and processed material is to be maintained at a level to mitigate generation of dust during transport and processing of the material, and the stockpiling of processed material awaiting delivery to the market.
- Internal haul roads and working areas are to be watered as required using the on-site water tanker.
- Maintain dust deposition monitoring gauges at existing locations. Gauges are to be monitored during the extraction process.
- A complaints register is to be established to record complaints of dust from the facility.

Performance Indicators

- Public complaints register.
- Visual inspection of site on a daily basis and at time of complaints.

Responsible Person/Organisation

- Site Manager.

Reporting/Review

- Maintenance of complaints register.
- Recording of data from dust deposition gauges.
- Annual Environment Report.

Corrective Action Mechanisms

- Review operating procedures.

8.2.2 Stormwater Management

Objectives

- Management of the quality of runoff to minimise the possibility of polluted runoff from the site.
- Capturing and storing runoff to maximise the re-use of runoff water within the extraction and rehabilitation process.

- The provision of adequate measures to manage the expected quality of runoff from the different areas of the site.

- To ensure the integrity of the Soil and Water Management Strategy.

Tasks/Actions

- All roof water from the office complex is to discharge to rainwater tanks for re-use in the office and amenities area.

- Stormwater runoff from the extraction areas is to drain to a specific storage pond for re-use within the extraction process.

- Construction of water management facilities as per the Soil and Water Management Strategy, Process Water Dam Design and Conceptual Mine Plan.

- Monitor water level and general appearance of the storage basins as required by the Soil and Water Management Strategy, and if necessary, chemical dosing will be used to assist in maintaining water quality.

- Site Manager to inspect the site at least weekly paying attention to:

  - ensuring that drains operate properly and effect any necessary repairs.

  - removal of spilled sand or other material from hazard areas, including lands closer than five metres from areas of likely concentration or high velocity flows especially waterways and access roads.

  - constructing additional erosion and/or sediment control works as might become necessary to ensure the desired water control is achieved, i.e. make ongoing changes to the Soil and Water Management Plan.

  - maintain erosion and sediment control measures in a functioning condition until all earthworks are completed and the site is rehabilitated.

- Remove accumulated sediments from the sediment basin whenever less than design capacity remains for sediment basin and dispose of material as part of the site rehabilitation.

- Maintain a log book and record at least weekly and immediately before and after rainfall:

  - the volume of any rainfall events.

  - the condition of any soil and water management works.

  - application of any flocculating agents to the sediment basin.

  - remedial works.

Performance Indicator

- Performance of sediment basin and other control devices.

Responsible Person/Organisation

- Site Manager.

Reporting and Review

- Maintain log book.
- Annual Environment Report.

Corrective Action Mechanisms

- Blocked drains cleared immediately upon detection of blockage.
- Clearance of sediment from sediment pond.
- Review of operation procedures.

8.2.3 Rehabilitation

Objectives

- To ensure that revegetation of the site is undertaken progressively as allowed by the completion of earthworks.
- To ensure that eventually the site is left in a stable condition which blends with the general land uses of the Maroota area in accordance with the rehabilitation plan for the site.

Tasks/Actions

- Lands which have ceased to be directly involved in the extraction process will be rehabilitated in accordance with the rehabilitation plan.
- Implementation of the Rehabilitation Plan.

Performance Indicator

- Success of rehabilitation and survival of planted species.

Responsible Person/Organisation

- Site Manager.

Reporting and Review

- Annual Environment Report.

Corrective Action Mechanisms

- Remove and replace dead or diseased plants.
- Investigate cause of death and/or disease.
- Take remedial action to improve conditions for sustained growth.

8.2.4 Emergency Response and Contingency Plan

Objectives

- To ensure that in the event of an environmental accident the necessary procedures are put in place to mitigate the impact on the environment.
- To ensure adequate fire fighting equipment and procedures are in place to limit loss and/or damage to property during a fire event.
- To maximise the safety of employees and other individuals on site at the time of an on-site emergency event.

Tasks/Actions

- In the event of environmental accident, the Site Manager is to assess the significance of the accident and take appropriate action.
- If the accident is determined to be significant, the facility is to immediately close until such time as the integrity of the environment has been restored to that which prevailed prior to the accident.
- A register of environmental accidents is to be kept on site at all times.
- A 24 hour contact phone number shall be provided on a sign at the entrance to the site.
- Fire fighting equipment is to be installed on site as required by the controlling authorities.
- Smoke alarms are to be provided in the office building and equipment enclosures.
- Maintenance and checking of fire fighting equipment as required by approvals.
- Train all staff in procedures for fire fighting and evacuation in case of fire event.

- Preparation of a fire evacuation plan.
- Train personnel in the procedures should fire fighting equipment fail.

Performance Indicators

- Environmental accident record.
- Site incident accident record.
- Satisfactory compliance with the Building Code of Australia with regard to fire fighting equipment.
- Completion of continuing education of personnel in emergency procedures.
- Fire safety record.
- Compliance with maintenance requirements for fire fighting equipment.

Responsible Person/Organisation

- Site Manager.

Reporting/Review

- Maintenance of incident/accident reports.
- Immediate reporting of environmental accident.
- Recording of accident in environmental accident register with determination of significance, cause and future preventative measures.
- Maintenance of register as required.
- Annual Environment Report.

Corrective Action Mechanisms

- Review operation procedures.
- Remove and replace faulty fire fighting equipment.

8.2.5 Noise Control

Objective

- To ensure noise emanating from the extraction operation does not adversely impact on land uses in the environs of the site.

Tasks/Actions

- Operational noise levels emanating from the site do not exceed the levels contained in the EPA Licence for the extractive industry.
- All mobile and fixed equipment will be noise tested on arrival and at twelve (12) monthly periods thereafter.
- Front-end loaders, scrapper, bulldozer (if required), and water cart are fitted with recognised silencers to ensure maximum mitigation of acoustic impact.
- Earth berms are to be constructed and maintained as indicated in the Environmental Impact Statement and the Noise Impact Assessment Report.

Performance Indicator

- Noise level goals are not exceeded.

Responsible Person/Organisation

- Site Manager.

Reporting/Review

- Monitoring of acoustic levels.
- Maintenance of monitoring reports.
- Annual Environment Report.

Corrective Action Mechanism

- Review operation procedures.
- Check all noise generating equipment.
- Repair or remove offending machinery or parts thereof.

8.2.6 Site Landscaping

Objectives

- To ensure that the visual impact of the facility is limited.
- To provide for a more pleasant working environment and a screen to the development from outside the site.

Tasks/Actions

- The perimeter of the site is to be landscaped in accordance with the landscape plan and the rehabilitation plan for the site.
- Landscaping is to be maintained to ensure that its condition remains as described in the landscape plan.

Performance Indicators

- Visual perception of the site from adjoining land uses.
- Maintenance of the landscaping as per landscaping plan.

Responsible Person/Organisation

- Site Manager.

Reporting/Review

- Weekly inspection of condition of landscaping works.
- Annual Environment Report.

Corrective Action Mechanisms

- Remove and replace dead or diseased plants.
- Investigate cause of death and/or disease.
- Take remedial action to improve conditions for sustained growth.

8.2.7 Complaints Procedure

Objective

- To ensure that all valid complaints are recorded and appropriate corrective action taken.

Tasks/Actions

- Complaints will only be accepted from identified complainant(s).
- Complaints will be investigated within 4 hours of the complaint being made during business hours, and within 12 hours of the complaint being made out of business hours.
- Response to the complaint will be in writing by either fax or letter. Oral responses are to be avoided and only given where absolutely necessary.
- Written responses are to be given within 24 hours of the completion of the investigation.
- All complaints are to be logged in a complaints register.
- Where a complaint has been substantiated, immediate action is to be taken to remedy the cause of the complaint.

Performance Indicators

- The number of substantiated complaints.
- Response time to investigate and respond to complaint.
- Response time to remedy the cause of a substantiated complaint.

Responsible Person/Organisation

- Site Manager.

Reporting/Review

- Maintenance of complaints register.
- Annual Environment Report.

Corrective Action Mechanisms

- Review operation procedures.
- Instigate measures to mitigate source of complaint.

8.2.8 Occupational Health and Safety

Objective

- To ensure the health, safety and welfare of all employees and non-employees as prescribed in the Occupational Health and Safety Act (1983).

Tasks/Actions

- Development and implementation of a comprehensive and integrated occupational health and safety management plan including:
  - Development of necessary occupational health and safety policies.
  - Development of safe work practices and procedures.
  - Development and implementation of an appropriate hazard identification, assessment and control procedure.
  - Development and implementation of an appropriate accident investigation procedure.
  - Development and implementation of an accident and illness reporting procedure.

Performance Indicators

- Percentage of employees with a comprehensive safety training plan developed and being implemented.
- Percentage of staff involved in hazard identification, assessment and control.
- Number of compensation claims.
- Accident reports.

Responsible Person/Organisation

- Site Manager and all employees of the facility.

Reporting/Review

- Maintenance of accident record register. Immediate reporting of accidents to Site Manager.
- Annual Environment Report.

Corrective Action Mechanisms

- Review occupational health and safety procedures.
- Instigate education program.

8.2.9 Groundwater

Objective

- To ensure the extraction process does not have a significant and adverse impact on the regional groundwater of the Maroota area.

Tasks/Actions

- Maintenance of the Groundwater Monitoring Wells installed on the site.
- Undertake measurements at monitoring wells as required by development consent and/or licence agreement.

Performance Indicators

- Impact of the extraction on the groundwater level.

Responsible Person/Organisation

- Site Manager.

Reporting/Review

- Maintenance of groundwater monitoring register.
- Annual Environment Report.

Corrective Action Mechanisms

- Review operational procedures.

---------- ooo ----------

Part Nine
CONCLUSIONS

9.1 Introduction

It is the intention of the Applicant to extract sand, pebbles and clay from land on the corner of Roberts Road and Old Northern Road, Maroota.

The proposed development has been designed to incorporate the environmental safeguards necessary to ensure that it will have no significant impact on the environment.

Nevertheless, the proposed development has the potential to have an adverse impact on the environment, in particular with regard to flora and fauna, air quality, noise, water quality, traffic and groundwater.

As detailed in this EIS, specific studies have been performed to ascertain the impact of the proposed development on the abovementioned aspects of the environment. The following conclusions have been made.

9.2 Flora and Fauna

A comprehensive flora and fauna study (refer **Appendix 8**) has concluded that, with the recommended mitigation measures in place as proposed in the EIS, there should be no significant and adverse impact resulting from the proposed extraction.

9.3 Air Quality

Potential impacts of the proposed facility on the surrounding residences have been modelled (refer **Appendix 10**). The results indicate that the proposed operations on the site are unlikely to adversely affect nearby residences with regard to dust deposition.

An attempt has been made to quantify existing dust levels due to current operations at the site, in order to determine what the acceptable increases would be to meet air quality goals at the nearby sensitive receptors. The assessment has shown that the operations are predicted to comply with both the long-term and short-term concentration goals, as well as the deposition goals. Indeed, in some cases, it may be that the dust levels decrease with the proposed development, as the activities move further away from Roberts Road during the life of the project.

9.4 Acoustic Environment

An acoustic assessment of the proposed extraction has been undertaken with the following conclusion:

> *"The sand mining industry in this area has been able to operate by using specific measures to reduce noise nuisance and enable rehabilitation of land back to viable market gardens.*
>
> *The proposed extraction of sand would also be able to satisfy acceptable acoustic criteria. Long term community noise monitoring has taken place and the results used to determine acoustic design objectives to protect the amenity of nearest residents. The assessment criteria have been formulated from the Baulkham Hills Shire Council Development Control Plan No. 500 and criteria setout in the NSW EPA guidelines.*
>
> *The assessment that has been undertaken has found that the use of earth berms and the implementation of a noise management plan would provide significant noise control. The mobile equipment in use generates noise levels free of tonal or other annoying characteristics.*
>
> *The predicted noise emissions with noise controls in place represent a significant improvement in current noise emissions from the site. There have been no known complaints lodged with quarry management regarding excessive noise from the current operations. Furthermore, discussions with residents at the most potentially affected locations have found that they are not annoyed by noise from the site and are generally supportive of the site management. Following the implementation of controls and a comprehensive noise management plan, it is considered unlikely that noise levels at the residents will cause concern.*
>
> *An assessment of traffic noise impact has determined that the development will have little or no impact on residential traffic noise levels provided the number of traffic movements are limited to approximately 100 movements per day.*
>
> *Several safeguards have also been recommended to ensure that the site will continue to operate in a manner that will not have an adverse effect on community noise levels."*

The above recommendations have been incorporated into the design of the proposed extraction and also within the Outline Environmental Management and Rehabilitation Plan. It should be noted that since the preparation of the acoustic assessment report, the Applicant has advised that the plant has been converted from diesel to electric power, which will generate less noise impact.

9.5 Water Quality

As detailed in the EIS, the following strategies have been developed to ensure the integrity of water quality both on the site and in the downstream waters of the Shire:

1. A soil and water management plan (refer to **Appendix 16**);

2. A surface water management strategy (refer to **Appendix 7**), and

3. A rehabilitation strategy from an erosion and sediment control perspective (refer to **Appendix 14**).

The implementation of those strategies will ensure that no sediment laden waters enter the downstream waters of the area.

These strategies have recognised the means by which the integrity of the water quality of Coopers Creek can be maintained.

The surface water management system will provide for optimum re-use of resources while ensuring that the environmental impacts are minimised.

9.6 Traffic

The traffic generation from the proposed development has been assessed to determine the impact that traffic will have on the operation of the intersection of Old Northern Road with Roberts Road, with the conclusion that no impact is expected on either the Level of Service or Degree of Saturation of that intersection as a result of the proposed development.

9.7 Groundwater

A program of work was conducted to gather new and updated information on the groundwater conditions under and around the proposed extraction. The program comprised:

- the establishment of two groundwater monitoring wells;

- the hydraulic testing of the new wells;

- the measurement of salinity in samples collected from the above-mentioned wells; and

- the setting up of a computer model to simulate the existing groundwater conditions and the effects of mining upon the surrounding rock mass at the end of the extraction period.

The conclusion of the groundwater impact assessment is that the environmental impact of the

proposed development upon the groundwater in the known aquifers in the area is likely to be negligible after the recommended mitigation measures contained in the surface water management strategy are in place and monitoring procedures have been implemented.

The change in landform and the removal of soil material above the shallow and deep aquifers is likely to result, on balance, in beneficial long term effects to those aquifers, represented by increased groundwater recharge rates.

Surface water quality should be maintained by the prevention of releases of turbid water to the natural drainage system due to the internally draining design of the development.

---------- ooo ----------

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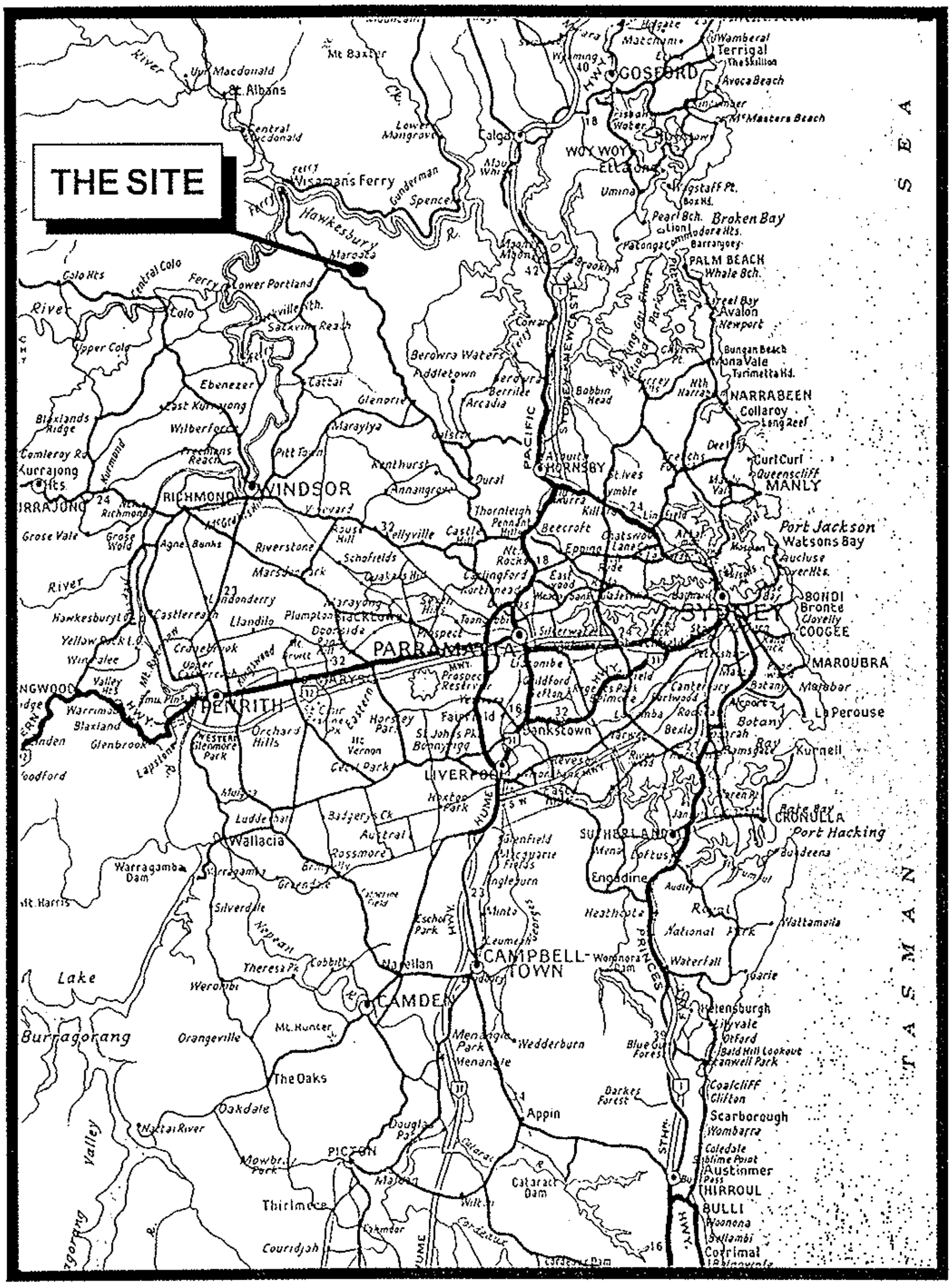
Woodward Clyde. 1999c. *"Lots 1 and 2, DP 228308, Lot 2, DP 312327, Maroota, Development Application, Conceptual Mine Plan"*. Prepared for Nexus Environmental Planning Pty Ltd.

Figures



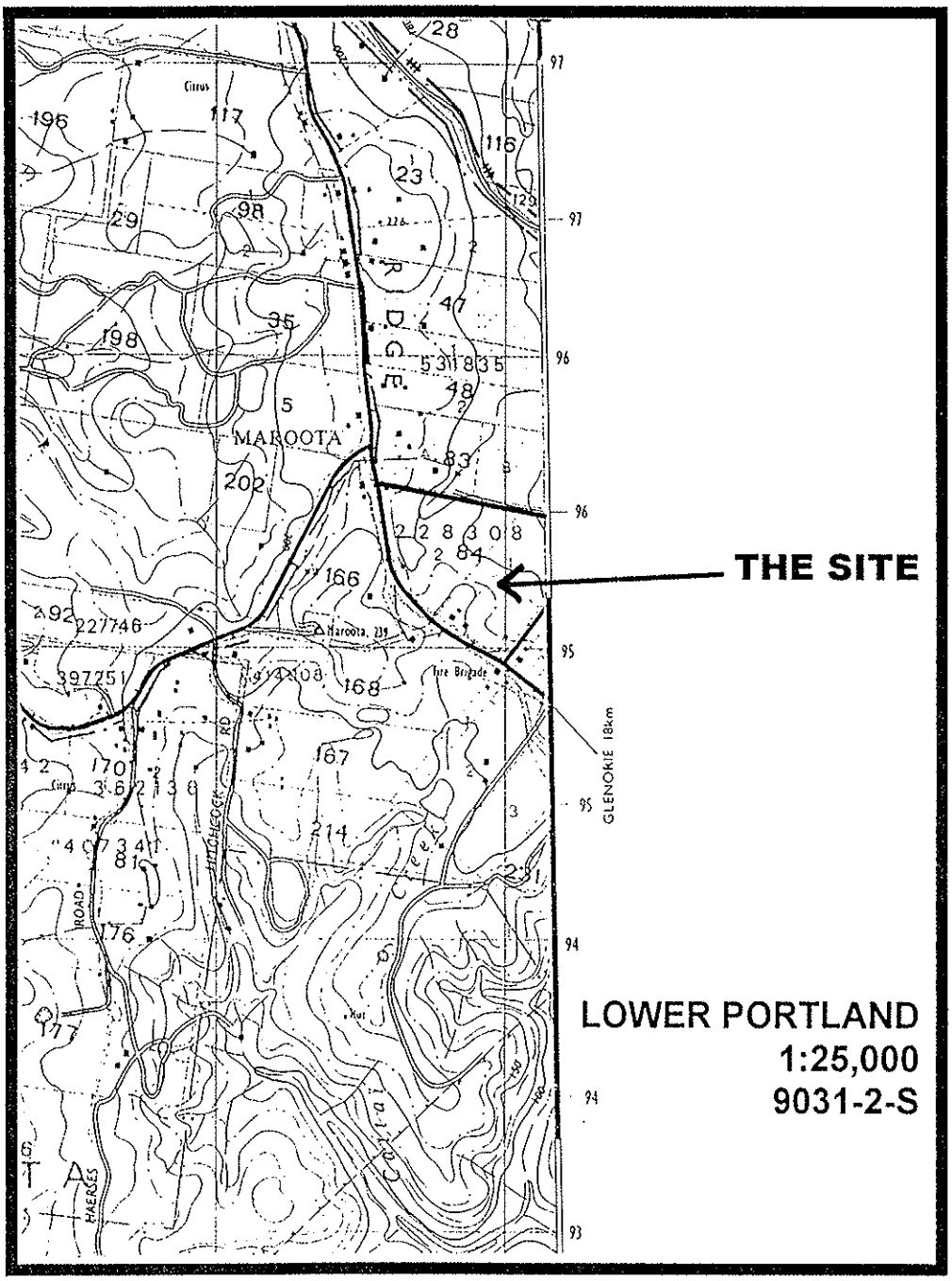
DR L S MARTIN

ENVIRONMENTAL IMPACT STATEMENT
SAND EXTRACTION
ROBERTS ROAD
MAROOTA

NEXUS ENVIRONMENTAL PLANNING PTY LTD

B705.1 After: UBD

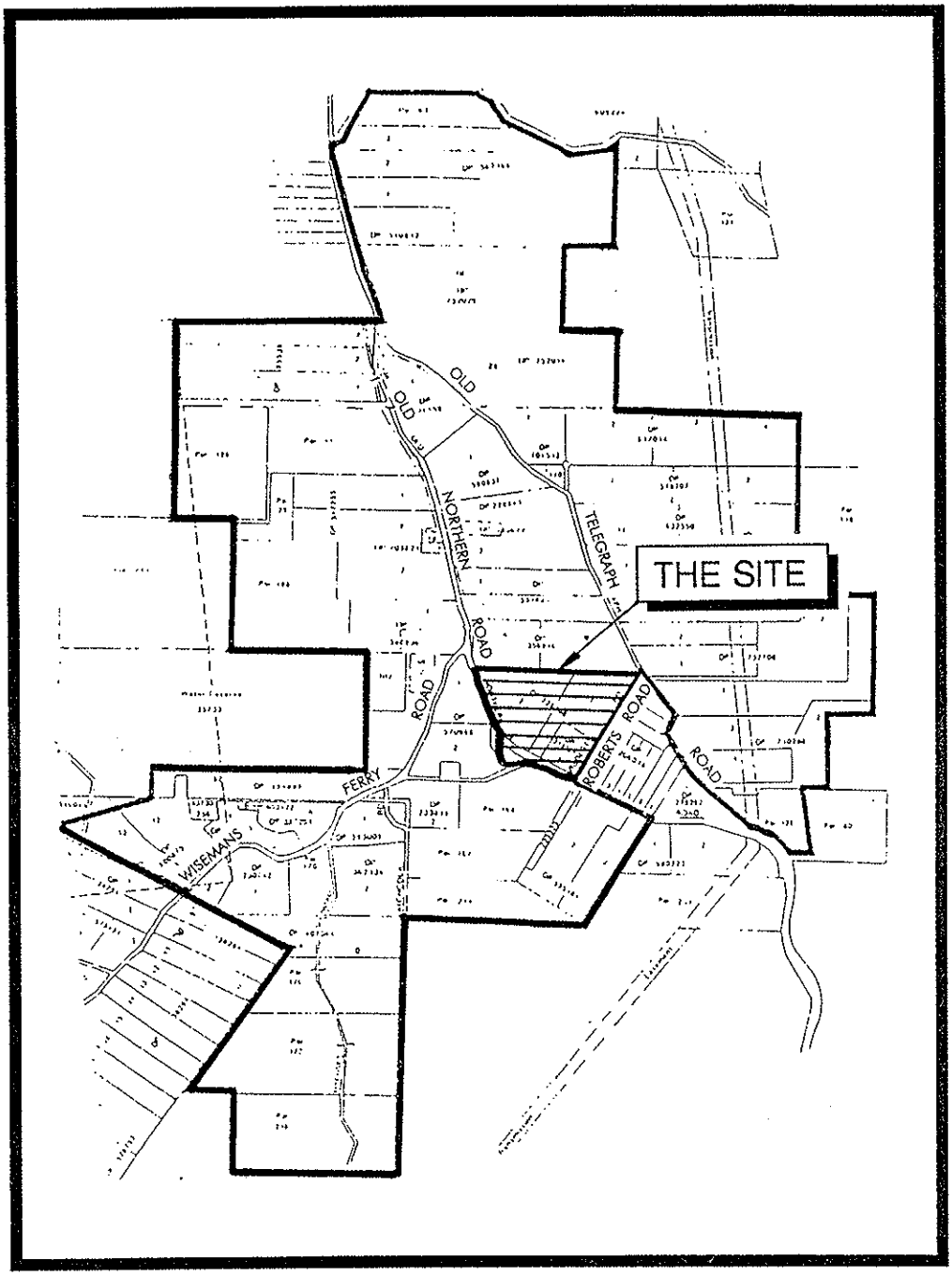
Figure 1: REGIONAL LOCATION



DR L S MARTIN
ENVIRONMENTAL IMPACT STATEMENT SAND EXTRACTION ROBERTS ROAD MAROOTA
NEXUS ENVIRONMENTAL PLANNING PTY LTD

B705.1 After: CMA

Figure 2: SITE LOCATION



Sydney Regional Environmental Plan No 9—Extractive Industry (No 2) (Amendment No 1)

DR L S MARTIN
ENVIRONMENTAL IMPACT STATEMENT SAND EXTRACTION ROBERTS ROAD MAROOTA
NEXUS ENVIRONMENTAL PLANNING P.TY LTD

B705.1 After: DUAP

Figure 3: SREP No.9 AREA

NOTES:

THE PURPOSE OF THIS SURVEY WAS TO OBTAIN TOPOGRAPHICAL DETAIL AS REPRESENTED ON THIS PLAN.

REDUCED LEVELS ARE BASED ON AUSTRALIAN HEIGHT DATUM (AHD).

CONTOURS ARE BASED ON AUSTRALIAN HEIGHT DATUM (AHD) AND ARE AT INTERVALS OF 1 METRES.

ORIGIN OF LEVELS IS PM33899, RL214.041, VERTICAL ACCURACY 1 AS OBTAINED FROM THE SURVEYOR-GENERAL'S DEPARTMENT - SCIMS ON 22.04.1998.

COORDINATES AND AZIMUTH ARE BASED ON A LOCAL COORDINATE SYSTEM. BOUNDARIES HAVE NOT BEEN DEFINED OR MARKED.

BEARINGS, DIMENSIONS AND AREAS SHOWN HEREON HAVE BEEN COMPILED FROM PUBLIC RECORDS AND ARE SUBJECT TO A BOUNDARY SURVEY.

ONLY TREES WITH A TRUNK DIAMETER OF GREATER THAN 0.3 METRES HAVE BEEN SURVEYED.

ONLY THE TOE OF STOCKPILES HAVE BEEN SURVEYED. CONTOURS HAVE BEEN CALCULATED EXCLUDING STOCKPILES.

NO LEVELS HAVE BEEN OBSERVED AT THE BASE OF SILT PONDS OR EXCAVATION AREAS.

LEGEND

BENCH MARK	△	PIPE INVERT	
COMMUNICATIONS PIT	◪	POWER POLE	○
DUST GAUGE	⌀	SIGN	
GAS MARKER	▦	TREE	APPROXIMATE EXTENT OF FOLIAGE; APPROXIMATE TRUNK DIAMETER
MANHOLE	⊛		
MONITORING WELL	⌖	WATER SERVICE	

DETAIL SURVEY
LAND CONTAINED IN CERTIFICATE OF TITLE 1/228308, 2/228308 & 2/312327.
OLD NORTHERN ROAD
MAROOTA
IN THE LOCAL GOVERNMENT AREA OF
BAULKHAM HILLS

RE: NEXUS ENVIRONMENTAL PLANNING

RATIO NTS	SURVEYED BA, DM & PC.
LEVEL DATUM AHD	DRAWN BW
DATE 14.01.1999	CAD FILE CH3160B1.DWG
SHEET 1 OF 1	REFERENCE CH3160

Figure 4
REDUCED SURVEY PLAN

WILLIAM L. BACKHOUSE
Pty. Limited A.C.N. 003 000 708
Registered Surveyors, Planners & Development Consultants

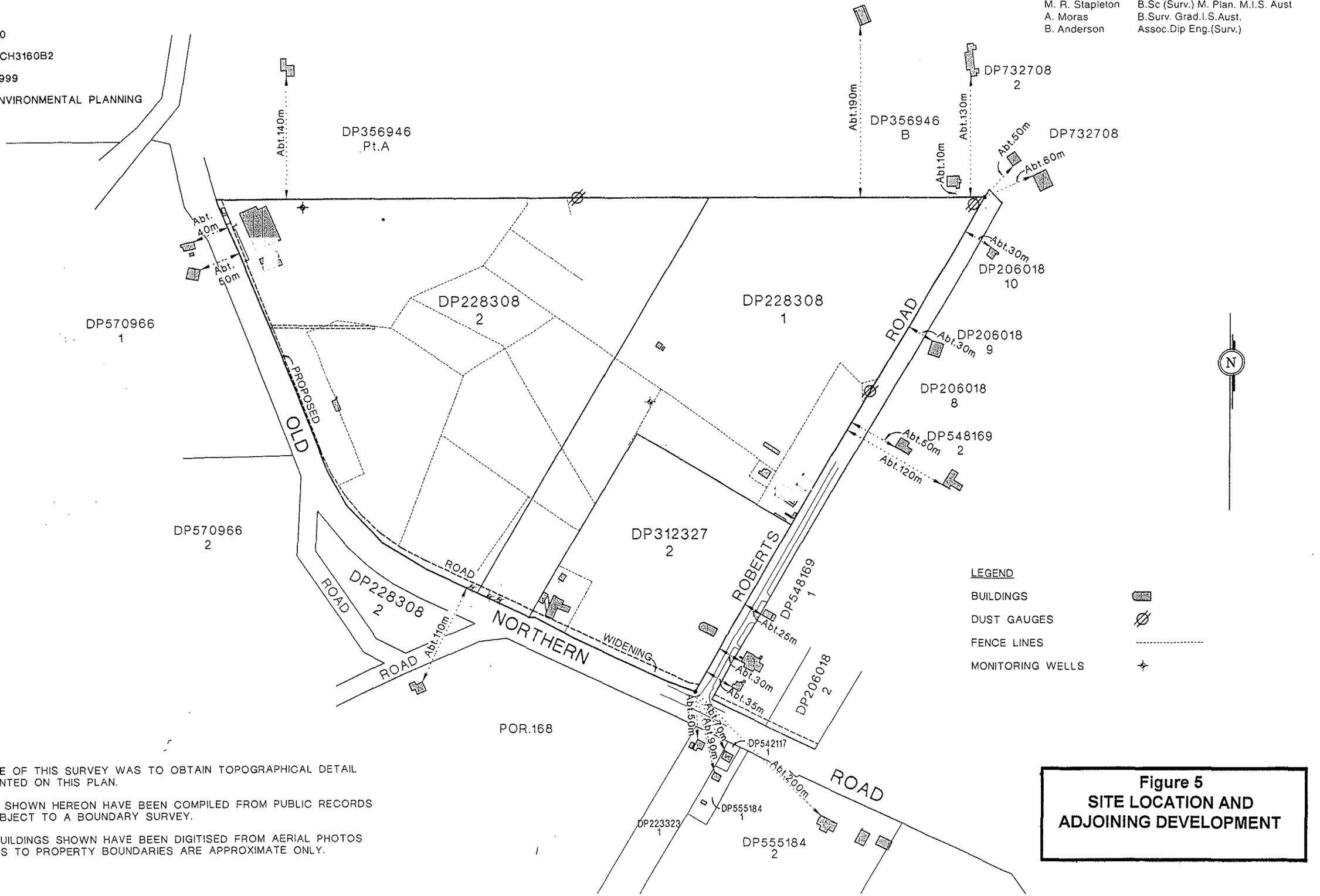
W. L. Backhouse B.Surv. M.I.S. Aust. A.I.M.M.
M. R. Stapleton B.Sc (Surv.) M. Plan. M.I.S. Aust
A. Moras B.Surv. Grad.I.S.Aust.
B. Anderson Assoc.Dip Eng.(Surv.)

SCALE: 1:4000

REFERENCE: CH3160B2

DATE: 28.01.1999

RE: NEXUS ENVIRONMENTAL PLANNING



LEGEND

BUILDINGS

DUST GAUGES

FENCE LINES

MONITORING WELLS

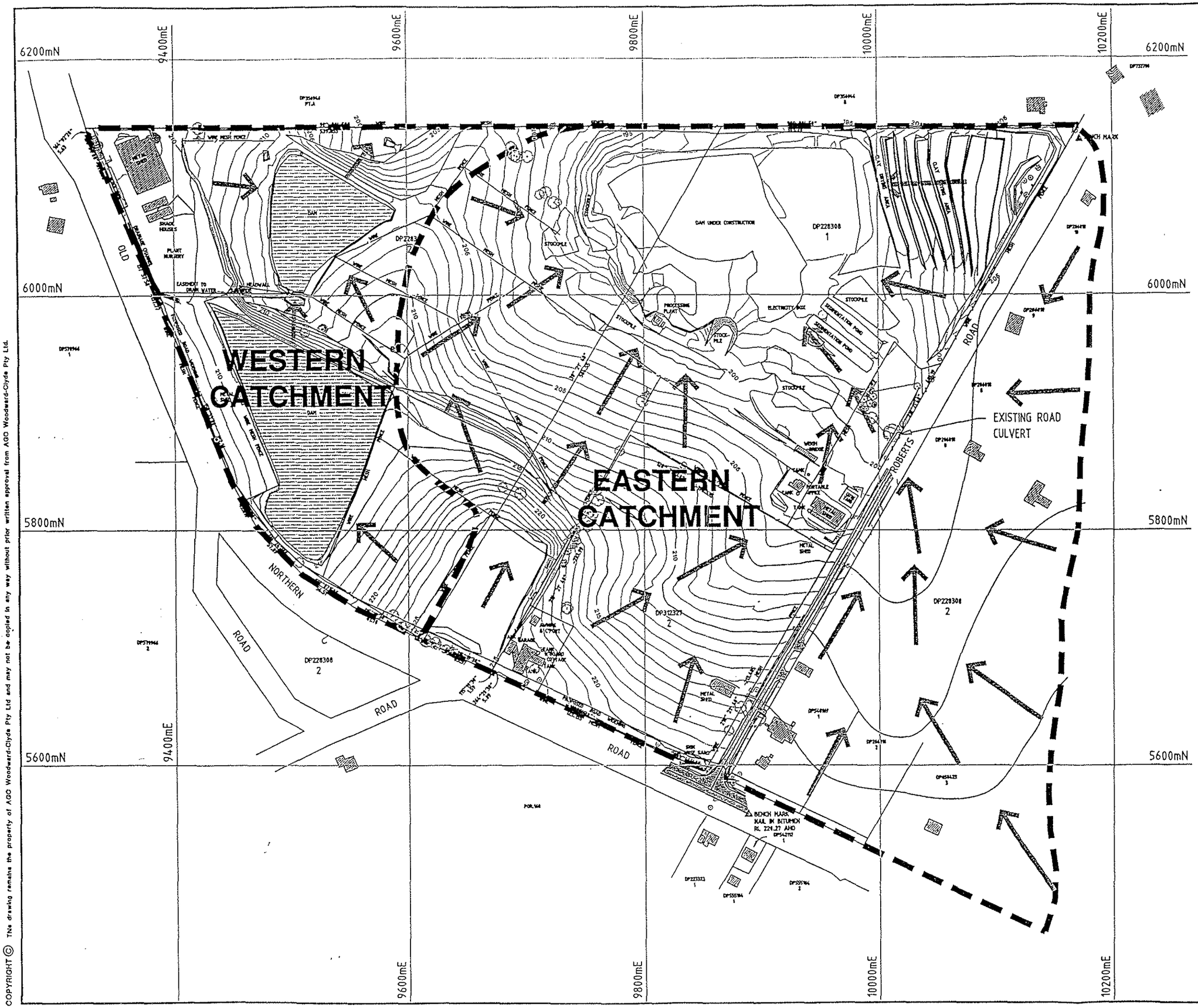
NOTES:

THE PURPOSE OF THIS SURVEY WAS TO OBTAIN TOPOGRAPHICAL DETAIL AS REPRESENTED ON THIS PLAN.

BOUNDARIES SHOWN HEREON HAVE BEEN COMPILED FROM PUBLIC RECORDS AND ARE SUBJECT TO A BOUNDARY SURVEY.

ADJACENT BUILDINGS SHOWN HAVE BEEN DIGITISED FROM AERIAL PHOTOS AND OFFSETS TO PROPERTY BOUNDARIES ARE APPROXIMATE ONLY.

Figure 5
SITE LOCATION AND ADJOINING DEVELOPMENT



REVISION: **B** DESIGNED: **SRR**

SCALE: **AS SHOWN** DRAWN: **LJE**

DRAWING No: **A8602019\0001** CHECKED: SRR

CAD FILE NO: **G012** APPROVED: FC

DATE: 22/6/99 STATUS: **FINAL**

LEGEND

CATCHMENT BOUNDARIES

DIRECTION OF SURFACE DRAINAGE

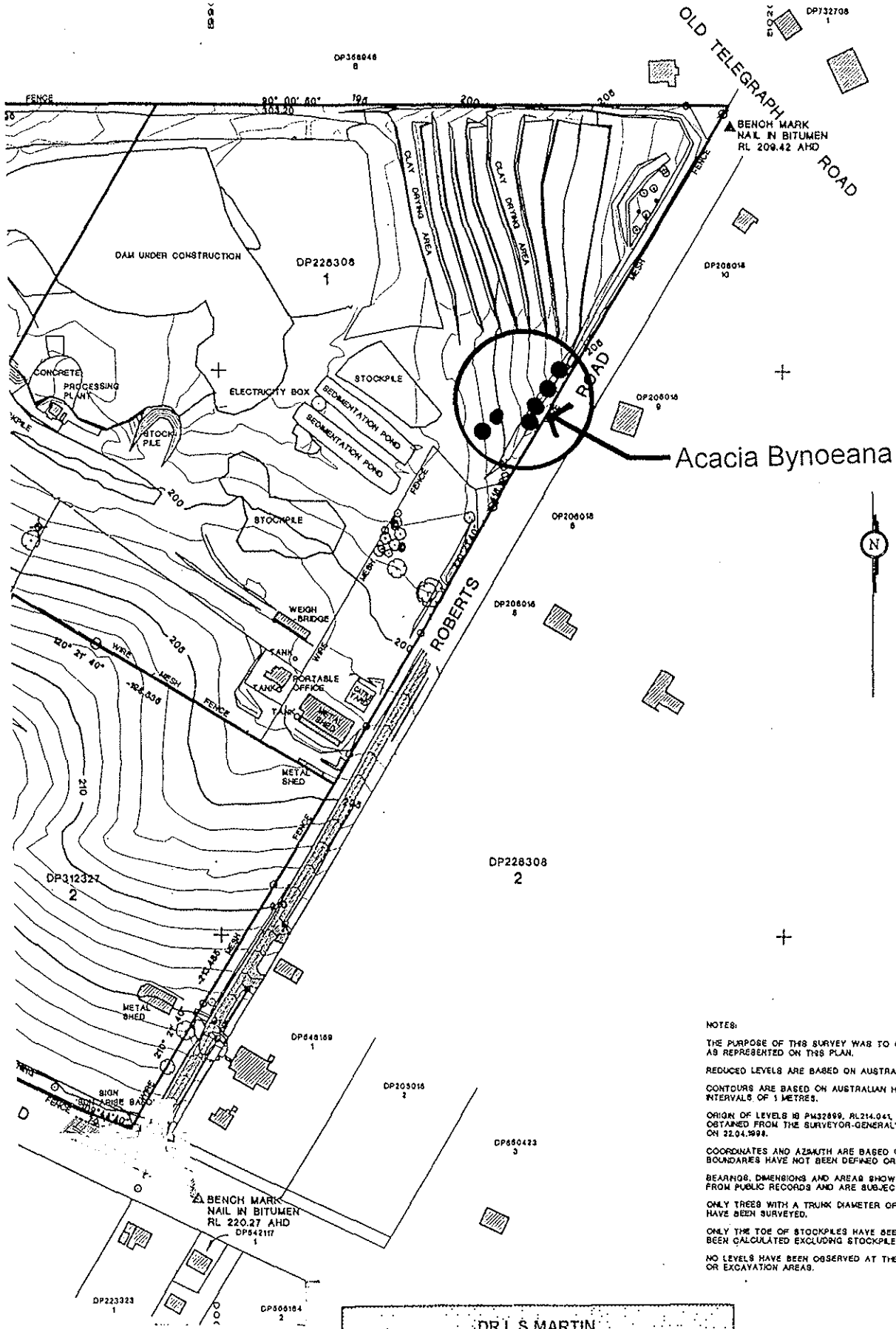
SOURCE :
WILLIAM L. BACKHOUSE PTY LIMITED REGISTERED SURVEYORS & PLANNERS DETAIL SURVEY LAND CONTAINED IN CERTIFICATE OF TITLE 1/228308, 2/228308 & 2/312327 OLD NORTHERN ROAD MAROOTA

0 50 100 150
metres

CLIENT
NEXUS ENVIRONMENTAL PLANNING PTY LTD

Figure 6
DRAINAGE CATCHMENTS

Woodward-Clyde



NOTES:

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ONLY THE TOE OF STOCKPILES HAVE BEEN SURVEYED. CONTOURS HAVE BEEN CALCULATED EXCLUDING STOCKPILES.

NO LEVELS HAVE BEEN OBSERVED AT THE BASE OF SILT PONDS OR EXCAVATION AREAS.

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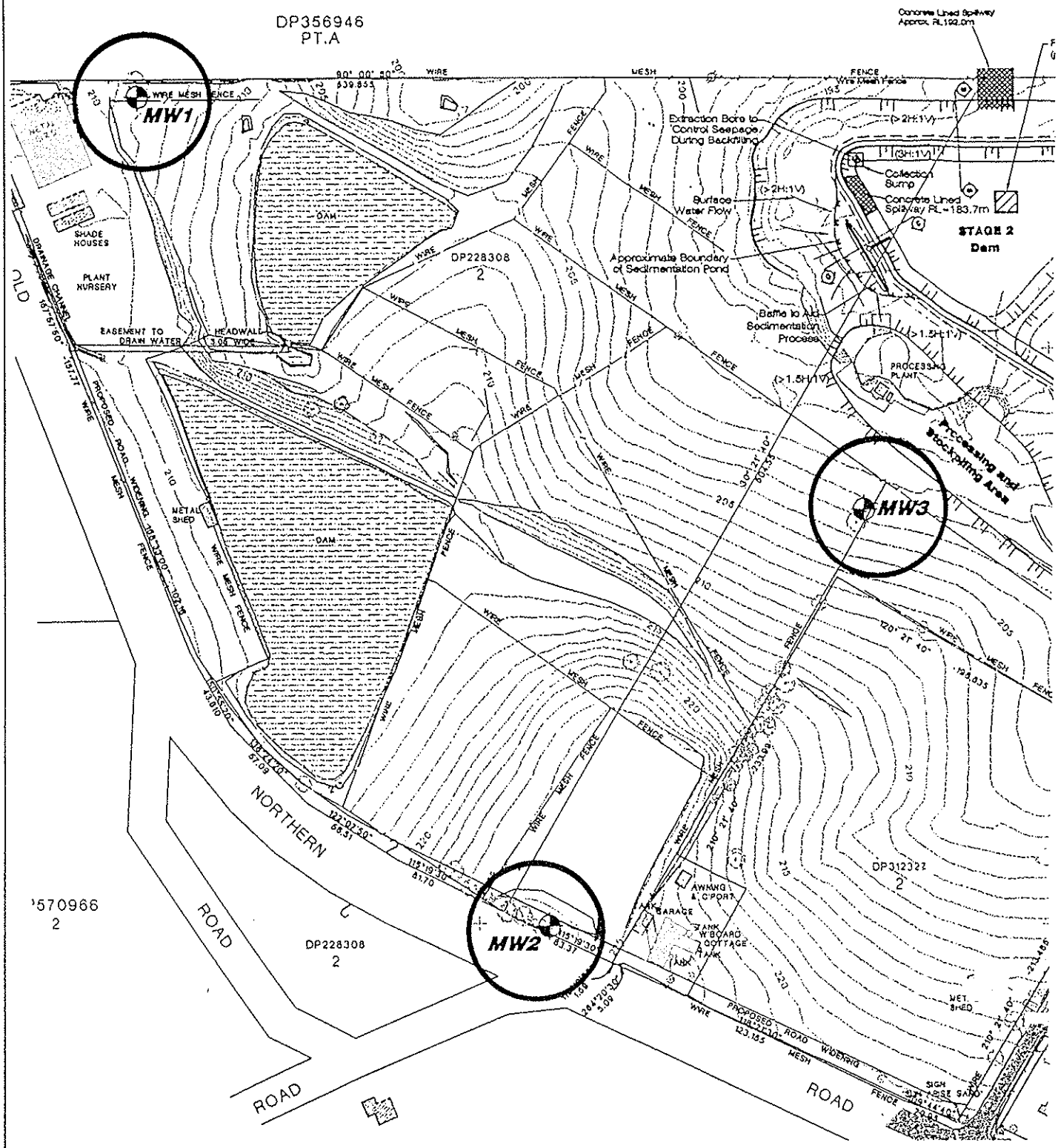
ENVIRONMENTAL IMPACT STATEMENT
SAND EXTRACTION
ROBERTS ROAD
MAROOTA

NEXUS ENVIRONMENTAL PLANNING PTY LTD

B705.1 After: AES

Figure 7: LOCATION OF ACACIA SPECIES



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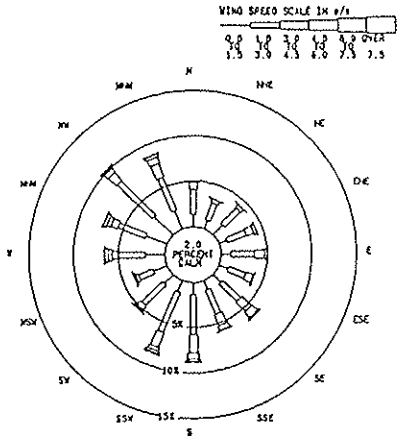
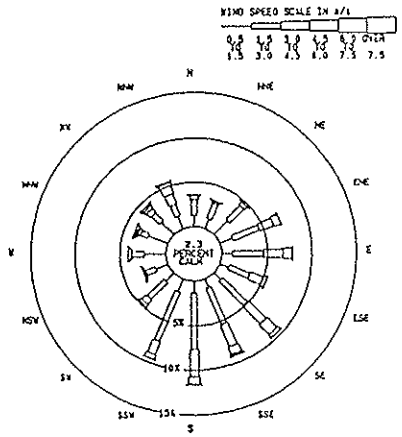
B705.1 After: WOODWARD CLYDE

Figure 8: LOCATION OF MONITORING BORES

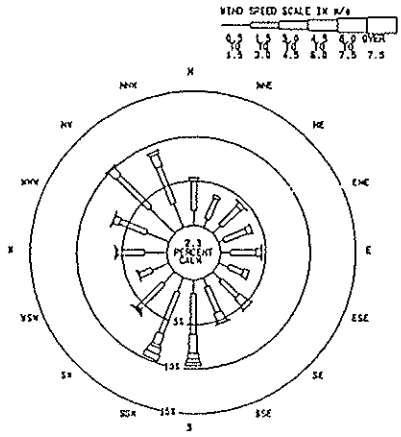


DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Kurrajong - Annual 1997

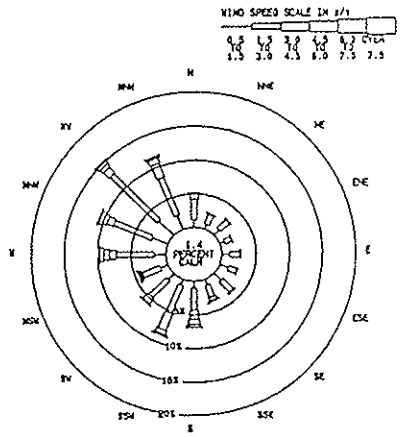
ANNUAL AND SEASONAL WINDROSES FOR KURRAJONG – 1997



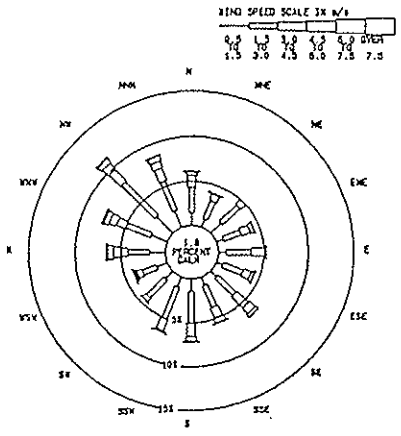
DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Kurrajong - Summer 1997



DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Kurrajong - Autumn 1997



DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Kurrajong - Winter 1997



DISTRIBUTION OF WINDS
FREQUENCY OF OCCURRENCE IN PERCENT
Kurrajong - Spring 1997

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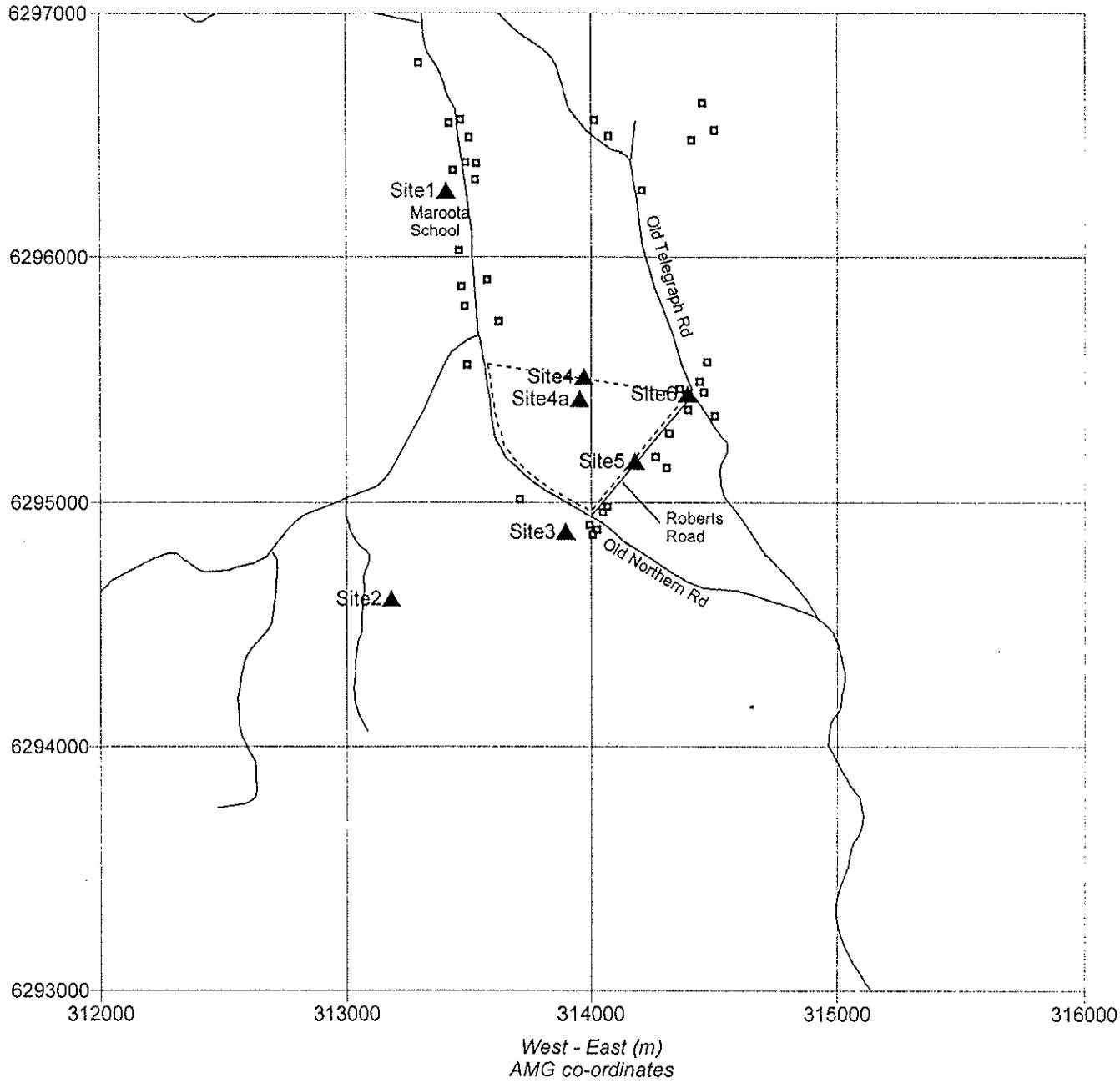
ENVIRONMENTAL IMPACT STATEMENT SAND EXTRACTION ROBERTS ROAD MAROOTA
NEXUS ENVIRONMENTAL PLANNING PTY LTD

B705.1 After: HOLMES AIR SCIENCES

Figure 9: WIND ROSES



Location of proposed site and dust deposition gauges

▲ Dust deposition gauges
□ Residences
---- Lease boundary

DR L S MARTIN

ENVIRONMENTAL IMPACT STATEMENT
SAND EXTRACTION
ROBERTS ROAD
MAROOTA

NEXUS ENVIRONMENTAL PLANNING PTY LTD

B705.1 After: HOLMES AIR SCIENCES

Figure 10: DUST GAUGE LOCATIONS

WILLIAM L. BACKHOUSE
Pty. Limited A.C.N. 003 000 708
Registered Surveyors, Planners & Development Consultants

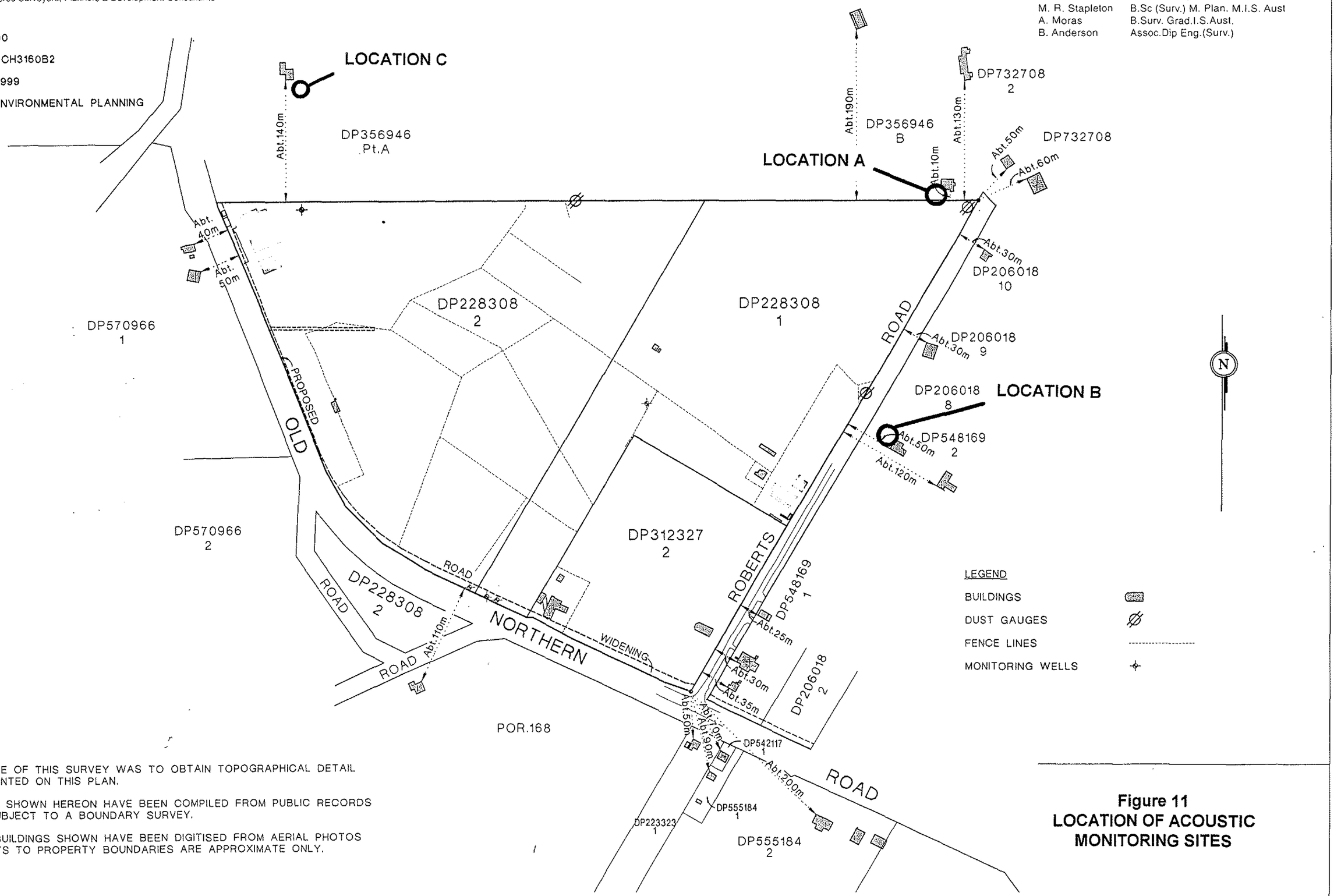
W. L. Backhouse B.Surv. M.I.S. Aust. A.I.M.M.
M. R. Stapleton B.Sc (Surv.) M. Plan. M.I.S. Aust
A. Moras B.Surv. Grad.I.S.Aust.
B. Anderson Assoc.Dip Eng.(Surv.)

SCALE: 1:4000

REFERENCE: CH3160B2

DATE: 28.01.1999

RE: NEXUS ENVIRONMENTAL PLANNING



LEGEND

BUILDINGS

DUST GAUGES

FENCE LINES

MONITORING WELLS

NOTES:

THE PURPOSE OF THIS SURVEY WAS TO OBTAIN TOPOGRAPHICAL DETAIL AS REPRESENTED ON THIS PLAN.

BOUNDARIES SHOWN HEREON HAVE BEEN COMPILED FROM PUBLIC RECORDS AND ARE SUBJECT TO A BOUNDARY SURVEY.

ADJACENT BUILDINGS SHOWN HAVE BEEN DIGITISED FROM AERIAL PHOTOS AND OFFSETS TO PROPERTY BOUNDARIES ARE APPROXIMATE ONLY.

Figure 11
LOCATION OF ACOUSTIC MONITORING SITES

DP356946 PT.A

DP356946 B

DP732708 1

OLD TELEGRAPH ROAD

ROBERTS ROAD

NORTHERN ROAD

OLD ROAD

MW1

MW2

MW3

WIRE MESH FENCE

Concrete Lined Spillway Approx. RL192.0m

Floating Pontoon (process water pump)

Extraction Bore to Control Seepage During Backfilling

Collection Sump

Concrete Lined Spillway RL=183.7m

Surface Water Flow

Approximate Boundary of Sedimentation Pond

Baffle to Aid Sedimentation Process

Temporary Dam Wall (To be Breached when Stage 2 Dam Construction is Complete)

STAGE 2 Dam

STAGE 1 Dam

PROCESSING PLANT

Processing and Stockpiling Area

Surface Water Drains

Weighbridge

PORTABLE OFFICE

METAL SHED

SHADE HOUSES

PLANT NURSERY

BASEMENT TO DRAIN WATER

HEADWALL 3.05 WIDE

DRAINAGE CHANNEL

PROPOSED ROAD WIDENING

DAM

AWNING & CARPORT

GARAGE

TANK

WOODARD COTTAGE

SIGN "HOUSE SALE"

BENCH MARK NAIL IN BITUMEN RL 209.42 AHD

BENCH MARK NAIL IN BITUMEN RL 220.27 AHD DP842117 1

DP228308 1

DP228308 2

DP206018 10

DP206018 9

DP206018 8

DP206018 2

DP570966 1

DP570966 2

DP312327 2

DP548169 1

DP650423 3

DP223323 1

DP555184 2

DP555184 1

POR.168

N6000

N5700

E9300

E9500

E9900

E10200

LEGEND

- CROSS SECTION LOCATION
- PROPOSED PROCESS WATER DAM
- (1.5H : 1V) RECOMMENDED BATTER SLOPES
- RECOMMENDED BATTER SLOPES

0 50 100 150 metres

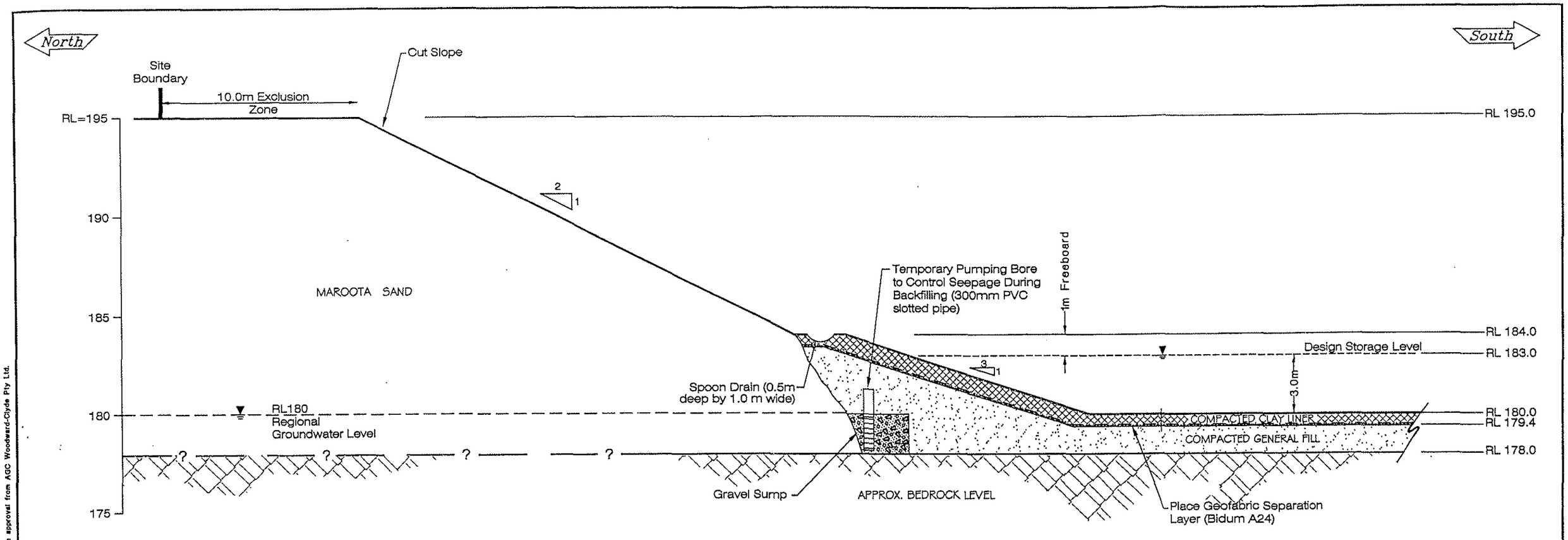
REVISION:	B	DESIGNED:	SRR
SCALE:	AS SHOWN	DRAWN:	LJE
DRAWING No:	A8602019\0001	CHECKED:	
CAD FILE NO:	Q018	APPROVED:	
DATE:		STATUS:	FINAL

CLIENT

NEXUS ENVIRONMENTAL PLANNING PTY LTD

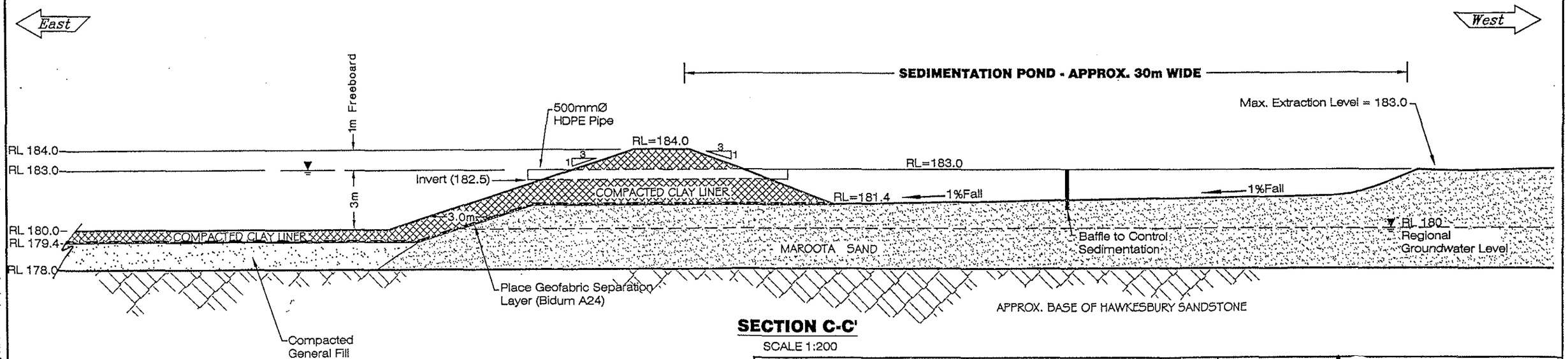
Figure 12
PROPOSED WATER DAM LAYOUT

Woodward-Clyde



SECTION B-B'

SCALE 1:200



SECTION C-C'

SCALE 1:200

0 2 4 6 8 10 metres

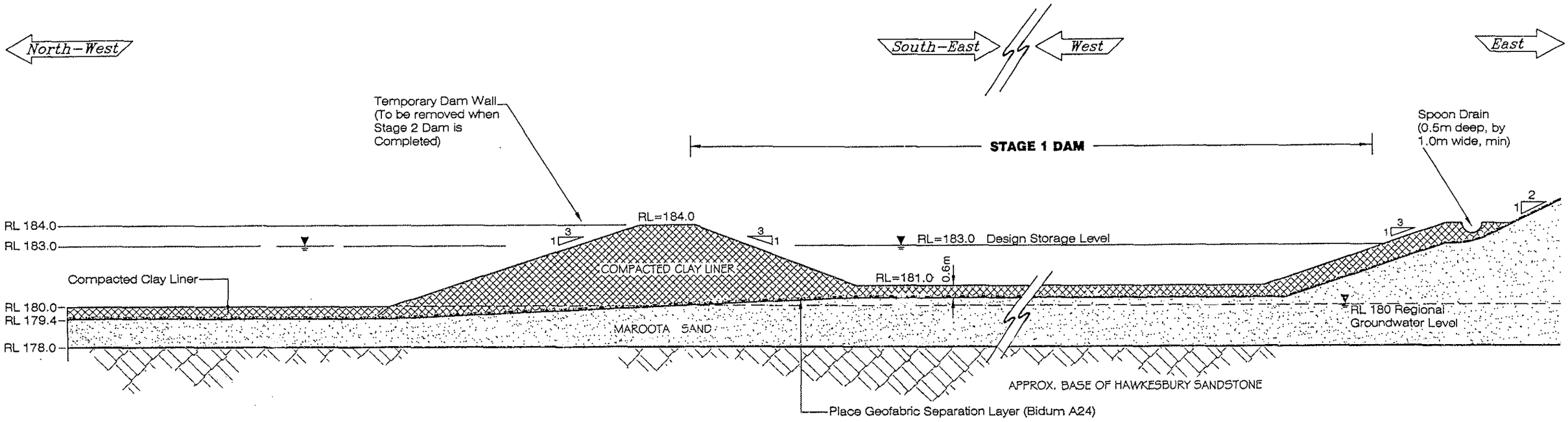
Woodward-Clyde

CLIENT
NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT
LOT 1 & 2, DP228308, LOT 2, DP31327, MAROOTA DEVELOPMENT APPLICATION-PROCESS WATER DAM DESIGN

REVISION: B	DESIGNED: SRR
SCALE: AS SHOWN	DRAWN: LJE
DRAWING No: A8602019\0001	CHECKED: SRR
CAD FILE NO: G008	APPROVED: FC
DATE: 22/6/99	STATUS: FINAL

Figure 13
PROPOSED WATER DAM CROSS SECTIONS



SECTION D-D'

SCALE 1:200

0 2 4 6 8 10
metres

Woodward-Clyde

CLIENT
NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT
LOT 1 & 2, DP228308, LOT 2, DP31327, MAROOTA DEVELOPMENT APPLICATION PROCESS WATER DAM DESIGN

REVISION: B
DESIGN: SRR
SCALE: AS SHOWN
DRAWN: LJE
DRAWING No: A8602019\0001
CHECK: SRA
CAD FILE NO: G017
APPRO: TC
DATE: 22/6/99
STATUS: FINAL

Figure 14
PROPOSED TEMPORARY WATER DAM CROSS SECTION

T:\DRAFTING\A86\02019\0002\-G-005.dwg 27-05-99\4:25 pm

9400mE 9600mE 9800mE 10000mE 10200mE

6200mN 6000mN 5800mN 5600mN 5400mN

SEDIMENTATION POND

10m Min

OLD TELEGRAPH ROAD

EXISTING DAM

STAGE 2

ACTIVE CELL 1A

PROCESS WATER DAM RL 180m

CLAY DRYING AREA

OLD

CELL 1C

CELL 1D

PROCESSING PLANT

30m Min

EXISTING DAM

CELL 1F

SAND STOCKPILE

Access

CELL 1B

EXISTING ROAD CULVERT

ROAD

CELL 1E

WEIGHBRIDGE

STAGE 1

ROBERTS

OFFICE

CELL 1H

CELL 1G

SITE ENTRANCE

CELL 1J

CELL 1I

TOPSOIL STOCKPILE

NORTHERN

ROAD

CELL 1K

30m Min

30m Min

ROAD

ROAD

N

DESIGNED: AGK DRAWING No: A8502019-0002-G-005

DRAWN: IBS REVISION: B

CHECKED: SCALE: 1 : 1500

APPROVED: CAD FILE No: -G-005

STATUS: FINAL DATE:

LEGEND

STORMWATER COLLECTION DRAINS

ACTIVE CELL AREA

SOURCE :
WILLIAM L. BACKHOUSE PTY LIMITED REGISTERED SURVEYORS & PLANNERS DETAIL SURVEY LAND CONTAINED IN CERTIFICATE OF TITLE 1/228308, 2/228308 & 2/312327 OLD NORTHERN ROAD MAROOTA

REV	REV DESCRIPTION	BY	DATE
B	AMENDMENTS	IBS	JUNE 99

0 20 40 60 80 100 120
SCALE - 1 : 1500 (Metres) (A1)

CLIENT
NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT

Figure 15
CELL 1A EXTRACTION

Woodward Clyde

T:\DRAFTING\A86\02019\0002\-G-006.dwg 27-05-99\4:16 pm

9400mE 9600mE 9800mE 10000mE 10200mE

6200mN 6000mN 5800mN 5600mN 5400mN

TOPSOIL STOCKPILE

SEDIMENTATION POND

10m Min

OLD TELEGRAPH ROAD

EXISTING DAM

STAGE 2

CLAY DRYING AREA

PROCESS WATER DAM RL 180m

CELL 1C

CELL 1D

PROCESSING PLANT

ACCESS

ACTIVE CELL 1B

OLD ROBERTS ROAD

30m Min

EXISTING DAM

CELL 1F

SAND STOCKPILE

CELL 1E

WEIGHBRIDGE

STAGE 1

OFFICE

CELL 1H

CELL 1G

SITE ENTRANCE

CELL 1J

CELL 1I

CELL 1K

NORTHERN ROAD

30m Min

30m Min

ROAD

N

LEGEND

STORMWATER COLLECTION DRAINS

ACTIVE CELL AREA

SOURCE :
WILLIAM L. BACKHOUSE PTY LIMITED
REGISTERED SURVEYORS & PLANNERS
DETAIL SURVEY LAND CONTAINED IN
CERTIFICATE OF TITLE 1/228308,
2/228308 & 2/312327 OLD NORTHERN
ROAD MAROOTA

REV	REV DESCRIPTION	BY	DATE
B	FINAL AMENDMENTS	IBS	JUNE 99

0 20 40 60 80 100 120
SCALE - 1 : 1500 (Metres) (A1)

CLIENT
NEXUS ENVIRONMENTAL
PLANNING PTY LTD

PROJECT

Figure 16
CELL 1B EXTRACTION

Woodward Clyde

DESIGNED: AGK DRAWING No: A8602019-0002-G-006
DRAWN: IBS REVISION. B
CHECKED: SCALE. 1:1500
APPROVED: CAD FILE No: -G-006
STATUS: FINAL DATE:

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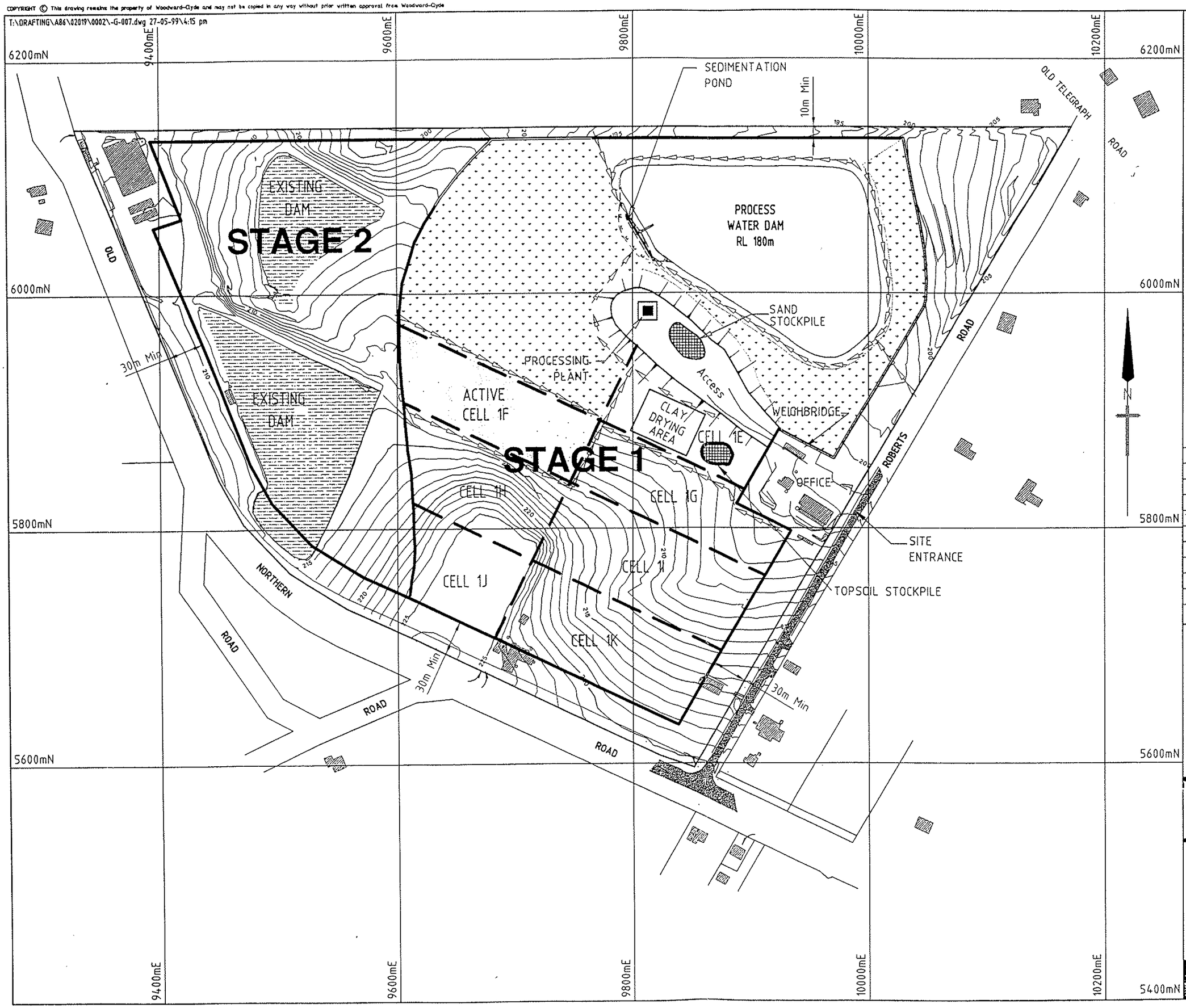


DESIGNED: **AGK** DRAWING No. **A8602019-0002-G-007**

DRAWN: **IBS** REVISION: **B**

CHECKED: SCALE: **1 : 1500**

APPROVED: CAD FILE No: **-G-007**

STATUS: **FINAL** DATE:

LEGEND

- STORMWATER COLLECTION DRAINS
- ACTIVE CELL AREA
- REHABILITATION CELL AREA

SOURCE :
WILLIAM L. BACKHOUSE PTY LIMITED
REGISTERED SURVEYORS & PLANNERS
DETAIL SURVEY LAND CONTAINED IN CERTIFICATE OF TITLE 1/228308, 2/228308 & 2/312327 OLD NORTHERN ROAD MAROOTA

REV	REV DESCRIPTION	BY	DATE
B	FINAL AMENDMENTS	IBS	JUNE 99

0 20 40 60 80 100 120
SCALE - 1 : 1500 (Metres) (A1)

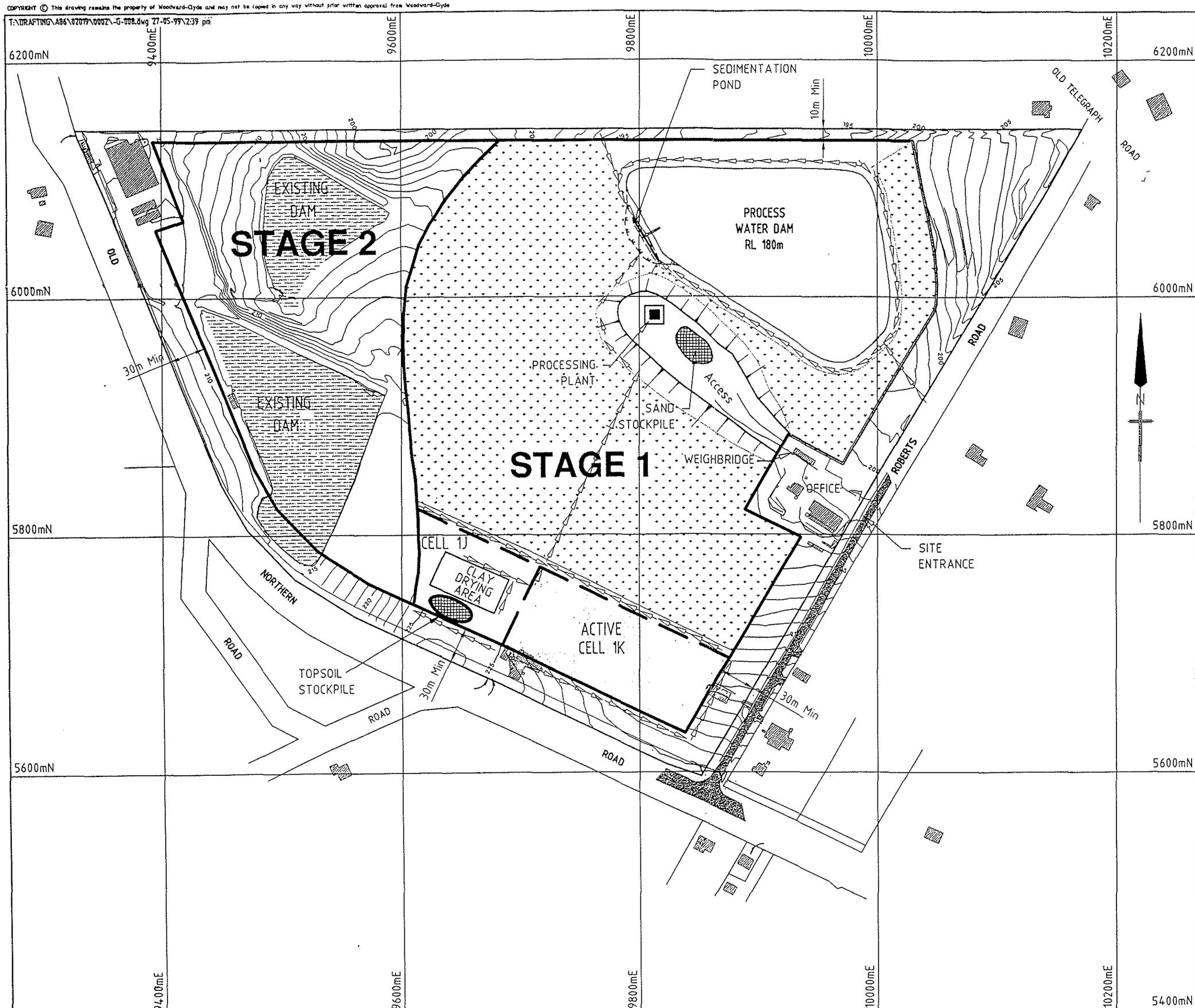
CLIENT
NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT

Figure 17
CELL 1F EXTRACTION

Woodward Clyde

T:\DRAFTING\A86\02019\0002\-G-008.dwg 27-05-99\2:39 pm



DESIGNED: AGK DRAWING No: A8502019-0002-G-008

DRAWN: IBS REVISION: B

CHECKED SCALE: 1:1500

APPROVED CAD FILE No: -G-008

STATUS: FINAL DATE:

LEGEND

- STORMWATER COLLECTION DRAINS
- ACTIVE CELL AREA
- REHABILITATION CELL AREA

SOURCE :
WILLIAM L. BACKHOUSE PTY LIMITED
REGISTERED SURVEYORS & PLANNERS
DETAIL SURVEY LAND CONTAINED IN
CERTIFICATE OF TITLE 1/228308,
2/228308 & 2/312327 OLD NORTHERN
ROAD MAROOTA

REV	REV DESCRIPTION	BY	DATE
B	FINAL AMENDMENTS	IBS	JUNE99

0 20 40 60 80 100 120
SCALE - 1 : 1500 (Metres) (A1)

CLIENT
NEXUS ENVIRONMENTAL
PLANNING PTY LTD

PROJECT

Figure 18
CELL 1K EXTRACTION

Woodward Clyde

T:\DRAFTING\A86\02019\0002\-G-009.dwg 27-05-99\3:10 pm

9400mE 9600mE 9800mE 10000mE 10200mE

6200mN 6000mN 5800mN 5600mN 5400mN

SEDIMENTATION POND

10m Min

OLD TELEGRAPH ROAD

ACTIVE CELL 2A

CELL 2B

STAGE 2

PROCESS WATER DAM RL 180m

OLD ROBERTS ROAD

30m Min

CELL 2C

EXISTING DAM

CELL 2D

PROCESSING PLANT

SAND STOCKPILE

Access

STAGE 1

WEIGHBRIDGE

OFFICE

SITE ENTRANCE

TOPSOIL STOCKPILE

CLAY DRYING AREA

CELL 1K

NORTHERN ROAD

ROAD

30m Min

ROAD

30m Min

ROAD

N

DESIGNED: AGK DRAWING No: A8602019-0002-G-009

DRAWN: IBS REVISION: B

CHECKED: SCALE: 1:1500

APPROVED: CAD FILE No: -G-009

STATUS: FINAL DATE:

LEGEND

STORMWATER COLLECTION DRAINS

ACTIVE CELL AREA

REHABILITATION CELL AREA

SOURCE :
WILLIAM L. BACKHOUSE PTY LIMITED REGISTERED SURVEYORS & PLANNERS DETAIL SURVEY LAND CONTAINED IN CERTIFICATE OF TITLE 1/228308, 2/228308 & 2/312327 OLD NORTHERN ROAD MAROOTA

REV	REV DESCRIPTION	BY	DATE
B	FINAL AMENDMENTS	IBS	JUNE 99

0 20 40 60 80 100 120
SCALE - 1 : 1500 (Metres) (A1)

CLIENT
NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT

Figure 19
CELL 2A EXTRACTION

Woodward Clyde

T:\DRAFTING\A86\02019\0002\-G-010.dwg 27-05-99\4:53 pm

9400mE 9600mE 9800mE 10000mE 10200mE

6200mN 6000mN 5800mN 5600mN 5400mN

SEDIMENTATION POND

10m Min

OLD TELEGRAPH ROAD

TOPSOIL STOCKPILE

CELL 2B

CLAY DRYING AREA

PROCESS WATER DAM RL 180m

OLD

ACTIVE CELL 2C

30m Min

PROCESSING PLANT

Access

SAND STOCKPILE

WEIGHBRIDGE

OFFICE

ROBERTS ROAD

CELL 2D

STAGE 1

SITE ENTRANCE

NORTHERN ROAD

30m Min

30m Min

ROAD

N

DESIGNED: AGK DRAWING No: A8602019-0002-G-010

DRAWN: IBS REVISION: B

CHECKED: SCALE: 1:1500

APPROVED: CAD FILE No: -G-010

STATUS: FINAL DATE:

LEGEND

STORMWATER COLLECTION DRAINS

ACTIVE CELL AREA

REHABILITATION CELL AREA

SOURCE :
WILLIAM L. BACKHOUSE PTY LIMITED
REGISTERED SURVEYORS & PLANNERS
DETAIL SURVEY LAND CONTAINED IN
CERTIFICATE OF TITLE 1/228308,
2/228308 & 2/312327 OLD NORTHERN
ROAD MAROOTA

REV	REV DESCRIPTION	BY	DATE
B	FINAL AMENDMENTS	IBS	JUNE 99

0 20 40 60 80 100 120
SCALE - 1 : 1500 (Metres) (A1)

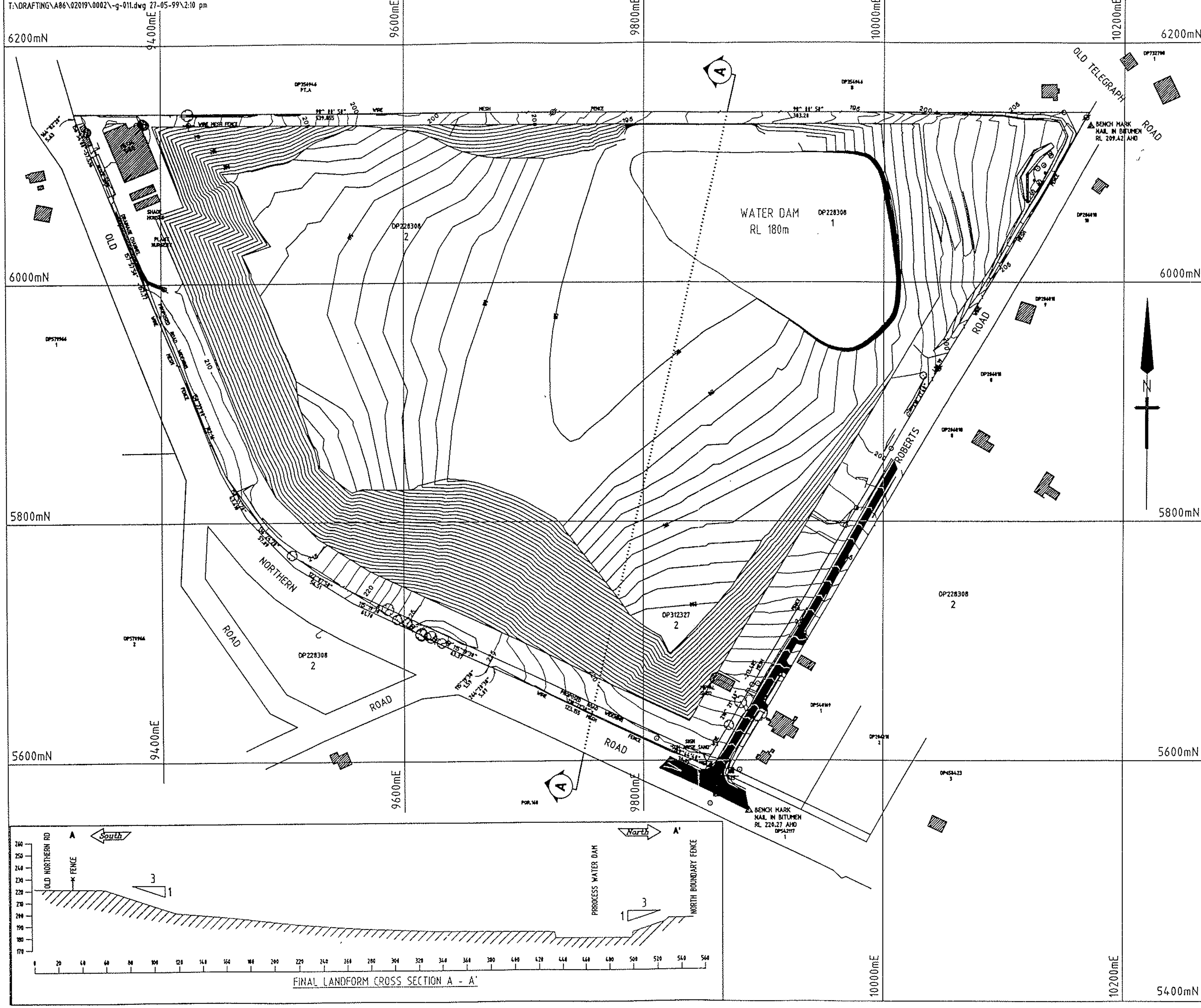
CLIENT
NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT

Figure 20
CELL 2C EXTRACTION

Woodward Clyde

T:\DRAFTING\A86\02019\0002\-g-011.dwg 27-05-99\2:10 pm



DESIGNED: AGK	DRAWING No: A8602019-0002-G-011		
DRAWN: IBS	REVISION: B		
CHECKED:	SCALE: 1 : 1500		
APPROVED:	CAD FILE No: -G-011		
STATUS: FINAL	DATE:		

SOURCE :
WILLIAM L. BACKHOUSE PTY LIMITED
REGISTERED SURVEYORS & PLANNERS
DETAIL SURVEY LAND CONTAINED IN
CERTIFICATE OF TITLE 1/228308, 2/228308 &
2/312327 OLD NORTHERN ROAD MAROOTA

REV	REV DESCRIPTION	BY	DATE
B	FINAL AMENDMENTS	IBS	JUNE 99

0 20 40 60 80 100 120
SCALE - 1 : 1500(Metres) (A1)

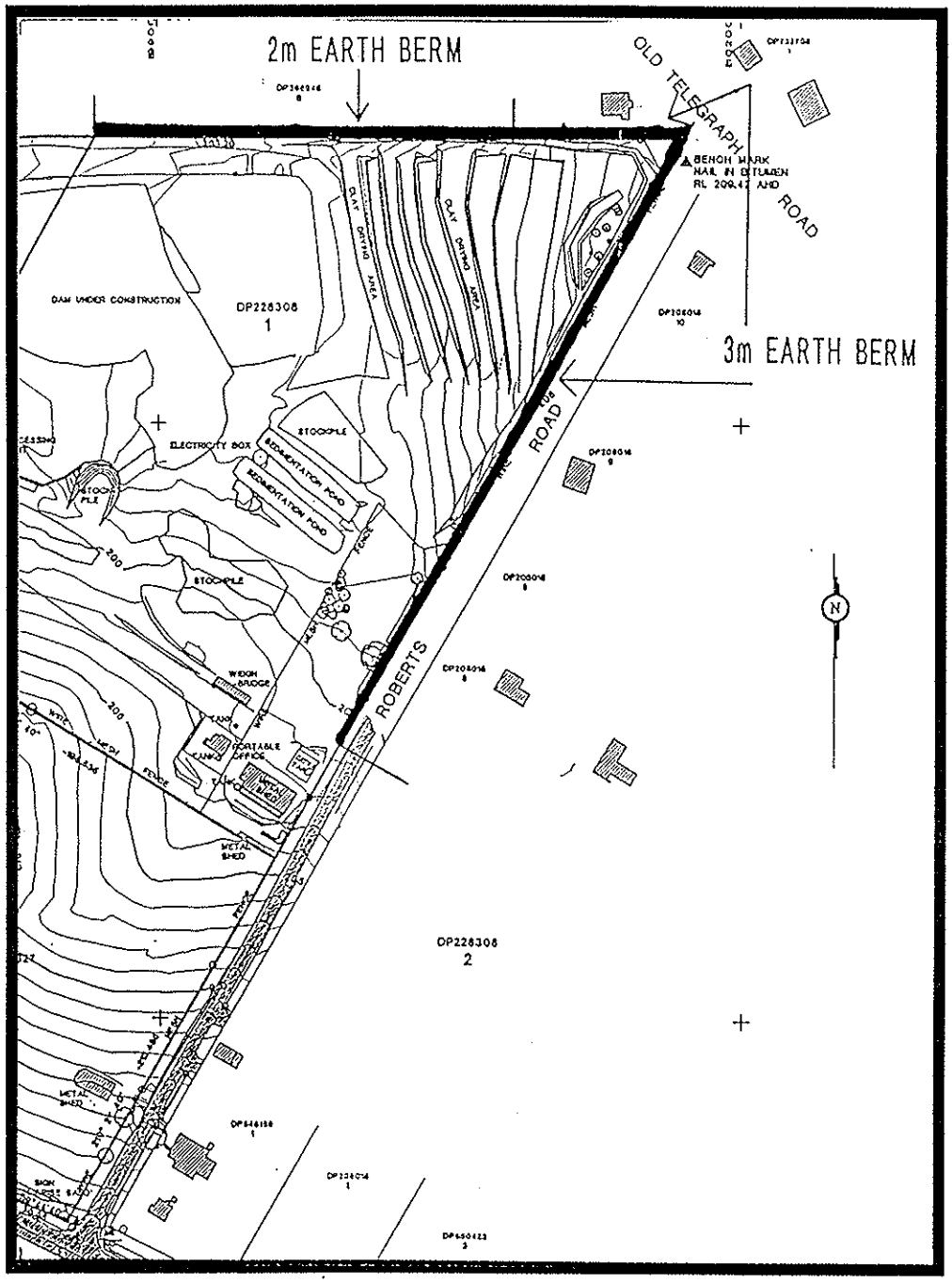
CLIENT

NEXUS ENVIRONMENTAL PLANNING PTY LTD

PROJECT

Figure 21
FINAL LANDFORM CONTOURS

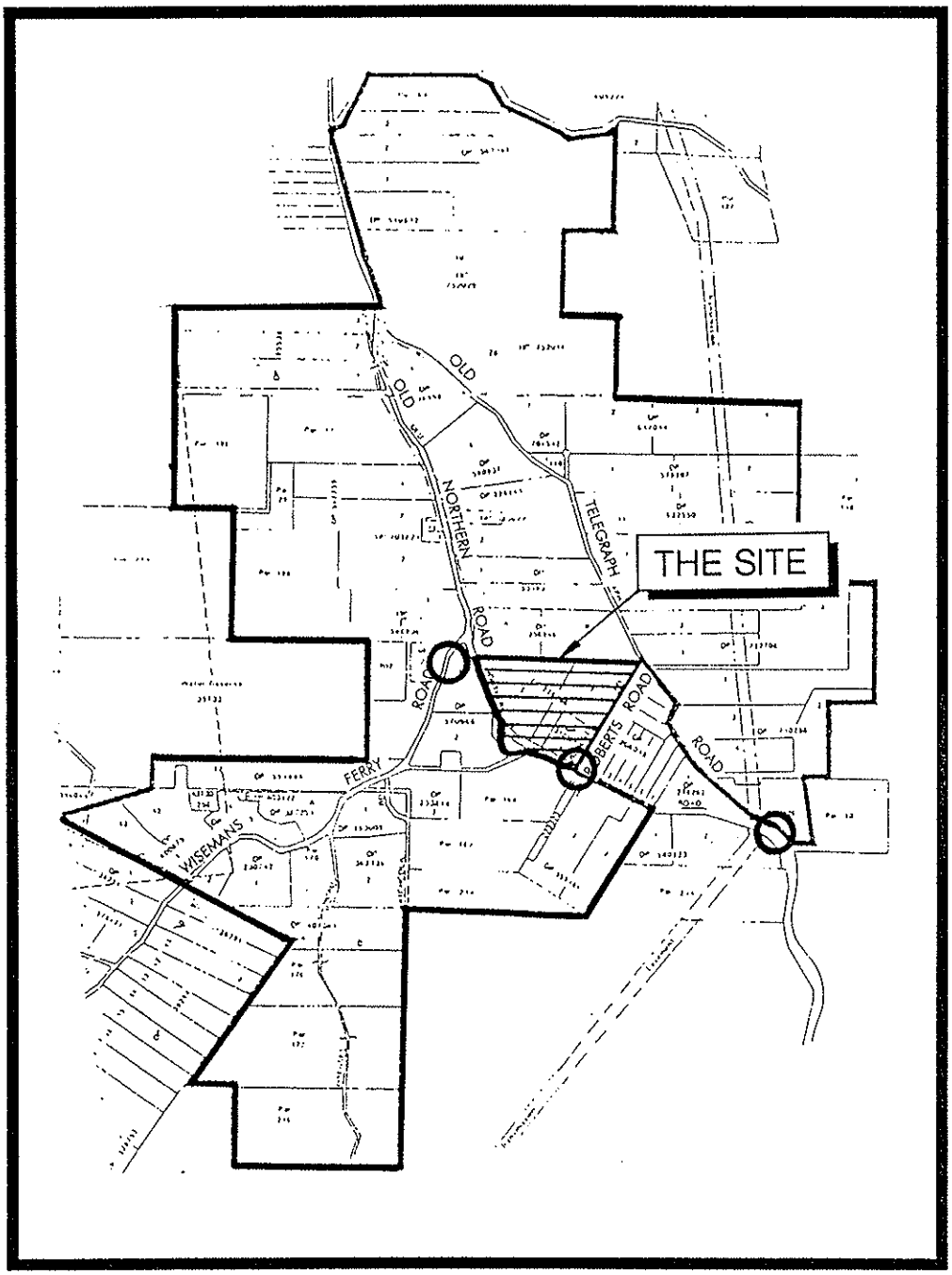
Woodward Clyde



DR L S MARTIN
ENVIRONMENTAL IMPACT STATEMENT SAND EXTRACTION ROBERTS ROAD MAROOTA
NEXUS ENVIRONMENTAL PLANNING PTY LTD

B705.1 After: BENBOW

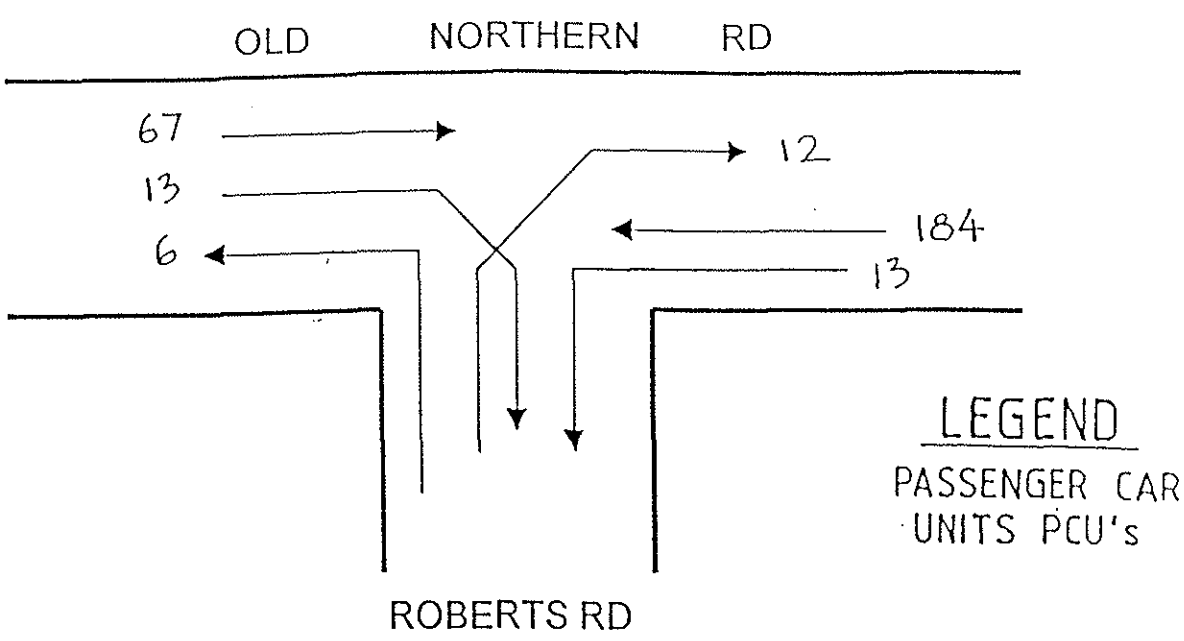
Figure 22: LOCATION OF EARTH BERMS



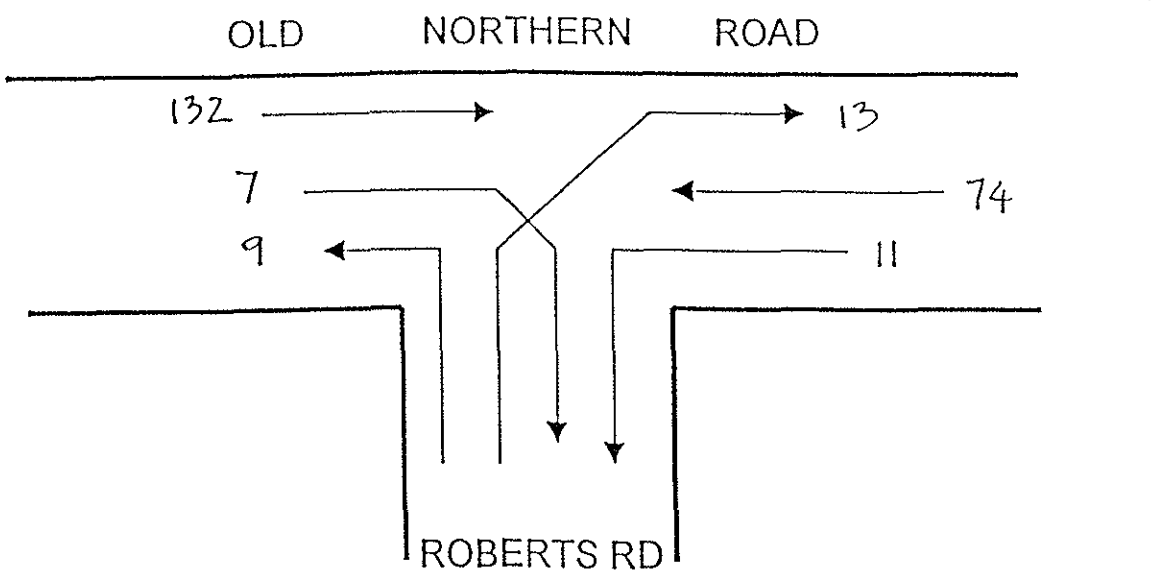
DR L S MARTIN
ENVIRONMENTAL IMPACT STATEMENT SAND EXTRACTION ROBERTS ROAD MAROOTA
NEXUS ENVIRONMENTAL PLANNING PTY LTD

B705.1 After: BENBOW

Figure 23: LOCATION-TRAFFIC COUNTERS



MORNING PEAK HOUR TRAFFIC
VOLUMES 7:00 – 8:00 am



AFTERNOON PEAK HOUR TRAFFIC
VOLUMES 4:30 – 5:30pm

Figure 25
ESTIMATED INTERSECTION VOLUMES ROBERTS ROAD & OLD NORTHERN ROAD

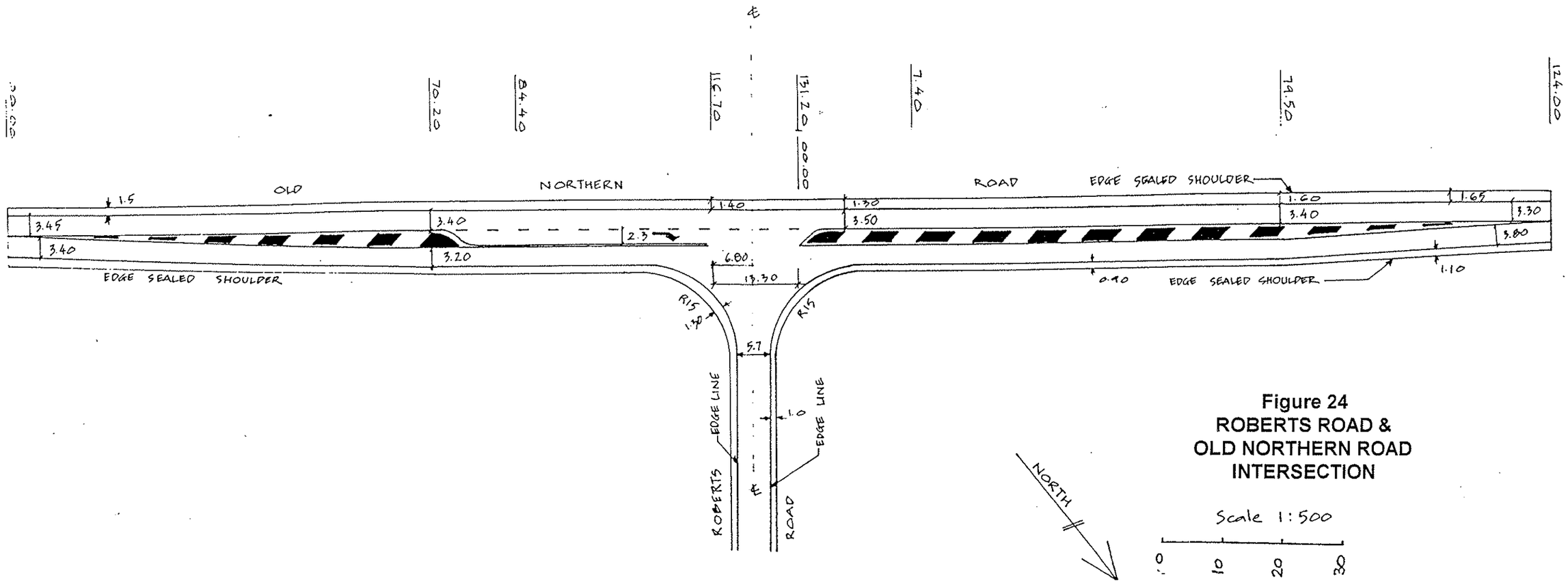


Figure 24
ROBERTS ROAD &
OLD NORTHERN ROAD
INTERSECTION