



EIS 1058

AB020106

Proposed sand extraction, part Lot 43 & Lot B, Londonderry :
environmental impact statement



CSR LIMITED

TRADING AS

THE READYMIX GROUP

PROPOSED SAND EXTRACTION

PART LOT 43 & LOT B

LONDONDERRY

ENVIRONMENTAL

IMPACT STATEMENT

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IMPACT STATEMENT

TAYLOR THOMSON WHITTING PTY LTD

NOVEMBER 1994

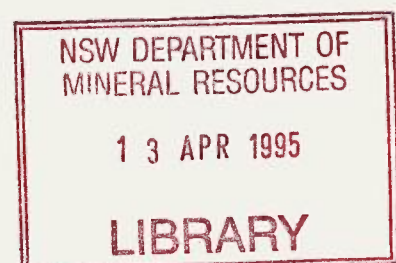


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Project Description

Consent is sought by the Readymix Group from Penrith City Council for the extraction and transportation of construction industry sand from Part Lot 43 DP 585210 and Lot B DP 444984 from within the Londonderry/Agnes Banks Sand Management Area.

This Environmental Impact Statement supports the Development Application in accordance with the requirements for Designated Development under the provisions of the Environmental Planning and Assessment Act, 1979.

The land under consideration has been identified as an important sand resource for the Sydney region. It is included in the Sydney Regional Environmental Plan No. 9 - Extractive Industry on Sheet 5 of 11 (Agnes Banks). Project management and development of this proposal is consistent with the planning recommendations for resource extraction detailed in the Regional Environmental Plan.

The Project consists generally of the following stages:

- Removal of existing vegetation and topsoil
- Extraction of sand resource
- Processing of sand (in existing works area with existing consent)
- Transportation of processed sand for use in the Sydney region
- Recontouring and rehabilitation of the site in accordance with the Management Plan.

Effective Controls will be implemented at all stages of the project to ensure mitigation of all impacts on the environment.

ENVIRONMENTAL PLANNING AND ASSESSMENT ACT, 1979
(SECTION 77 (3) (d))

ENVIRONMENTAL IMPACT STATEMENT

This statement has been prepared on behalf of The Readymix Group being the applicant making the development application referred to below.

The Statement accompanies the development application in respect of the development described below:

Proposed extraction and processing of sand described in Environmental Impact Statement prepared by Taylor Thomson Whitting Pty Ltd Consulting Engineers.

The development application related to the land described as follows:

Street/Locality: Londonderry

Real property description: Part Lot 43 DP 585210 and Lot B DP 444984, Parish of Castlereagh, City of Penrith

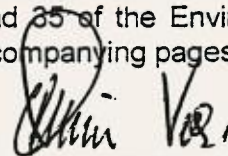
The contents of this statement, as required by Clause 34 of the Environmental Planning and Assessment Regulation, 1980, are set forth in the accompanying pages.

Name, Qualifications and Address of person who prepared Environmental Impact Statement:

Kevin Brian Vos
for and on behalf of
Taylor Thomson Whitting Pty Ltd
Consulting Engineers
48 Chandos Street
ST LEONARDS NSW 2065

Certificate,

I, Kevin Brian Vos care of 48 Chandos Street, St Leonards, hereby certify that I have prepared the contents of this statement in accordance with Clauses 34 and 35 of the Environmental Planning and Assessment Regulation, 1980, are set forth in the accompanying pages.



Signature

14 November 1994.

Date

PART 1

EXECUTIVE SUMMARY

1.1 Executive Summary

Consent is sought by the Readymix Group from Penrith City Council for the extraction of sand from Part Lot 43 DP 585210 and Lot B DP 444984 (refer Figure 1.2 and Drawing No.1) from within the Londonderry/Agnes Banks Sand Management Area.

The extraction of sand in the Londonderry/Agnes Banks area has been carried out over the past 34 years.

The area was identified in Sydney Regional Environmental Plan No. 9 as a significant sand resource within the Sydney region. The sand is typically a fine - medium grained quartz sand containing a significant proportion of clay and silt sized particles. It is the presence of these fine grained particles which makes the material valuable as a source of bricklayer's sand. The sand can also be washed and screened to produce a very clean quartz sand suitable for use in the concrete industry.

The Management Plan which was adopted in principle by Penrith City Council on 18 March 1982 provides for a coordinated approach to the extraction of sand and subsequent rehabilitation. Supplementary reports to the Management Plan have been prepared at the request of Council to provide additional information to that detailed in the Management Plan. Supplementary Report No.1 refers to water quality and drainage. This report details drainage within the Management Area shown in Figure 1.1 as it currently exists and addresses sedimentation and water quality. Supplementary Report No.2 refers to revegetation, sedimentation and erosion control. This report provides additional information with regard to revegetation methods and procedures and the implementation of sedimentation of erosion control measures.

The proposed development is an extension of the existing operation of the Readymix Group within the Management Area shown in Figure 1.1 and is to provide additional quantity of sand to allow the continuation of the Readymix Group's existing operation within the Management Area. It should be noted that this is one of the few remaining areas within the Management Area which does not have development consent.

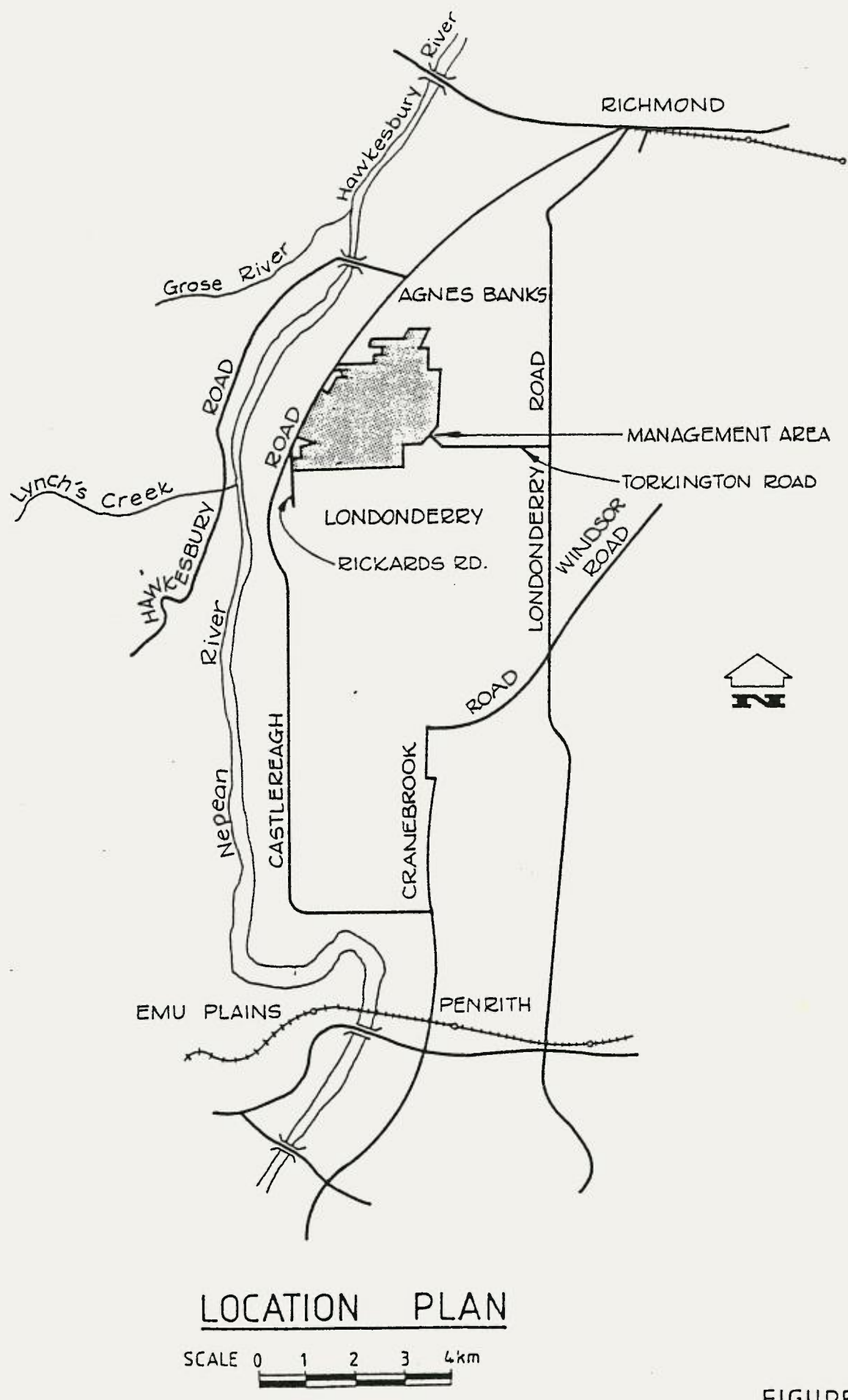
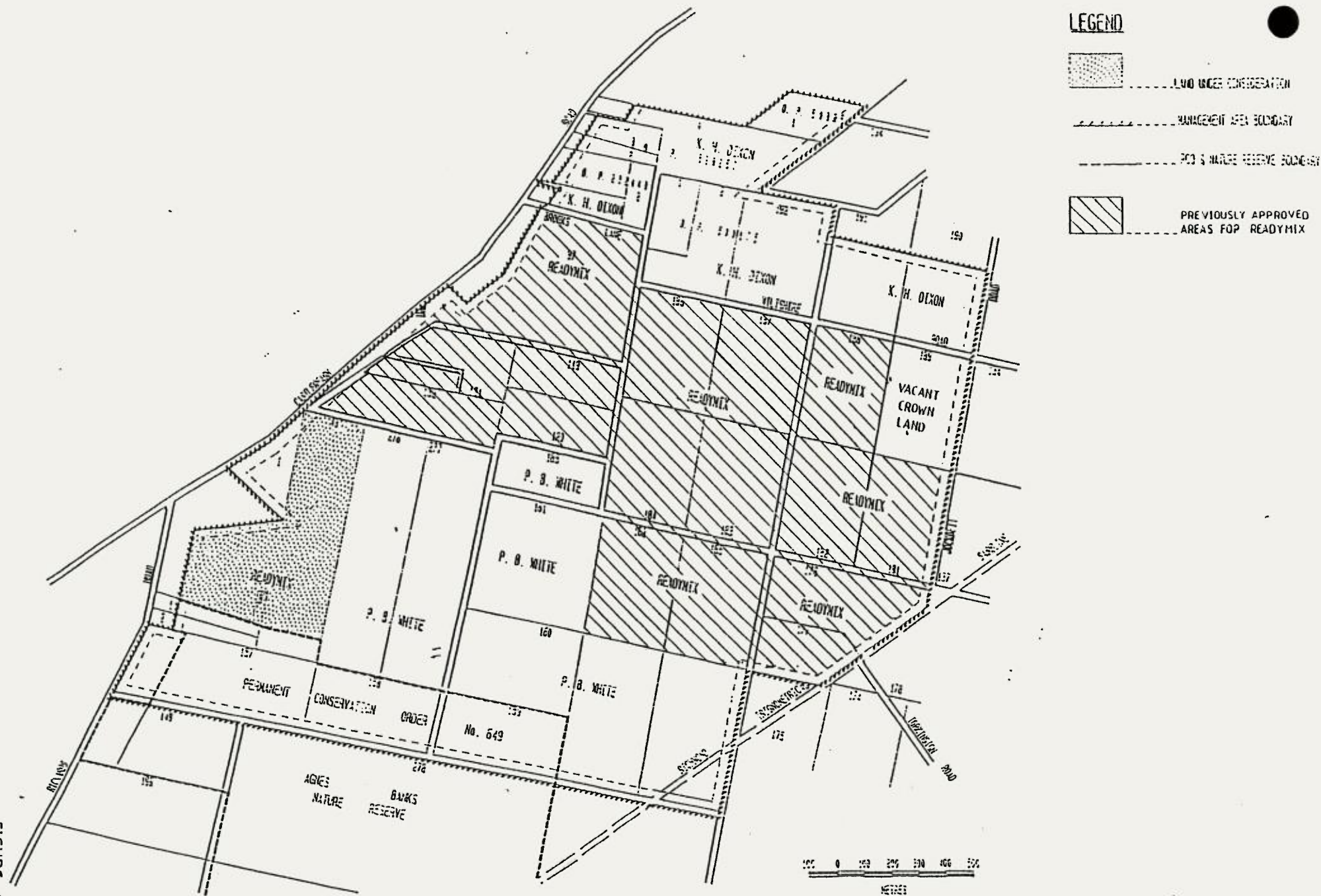


FIGURE 1.1

FIGURE 1-2



LONDONDERRY / AGNES BANKS MANAGEMENT AREA

● The extraction operation includes:

- * Strip existing topsoil and stockpile for reuse or spread on areas prepared for rehabilitation
- * Extraction of sand from a working face with a front-end loader
- * Extracted sand is transported to Readymix's existing works area in a 35 tonne off-road truck. The transport route is along existing haul roads within the Management Area which are regularly maintained by the operators. The washed or dry screened sand is then stockpiled adjacent to the processing plant.
- * Trucks remove processed sand from stockpiles in the works area for delivery to the market.
- * On completion of extraction, areas are prepared for rehabilitation.

The approximate quantity of sand to be extracted is estimated at 2.1 million tonne (raw feed) or approximately 1.2 million cubic metres. At an annual production rate of 150,000 tonne per annum, it is anticipated that progressive extraction and rehabilitation would take 7 to 10 years depending upon market demand.

All access to Part Lot 43 and Lot B will be via the access roads contained within the Management Area from the processing plant and works area operated by Readymix at the south-east end of the Management Area. The access roads are used only by works related vehicles and are regularly maintained by an on-site grader and water cart. It is estimated that two 35 tonne off road trucks would make a total of 60 - 70 round trips per day between the extraction areas and the processing plant on Portion 176.

This proposal has no impact on the current mode of operations or on the level of sales from the works area. As such, there is no impact on the generation of additional truck movements. Access to the works area is principally via Torkington Road, but may also occur from Castlereagh Road via Brooks Lane. The Torkington Road entrance links the site with the most direct routes to the Sydney region. The Castlereagh Road entrance provides for early morning entry to the works area together with a limited percentage of deliveries to the north-west.

Part Lot 43 and Lot B are on the northern side of the Permanent Conservation Order area. A groundwater investigation has been carried out to determine an acceptable stand off to the Permanent Conservation Order area such that extraction will not affect the water table and subsequently vegetation within the Permanent Conservation Order area. The groundwater investigation adopted a standoff of 45 metres and the construction of a low permeability cross (clay) curtain within the standoff in order to minimise the impact on local groundwater tables.

Extraction and rehabilitation is carried out on a staged basis to minimise the area open for extraction. As extraction commences in a new area, the preceding area is prepared for rehabilitation. Rehabilitation will provide for grass and/or close crop with small dams. The final land being suitable for grazing and cultivation. During extraction and rehabilitation, measures at the site are designed to ensure that the final landform is stable, surface drainage is adequate and sedimentation is controlled.

Control measures will also be implemented to minimise impacts on adjoining properties from noise, dust and visual amenity associated with the proposed development. The effects of the proposal on the physical and social environment in the vicinity of the site have been predicted from current extractive operations by Readymix. It is considered that the control measures incorporated in the proposal will ensure that these effects are contained to within acceptable limits.

PART 2

INTRODUCTION

The extraction of sand in the Londonderry/Agnes Banks area has been carried out over the past 34 years.

In 1976 the Department of Mines, Land Board Office and Penrith City Council requested that Dixon Sands Pty Ltd (now K H Dixon Pty Ltd), Farley and Lewis Pty Ltd (now CSR Ltd trading as The Readymix Group) and Pacific Mining Limited, undertook a detailed study to formulate an acceptable and coordinated approach to the extraction of sand and subsequent rehabilitation in the Londonderry/Agnes Banks area. Taylor Thomson Whitting Pty Ltd were commissioned by the extraction companies to prepare a Management Plan and negotiate with the Land Board Office and Penrith City Council on standard conditions of consent to apply to the Management Area.

It is important to appreciate that consent is already held for the majority of the land holdings in the Londonderry/Agnes Banks Management Area. (Refer Figures 1.1 and 1.2).

In broad terms, the Management Plan defines requirements for:-

- (a) Sequence of extraction
- (b) Progressive rehabilitation and standards
- (c) Definition of final surface levels after rehabilitation
- (d) Interim and final site drainage incorporating detention basins
- (e) Exit routes for transport and delivery of the resource.

The extraction of sand is therefore proceeding on a planned and coordinated basis as discussed in the Management Plan. As extraction and rehabilitation proceeds, finished surface levels are established in accordance with the Management Plan which will ensure adequate drainage to the area is maintained.

The operations are monitored on a regular basis with Land Management meetings. The Management team consists of representatives from each of the extraction companies, Penrith City Council, The Department of Conservation and Land Management and The Department of Mineral Resources. Additional representation is called upon from other relevant Government departments if and when required on a task force basis.

A Permanent Conservation Order (PCO) was gazetted on March 10, 1989 along the Southern boundary of the Management Area adjacent to the Nature Reserve. The PCO area comprises Part Portion 157, Portions 158 and 159, Part Lots 1 and 2 DP 566898 and Part Lot 43 DP 585210. The PCO area was created to preserve additional associations of flora which are distinctive to the sand deposit, which were not well represented in the Nature Reserve.

Supplementary reports have been prepared at the request of Council to provide additional information to that detailed in the Management Plan. Supplementary Report No. 1, refers to water quality and drainage. This report details drainage within the Management Area as it currently exists and addresses sedimentation and water quality. Supplementary Report No. 2 refers to revegetation, sedimentation and erosion control. This report provides additional information with regard to revegetation methods and procedures and the implementation of sedimentation and erosion control measures.

2.2 Deferral of Development Application

Since 1976 Penrith City Council has discouraged the submission of Development Applications for holdings within the Management Area on the basis that it would not approve such submissions until the Management Plan was adopted by Council.

Any Development Applications lodged on or after September 1, 1980, would be determined in accordance with the Environment Planning and Assessment Act, 1979 and would require to be accompanied by an environmental impact statement.

Advice received from the Department of Planning in their letter dated November 1, 1990 outlined the following requirements which the environmental impact statement is to consider:

- (a) Relationship to the Londonderry/Agnes Banks Management Area
- (b) Background information
- (c) Detailed description of the proposal
- (e) Assessment of environmental impact and measures to be taken to reduce the impact.

2.3 Adoption of Management Plan

Penrith City Council on March 18, 1982 adopted in principle the Management Plan for the extraction of sand and rehabilitation of the area.

2.4 Land Under Consideration

The land under consideration is shown on Figure 1.2 and Drawing No. 1 and is within the Management Plan for the Londonderry/Agnes Banks extraction area.

Part Lot 43 and Lot B is freehold land owned by the Readymix Group. The Northern part of Part Lot 43 has been cleared and is well grassed. The Southern part of Part Lot 43 and Lot B adjacent to the PCO area is natural bushland with several fire trails.

Attached Drawings

The attached drawings have been taken from the Management Plan and show:

- (a) Site Plan - Drawing No.1
- (b) Sand/Clay Interface Contours - Drawing No.3

The remaining attached drawings show:

- (c) Finished Surface Levels and Sections - Drawing No.2
- (d) Stage Development Plan - Drawing No.4
- (e) Acoustic Plan - Drawing No.5
- (f) Noise Measurement Locations - Drawing No.6

PART 3

EXISTING ENVIRONMENT

The land in the application is located in the Parish of Castlereagh, City of Penrith and within the Londonderry/Agnes Banks Management Plan for the extraction of sand. (Refer Figure 1.2).

Part Lot 43 has an area of approximately 24 hectares and Lot B has an area of 0.4 hectares. Part Lot 43 and Lot B is freehold land owned by the Readymix Group.

3.2 Natural Environment

3.2.1 Geology and Topography

In the Londonderry/Agnes Banks area, a large deposit of sand and clayey sand overlies the Tertiary deposits of Londonderry clay. The Management Area has been identified as a significant deposit of fine-medium grained clayey sand in the Sydney Regional Environmental Plan No. 9 - (Extractive Industry) and Planning Report (1986) by the Department of Environment and Planning.

The sand is believed to be either Pleistocene or early Holocene in age. Although past opinion has favored an aeolian origin for this sand, it is believed that the sand may have been partly or wholly stream deposited at the former confluence of the Grose and Hawkesbury Rivers. The sand is podsolised and very little, if any, evidence of its origin is apparent. The sand varies in depth from 3 to 5 metres with a maximum depth of excavation of about 8 metres.

Part Lot 43 and Lot B are approximately 30 metres above sea level. Crests are located at the Northern and Southern ends of Part Lot 43. The site, including Lot B, generally falls towards the middle of the Eastern boundary of Part Lot 43. The average ground slope is generally flatter than 1 in 100.

There are no major drainage watercourses across the site. The water table depth varies and has a seasonal fluctuation in the order of 2 metres.

3.2.2 Flora

The flora in the vicinity of the site is distinctive to the sand deposit of the Management Area. The flora is in many ways similar to coastal sand dune vegetation.

The Agnes Banks Nature Reserve was proclaimed along the Southern boundary of the Management Area in 1981 by the National Parks & Wildlife Service. The Nature Reserve was created to preserve part of the flora typical to the sand deposit. A Permanent Conservation Order was gazetted on March 19, 1989 along the Southern Boundary of the Management Area adjacent to the Agnes Banks Nature Reserve. The Permanent Conservation Order area was created to increase the area of the vegetation from the sand associations in the Agnes Banks Nature Reserve. The Agnes Banks Nature Reserve and the Permanent Conservation Order area have been placed on the interim listing of places to be entered in the Register of the National Estate by the Australian Heritage Commission.

There are five vegetation associations which are distinctive to the sand deposit. These were identified by D H Benson (Plant Ecologist) of the Royal Botanic Gardens in 1975 as part of the determination of the area for the Nature Reserve. A further and more extensive survey was undertaken by D H Benson in 1976. This survey covered the whole of the Londonderry/Agnes Banks sand deposit and a report of the survey was published in *Cunninghamia*, Volume 1 (1981).

A vegetation survey of the area covered by the Permanent Conservation Order was carried out by Mount King Ecological Surveys in 1986. This survey included the area of Part Lot 43 and Lot B which is still vegetated. The vegetation survey confirms the plant communities described by D H Benson, however, the independent resultant vegetation map differs in detail to that of D H Benson due to the much broader scale of sampling by D H Benson.

Of the five vegetation associations found on the sand deposit, only one vegetation association is found on Part Lot 43 and Lot B. This vegetation association is Woodland (Type 2) and was the most widespread association of the sand deposit. The vegetation is located on the South East portion of Lot 43 and the Southern part of Lot B adjacent to the Permanent Conservation Order area. This area of natural vegetation was excluded from the PCO area as it has been extensively disturbed. Details of the vegetation are given in Annexure A. The remainder of Part Lot 43 and Lot B has been cleared and is well grassed.

The Woodland is dominated by trees of *Eucalyptus sclerophylla*, 10 to 15 m high with smaller trees of narrow-leafed Apple and Saw Banksia. The understorey is dense, approximately 2m tall and is composed of a rich diversity of shrubs including *Leptospermum attenuatum* (Paperbark Teatree), *Conospermum taxifolium*, *Ricinocarpos pinifolius* (Wedding Bush), *Petrophile pulchella*, *Brachyloma daphnoides* (Daphne Heath), *Persoonia nutans* ssp. *nutans* (Nodding Geebung) and *Bossiaea obcordata*. Ground cover is sparse, and litter cover well developed. Considerable variation in tree height and girth, shrub density/diversity and litter cover is observable within the remaining samples of this vegetation type. The variation is largely attributable to the effects of fire.

During the survey species lists were compiled and are shown in Annexure A. None of the species are rare, with the exception of *Persoonia nutans* ssp. *nutans* and *Petrophile sessilis* which were observed sporadically throughout the type 2 Woodland.

Neither of these species were recorded on Part Lot 43 with the transect from Portion 157 to Lot 43. *Persoonia nutans* ssp. *nutans* was found to be well represented in Woodland (Type 3) in the Clemson holdings on the Western side of Rickards Road.

No further populations of *Petrophile sessilis* were located other than those noted during the transect through Portion 157 in the Permanent Conservation Order area.

3.2.3 Fauna

Initial advice from Penrith City Council was that a Fauna Impact Statement was required to form part of the development application submission for Part Lot 43 and Lot B. With the more recent changes to the Environmental Planning and Assessment Act (as a consequence of the Timber Protection Bill) an assessment of whether a Fauna Impact Statement is necessary or was not based upon the likelihood of any endangered species being affected by the development.

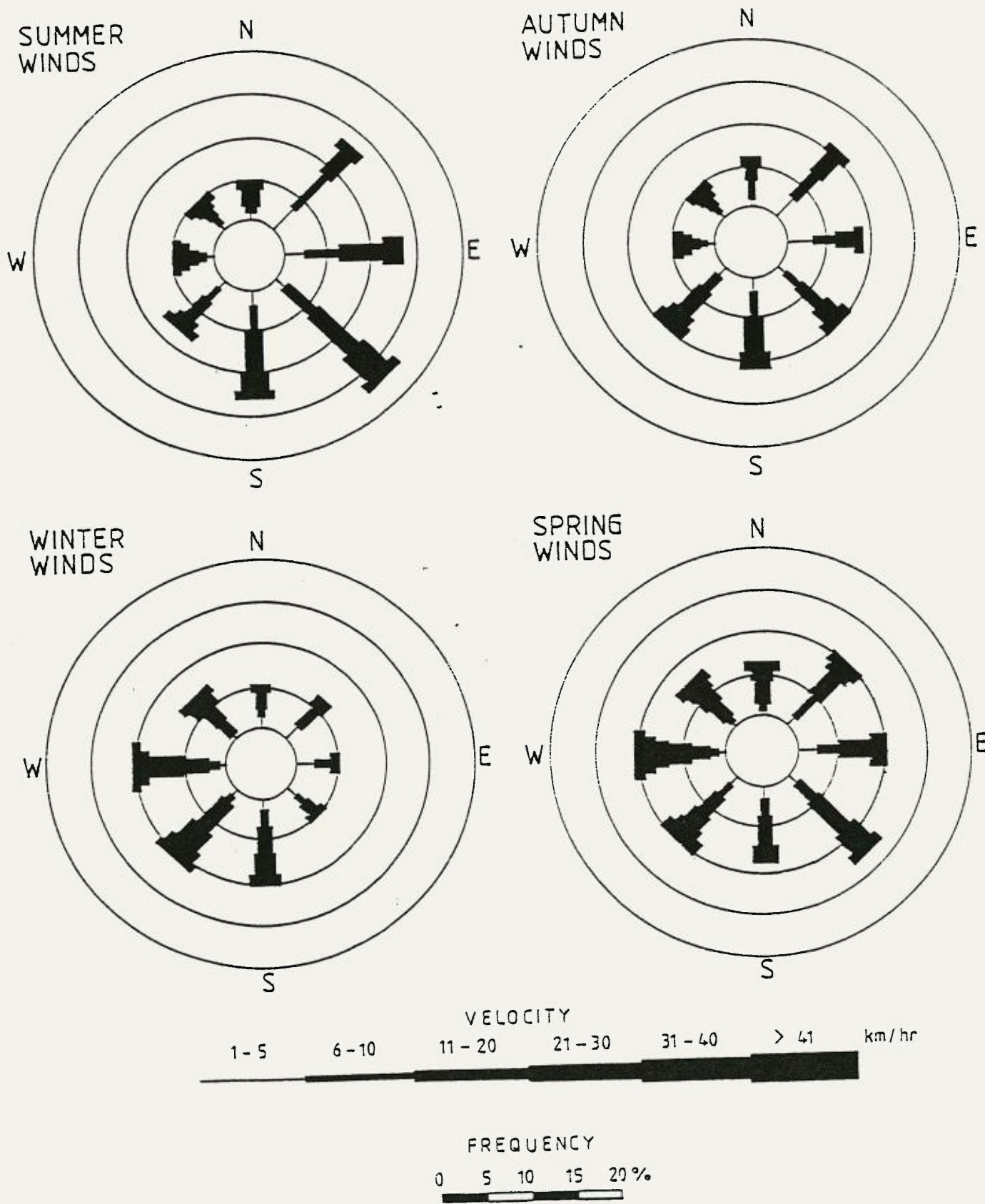
A fauna study of Part Lot 43 and Lot B has been carried out by Mount King Ecological Surveys. The study advised that the Londonderry/Agnes Banks area has been extensively surveyed for fauna in recent years. Much of this data was used in the assessment of the site. Part Lot 43 and Lot B was inspected on several occasions by Mount King Ecological Surveys and the results of these inspections was also used to assess the site.

About half of Part Lot 43 and Lot B contains native bushland which supports a variety of faunal species. The assemblage of species is typical of that found within bushland areas of Sydney and are widely distributed and relatively common throughout south-eastern Australia. The study finally assesses the impacts upon the fauna from the sand extraction process.

3.2.4 Meteorology

Generally the climate is temperate with warm to hot summers and cool to mild winters. Average annual rainfall is 800mm with the wettest months being January, February and March and the driest months, August and September.

Wind roses for the station of Richmond approximately 6 kilometres to the North-East are shown in Figure 3.1. The wind roses show the sources of wind and a frequency analysis of the percentage of total winds (all speeds) versus direction for the four seasons of the year. Summer winds are predominantly from the South-East quadrant and winter winds are predominantly from the South-West quadrant.



WIND, SPEED AND DIRECTION FOR RICHMOND, N.S.W.
FIGURE 3.1

3.2.5 Surface Drainage

Part Lot 43 and Lot B forms part of the catchment which drains to a tributary of Rickabys Creek. Rickabys Creek drains into the Hawkesbury River near Windsor. The catchment area of the tributary at Torkington Road which is on the downstream side of the Management Area is 21.2 square kilometres. Part Lot 43 and Lot B forms approximately 1.2% of the catchment area. The catchment upstream of Londonderry Road is not influenced by flooding from the Hawkesbury River.

Part Lot 43 and Lot B are generally located on high ground cresting at Castlereagh Road. The surrounding area falls to a natural depression which drains from West to East through the centre of Part Lot 43. The depression then drains to the East to holding dams currently used by Pacific Mining Ltd for their sand processing operations. The average ground slope is flatter than 1 in 100 and localised ponding of water occurs in various areas which creates nuisance flooding. This type of flooding is experienced by the small rural holdings in Rickards Road.

3.2.6 Groundwater

With the gazettal of the Permanent Conservation Order area on 10 March 1989 the Heritage Council of New South Wales advised that Sydney Regional Environmental Plan No.9 (SREP9) was being revised to exclude the area of the Permanent Conservation Order. The amendment of the SREP9 boundary would also require the amendment of the Management Area boundary and the provision of an adequate buffer zone to safeguard the heritage values of the area covered by the Permanent Conservation Order.

A groundwater study of Lot 43 and the surrounding area was carried out by Mackie Martin and Associates P/L which included field testing for hydrologic properties of the sands, monitoring of local groundwater movements, and development of a computer based model of the local groundwater system to assess impact.

The regional water table is presently impacted within the Management Area by excavations which induce seepage, and by ponding which initiates recharge back to the water table. Seepage reduces to negligible levels during low rainfall periods while during wet periods, local and regional water tables rise, often to the surface.

Rainfall infiltration across the site provides the mechanism by which groundwater fluctuations occur. The effective groundwater recharge and evapotranspiration across the area is a function of prevailing geological and soil moisture conditions, site interception and infiltration/runoff characteristics, drainage and vegetative cover. Soil moisture conditions will determine the effective component of rainfall that enters the groundwater system. Rainfall characteristics, evaporation (due to radiation and wind) and transpiration (due to vegetation) in the area will determine the way these conditions are developed.

Shallow aquifers in the region are dominantly rainfall driven. Rain infiltrates the shallow sands and migrates downward, eventually being deflected at the water table and at less permeable zones. Horizontal flow is then established with regional gradients and flow directions being controlled by topography.

The Yarramundi swamps act as both a source and a sink for the groundwater system.

During rainy periods the water levels in the ponds will rise and force downward seepage while during drought periods the swamps will offer increased evaporation potential thus removing water from the aquifer system.

Seven bore sites were drilled by Mackie Martin to assess the transmission capacity of the sand and to determine the geometry of the water table. Formations penetrated by drilling comprised shallow sands with various amounts of silt and clay to a depth of about 5 metres, the clay content generally increasing at depths greater than 3 metres. The layer of coffee rock generally found at a metre below the surface was not detected during the survey, although dark coloured sands evident in a few bores may correlate laterally to coffee rock.

A continuous water level recorder was installed in one bore and groundwater fluctuations were monitored over several months. Depths to standing water were in the range of 1 to 2 metres although the water table has been known to break the surface during periods of heavy rainfall. Some perching may also occur in areas of pronounced induration. The groundwater generally parallels the surface topography.

3.2.7 Acoustic Environment

The immediate area surrounding Part Lot 43 and Lot B consists of bushland, except for the Pacific Mining Ltd processing plant and stockpiles which are located approximately 850 metres East of the Site and small rural holdings to the West fronting Rickards Road and Castlereagh Road.

An ambient noise survey was conducted to establish the existing acoustical environment in the vicinity of the site. A report detailing the results of the survey is shown in Annexure D. An acoustic plan showing contours of potential noise generated by equipment located on the boundary is given in Drawing No. 5

Measurements were carried out during the potentially critical early morning period at five locations in the area (see Drawing No. 6 for measurement locations A, B, C, F and G). These locations were chosen as being representative of the existing ambient noise at the nearest potentially exposed residences around the site to the proposed extractive operations.

The ambient noise in the district comprises two general components. Firstly, a relatively steady background sound level from distant traffic, machinery, insects, etc. Secondly, higher noise level peaks caused by individual vehicles, aircraft, operation of farm machinery and intermittent operation of closer machinery. The district is free from continuous noise from industrial processes. The noise emissions from extractive operations have similar acoustic characteristics to trucks on Castlereagh Road and operation of diesel powered agricultural machinery.

These two components were quantified by measuring the statistical noise levels L90 (minimum background level) and L10 (average maximum level), corresponding to the A-weighted sound levels exceeded for 90% and 10% of the relevant measuring period respectively.

Noise is generally measured on the A-weighted logarithmic scale in dBA which has been found to give a good correlation between human response and acoustic energy.

Some examples of noise levels on this scale produced by common noise sources are shown below.

COMPARATIVE SOUND LEVELS

Source	Noise Level	
	dBA	Response
Soft Whisper (5m)	30	Very quiet
Lift auto Traffic (30m)	50	Quiet
Air Conditioning Unit (6m)	60	
Freeway Traffic (15m)	70	Intrusive
Pneumatic Drill (15m)	80	Annoying

At Location A in Brooks Lane, (see Drawing No. 6) the typical minimum background levels (L90) ranged from 37 dBA to 45 dBA. This location was influenced by noise from continuous or semi-continuous industrial and farming activity (e.g. irrigation pumps, processing plant, distant sand extraction and gravel quarry equipment etc.).

The average maximum sound levels (L10) were dominated by noise from traffic on Castlereagh Road and, at times, by the noise of aircraft from Richmond Airbase.

Location	Distance from Castlereagh Rd	Typical Range of Levels	
		L10	L90
A	460m	45dBA - 56dBA	37dBA - 45dBA
B	200m	51dBA - 52dBA	33dBA - 40dBA
C	600m	43dBA - 57dBA	33dBA - 38dBA
F	1500m	45dBA	37dBA
G	10m	63dBA	44dBA

Locations D and E not applicable.

3.3 **Man Made Environment**

3.3.1 **Existing Land Use**

Part Lot 43 and Lot B with an area of approximately 24.4 hectares is freehold land owned by Readymix. The Northern part of Part Lot 43 has been cleared and the Southern part is bushland with several fire trails. A pony club presently leases Part Lot 43 from Readymix for horse riding activities.

The area to the West of Part Lot 43 and Lot B is Castlereagh Road, Rickards Road and small rural holdings. The area to the South of Part Lot 43 and Lot B is the Permanent Conservation Order area. The area to the North is Public Road Reserve and freehold land owned by Readymix who have development consent for the extraction of sand under the Management Plan. The area to the East of Part Lot 43 and Lot B is Crown land. Pacific Mining Ltd has Permissive Occupancy over this Crown land and has development consent for the extraction of sand under the Management Plan.

3.3.2 **Zoning**

The site is zoned Rural 1 (a1) under Penrith City Council IDO 93. This is rural zoning permitting any rural activity with lot sizes being restricted to 40 hectares minimum. The extraction of sand from land within the Management Area may be carried out with the consent of Penrith City Council.

Site Access

All access to the site will be from within the Management Area. Access is primarily required for the transportation of the extracted sand to the processing plant located on Portion 176 at the South Eastern corner of the Management Area. Transportation of the extracted sand will be by 35 tonne off-road truck along the existing unsealed roads within the Management Area.

Access to Part Lot 43 and Lot B will be by the road reserve along the Northern boundary of Part Lot 43. It should be noted that the proposed extraction in this part of the Management Area will not be associated with any traffic generation along Rickards Road and Castlereagh Road. The access roads are shown on Drawing Number 4.

Urban Development

The closest houses to Part Lot 43 and Lot B are small rural holdings.

These rural holdings are generally located along the Western edge of the Management Area on both sides of Castlereagh Road (MR 75) which connects Penrith (approximately 14 km to the South of Part Lot 43) to Richmond (approximately 7 km to the North-East of Part Lot 43).

The township of Agnes Banks which has some residential properties, is located approximately 3 km to the North-East of Part Lot 43 on Castlereagh Road.

The nearest houses to Part Lot 43 and Lot B are small rural holdings in Rickards Road on the Southern side of its intersection with Castlereagh Road. The nearest house to any area of extraction on Part Lot 43 is in Rickards Road approximately 60m from the Western most boundary of Part Lot 43.

Services and utilities are required in the Management Area by the three operating companies at their sand processing plants where other facilities such as weighbridges, staff amenities, workshops, etc., are located. The services and utilities which are required in the works areas are overhead power and telephone lines. These are presently located in Castlereagh Road, Rickards Road, Brooks Lane, Wiltshire Road and Torkington Road.

A reticulated water supply system for drinking purposes is not available in the Management Area. All drinking water is stored in tanks in the operating companies works areas for use with staff amenities. Shower and toilet facilities in the staff amenities are connected to septic tank systems.

Water is required for washing the sand at the processing plants. Surface runoff from approximately 60% of the Management Area is generally drained to holding dams. For the processing operation water is pumped from the holding dams to the respective processing plants from where the water with suspended fines is pumped to settling ponds. The water gravitates through several settling ponds before it drains back to the holding dam. Water is a valuable commodity for the processing operation and efforts are made for the conservation of runoff.

If additional make up water is required in times of extreme dry weather, the operating companies have pipelines across Castlereagh Road to the Nepean River from where water can be pumped under license.

All internal roads and Torkington Road are regularly watered by water cart to control atmospheric dust.

PART 4

EXTRACTION PROPOSAL DESCRIPTION

General

The extraction of sand in the Londonderry/Agnes Banks Management Area has been carried out over the past 34 years.

The extractive industry as carried out by Readymix involves the removal of sand by front-end loader and off-road truck. The front-end loader forms an excavation face and extracts directly from the working face to load the off-road truck.

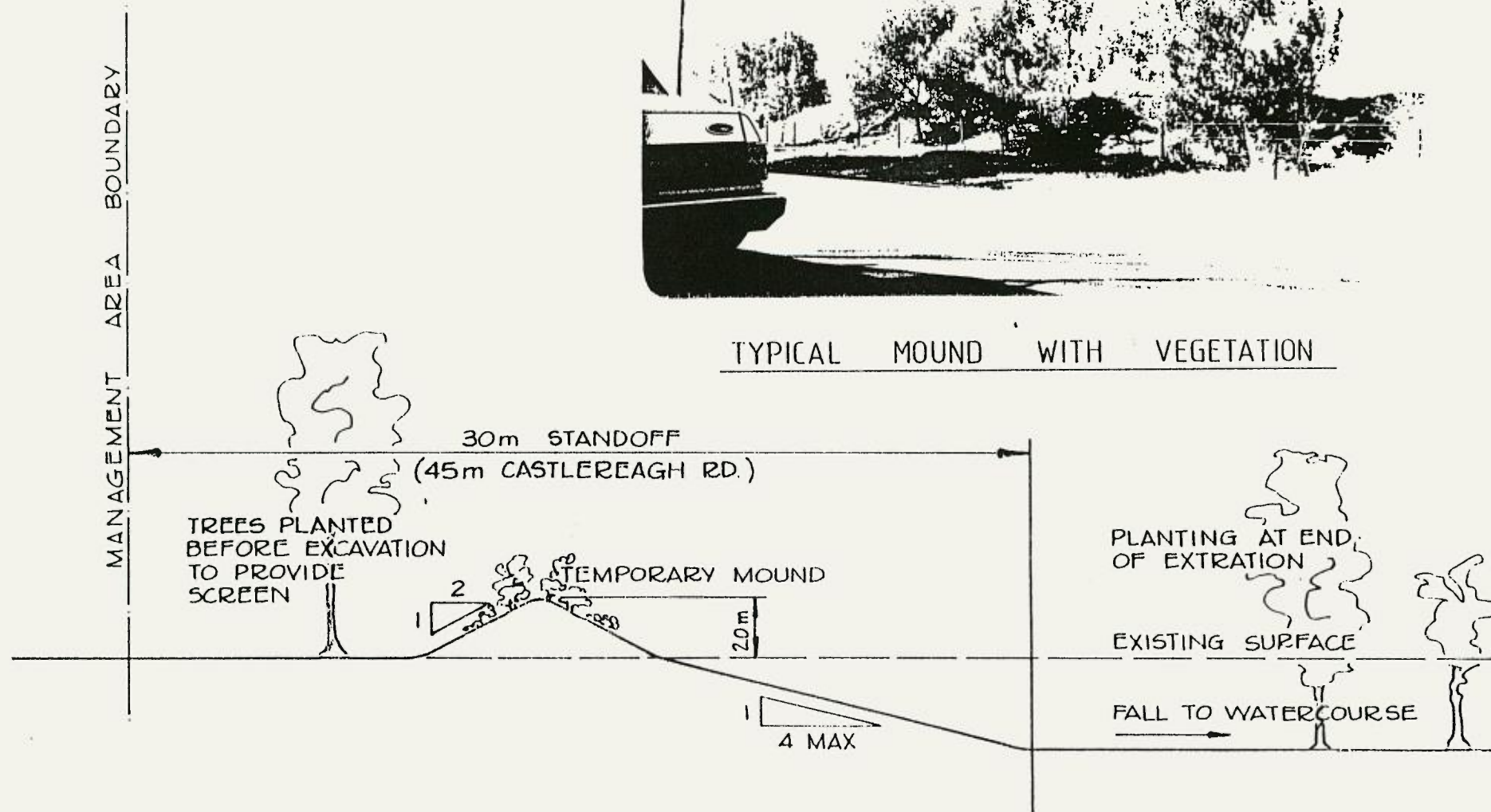
Sand is transported by off-road truck through the Management Area to the existing processing plant located on Portion 176 and operated by Readymix. Stockpiling of washed sand is to be carried out adjacent to the processing plant and not on the site under consideration.

Part Lot 43 and Lot B is located within and along the Southern and Western boundaries of the Londonderry/Agnes Banks Management Area. (See Drawing No. 1).

A 30m standoff will be provided along the Western boundary of Part Lot 43. A 45m standoff will be provided across the North West corner of Part Lot 43. A 45m standoff will be provided along the Southern boundary of Part Lot 43 adjacent to the Permanent Conservation Order area. The standoff will contain temporary mounding and planting to provide screening to the site. The standoff will incorporate 1 in 4 batters from the existing surface level to the extracted surface level as shown on Figure 4.1 and Drawing No. 2.

Resource Potential

The Management Area is only one of three significant deposits of fine-medium grained clayey sand being extracted in the Sydney region at present. This was identified in the Regional Environmental Plan No. 9 - (Extractive Industry) and Planning Report by the Department of Planning. The other deposits are at Elderslie which is approximately 6km South-West of Campbelltown and Maroota which is approximately 30 km north of Castle Hill.



TYPICAL MOUND WITH VEGETATION

TYPICAL SECTION AT MANAGEMENT AREA BOUNDARY

SCALE 1:200 NATURAL

FIGURE 4.1

Alternative sources of clayey sand for bricklaying mortar are at Pitt Town and Menangle Park. Deposits of fine-medium grained sand suitable for usage in concrete occur at the Richmond Lowlands, Wrights/Wellums Creek (McDonald Valley), Botany Bay and offshore from Sydney. However, none of these resources are currently available for extraction in the near future because of land use and/or environmental conflicts and the need for further detailed land management or environmental studies.

Part Lot 43 and Lot B were investigated as part of the Land Management study and isopachs of sand were obtained as described in Section 3 of the Report. The isopachs of sand for the Management Area are shown on Drawing No. 3.

The sand is believed to be either Pleistocene or early Holocene in age. Although past opinion has favored an aeolian origin for this sand it is believed that the sand may have been partly or wholly stream deposited at the former confluence of the Grose and Hawkesbury Rivers.

The sand is typically a fine-medium grained quartz sand containing a significant proportion of clay and silt sized particles. It is the presence of these fine grained particles which makes the material valuable as a source of bricklayer's sand. The sand can also be washed and screened to produce a very clean quartz sand suitable for use in the concrete industry or further refined for glass manufacture. The quantity of sand remaining in the Londonderry/Agnes Banks deposit has been estimated at 6 million cubic metres.

The sand overlies clay deposits, however, the transition between sand and clay is often gradual and to some degree a matter of definition

Part Lot 43 and Lot B are located towards the South Western area of the sand deposit.

The average depth of sand on Part Lot 43 and Lot B is 4.0m to 5.0m.

The approximate quantity of sand is estimated at 2.1 million tonnes (1.2 million cubic metres) which is a valuable resource.

4.3 Proposed Method of Extraction

Extraction of the sand commences by stripping the vegetation and upper horizon of sand (200mm thick) containing organic matter. This sand is stockpiled in mounds 3.5m maximum height for spreading in the rehabilitation stage.

The front-end loader excavates into the sand to form a working face. The front-end loader then extracts sand directly from the working face and loads the 35 tonne off-road truck. This method allows blending of the sand over its full depth with poorer quality layers being mixed with the sand. This ensures full use of the resource with no wastage of poorer quality sand. A typical working face in an extraction area is shown in Figure 4.2.

Sand is then transported by off-road truck through the Management Area to the existing processing plant operated by Readymix on Portion 176 at the South-East end of the Management Area. The washed or dry screened sand is then stockpiled adjacent to the processing plant.

Stockpiling of sand for sales will generally not exceed 60 days supply.

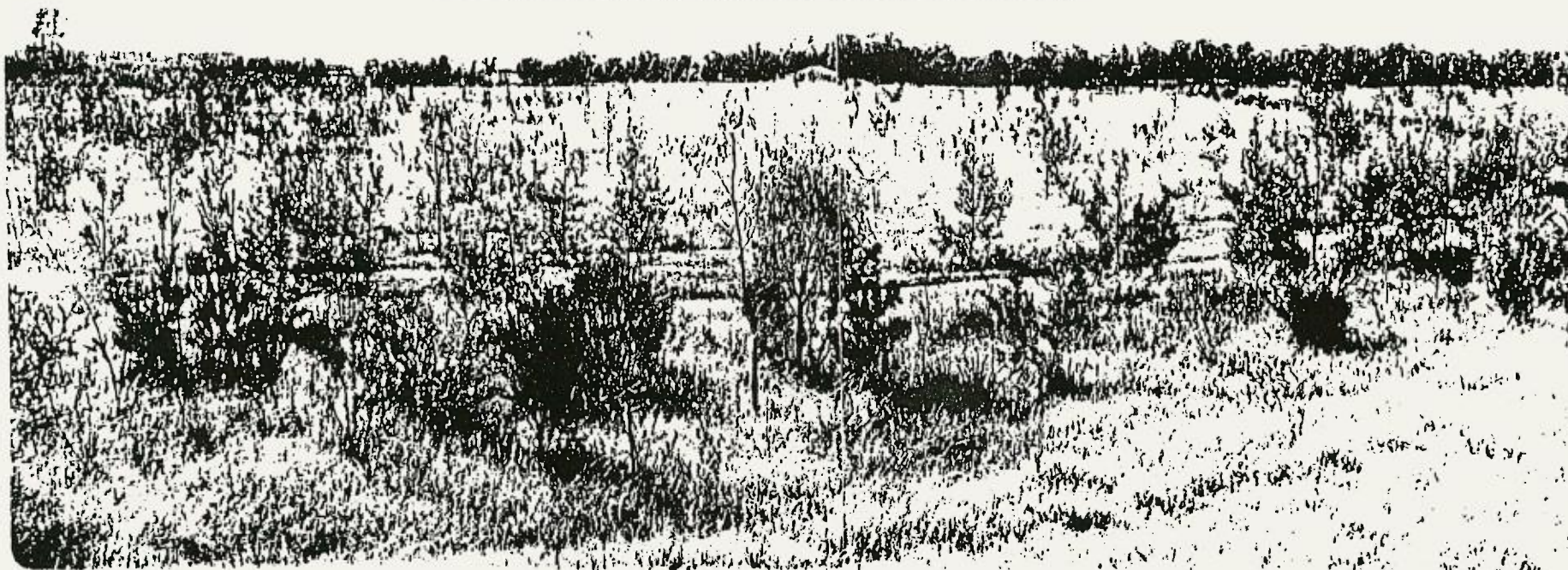
4.4 Plant, Equipment and Personnel

Readymix presently have 9 employees at their Londonderry sand extraction and processing operation. Of these employees the following plant and personnel would be located at the extraction face.

1 front-end loader (4.5 cubic metre bucket)	1 operator
2 x 35 tonne off-road trucks	2 operators



TYPICAL WORKING FACE IN EXTRACTION AREA



TYPICAL REHABILITATION

A water cart is permanently available for the control of atmospheric dust on roads.

Staff amenities including toilet facilities (septic tank) and lunch room, etc., are provided near the processing plant operated by Readymix on Portion 176. The processing plant is approximately 2km to the East of Part Lot 43 and Lot B. These facilities are also used by personnel associated with the processing plant, weighbridge and workshop.

Working hours would be 6.00 am to 6.00 pm, six days a week which is no change from the existing working hours. These times are often shortened as the rate of production is controlled by the market demand.

4.5 Energy Statement

4.5.1 Introduction

The Readymix Group proposed to extract sand from Part Lot 43 and Lot B within the Londonderry/Agnes Banks Management Area.

The operation involves the extraction of sand from the subject land and the transportation of this material to the processing plant. Extraction is carried out using a front-end wheel loader. Transportation of the unprocessed sand is carried out with two (2), thirty-five(35) tonne capacity, off-road dump trucks.

4.5.2 Operation Energy Requirements

4.5.2.1 Sand Extraction

The proposed extractive operation will be carried out using a 4.5 cubic metre capacity Komatsu WA - 500 front-end wheel loader, or equivalent. The annual fuel requirement for the wheel loader, based on average annual machine operating hours amounts to 51,000 litres.

Processing Plant and Works Area

The two 35 tonne off-road dump trucks are expected to complete a total of 60-70 round trips per day over a typical haul distance of 4 kms return. Based on the average annual machine operating hours annual fuel requirements of these trucks will be in the order of 85,000 litres. The number of trips will vary according to market demand and also includes cartage of topsoil associated with the stripping and rehabilitation phases of the work.

4.5.3

Combined Fuel Usage

It is estimated that approximately 136,000 litres of distillate and 1,260 litres of oil will be consumed annually in the extraction and transportation of sand transportation of topsoil within the site.

4.5.4

Justification of Equipment Used

The equipment presently used by Readymix within the Management Area has been found to be quite satisfactory, providing a cost-effective, efficient and operationally flexible mode of winning and hauling unprocessed sand to the processing plant.

4.5.5

Conclusion

The energy consumption for the proposed development is considered acceptable, as the sand being manufactured is an important construction material.

This proposal implies, by way of location, significant energy savings in terms of cartage of the final product to the market place.

Cartage costs are a significant component of the final selling price for sand in the Sydney region. The closer the resource is to the market place, the lower the cartage distance, fuel consumption and thus a cheaper final product.

Project Time Scale

It is anticipated that extraction of the site will commence in 1995. Progressive extraction and rehabilitation would take seven to ten years depending upon market conditions. The Regional Environmental Study of Sydney's Extractive Industry (1984) shows that construction sand production in the Sydney region between 1968 and 1982 remained constant with no growth and only experienced fluctuations depending upon market conditions.

Planned Sequence of Extraction

Extraction will be carried out in seven stages as shown on Drawing No. 4. Extraction will commence at the Southern end of Part Lot 43. A temporary drainage channel will be formed along the Eastern boundary of Part Lot 43 to connect the existing drainage channel in Portion 132. The temporary drainage channel will ensure that the extracted areas are drained and that no ponding of surface runoff will occur. The drainage channel drains to a holding dam on Portion 162 and 165.

Alternatively, if extraction of Portions 276 and 277 by Pacific Mining Ltd which is proceeding to the West coincides with the extraction of Part Lot 43, the extracted areas on Part Lot 43 could drain to the East as proposed by the finished surface levels of the Management Plan.

Rehabilitation

Part Lot 43 and Lot B are approximately 30m above sea level. Crests are located at the Northern and Southern ends of Part Lot 43 and the terrain generally falls towards the middle of the Eastern boundary of Part Lot 43. The average ground slope is also generally flatter than 1 in 100.

Part Lot 43 and Lot B forms part of the catchment which drains to a tributary of Rickaby's Creek. Rickaby's Creek drains into the Hawkesbury River near Windsor. The catchment area of the tributary at Torkington Road which is on the downstream side of the Management Area is 21.1 square kilometres. Part Lot 43 and Lot B form approximately 1.2% of the catchment area.

On completion of extraction finished surface levels will comply with the finished surface levels as determined in the Management Plan. The finished surface levels within the Management Area will be up to 4m lower than the existing surface levels.

New watercourses together with detention basins are to be formed to suit the finished surface levels. The watercourses will have a longitudinal slope consistent with existing watercourses in the area but the crossfall to the watercourses will be improved with grades being greater than 1 in 100. Surface runoff from within the Management Area will therefore be improved from that of the existing condition.

Watercourses are to be formed at the Northern and Central part of Part Lot 43 and drain to the East. The watercourses will join on Portion 277 and a detention basin is to be formed at the Eastern boundary of Portion 277.

It is intended that each stage would be progressively worked and restored to minimise the area of land under extraction.

A progressive extraction/rehabilitation programme will be adopted whereby rehabilitation will commence immediately extraction is completed on a stage by stage basis.

Part Lot 43 and Lot B is freehold where rehabilitation would provide for grass and/or close crop with small dams. The final land being suitable for grazing and cultivation. This rehabilitation is described as "Grazing and Pasture".

Rehabilitation of the site will be by the techniques as defined in the Management Plan and Supplementary Report No. 2, Revegetation, Sedimentation and Erosion Control. The Management Plan discusses the rehabilitation of extracted sites, however, the methods and species defined are generalised and not site specific. Penrith City Council requested that additional information be provided with regard to rehabilitation and this is outlined in Supplementary Report No. 2.

All rehabilitation will be carried out in consultation with the Department of Conservation and Land Management. This will include spreading of topsoil and fertiliser addition when required together with selection of suitable grasses and species lists for sowing at an appropriate time.

It has been suggested that more work could be done with species indigenous to the area and other methods could be considered with the revegetation process. All revegetation has previously been carried out by the planting of tubestock, however, seeding trials are presently being carried out in consultation with the Department of Conservation and Land Management to assess the most effective form of rehabilitation.

The Department of Conservation and Land Management will be consulted on a site specific basis for the selection of suitable grasses and rate of spreading. Readymix has also found that natural regeneration of grasses occurs very effectively from the respread topsoil. Copses of trees will be provided by the planting of tubestock or sowing of seed. With the seeding trials presently being undertaken on site, efforts are being made to include species which are indigenous to the area in the species list. The species list has also been given to the National Parks and Wildlife Service for comment. Seed from native species is being collected during clearing and is stored for re-vegetation. This seed should be successful as it is acclimatised to the region.

Maintenance in the form of refertilisation (where appropriate for non native species) and replanting or reseeding will be carried out as required in order that the specified density of revegetation is achieved. Where appropriate, details of species and planting or seeding densities will be recorded to monitor growth rates with regard to soil type and groundwater. This information will be beneficial with the rehabilitation of future sites. Soil erosion control measures will also be implemented at agreed locations in accordance with Supplementary Report No. 2. These structures are monitored on a regular basis by the Department of Conservation and Land Management to ensure their effective operation.

PART 5

ENVIRONMENTAL IMPACT AND MITIGATIONS

General

The proposed sand extraction is similar to other operations in the surrounding area as described in the Management Report.

Although vegetation from the Southern part of Part Lot 43 and Lot B will be progressively removed during the operation, experience with other areas of sand extraction in the Management Plan shows that natural rehabilitation commences soon after the top horizon is respread.

Visual Quality

Part Lot 43 and Lot B are visible from Castlereagh Road and Rickards Road. The Northern part of Lot 43 and Lot B have been cleared and are well grassed. The Southern part of Part Lot 43 is natural bushland with fire trails.

The small rural holdings to the West of Part Lot 43 have a 30m standoff with a 45m standoff adjacent to Castlereagh Road. A 45 m standoff will be provided along the southern boundary of Part Lot 43 and Lot B adjacent to the Permanent Conservation Order area. The standoff includes mounding (bund wall) and screening with vegetation which will reduce the visual impact of extraction. The mounds will be formed some time prior to the commencement of extraction in order that the vegetation can become well established.

The extraction process is a low intensity operation and extensive stockpiling of sand will not occur on the site ahead of the loading phase. As extraction proceeds below the existing surface level, the extractive operation will not be clearly visible. Therefore, the extractive operation will not have a significant visual impact from areas outside the Management Area.

On completion of extraction and rehabilitation the finished surface level will be up to 4m lower than the existing surface level. The lowering of Part Lot 43 and Lot B having an area of 24.4 hectares will not be significant when compared with the uniform lowering of the Management Area (3.7 square kilometres). With the standoff along the Management Area boundary it is considered that the extraction will not have any adverse visual impact on adjoining properties.

On completion of the extraction and rehabilitation, the mounding in the standoffs will be removed.

5.3

Acoustic Environment

In conjunction with the ambient noise survey carried out by Richard Heggie Acoustics Pty Ltd., noise emissions from typical equipment used in the extraction operations were determined. Further acoustical studies were conducted by The Readymix Group's acoustical consultant to determine the attenuation effects for the site.

Under conditions of maximum engine speed, noise emission from the front end loader ranged from 88 dBA at 7.5m and 76 dBA at 30m (irrespective of orientation of the loader). This loader has since been replaced by a unit which emits lower noise levels. For the attenuation study a front end loader was located on the extractive side of the bund wall (minimum height of 3m) and operated under conditions of maximum engine speed. Noise levels were conducted under normal atmospheric conditions and are the most indicative method of determining attenuation of sound for the site.

The areas along the perimeter of the Management Area from which sand is extracted are set back 30m from the site boundaries. This setback is increased to 45m at Castlereagh Road and 45m at the Permanent Conservation Order area. These standoffs incorporate mounding and screening with vegetation to reduce the visual and acoustical impact of the extractive operations. As a noise control measure the bund walls will have a minimum height of 3m along the western boundary of Part Lot 43.

The extractive operations will remove approximately 4m to 5m depth of sand and therefore as the extraction proceeds in a southerly direction parallel to the bund wall, the effective acoustic height of the bund wall increases over the 3m design height. The noise emissions from the extractive operations will be attenuated by several factors. Peculiar to the site are the soft ground cover providing good ground absorption of sound incident onto the surface of the extraction areas and the use of bund walls. The well known sound attenuation due to distance applies and as the topography of the site is flat, a 6 dBA attenuation per doubling of distance would apply.

However, to determine the actual attenuation of noise from extractive equipment, a Terex front end loader was located at distances of 30-300m from the bund wall. Background noise levels during the measurements were less than 35 dBA and therefore no contribution from other sources of noise affected the measurements. (The Terex front end loader of Readymix is fitted with an environmental muffler as standard equipment).

Under worst operating conditions, the noise levels were reduced to 42 dBA or less when the front end loader was operated in the 100-300m zone. In the 30-100m zone the noise levels ranged from 50 dBA down to 42 dBA. Calculations have determined that at a distance less than 80m from the bund wall, the noise levels begin to exceed EPA criteria. Therefore when extraction takes place up to 80m from the bund wall, the L10 levels will be within 5 dBA of the ambient background levels (L90 from noise surveys). This is within EPA criteria.

During the construction of the bunds the maximum noise levels from the front end loader will exceed the existing L10 levels at some of the nearer residences. However, the duration of the construction period will be short and thereafter the mounds will act as effective acoustic barriers.

When extraction takes place within the zone 30-80 metres from the bund, the L10 levels will be 8-9 dBA above existing background levels. This is not considered to be a significant impact as the character of the noise from extractive equipment is very similar to the existing noise sources in the district. (Also, annoying tonal noises are removed from the equipment with environmental mufflers). However, this level is slightly outside EPA criteria and the following additional measures would be applied to extraction within this zone.

The times of operations for extraction within this zone will be reduced to a late morning start of 7.00am, when any disturbance to residents would be minimised. Further, extraction in this zone will be for a short duration only (up to 6 months) and to gain some additional attenuation from the bund wall, extraction will proceed in a southerly direction. Effectively this means extractive equipment would be operating at a level 3 - 4 m deeper than if equipment operated from the existing surface level.

If a comparison is made between the L10 levels from extraction equipment and the existing L10 levels in the ambient noise surveys, the noise levels from this equipment is seen to be at or below the ambient L10 levels. This is a decided advantage as the extractive equipment is not acoustically different from existing sources of noise in the district.

The typical noise emission level for an off-road truck similar to that proposed for the site is 85 dBA at 7.5m (i.e. slightly quieter than the front end loader). These trucks are also fitted with the environmental type muffler. The noise emissions from the operation of the haul truck will be within the same attenuations already determined for the front end loader.

Note that equipment used at the time of these measurements has since been replaced by quieter plant. Actual noise levels will decrease in proportion to the noise generated at the equipment.

Atmospheric Quality

Minor air pollution in the immediate vicinity of extraction work will occur from dust raised by the vehicles. Exhaust gases from the extraction equipment will be insignificant.

The sand has a natural moisture content which will vary depending upon seasonal conditions. The moisture content of the sand will also increase with an increase in depth which can assist dust control.

Dust can only result from stripped surfaces which have been dried by evaporation or by wind action. The prevailing winds are seasonal with winds being predominantly from the South-West quadrant in winter and from the South-East quadrant in summer. Residences in Rickards Road and Castlereagh Road will mainly be affected by winds from the East and South-East. These winds are predominant in summer and spring. The temporary mounding and screen planting in the 30m standoff will provide additional protection from dust to these residences. Dust is generally controlled as mentioned previously using the water cart. Therefore, dust should not be a significant problem.

Results from dust monitors currently installed on property boundaries show that dust levels meet EPA requirements.

Vibration

It is emphasised that the extraction is carried out without the use of blasting or the heavy earthmoving equipment necessary for extraction of hard materials. With the 30m, and 45m standoffs and the batters indicated on the boundary treatment, the question of vibration and subsidence of adjoining properties does not arise.

Surface Water

An extensive drainage investigation was carried out as described in Section 5 of the Management Plan.

New watercourses together with detention basins are to be formed to suit the finished surface levels. The watercourses will have a longitudinal slope consistent with existing watercourses in the area but the crossfall to the watercourses will be improved with grades being greater than 1 in 100. Surface runoff from within the Management area will therefore be improved from that of the existing condition and nuisance flooding experienced at present due to the existing ground slope being flatter than 1 in 100 should be eliminated.

Detention basins which are temporary storage reservoirs for low intensity, long duration rainfall are being formed in the Management Area to comply with the requirements of Penrith City Council. With the detention basins surface runoff from within the Management Area for the improved extracted state will be the same as that which existed prior to the commencement of extraction and will therefore not aggravate flooding problems downstream in Rickabys Creek. All detention basins are wholly within the Management Area and will not affect adjacent properties.

Portions 276 and 277 are Crown land over which Pacific Mining Ltd holds permissive occupancy. Extraction of Portions 276 and 277 has not been completed. Therefore, to allow Part Lot 43 and Lot B to drain, a temporary channel will be formed along the Eastern boundary of Part Lot 43 and drain to the North to connect to the existing channel constructed by Readymix on Portion 132.

On completion of extraction of the sand, some filling and trimming will be required to provide finished surface levels complying with the Management Plan.

Groundwater

From the bore sites and continuous water level recorder, it was noted that the groundwater table in the area of Lot 43 has a seasonal fluctuation in the order of 2 metres. Rainfall recharge to the aquifer is rapid, with groundwater levels observed to rise 0.3 metres within hours of a storm, this rapid response being typical of unconfined aquifers. After a recharge event, the groundwater recesses at a rate of 0.007 m/day due to transpiration from phreatophytes together with base flow discharge to ponds, rivers and excavations in the area.

The groundwater at the site was modelled using numerical modelling which allows the simulation of regional conditions. A finite element approach was utilised as this method offers a high level of flexibility in simulating complex geometries relating to aquifer extent, stream courses, excavations, settling and water storage ponds etc. The model used in the analysis extends from the limit of sands just east of Yarramundi Lagoon to the approximate eastern extremity of the sand extraction region to the east, a distance of 1 to 2 km beyond existing excavations. Limits of the model to the north and south have similarly been aligned with the sand extent.

The groundwater needed for the site prior to extraction was calibrated by the generation of a steady state water table surface according to field determined aquifer properties. Transmission capacities and rainfall infiltration were adjusted on a trial and error basis until modelled water table geometry reasonably matched measured field conditions. This became the reference model to which the water table post extraction was compared.

The water table follows the existing surface level as stated previously. A crest is located in the centre of the western part of Lot 43 and the groundwater level recedes in all directions from this location.

With a proposed 45 metre stand off along the Permanent Conservation Order area the groundwater levels were determined for the finished surface level post extraction. A number of model scenarios were tested to establish the sensitivity of the water table in the Permanent Conservation Order area and Nature Reserve. Modelling indicates that excavation to the 45 metre standoff will lower the water table by about 0.7 metres near the southern boundary of the Permanent Conservation Order area, and by about 0.5 metres several hundred metres into the Nature Reserve to the South of the Permanent Conservation Order area.

While groundwater levels throughout the area are not expected to be impacted significantly, some decline can be expected. As a means of minimising the impact on local groundwater tables, a low permeability dross (clay) curtain installed in the 45 metre standoff between the proposed excavations and the Permanent Conservation Order area and through the thickness of aquifer sands will impede groundwater flow from the Permanent Conservation Order area to Lot 43. The degree to which groundwater levels will be maintained on the Permanent Conservation Order side of the curtain is dependent on the width and hydraulic conductivity of the curtain. The proposed curtain will be a silty clay mix. A minimum required curtain width to maintain water levels in the Permanent Conservation Order area is calculated at 0.6 metres based upon maintenance of a 0.7 metre head difference across the curtain.

The clay/dross is reject material from Readymix's processing operation and the hydraulic conductivity k was determined from testing by an independent NATA registered laboratory. Installation of the clay curtain can be undertaken using conventional backhoe and slurry technology. Mackie Martin will be consulted with regard to the construction of the clay curtain.

5.8 Waste By-Products

No processing of sand will be carried out on Lot 43.

All sand will be transported to the existing processing plant, operated by Readymix at the South-East end of the Management Area on Portion 176.

There are two types of waste produced by the processing plant. The first type is a semi-dry waste and is material which does not pass through the vibrating screens. This material consists of lumps of clay and vegetable material. The waste is rejected by the plant and stockpiled adjacent to the plant. The waste material is then used for backfilling excavated areas.

The quantity of semi-dry waste is dependent upon the quality of the material being fed into the plant and generally varies from 10% to 20%.

The second type of waste produced by the plant is fines which are held in suspension from the washing process and consists of organic material, extremely fine silica sand and clay fractions. These fines are pumped to settling ponds. These fines may also be used for backfilling excavated areas.

Experience in other extraction areas has indicated that there is little difficulty in re-establishing grass and other vegetation in areas filled with semi-dry waste and fines.

5.9

Flora and Fauna

The site will be progressively excavated and rehabilitated as discussed in sections 4.6 and 4.7.

Change in sub-soil conditions from sand to clay will influence establishment and propagation of particular tree species.

The natural vegetation to be removed from the Southern part of Lot 43 and Lot B is Woodland (Type 2). This vegetation association extends to the south into the Permanent Conservation Order area and is found along the Northern part of the Permanent Conservation Order area. Rare and threatened species mentioned by D H Benson (1985) including *Acacia bynoeana*, *Restio pallens*, *Persoonia nutans* ssp *nutans* and *Petrophile sessilis*, were all observed during the transect of Portion 157. These species are all located within the Permanent Conservation Order area.

It was noted in the Commissioner's findings from the Commission of Inquiry associated with the establishment of the Permanent Conservation Order area that the natural vegetation at the southern end of Part Lot 43 and Lot B was excluded from the Permanent Conservation Order area as it has been extensively disturbed. It was also noted that endangered species such as *Persoonia nutans* ssp *nutans* have established naturally on rehabilitated areas within the Management Area.

The progressive excavation of Part Lot 43 and Lot B will result in the removal of vegetation cover and most of the habitat preferred by the fauna. Some animals will be displaced during the extraction operations and they may survive by colonizing nearby areas already containing established populations of the species. The individuals most likely to survive will be those with large home ranges i.e. many birds or those with only part of their home range inside the affected land.

All animal species known from the survey of Part Lot 43 and Lot B are relatively common and widespread throughout Eastern Australia and are well represented in nearby conservation areas. It is anticipated that there will be no significant change in the overall status of the fauna currently inhabiting Part Lot 43 and Lot B. The removal of the vegetation from the area should not disrupt any wildlife migratory corridors through the region.

Provided progressive rehabilitation is undertaken to extracted areas there is a high probability that most animal species presently located on Part Lot 43 and Lot B will recolonize. The addition of a water body similar to that found in the extracted area to the West of Portion 190 would be of benefit to many bird and other species.

5.10 Social and Economic Consideration

5.10.1 Land Use

All land within the Management Area is zoned Rural 1(a1) under Penrith City Council IDO 93 which was adopted on August 8, 1980. This is a rural zoning permitting any rural activity with lot sizes being restricted to 40 hectares

minimum. Extraction of sand from within the Management Area may then be carried out with the consent of Council. Part Lot 43 and Lot B is freehold land and rehabilitation will provide for a grass and/or close crop with the final land being suitable for grazing or cultivation.

The Department of Agriculture has been contacted to determine if any aspects of the proposed sand extraction will significantly effect agricultural land or agricultural industry. They have advised that the proposed sand extraction will have minimal effect on agriculture and is unlikely to seriously effect existing agricultural production.

The area is Class 4-5 of the Rural Land Evaluation Manual of the Department of Planning, due to the depth of sand. It would be suitable only for some specialised crops such as carnations. It was noted that the soil near Castlereagh Road is superior to the soil further to the East in the Management Area.

At present localised ponding of surface runoff occurs on Part Lot 43, Lot B and the adjoining small rural holdings in Rickards Road as a result of the flat topography of the area. The ponding of surface runoff creates nuisance flooding. With the extraction of sand on Part Lot 43 and Lot B surface runoff will be improved and thus marginally eliminate the nuisance flooding experienced at present.

The extraction of sand in the Management Area has been taking place for the past 34 years and the Management Plan was adopted by Penrith City Council on March 18, 1982. In assessing the effect of the proposal on the adjoining land, it is considered that the extraction of sand on Part Lot 43 and Lot B will not significantly affect local property values nor present any risk to the present activities being carried out on the adjoining small rural holdings.

A Draft Land Assessment for Crown land to the east of Part Lot 43 and Lot B was placed on public exhibition in February, 1992. The Draft Land Assessment stated that the Crown land within the Management Area had a high potential for the extraction of sand and in the short term extraction should continue in

accordance with the Management Plan and REP No. 9 subject to the approval of Penrith City Council.

5.10.2 Transportation

5.10.2.1 Internal Traffic and Road Systems

All access to Part Lot 43 and Lot B will be via the access roads contained within the Management Area from the processing plant and works area operated by Readymix at the South-East end of the Management Area.

The nature and function of the existing and future access roads will not alter under this proposal. Access roads are used by works related vehicles only and as such are not heavily trafficked.

The access roads are not formally constructed and the off-road truck will be an appropriate method of transporting excavated material. The roads are regularly maintained by an on-site grader and water cart.

It is estimated that two 35 tonne off-road trucks would make a total of 60-70 round trips per day between the extraction areas and the processing plant on Portion 176.

5.10.2.2 Traffic Generation

This proposal has no impact on the current mode of operations or on the level of sales from the processing plant and works area. As such, there is no impact on the generation of additional truck movements.

Presently access to the sand processing plant and stockpiles of processed sand is principally via Torkington Road, but may also occur from Castlereagh Road via Brooks Lane.

The Torkington Road entrance links the quarry with the most direct routes to the city of Sydney.

The Castlereagh Road entrance provides access for a limited percentage of deliveries to the North, South and West of the plant as well as providing access for early morning entry to the plant.

Between 5.30 am and 6.00 am approximately one to five trucks enter the site to receive early morning deliveries for dispatch to city concrete plants.

The Torkington Road entrance is regularly maintained by the operators within the Management Area so that an acceptable level of serviceability is sustained.

Readymix has installed directional and safety signs to ensure controlled and safe traffic flow in and around the quarry site.

Furthermore, the site is equipped with a modern weighbridge so that all out-going loads may be checked for compliance with maximum legal allowable weight.

5.10.3

Socio-Economic Benefits

The final price of the sand will depend on the cost of winning the sand, processing costs and transportation costs. Often, the most critical factor will be the transport cost. As the cost of the sand is a component of general construction costs, it is desirable as far as is consistent with achieving environmental objectives, to locate extraction close to the construction market.

Londonderry is one of only two significant deposits of fine-medium grained clayey sand operating in the Sydney region. Its location on the Western outskirts of the Sydney metropolitan area is ideal for supply to the Western region of Sydney, in itself a significant market. Due to the close proximity of high standard transport routes access to the greater Sydney metropolitan market is also assured.

The extraction and processing of sand is not employment intensive but has a significant effect on employment in the building and construction industry. The extraction of sand on Part Lot 43 and Lot B will not create any new employment.

Unless approval is given for extraction for Part Lot 43 and Lot B it is likely that operations will cease within 12 to 18 months. This is likely to have an adverse effect on socio-economic benefits to the community.

The State Government will derive revenue from the extraction operation through royalty payments on Crown land and through indirect taxes associated with the industry.

5.10.4 Conservation Values

The Londonderry/Agnes Banks sand deposit is almost contained within the Management Area. The flora is distinctive to the sand deposit and is typical of flora usually found on coastal dunes. A Nature Reserve under the control of the National Parks and Wildlife Service has been created along the Southern boundary of the Management Area. A Permanent Conservation Order area has also been created along the Southern boundary of the Management Area to conserve additional vegetation associations which were not included in the Nature Reserve. The area is known as Agnes Banks Nature Reserve and adjoining areas, comprises an area of approximately 270 hectares and has been placed on the interim listing of places to be entered in the Register of the National Estate by the Australian Heritage commission. Of the five vegetation associations found on the Londonderry/Agnes Banks sand deposit, four are found within the Agnes Banks Nature Reserve and adjoining areas. The fifth vegetation association which is sedgeland, has been completely removed from the sand deposit.

The National Park and Wildlife Service has been contacted concerning the existence of relics or Aboriginal Places on the site. They advised that no sites are recorded as existing. However, no systematic survey has been undertaken in the area. Therefore, an archaeological survey of the site was required.

An archaeological survey was undertaken by Mr J L Kohen of the School of Biological Sciences at Macquarie University. The results of the survey are appended in Annexure F. Mr Kohen recorded a site at Agnes Banks in 1983. The site coded AB/1 (Agnes Banks 1) on Figure 2 of Annexure F is at the Western end of Wiltshire Road at the intersection of a non-public road.

Aboriginal artifacts were found at two locations on Part Lot 43 during the survey and were coded AB/7 and AB/8 as shown on Figure 4 of Annexure F. Both of these locations are isolated finds. The sites contained a steep chert "scraper" and a utilised chert flake. The sites are believed to be late Holocene and are probably less than 2000 years old.

The results of the survey have been discussed with the Mount Druitt Lands Council. They have indicated that the sites located in the survey are of no special significance to the local Aboriginal community, but recommend that the artifacts located should be collected before extraction commences.

As all Aboriginal relics in NSW are protected by law, permission has been obtained from the National Parks and Wildlife Service for the collection of the artifacts.

PART 6

ASSESSMENT OF ENVIRONMENTAL IMPACT

Part 5 discusses the environmental impacts and mitigations of the proposed development and can be summarised as follows:

- * The extractive operation will not have a significant visual impact from areas outside the Management Area.
- * Noise from the extraction areas will have negligible impact on nearby residences. When extraction takes place within the zone 30 - 80 metres from the western boundary of Part Lot 43 the times of operation will be reduced to a late morning start of 7.00 am to minimise disturbance to the nearest residence.
- * Dust from extraction areas, stockpiling and access roads will be controlled by water cart. Exhaust gases from the extraction equipment will be insignificant.
- * As extraction is carried out without the use of blasting or heavy earthmoving equipment, the question of vibration and subsidence of adjoining properties does not arise.
- * Finished surface levels will be adopted in order to maintain surface drainage as described in the Management Plan.
- * Sedimentation and erosion control measures will be put in place to the requirements of the Department of Conservation and Land Management.
- * A 45 metre standoff will be provided along the southern side of Part Lot 43 and Lot B to the Permanent Conservation Order area. A low permeability dross (clay) curtain will be constructed in this standoff through the thickness of aquifer sands to impede groundwater flow from the Permanent Conservation Order area to Lot 43.

- * It is noted that the existing vegetation at the southern end of Part Lot 43 and Lot B has been extensively disturbed and hence the vegetation associations are not considered as being significant for conservation.
 - * The fauna survey stated that disturbance of the area for the proposed development should not have any significant impact upon the overall status of any native species found there.
 - * All access to Part Lot 43 and Lot B will be via access roads contained within the Management Area from the existing processing plant and works area operated by Readymix.
 - * Access to the processing plant and works area is principally via Torkington Road. This proposal will provide for the extension of the existing operation and will not impact on the generation of additional truck movements.
 - * The proposal will realise in economic benefits to the community through indirect taxes associated with the industry. It will also provide continued employment and ongoing income to local suppliers servicing the existing operation. If the proposal does not proceed, it is likely that Readymix operations will cease in 12 to 18 months.
 - * Although the extractive industry is not labour intensive, it has an indirect but significant effect on employment in the building and construction industry.
- Closure of operations is likely to have an adverse effect on the socio-economic benefits to the community.

6.2

Conclusions

The effects of the proposal on the physical and social environment in the vicinity of the site have been predicted from current operations by Readymix.

It is considered that the control measures incorporated in the proposal will ensure that these effects are continued to within acceptable limits.

The consequence of not carrying out the extractive operation would be significant. Readymix already has considerable investment in sand extraction and processing operations within the Management Area and this proposal allows continued operation for an additional seven to ten years.

The Londonderry/Agnes Banks Sand Management Area is one of the few sources of fine - medium grained clayey sand in the Sydney region. In the future, there will be a shortage of this type of sand located in close proximity to the Sydney market and increased transport distance will mean increased cost.

Therefore, it is considered that the extraction of sand from the site will provide for the extension of existing approval operations and that the control measures outlined will result in minimal impact on the surrounding area.

PART 7

NON-DEVELOPMENT OPTION

Non-Development Option

The consequences to Readymix and the community of not proceeding with the proposed development are considerable.

This proposal involves consolidating an existing operation which employs 9 personnel. The resource has been identified as being one of three significant deposits of fine - medium grained clayey sand being extracted in the Sydney region at present.

The final products have enjoyed a high degree of market acceptance for the past 34 years and due to location, the operation can offer reduced costs through lower cartage distances.

While it is possible that an alternative site could be located in the future, it is unlikely that the location of such a site would be as well suited to supplying the Sydney Region. Readymix have considerable capital investment in the Management Area and the cost of such an alternative would be significant.

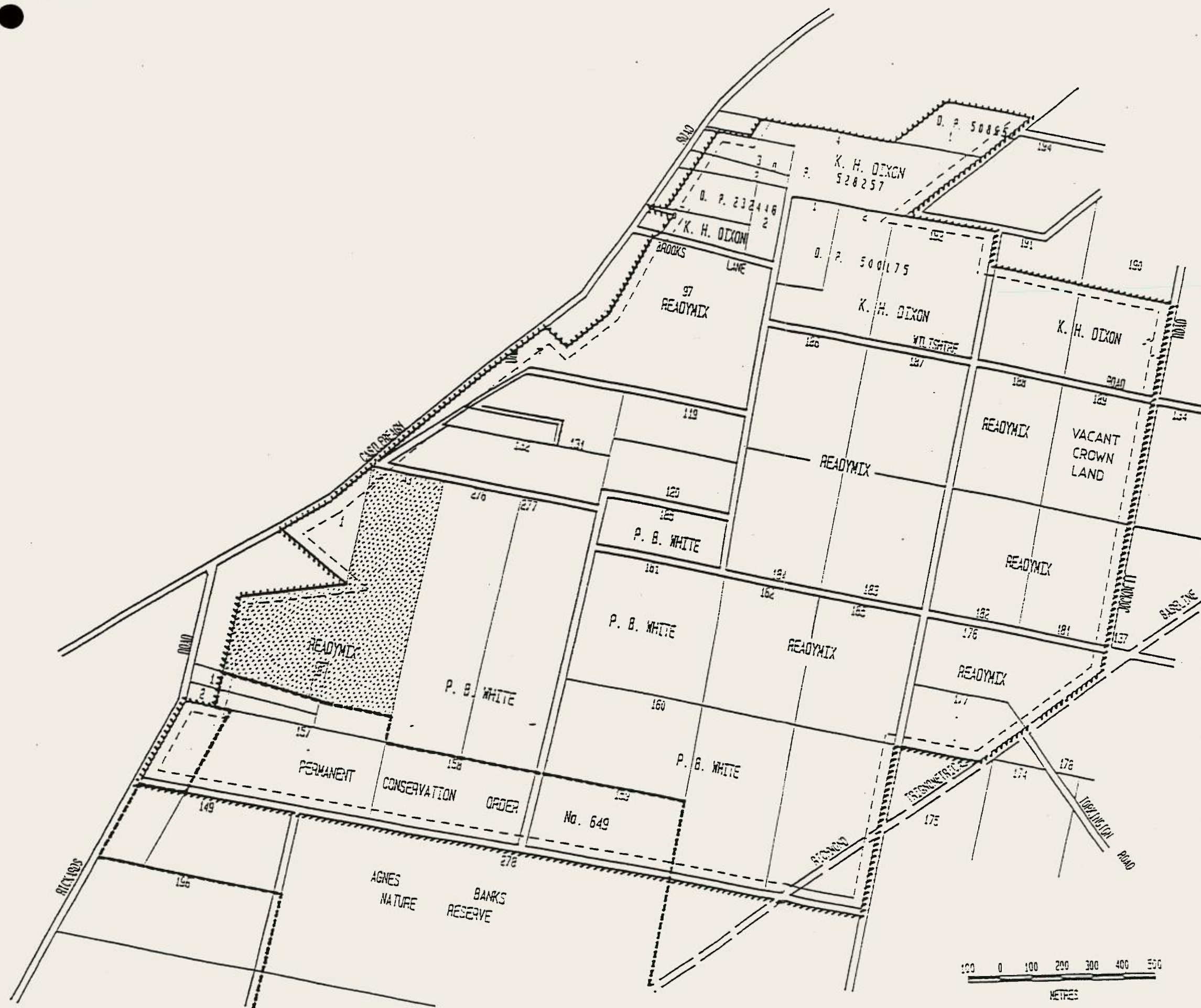
Part Lot 43 and Lot B is located within the Londonderry/Agnes Banks Land Management Area and Sydney Environmental Plan No.9 and the proposal is consistent with surrounding land use.

If operations are not undertaken in Part Lot 43 and Lot B, it is likely that all operations will cease within 12 to 18 months with consequent negative effects on the socio-economic benefits to the community.

DRAWINGS

-----MANAGEMENT AREA BOUNDARY

----- PCD & NATURE RESERVE BOUNDARY



PROJECT

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EXTRACTION MANAGEMENT

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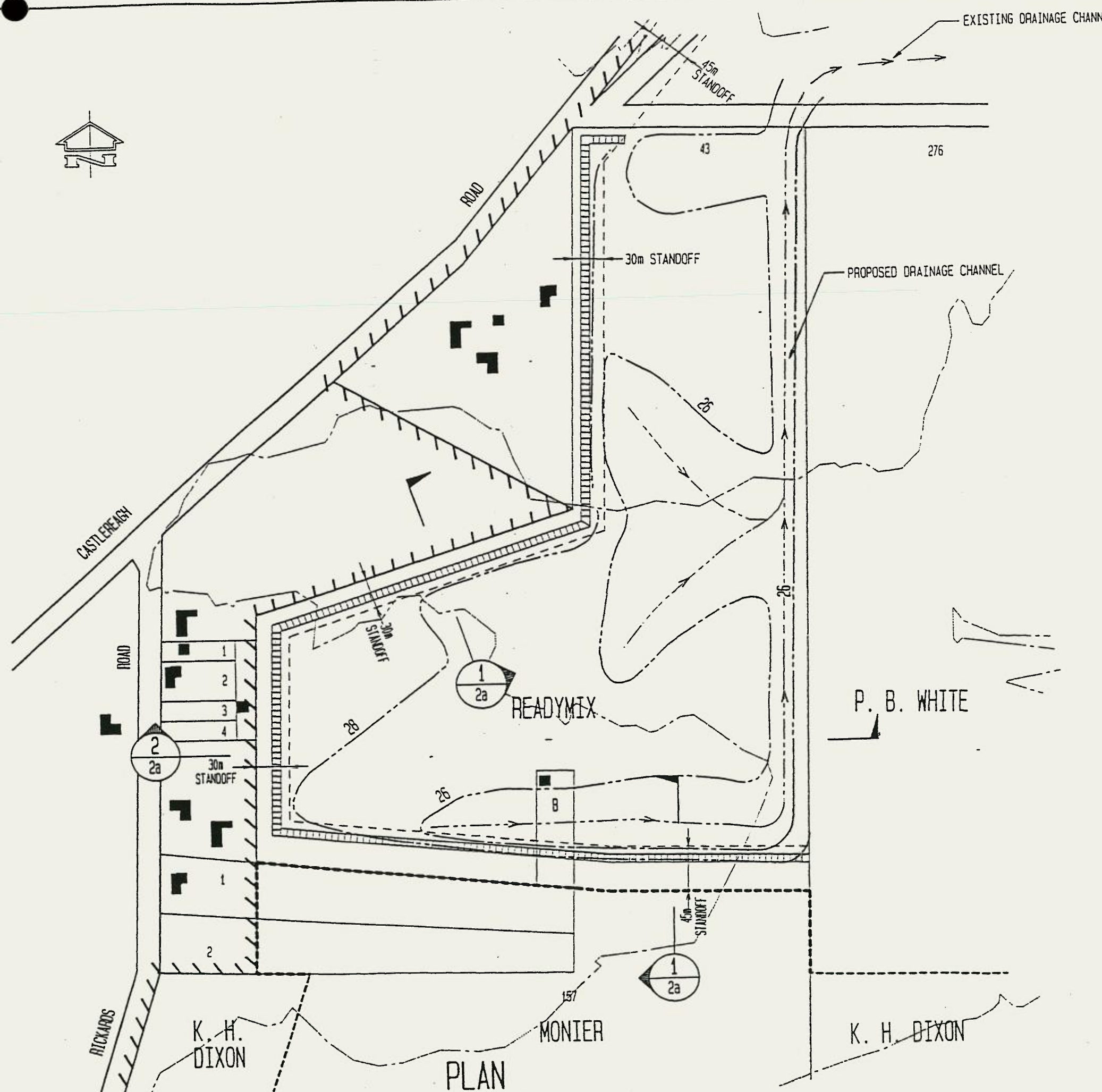
SITE PLAN

CLIENT

THE READYMIX GROUP

TAYLOR THOMSON WHITFIELD
PVT. LTD. (Incorporated in N.S.W.)
CONSULTING, STRUCTURAL & CIVIL ENGINEERS
48 CHANCERY ST., ST. LEONARDS NSW 2238, TEL. 03 729 1144, FAX 03 729 1145

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SCALE NTS	APPROVED	DATE APRIL 93	DWG NO. 1



LEGEND

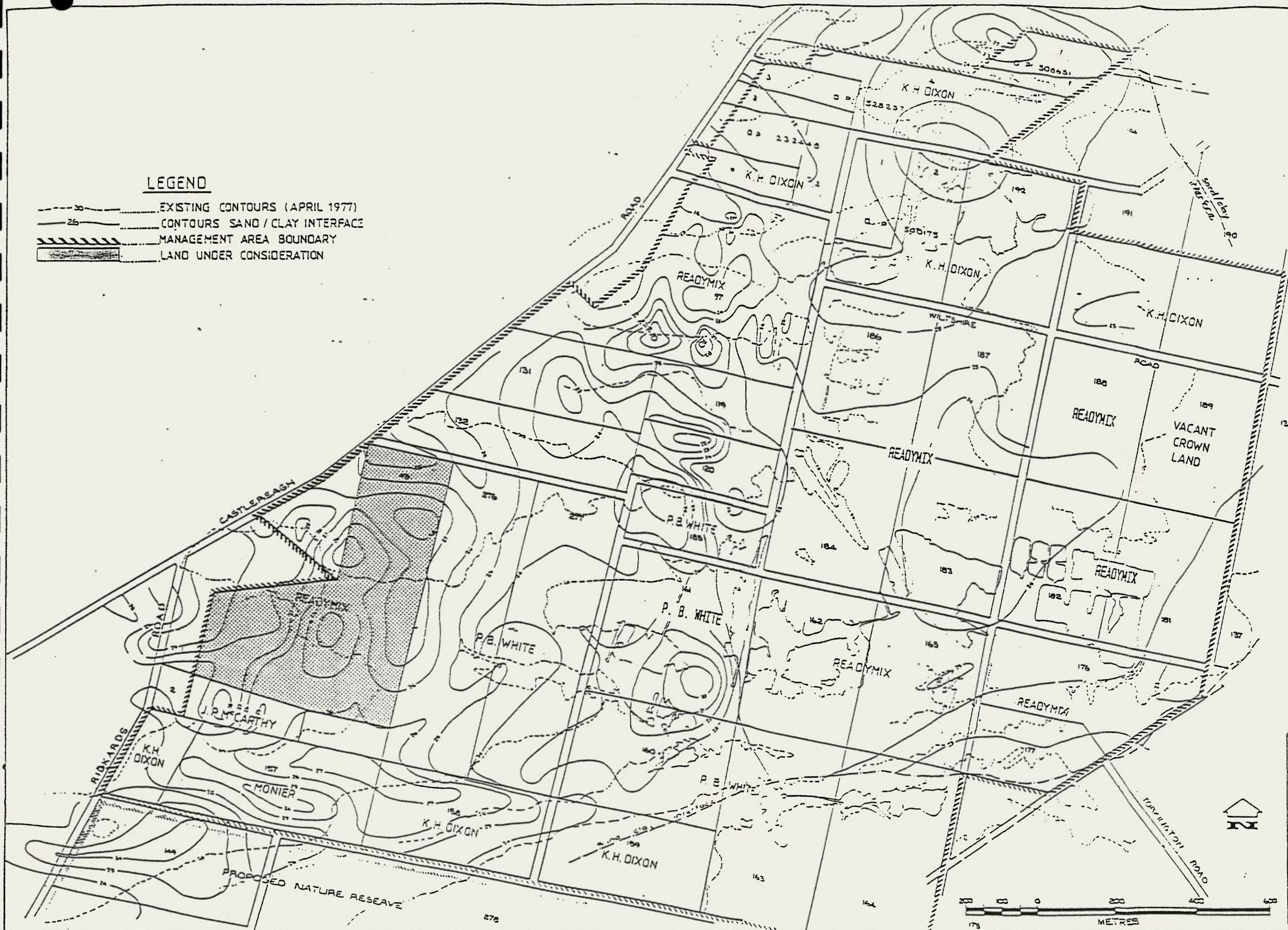
- EXISTING CONTOUR
- FINISHED CONTOUR
- MANAGEMENT AREA BOUNDARY
- ACCESS ROAD
- PCO & NATURE RESERVE BOUNDARY
- TEMPORARY MOUND
- EXISTING BUILDINGS
- PROPOSED WATERCOURSE

PLAN
SCALE 1:4000

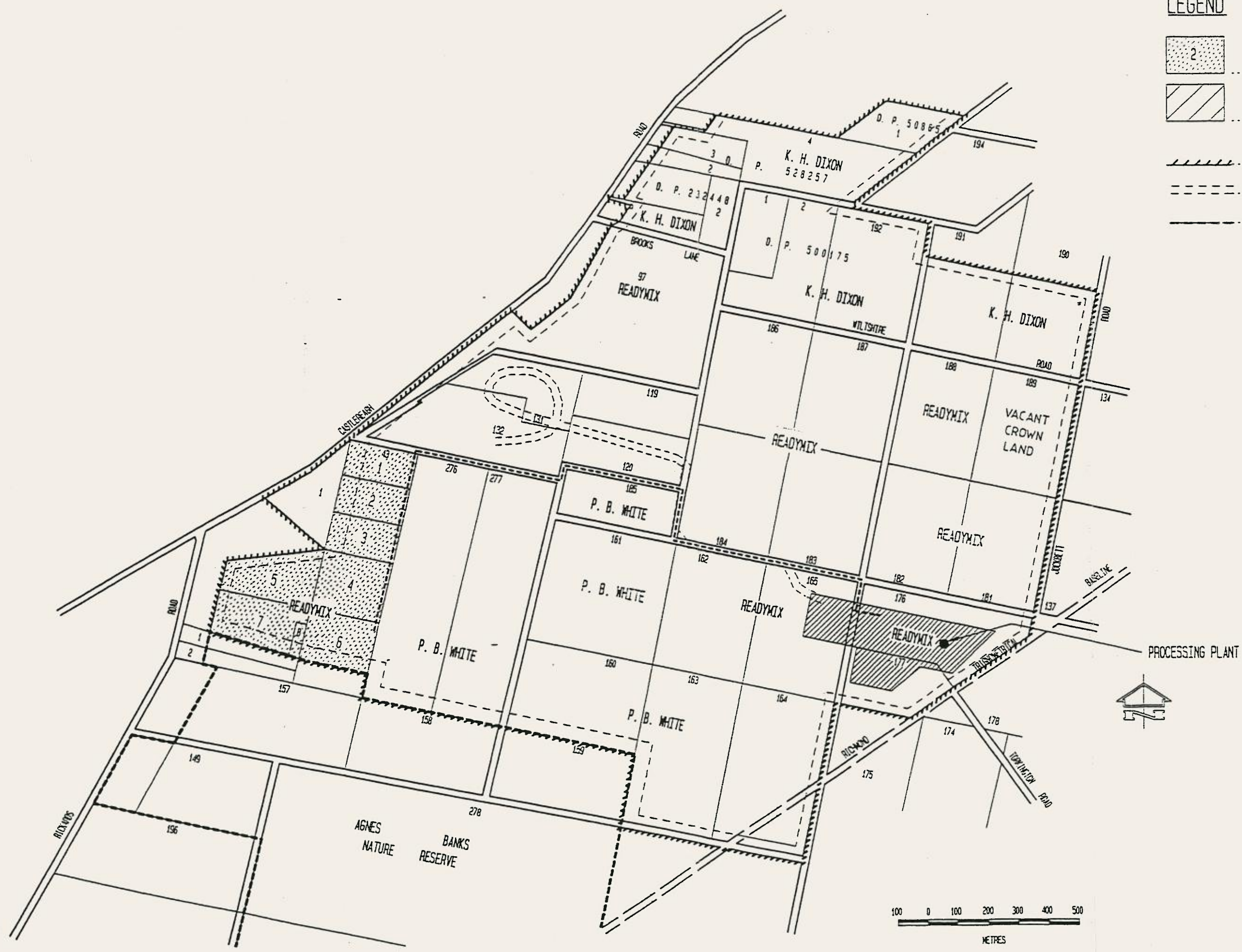
PROJECT			
LONDONDERRY SAND EXTRACTION MANAGEMENT			
SHEET SUBJECT			
PLAN OF FINISHED SURFACE LEVELS & SECTIONS			
ARCHITECT			
READYMIX GROUP			
TAYLOR THOMSON WHITTING			
PTY. LTD. (Incorporated in N.S.W.)			
CONSULTING, STRUCTURAL & CIVIL ENGINEERS			
48 CHANDOS ST., ST. LEONARDS NSW 2065 TEL. 03 7289 FAX. 03 3146			
DRAWN	DESIGN	DATE	JOB NO.
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CHIEF O'MAN	APPROVED	SCALE	DRG NO.
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LEGEND

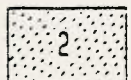
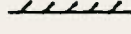
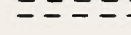
- EXISTING CONTOURS (APRIL 1977)
- CONTOURS SAND / CLAY INTERFACE
- MANAGEMENT AREA BOUNDARY
- LAND UNDER CONSIDERATION



PROJECT			
PROPOSED SAND EXTRACTION LOT 43			
SHEET SUBJECT			
SAND / CLAY INTERFACE CONTOUR PLAN			
READYMIX GROUP			
MARSDEN ST. PARRAMATTA			
TAYLOR THOMSON WHITTING			
CONSULTING ENGINEERS			
DATE	SCALE	PROJECT NO.	83220
As Shown			3

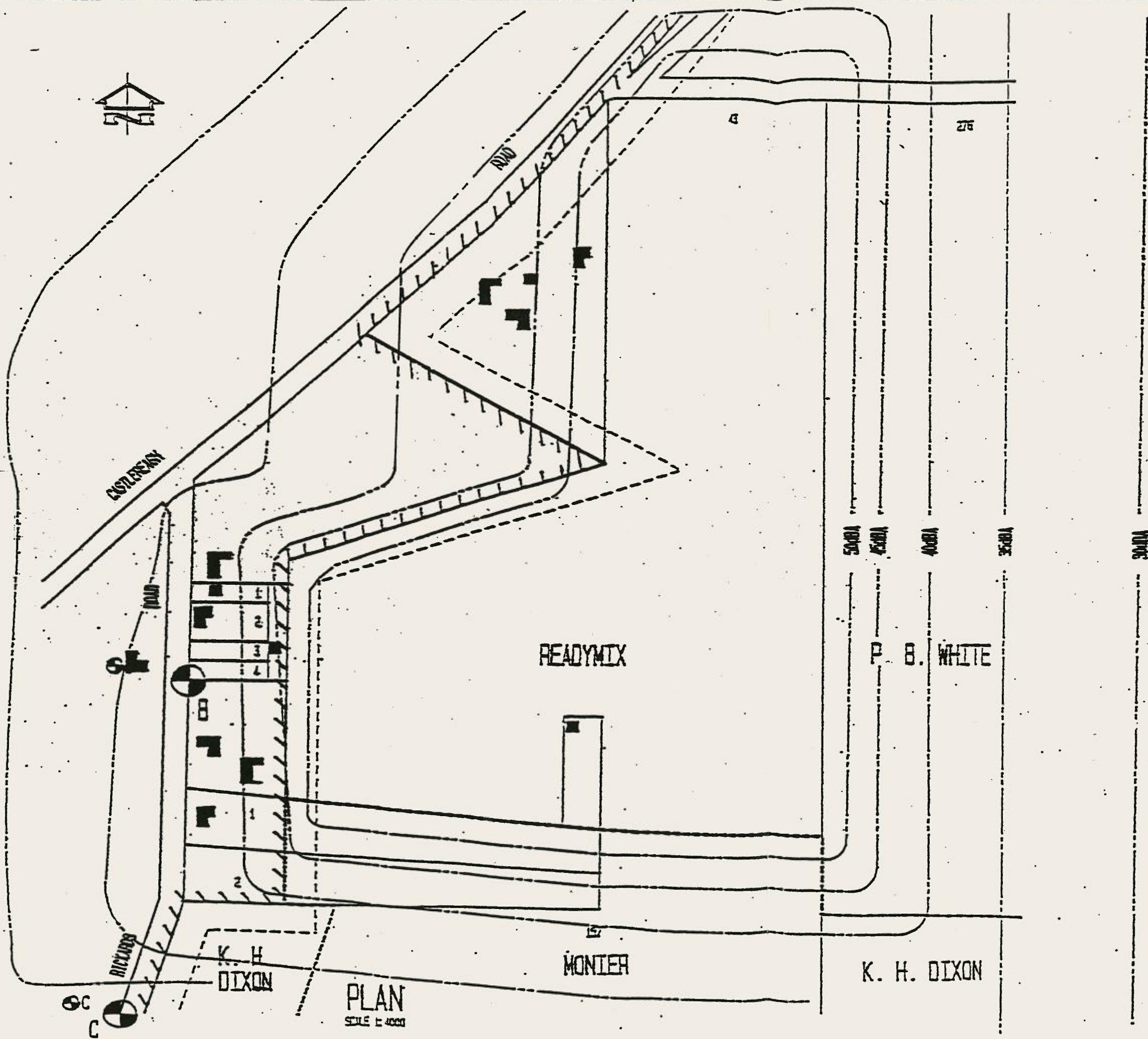


LEGEND

-  LAND UNDER CONSIDERATION & EXTRACTION STAGE NUMBER
-  WORKS AREA
-  MANAGEMENT AREA BOUNDARY
-  ACCESS ROAD
-  PCO & NATURE RESERVE BOUNDARY

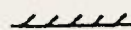


PROJECT			
LONDONDERRY SAND EXTRACTION MANAGEMENT			
SHEET SUBJECT			
STAGE DEVELOPMENT PLAN			
ARCHITECT			
TAYLOR THOMSON WHITTING			
PTY. LTD. (Incorporated in N.S.W.)			
CONSULTING, STRUCTURAL & CIVIL ENGINEERS			
48 CHAMBERS ST., ST. LEONARDS NSW 2065, TEL. 02 7288 7288, FAX 02 7288 7288			
DESIGN	DRAWN	CHECKED	JOB No.
KV	AM		83220
SCALE	APPROVED	DATE	DATE No.
1:12500		FEB 92	4



PROJECT			
LONGMEADRY SAND EXTRACTION MANAGEMENT			
SHEET TITLE			
ACOUSTIC PLAN LOT 43 & LOT 1			
OWNER			
READYMIX CORP.			
DESIGNER			
TAYLOR THOMSON WHITTING			
P.E. L.R. (REGISTERED IN P.E.C.)			
CONSULTING, SURVEYING & CIVIL ENGINEERS			
4 CHURCH ST., ST. LEONARD'S BY SEA, S.E. 26 229, TEL. 041 214			
DATE	DESIGN	SCALE	SHEET NO.
17	18	1/4" = 1'	83220
CHECKED & NAME	APPROVED	SCALE	SHEET NO.
17	18	1/4" = 1'	5

LEGEND

-  LAND UNDER CONSIDERATION
-  MANAGEMENT AREA BOUNDARY
-  PCO & NATURE RESERVE BOUNDARY
-  A BACKGROUND NOISE SURVEY LOCATIONS



PROJECT			
LONDONDERRY SAND EXTRACTION MANAGEMENT			
SHEET SUBJECT			
NOISE MEASUREMENT LOCATIONS			
ARCHITECT			
TAYLOR THOMSON WHITTING			
PTY. LTD. (Incorporated in N.S.W.)			
CONSULTING, STRUCTURAL & CIVIL ENGINEERS			
48 CHANCOS ST., ST. LEONARDS NSW 2065. TEL. 439-7288. FAX. 439-3146			
DESIGN	DRAWN	CHECKED	JOB NO.
KV	AM		83220
SCALE	APPROVED	DATE	DWG NO.
1:12500		FEB 92	6

ANNEXURE A

FLORA SURVEY



VEGETATION SURVEY OF SAND EXTRACTION LEASE AT LONDONDERRY

by

MOUNT KING ECOLOGICAL SURVEYS

INTRODUCTION

Considerable information on the floristics and structure of the vegetation of the Agnes Banks sands was already available (Benson, 1981) and this was used as a basis for the survey carried out. Some of the more outstanding features described by Benson (1981), such as the vegetation patterning due to east - west striking dunes originally best developed in the northern region of the deposit, are no longer observable due to both the mining of much of the northern region and to the reduction in dune amplitude from north to south on the original deposit.

THE SURVEY

The survey was carried out by Dr.T.M.Straede using two approaches:

(1) Two north to south transects [A-A and B-B, Figure 1] were examined in detail for floristic and structural composition; they were designed to sample as much variation within the sand vegetation as possible and to cross the sand/clay boundary. The vegetation was sampled at 50m intervals (adjusting for trails, bore sites, etc) where 5m radius plots were assessed for species composition, cover, structure and girths of all trees and saplings over 15cm GBH. Notes on litter cover, bare soil and fire history were also recorded at each site.

(2) Having learnt to recognise the structural units of Benson (1981) during preparation of the detailed transects an attempt was made to map their distribution in more detail by walking through the site and around the boundaries.

(3) The remaining areas of sand deposit vegetation outside the site were investigated to ascertain their major species and structural composition. Particular attention was paid to Part Portion 157 adjacent to Rickards Road and to the considerable stand of natural vegetation belonging primarily to the Clemson family between Rickards Road and Castlereagh Road. The Nature Reserve was also briefly surveyed, adjacent to A1, and along vehicle tracks.

RESULTS AND DISCUSSION

In Figure 1 a vegetation map of the site and adjacent areas based on the results of both endeavours is shown. It should however be noted that very few association boundaries are as sharp on the ground as on the map, and that vestiges of low amplitude dunes in fact create a richer and more diverse

assemblage of associations than it is possible to indicate after a quick survey.

Vegetation Associations (after Benson, 1981).

(1) Low Open Forest of *Banksia serrata* [Saw Banksia] and *Angophora bakeri* [Narrow-leaved Apple] (Photos 1 and 2).

An undisturbed sample of this community is now confined to one locality on the remaining sand deposit, but outside the present study area—to the south of Brooks Lane access to the sand treatment plant [Lot 97]. A very battered remnant is present on the Castlereagh end of Portion 132.

This community marked the well drained dune crests, particularly in the north of the sand deposit, so that it is interesting that a narrow, shallow dune crest within the study area shows similar structure, though not the complete range of species typical of the Brooks Lane stand. Both these remnants are not considered as being in as good a condition or as extensive as that located on Brooks Lane. The remnant recorded on the Northern end of the Clemson properties is most unusual in that rather than the typical canopy of *Angophora bakeri* and *Banksia serrata*, and the occasional *E. sclerophylla* to 13m, the canopy consists of *A. bakeri*, *B. serrata* and *Casuarina littoralis*. The ground stratum is dominated by *Pteridium esculentum* [Bracken] and *Lomandra longifolia*, with very few of the usual scattered scrub species [*Ricinocarpos pinifolius*, *Bossiaea rhombifolia*, *Eriostemon myoporoides*] and grasses.

(2) Woodland of *Eucalyptus sclerophylla* [Scribbly Gum], *Angophora bakeri* and *Banksia serrata* (Photo 3).

Once the most widespread association of the sands, this community is well represented within the northerly portion of the survey area, but is not present in the Nature Reserve. The uncleared portion of Lot 43 consists primarily of this vegetation type, with a narrow band occurring also along the northern margin of Portions 157 and 158, and on the uncleared part of Portion 165 adjacent to the treatment plant, and on Portions 132, 120 and 97.

The community is dominated by trees of *E. sclerophylla*, 10 to 15m high with smaller trees of Narrow-leaved Apple and Saw Banksia. The understory is dense, approximately 2m tall and is composed of a rich diversity of shrubs including *Leptospermum attenuatum* [Paperbark Teatree], *Conospermum taxifolium*, *Ricinocarpos pinifolius* [Wedding Bush], *Petrophile pulchella*, *Brachyloma daphnoides* [Daphne Heath], *Persoonia nutans* ssp *nutans* [Nodding Geebung] and *Bossiaea obcordata*. Ground cover is sparse, and litter cover well developed. Considerable variation in tree height and girth, shrub density/diversity and litter cover is observable within the remaining samples of this vegetation type. The variation is largely attributable to the effects of fire. Of particular interest is the variation in the *B. serrata* component, where frequent fires have reduced once

mature individuals to sapling size coppices. This species in this area appears to establish successfully from seed only rarely, so that as repeated fires actually kill some of the individual plants the density of the species declines within the community. Reduction in fire frequency is indicated for any sample of this community retained for future enjoyment.

(3) Woodland of *Eucalyptus sclerophylla*, *Eucalyptus parramattensis* [Drooping Red Gum] and *Banksia aemula* (Photos 4-7).

This community is well represented within the survey area [Portion 157], in the Nature Reserve to the south and in a splendid mature sample on the Clemson properties between Rickard and Castlereagh Roads. It is not present elsewhere on the sand deposit.

Trees of *E. sclerophylla* to 12m and *E. parramattensis* to 10m dominate this community, with a well developed tall shrub layer to 7m of *Banksia aemula*. The understory consists of a rich diversity of shrubs as in the previously described association, including *Leucopogon ericoides* [Pink Beard-Heath], *Philotheca salsolifolia* and tussocks of *Xanthorrhoea* sp. [Black Boys], *Lepyroidia scariosa*, *Hypolaena fastigiata* and *Lomandra* spp. to 0.5m is better developed.

Banksia aemula and *Banksia serrata* are extraordinary difficult to separate on gross morphology in the field, their major difference is in the shape of the stigma. During the field survey the stigma shape was constantly checked to ascertain the boundary between associations 2 and 3. During such a casual investigation many plants could not be satisfactorily ascribed to either species because of the intermediate stigma shape. On referral to D. Benson [National Herbarium] it appears that hybrids are possible [George, 1981], but that to date no natural hybrid population has been investigated; this population, along the northern boundary of Portion 157 and the Clemson holdings may be unique.

Two, possibly three ages of this community since the last fire were observed within the study area, the Nature Reserve and Clemson's holdings. The most mature was last burnt in 1967-68 and is located on Clemson's holdings whilst the most recent [burnt 5 to 6 years ago] are found on the Nature Reserve and Portion 157. It should be noted that a large portion of these last two areas are shown in Figure 1 as intermediate between community (3) and the community next to be described i.e. community (4)-Low Woodland of Drooping Red Gum. Some, at least, of the ecotonal nature of this zone is due to frequent fires, as species dominant in community (4), particularly the monocots and *Banksia aspleniifolia* [Rock Banksia] which are favoured by a more open canopy, and are adapted to variable frequencies and durations of water logging are also present, though inconspicuous, throughout the mature specimens of community (3) surveyed. Both the monocots and Rock Banksia have underground perennating organs and can

exist for years in a suppressed, almost dormant state, awaiting the fire which removes the canopy and in doing so increases the frequency and duration of soil waterlogging until the canopy regrows. The evapotranspiration rate of the mature canopy of a type 3 community presumably drains the soil fast enough for it to remain as this type. However, with canopy loss through fire, the soil water status is transformed to that favouring community 4. Repeated fires will therefore produce a much wider, more complex and mesic ecotone than would be observable in a mature area. It is also possible that the number and frequency of fires could become so high that the boundary between 3 and 4 could be altered, with community 4 replacing 3, as species from 3 are slowly eliminated by the maintenance, almost permanently, of a type 4 soil status.

(4) Low Woodland of *Eucalyptus parramattensis* [Photo 8].

This community marks the most poorly drained situations on the site, as (5) Sedgeland is now removed completely from the sands. This community is also present in the Nature Reserve and in the north-east corner of the deposit [Portions 189, 190 and 191], and a tiny sample in the south-east corner of Portion 165, near the treatment plant.

The major feature of this community is the abundant ground cover of 0.5m of monocots, particularly sedges and rushes such as *Lepyroidia scariosa*, *Leptocarpus tenax*, *Cyathochaeta diandra* and *Schoenus brevifolius*, intermingled with small shrubs such as *Melaleuca thymifolia*, *Kunzea capitata* and *Baeckea diosmifolia*, beneath a well developed shrub cover dominated by *Banksia aspleniifolia* and *Leptospermum flavescens* to 2m, with a scattered, often absent stratum of small twisted trees of Drooping Red Gum up to 10m tall. Individuals of *E. sclerophylla* may also be present, and dense thickets and/or individual trees of Narrow-leaved Apple may also be present.

As discussed under community (3), woodland of *E. sclerophylla*, *E. parramattensis* and *Banksia aemula*, considerable portions of the present extent of this community may be fire produced ecotonal stages potentially able to become community type 3, but is probable that even with infrequent fires not only would most "pure" samples remain as type 4, but other areas would stabilize to an ecotonal mosaic between types 3 and 4. A natural, stabilized ecotone, characterised by the presence of *Banksia spinulosa* occurs along the boundary of this community and the adjacent Open Forest of *E. fibrosa* and *Melaleuca decora* [community type 6].

(6) Open Forest of *Eucalyptus fibrosa* [Broad-leaved Ironbark] and *Melaleuca decora* [White-heather Honey Myrtle] (Photo 9).

This community occurs primarily on the clays adjoining the sand deposit, though an ecotone is present between this association and various sand associations. This community is well represented in the Nature Reserve and surrounding freehold.

The tree canopy consists of *E. fibrosa* with some *E. parramattensis* at 15m over a shorter tree layer of *Melaleuca decora* to 8m. The understory consists of *Bursaria spinosa* shrubs to 2m, with shorter shrubs of *Dillwynia tenuifolia* and *Daviesia ulicifolia* over a well developed ground cover of grasses e.g. *Themeda australis*, *Aristida* sp. and *Entolasia stricta* and herbs e.g. *Goodenia billidifolia*. Where this community adjoins the sand deposit, a brief ecotone marked by the presence of *Hakea sericea* in the shrub layer occurs where shallow sand overlies the clay; this then gives way quite abruptly to sand communities [primarily types 3 and 4]

Vegetation Types Related to Clay Depth

In Figures 2 and 3 the floristic composition, structural attributes and association type are given for the two detailed transects and an attempt made to relate these to the depth to the clay/sand interface. The latter is not particularly successful except in a most general way, as the depth to the hardpan within the sand (data not available) once the clay layer falls below a certain (unknown) depth is probably of equal importance in determining the surface vegetation, as both act as a barely permeable layer causing lateral flow of water to dominate along the interface at times of intense rainfall. As Benson (1981) records, the "hardpan is close to the surface in the swales, but discontinuous or absent from the dune crests", also "Drainage in the centre of the dune area is internal swamps being formed in swales between the main dunes." While the area under survey does not contain "main dunes" and hence large contrasts in dune/swale vegetation, the remnants of low amplitude dunes will function in fundamentally the same way, but without the ability to produce the same high degree of contrast. Where the clay interface is close to the surface, within the truly clay species (e.g. B1 is a clay community although the surface has a thin sand cover) one could expect to observe a community similar to shallow swales between the high dunes, i.e. the Low Woodland of *E. parramattensis* (4). A graduation from 4 to 3/4 to 3 from east to west across portions 159 to 158 to 157 is indeed observed, which correlate roughly with increasing depth to the clay interface. Some of the mixed nature of 3-4 ecotone is possibly due to variable clay depth here, interacting with hardpan development in the sand, as well as to fire frequency.

The northern boundary of the portions 159 and 158 coincides approximately with a rapid deepening of the sand/clay interface and was marked by a visual and floristic change of comparative brevity between B4 and 6 (Photo 10). This same change was observed between 6 and 7; A7, 8 and 9 showed dune/swale type patterning presumably controlled primarily by the hardpan depth. This patterning appears unlikely in Lot 43 also even if the site remained unburnt for as long as A7, 8, 9.

VEGETATION MAPPING

Whilst the same vegetation associations were used as mapping units as used by Benson (1981) the resultant vegetation map differs considerably in detail from his. This is in part due to the much broader scale of sampling by Benson, without the concentration on detail within the areas under present consideration which contain a large proportion of an association (3) which is represented by only 1/24 samples in Benson's Survey. The boundary between the type 1-2 associations, and 3-4 associations on sand, and all sand associations, and the clay association (6) are common features on both maps. It should be noted that in the Benson report (Document 1) much more of association 2 is shown on portions 157 and 158 than is in fact present. On consulting with the author I find that this is a mistake made in the preparation of the map, and that the southern boundary is where it is shown in Figure 1.

SPECIES AND ASSOCIATION DIVERSITY: RARE SPECIES

In terms of diversity of species and associations, the profile A-A, north-south across portion 157 the J.P. McCarthy holding sampled the maximum available within the site. A distinct fire line was also observed between A6 and 7 (marked by a vehicle track) with the vegetation to the south appearing to have been burnt 6-7 years previously and that to the north probably at minimum 14-15 years ago. This contributed another element to the diversity sampled along this transect. In Figure 2 the presence of the rare and threatened species mentioned by Benson (1985 Document 3) *Acacia bynoeana*, *Restio pallens*, *Persoonia nutans* ssp *nutans* and *Petrophile sessilis* (Photos 11-13) were all observed during the traverse of section A-A in portion 157, all but *R. pallens* actually occurring within at least one of the sample plots. Whilst the *Persoonia nutans* and *Petrophile sessilis* were observed sporadically throughout the type 2 woodland (*E. sclerophylla*, *A. bakeri*, *B. serrata*), the *Acacia bynoeana* appeared to be very restricted in occurrence - plants were observed only over a narrow band N-S band circa 10m wide and a E-W band 80m wide. The *Restio pallens*, whilst not common, occurred sporadically in the 3-4 Woodland/Low Woodland communities.

During further exploration of the Clemson holdings, *Persoonia nutans* ssp *nutans* and *Restio pallens* were found to be well represented in community 3 [*B. aemula*, *E. sclerophylla*, *A. bakeri* Woodland]. However, no further populations of *Acacia bynoeana* were located and no possible niches identified where it may occur. During investigations in the Nature Reserve, a species *Leucopogon virgatus* recorded by Benson [1985, Document 3] as being absent from the Reserve was located in an area adjacent to A1, where it was recorded during the survey. No further populations of *Petrophile sessilis* were located other than on land traversed by A-A and extending into Lot 43.

REPORT EVALUATION

The three reports prepared by Benson: Document 1, Document 2 - Benson 1981 and Document 3, were studied in detail. Document 1 predates the creation of the Nature Reserve since which time the extent and variety of plant associations have been reduced by both clearing and extraction. It should be noted that neither of the proposals A or B made for a Nature Reserve were achieved. The present Reserve contains only two of the five sand associations, and more than half of it consists of the clay association, which whilst valuable as a buffer, contributes nothing directly to conservation of the sand flora. Document 2 (Benson, 1981) was used as a basis for the survey carried out for this report, and has been frequently referred to. As a scientific paper, the objective data and analysis can be considered as *prima facie* evidence, only the interpretations and conclusions drawn by the author can reasonably be questioned. As already pointed out, the map prepared by Benson (1981) and that shown in Figure 1 do not entirely agree, however the latter finding does support the general relationships demonstrated by Benson's numerical analysis.

The floristic and structural similarities of this geographically disjunct assemblage of sand associations to other similar associations, as detailed by Benson (1981) can also be attested by the author who has worked extensively on coastal heathland communities and in the Mellong Swamps.

In general, the species are not in themselves rare (with noted exceptions) - many are part of the sandstone flora, nor are the associations elsewhere unknown (usually coastal). However, the whole community, with associations relating/intergrading with each other, in this isolated inland position, at a low elevation (Mellong Swamps are at much higher elevation, nor is the assemblage the same) is unique. The relationship with the surrounding/underlying clay is of interest but the internal dynamics controlled by soil water status/fire frequency is much more interesting, and in the case of the *B. aemula*/*B. serrata* interface/hybrid swarm, possibly provides a unique opportunity for population genetics/autoecological studies.

The only other occurrence of *B. serrata* known to the author in this general area is a tiny stand similar to Association 1 just north of Ebenezer on Wynark Lane. This is on Recent Sand, on freehold land, and is badly damaged. The National Herbarium have been advised of its existence.

Document 3 (Benson 1985) evaluates the area now under the Interim Conservation Order 569 of which a plan is provided. The claims made within this report, concerning Portions 157, 158 and 159 were found to be true. Portion 157 does contain all the rare or threatened species mentioned and is in good condition. It is true that the present Nature Reserve contains only a tiny portion

of the variety and area of the sand flora, but due to an error of mapping mentioned previously the addition of portions 157, 158 and 159 to the Nature Reserve would not achieve a particularly satisfactory conservation of the Type 2 Woodland of *B. serrata*, *E. sclerophylla* and *A. bakeri*. Investigations here carried out suggest that Portion 157 and the J.P. McCarthy holding and part of Lot 43 would provide a more representative sample of the remaining diversity, and protect the rare plants.

It should be noted that the ability of any small area of the sand flora in the long term to maintain its structure and floristics is questionable as pointed out repeatedly by Benson in all his publications. Associations adjoining clearings, roads, etc, (which do not disturb the sub-surface drainage) appear to be reasonably unaffected - weed invasion seems not to be a problem, probably due to the very low nutrient status of the sands. Sand extraction below the hardpan layer is a different matter.

Whilst the dry end of the spectrum of communities, essentially types 1 and 2B containing *B. serrata* are least likely to show any noticeable change for tens or even hundreds of years under mean climatic conditions, a series of drought years, combined with fires, may well result in much more rapid change - particularly a slow reduction in density of coppicing species including the dominant species.

The remaining associations, being influenced by the internal drainage of the sands, formerly controlled by the hardpan, are much more likely to be disrupted by adjacent extraction, as water will simply run out of the system altogether. Changes in structure and composition could in this case be expected to be more rapid, especially if successive droughts are experienced, and the area is burnt frequently. It is to be expected that species from the drier end of the spectrum would be favoured in regeneration and longterm survival, and should a closed canopy be achieved for any sustained period, the death of the waterlogging tolerant lignotuberous species would eventually occur. It must be appreciated that the area contains a high proportion of major cover contributing species that are adapted to fire through lignotubers which provide an inbuilt inertia, as far as response to gradual changes in the environment, so that actual changes in the distribution and relative areas of each association are likely to be very long term (hundreds of years).

As discussed in relationship to the complex ecotonal area between Associations 3 and 4, some of the communities could be considered as "two strategies in one package" communities, which could in itself work to the advantage of a community in adapting to a permanent change in water status, rather than a cyclical one. It should be remembered that not only, as outlined before, do these "2 in 1" communities have the ability to cope with fire, but also unburnt, cyclic changes in water table height/waterlogging status that take place beneath the community due to an approximately 15 year alternation of climate between

wet and dry periods (Photo 14). How wide is the plasticity and adaptability of the species genome and the geronimmort individuals which make up these communities? How many stresses may they weather at once? What happens if stress vectors which have always coincided in direction under natural climatic/fire patterns are thrown into opposition by the presence of an extraction depression close by? Such fundamental ecological questions are rarely asked, and so little is known about either species or community autecology that no-one can provide an answer.

SOURCE MATERIAL

DOCUMENT 1: Initial Benson Report and Proposal for a Nature Reserve at Agnes Banks. Note the final adopted Reserve was part of the area contained in Proposition A.

DOCUMENT 2: Report from Cunninghamia, Volume 1 [1981] "Vegetation of the Agnes Banks Sand Deposit, Richmond, New South Wales. by Doug Benson.

DOCUMENT 3: August Report by D.H.Benson prepared, presumably, for the National Parks and Wildlife Service.

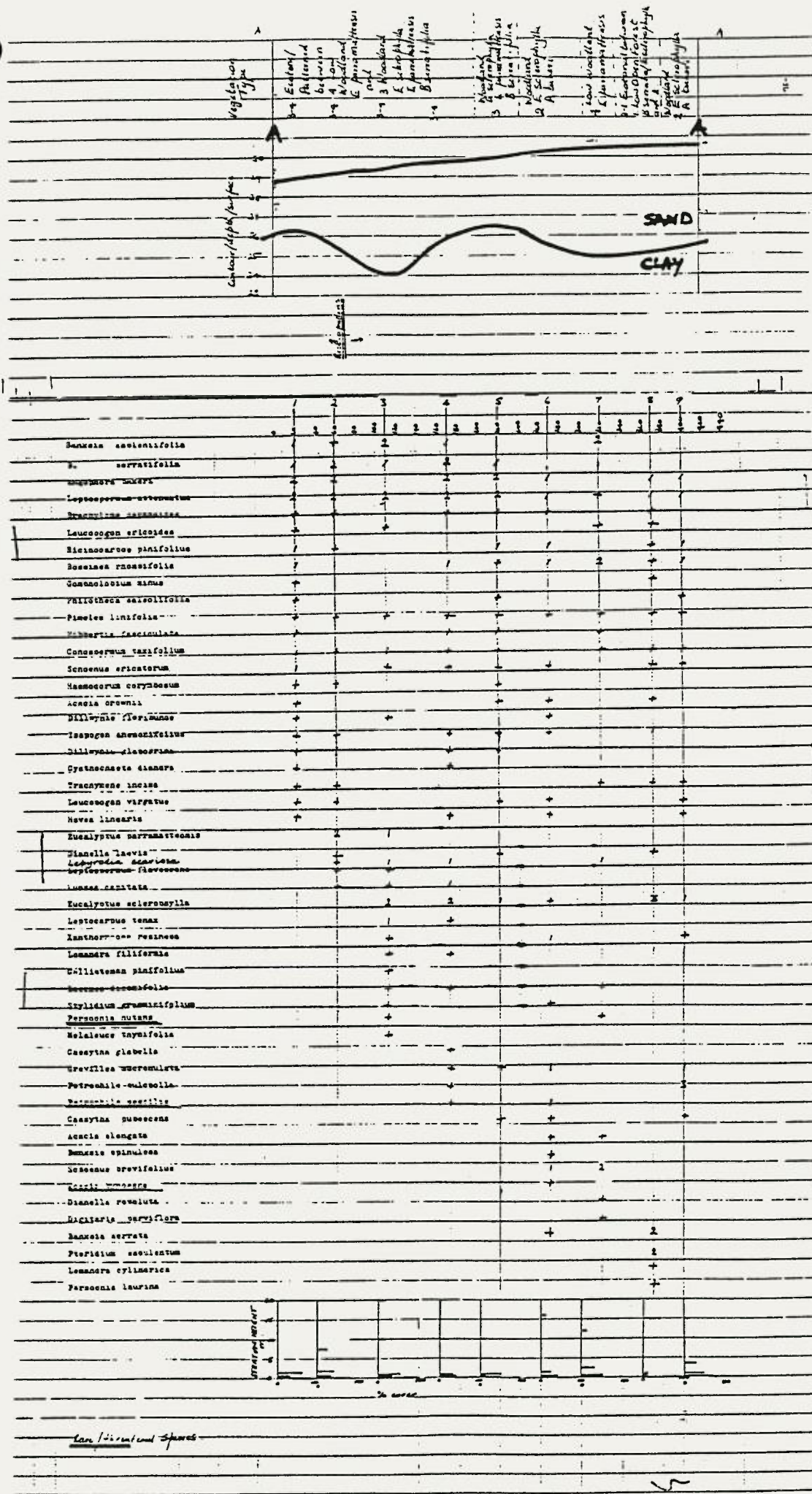


Figure 2. The floristic composition of sites (5m radius plot) at intervals along transect A-A (figure 1) related to clay depth (from map 1:2000 Preliminary Contours Sand/Clay Interface supplied by Taylor Thomson Whitting); vegetation type and structural attributes. Cover estimates: 1, 1.5%; 2, 5.25%; 3, 25-50%; 4, 50-75%; 5, 75-100%.

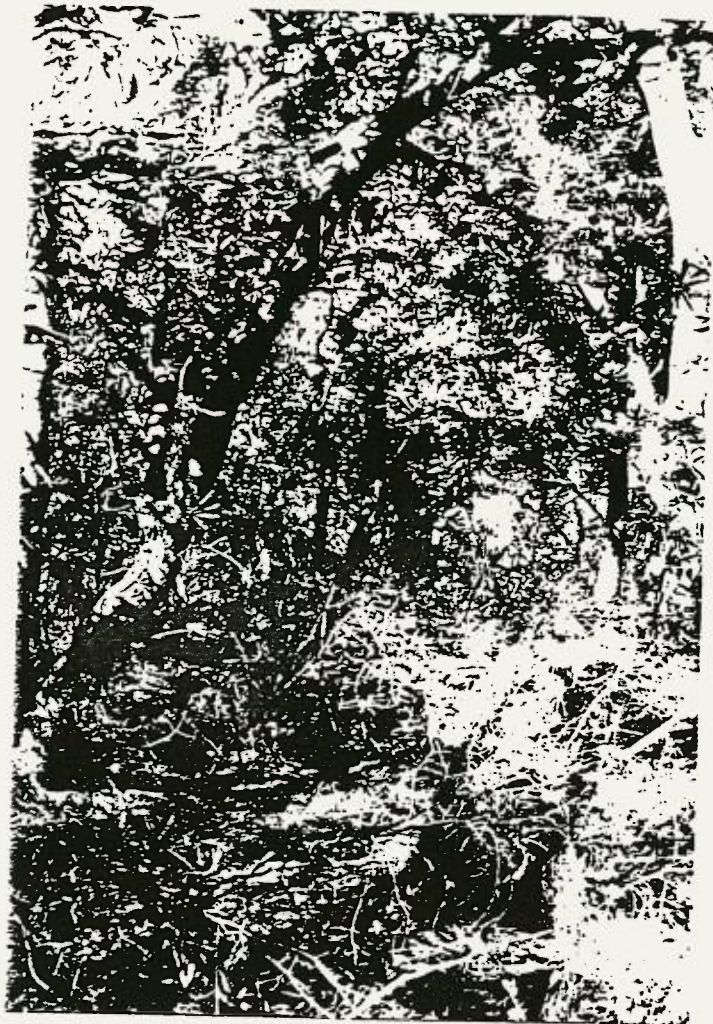


PHOTO 1: Low Open Forest of Saw Banksia and Narrow-leaved Apple [Type 1]



PHOTO 2: Remnant of Type 1 vegetation association on dune crest.



PHOTO 3: Woodland of Scribbly Gum, Narrow-leaved Apple
and Saw Banksia [Type 2]



PHOTOS 4-7: Woodland of Scribbly Gum, Drooping Red Gum
and Saw Banksia [Type 3 Association].

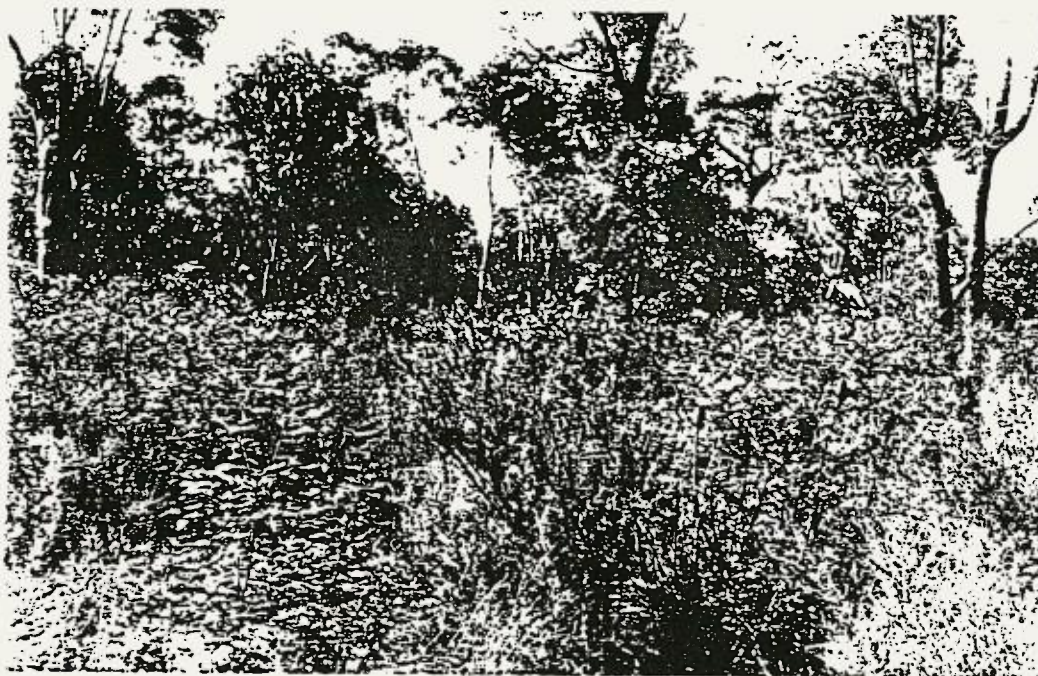


PHOTO 8: Low woodland of Parramatta Red Gum [Type 4 Association]



PHOTO 9: Open forest of Broad-leaved Red Ironbark and Melaleuca [Type 6 Association].

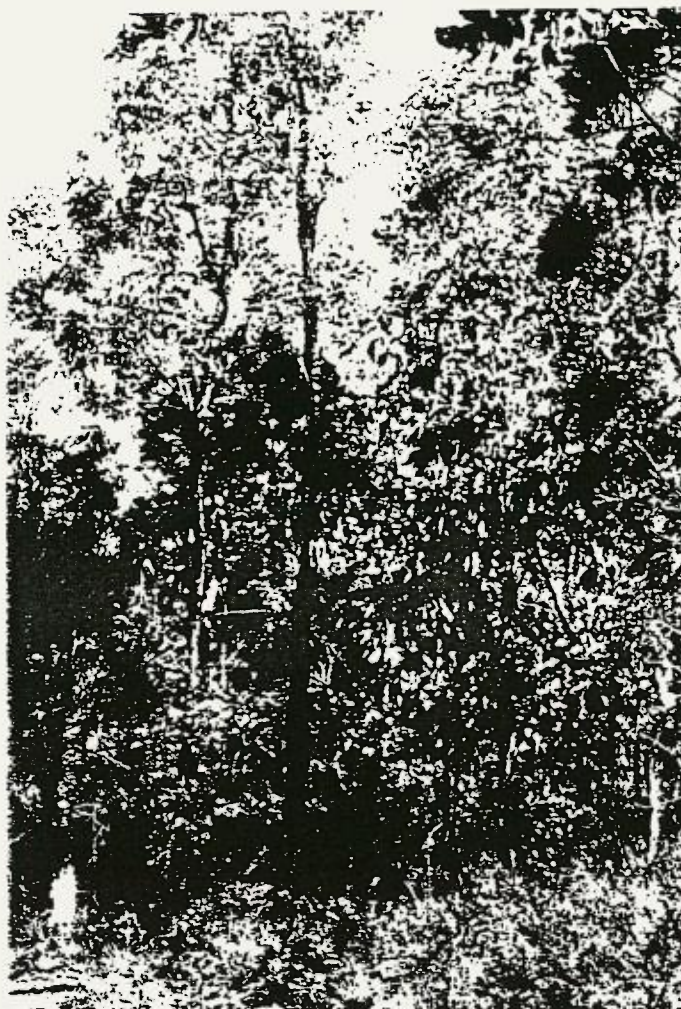


PHOTO 10: Sand/clay interface showing ecotone between Associations B4 and 6.



PHOTO 11: *Acacia bynoeana*

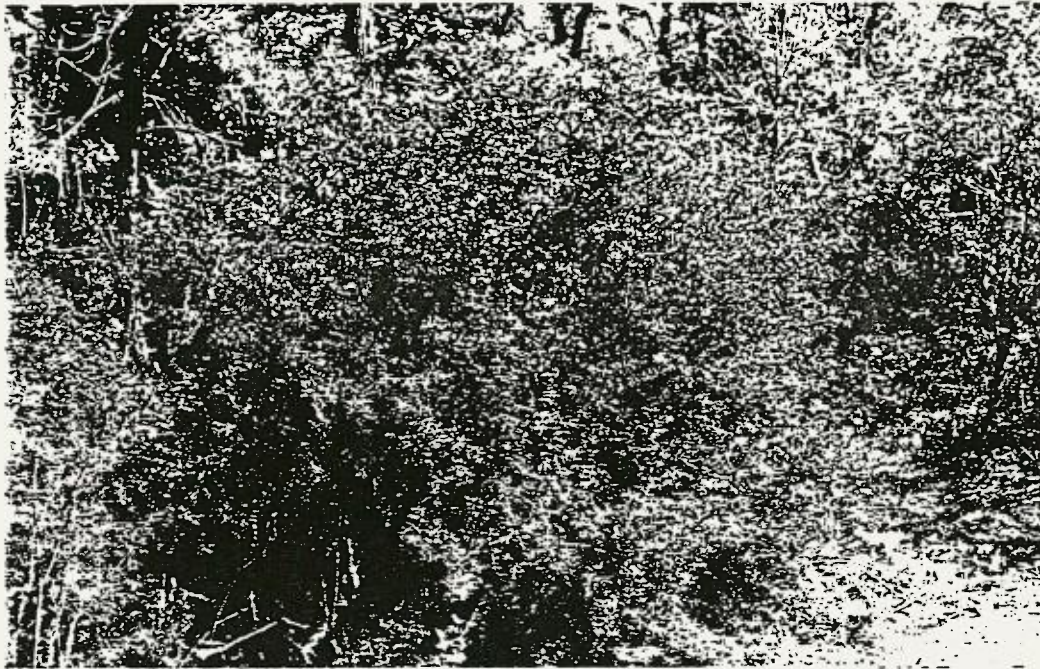


PHOTO 12: *Persoonia nutans* ssp. *nutans*

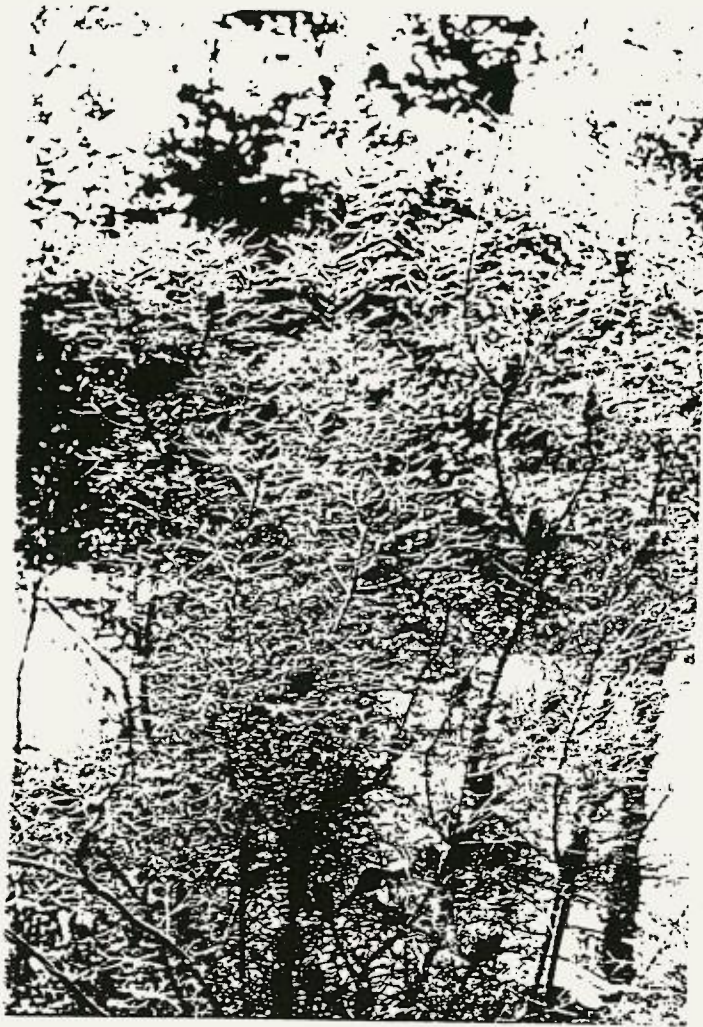


PHOTO 13: *Petrophile sessilis*



PHOTO 14: Parramatta Red Gum showing geronimmort form

ANNEXURE B

FAUNA SURVEY

LONDONDERRY/AGNES BANKS SAND MANAGEMENT AREA
PART LOT 43 AND LOT B

- FAUNA STUDIES -

by

MOUNT KING ECOLOGICAL SURVEYS

May 5, 1992

● LONDONDERRY/AGNES BANKS SAND MANAGEMENT AREA
PART LOT 43 AND LOT B
FAUNA STUDIES

1.0 BACKGROUND

Readymix Group are proposing to extract sand from part of the Londonderry/Agnes Banks Sand Management Area south of Richmond. The proposed sand extraction area includes part of Lot 43 and Lot B. Part Lot 43 and Lot B are located at the southern end of the Management Area and comprise a mixture of cleared land and native bushland.

The northern section of Part Lot 43 is cleared and grassed, whilst the southern section and the small Lot B supports a woodland community dominated by Eucalyptus sclerophylla, Banksia serrata and Angophora bakeri. Most of this community is relatively undisturbed, with some fire trials and rubbish dumping detracting from its overall conservation value. There is a small patch of regrowth woodland in the south-western corner of the site.

Part Lot 43 is located near the northern boundary of Agnes Banks Nature Reserve and is separated from the Reserve by a buffer area formed from Lots 157, 158 and 159.

Recent amendments to the Environmental Planning & Assessment Act [EPA Act] have included the addition of Section 112(1B) which prohibits the carrying out of activities which are "likely to significantly affect the environment of protected fauna" unless a Fauna Impact Statement has been prepared in accordance with Section 92D of the National Parks & Wildlife Act. Further amendments to the Act changed "protected" to "endangered" i.e. to those species listed on the interim Schedule 12 of the National Parks and Wildlife Act.

As a consequence of these changes to the EPA Act Penrith City Council considered that a Fauna Impact Statement would be necessary for the development of Part Lot 43. However this decision was based upon the first set of amendments to the EPA Act i.e. an assessment was based upon activities which are "likely to significantly affect the environment of protected fauna". With the more recent changes to the Act [as a consequence of the Timber Protection Bill] an assessment of whether a Fauna Impact Statement is necessary or not is now based upon the likelihood of any endangered species being affected by the development.

This report describes the fauna known and likely to occur in Part Lot 43 and Lot B and assesses the impacts upon the fauna from the sand extraction process. In addition the report assesses the need for a Fauna Impact Statement, based upon the guidelines for assessment of the significance of the likely effect upon the environment of endangered fauna have been set out in Section 4A of the amended EPA Act. As the Director of the National Parks and Wildlife Service has already provided requirements for a Fauna Impact Statement additional to those outlined in the Act these requirements will be addressed as part of the following report.

2.0 METHODOLOGY

The Londonderry/Agnes Banks area has been extensively surveyed for fauna in recent years and much of this data was used in an assessment of the site. In addition both Part Lot 43 and Lot B was inspected on several occasions during January and February 1992 by Dr Martin Denny. The results of these inspections were also used to assess the site.

Previous surveys of the area have included:

- (i) "Faunal survey of part of the Londonderry Sand extraction Lease" Report by Mount King Ecological Surveys to Taylor Thompson Whitting Pty Ltd, 1987
- (ii) "Checklist of reptiles, frogs and jewel beetles of the Agnes Banks area, New South Wales, Australia." by R.W.Wells and J.R.Turner. Published by Australian Biological Services, Sydney, 1988
- (iii) "Status of native birds and mammals in remnant vegetation, NW Sydney." Unpublished M.App.Sci. thesis University of Technology, Sydney, by P.J.Antcliff, 1989
- (iv) "Regional Waste Depot, Londonderry Fauna Studies" Report by Mount King Ecological Surveys to the Waste Management Authority, 1990

3.0 RESULTS

3.1 Faunal Assemblages

Eleven mammal [five native], 49 bird, 20 reptile and five amphibian species were either located or expected within the survey area [see Appendices 1 to 3]. The faunal species in the area are typical of those found within the County of Cumberland, particularly in the western areas. The low productivity of the sandy soils and the sparse understorey do not provide preferred habitats for a wide range of fauna, however, the species richness in the survey area is similar to that found in other sites nearby [Table 1].

The diversity of birds is slightly lower in areas associated with the sandy soils at Londonderry than the area associated with the richer soils [Waste Depot] and the sandy soils associated with the Nepean River at Elderslie. The mammal diversity is similar for all sites except Elderslie. Within the "Upper Hawksbury" area of Sydney the NSW Field Ornithologists Club have counted an average 145 bird species during their one-day Sydney Bird Count. However, there is a wide variety of habitats in the Upper Hawksbury Area which would not be found within the Londonderry survey site. The diversity of bird and mammal species is similar to a number of small sites within the Sydney district where it is usual to locate about 50 bird species and about 5 to 10 native mammal species.

TABLE 1: Faunal Diversity in Surveyed Areas in the Similar Habitat

AREA	FAUNAL DIVERSITY	
	MAMMALS [NATIVE]	BIRDS [INTRODUCED]
Waste Depot	10 (5)	66 (4)
Lots 189-191	8 (3)	47 (2)
Lot 43	11 (5)	49 (5)
Elderslie ¹	16 (10)	57 (6)

A. MAMMALS

The site supported a range of medium to small ground mammals which are found within most bushland areas of Sydney. Evidence for the presence of the Short-beaked Echidna was found as diggings in ant nests and some droppings. Although the Echidna is not considered as having a low population status throughout its range, but it could be considered locally important because of low numbers in urban areas of Sydney. It is believed to be affected by loss of food sources but is able to adapt to man-modified habitats e.g. urban parks, farms.

The Long-nosed Bandicoot is also considered as locally important because of low numbers in built-up areas. However it is widespread throughout Sydney and is considered a garden pest in many suburbs. The Common Brushtail Possum is found in a range of habitats such as forest, woodland and shrubland, as well as parks, gardens, farms etc. It is closely associated with humans and their dwellings. The two bat species are widespread throughout Sydney and the Flying-fox is known to be a pest species on orchards.

The remainder of the mammals are introduced and are closely associated with human settlement in the region. All introduced mammals found in the area are known to adversely affect the population status of native fauna and possibly contribute to the relatively low diversity of this faunal group.

Native mammals not located but expected include small ground species such as the Common Dunnart [found at the Waste Depot site], Brown Antechinus and Bush Rat. No macropods were located nor was there any evidence of their presence.

B. BIRDS

There were few birds associated with water located within the site as there were no permanent water bodies [either natural or artificial] in the area. The heron and duck were located exploiting temporary pools of water created by the heavy rains which fell early in 1992. The two raptors were sighted flying

1 "Elderslie Sand and Soil Deposits Land Management Study Volume VI Summary Environmental Impact Statement" Prepared for Camden Municipal Council by Longworth & McKenzie Pty Ltd, 1981

over the area and cannot be considered as closely associated with the site.

The grass habitat mainly found in the northern part of the site supported the Stubble Quail, Masked Plover, Richard's Pipit, Galah and Common Starling. Most of these species are found exclusively in the grassland, but the Galah also uses trees for perching and feeding. The introduced starling also uses trees for perching.

The wooded parts of the site supported the majority of bird species, all of which are commonly found in treed habitats. The White-throated Needletail, Welcome Swallow and Fairy Martin are aerial feeders and are not closely associated with any habitat. There were few honeyeaters located during the survey and other species could be expected.

C. HERPETOFAUNA

The reptiles and amphibians located within Lot 43 are considered common urban species [Spotted Grass Frog, Common Eastern Toadlet, Yellow-spotted Toadlet; Bearded Dragon, Jacky Lizard, Eastern Striped Skink, Eastern Grass Skink, Eastern Blue-tongued Lizard and Red-bellied Black-snake]. All species are considered common in the Londonderry/Agnes Banks area² and in Sydney^{3,4}.

3.2 Faunal Status

The population status of all mammal and bird species located in the survey area are considered as abundant, common or moderately common over their range. Some of the bird species are classed as uncommon within the Sydney region [Black-shouldered Kite, Australian Hobby, and Galah] but these ratings are a consequence of the species large home range [raptors] or have changed since assigned [Galah].

Some species are considered of local importance but are not classed as rare or endangered [echidna, bandicoot]. In the western parts of Sydney, where the land has not been as extensively built-up as inner and northern Sydney these species appear to be relatively common.

Antcliff⁵ found the Variegated Fairywren, Chestnut-rumped Heathwren [=Hylacola], New Holland Honeyeater and the Red-capped Robin in the Agnes Banks area and pointed out that these species had limited distribution and the "Further degradation of the Agnes banks remnant must be prevented if the Red-capped Robin is to be prevented from becoming regionally extinct." However none of these bird species were located during the present survey although they may occur in the area. The Red-capped Robin is considered abundant in N.S.W. and common in Australia.

2 "Checklist of reptiles, frogs and jewel beetles of the Agnes Banks area, New South Wales, Australia." by R.W.Wells and J.R.Turner. Published by Australian Biological Services, Sydney, 1988

3 "Reptiles of the Sydney Region" by K.Griffiths. A Three Sisters Production, Winmallee, 1987

4 "The Natural History of Sydney" Published by The Trustees of the Australian Museum, Sydney, 1972

5 "Conservation and management strategy for the remnant vegetation of North-west Sydney." P.J.Antcliff National Parks Journal Vol.33 pp10-14 1989

4.0 ASSESSMENT OF IMPACTS

The extraction of sand from the site will result in the loss of woodland and grassland habitat. Some animals will be displaced during the extraction process and a few may survive by colonizing nearby areas such as Agnes Banks Nature Reserve. Those species most likely to establish in new areas will be those with large home ranges i.e. birds, or with only part of their home range inside the affected area.

Overall, all the animal species known from the site are relatively common and widespread throughout eastern Australia and are well represented in nearby conservation areas. It is expected that the overall population [and conservation] status of the native species found in the site will not change as a consequence of the sand extraction process.

The Londonderry/Agnes Banks Sand Management Area is already fragmented by roads, land cleared for agriculture and houses, as well as for sand extraction. The loss of the wooded habitat from Lot 43 will not affect any wildlife corridors in the region.

5.0 MITIGATION

It is expected that the area will be rehabilitated after sand extraction, and, provided revegetation using local native species occurs, it is expected that recolonisation by native species from Agnes Banks Nature Reserve will occur.

6.0 IS A FAUNA IMPACT STATEMENT NECESSARY?

Guidelines for assessment of the significance of the likely effect upon the environment of endangered fauna have been set out in Section 4A of the amended EPA Act. The following factors must be considered under Section 4A of the Act to decide whether there is likely to be a significant effect on the environment of endangered fauna:

- a) The extent of modification or removal of habitat.
- b) The sensitivity of the species of fauna to removal or modification of its habitat.
- c) The time required to regenerate critical habitat i.e. the whole or any part of the habitat which is essential for the survival of that species.
- d) The effect on the ability of the fauna population to recover, including interactions between the subject land and adjacent habitat that may influence the population beyond the area proposed for development or activities.
- e) Any proposal to ameliorate the impact.

- f) Whether the land is currently being assessed for wilderness by the N.P.W.S., and
- g) Any adverse effect on the survival of that species of endangered fauna or of populations of that fauna.

Each factor will now be considered for the proposal at Londonderry.

- a) The extent of modification or removal of habitat.

About half of the approximate 50ha i.e. 25ha, contained within the site supports woodland habitat and will be lost during sand extraction. This habitat is widespread in the region and is well represented within Agnes Banks Nature Reserve.

- b) The sensitivity of the species of fauna to removal or modification of its habitat.

Nearly all species of native fauna located within the site are adapted to man-modified habitats and are widespread throughout Sydney. Although the two raptor species utilize cleared land and parks for food both are sensitive to changes in their nesting and roosting areas. However Lot 43 is not used for either by these species.

- c) The time required to regenerate critical habitat i.e. the whole or any part of the habitat which is essential for the survival of that species.

The area will be progressively rehabilitated as extraction continues and it is expected that woodland and shrubland habitat will be regenerated within five years of the commencement of the development.

- d) The effect on the ability of the fauna population to recover, including interactions between the subject land and adjacent habitat that may influence the population beyond the area proposed for development or activities.

All of the native species found in Lot 43 are also found in nearby Agnes Banks Nature Reserve as well as within other nearby areas. Nearly all are adapted to man-modified habitats and are capable of colonizing new areas.

- e) Any proposal to ameliorate the impact.

The site will be progressively rehabilitated using local native plants.

- f) Whether the land is currently being assessed for wilderness by the N.P.W.S., and

The land is not currently being assessed for wilderness by the N.P.W.S.

9) Any adverse effect on the survival of that species of endangered fauna or of populations of that fauna.

There are no species of endangered fauna known from the site so no adverse effects will occur on such species.

From the results of the survey undertaken of Part Lot 43 and Lot B and from an assessment of the likely impacts upon any fauna in the area it is concluded that no Fauna Impact Statement will be required.

7.0 CONCLUSION

About half of Part Lot 43 and Lot B contains native bushland which supports a variety of faunal species. The assemblage of species is typical of that found within bushland areas of Sydney and nearly all native species located are adapted to man-modified habitats and are widely distributed and relatively common throughout south-eastern Australia. No species having a high conservation status were located nor were any species listed on the interim Schedule 12 of the National Parks and Wildlife Act. It is concluded that there is no need for a Fauna Impact Statement.



Dr Martin Denny

May 5, 1992

APPENDIX 1: MAMMALIAN FAUNA KNOWN FROM OR NEAR PART LOT 43

SCIENTIFIC NAME	COMMON NAME	STATUS
PROTOTHERIA		
TACHYGLOSSIDAE		
<u>Tachyglossus aculeatus</u>	Short-beaked Echidna	C
MARSUPIALIA		
PERAMELIDAE		
<u>Perameles nasuta</u>	Long-nosed Bandicoot	C
PHALANGERIDAE		
<u>Trichosaurus vulpecula</u>	Common Brushtail Possum	A
EUTHERIA		
PTEROPODIDAE		
<u>Pteropus poliocephalus</u>	Grey-headed Flying-fox	C
VESPERTILIONIDAE		
<u>Chalinolobus gouldii</u>	Gould's Wattled Bat	C
MURIDAE		
<u>Mus musculus</u>	House Mouse	A
LEPORIDAE		
<u>Oryctolagus cuniculus</u>	Rabbit	A
CANIDAE		
<u>Canis familiaris</u>	Feral Dog	C
<u>Vulpes vulpes</u>	Fox	A
FELIDAE		
<u>Felis catus</u>	Feral Cat	A
EQUIDAE		
<u>Equus caballus</u>	Horse	C

Notes for Appendix 1:

1. Common and Scientific names from Strahan⁶.
2. Australian population status from Strahan⁶.

⁶ "Complete Book of Australian Mammals." by Strahan, R., Angus and Robertson, Sydney 1983

⁶ "Complete Book of Australian Mammals." by Strahan, R., Angus and Robertson, Sydney 1983

APPENDIX 2: AVIFAUNA KNOWN FROM OR NEAR PART LOT 43

SCIENTIFIC NAME	COMMON NAME	STATUS		
		Aust	NSW	CoC
<u>Ardea novaehollandiae</u>	White-faced Heron	C	A	C
<u>Anas superciliosa</u>	Pacific Black Duck	A	A	C
<u>Elanus notatus</u>	Black-shouldered Kite	MC	MC	U
<u>Falco longipennis</u>	Australian Hobby	MC	MC	U
<u>Coturnix pectoralis</u>	Stubble Quail	C	A	C
<u>Vanellus miles</u>	Masked Lapwing	C	A	C
<u>Larus novaehollandiae</u>	Silver Gull	A	A	A
<u>*Columba livia</u>	Feral Pigeon	C	A	A
<u>*Streptopelia chinensis</u>	Spotted Turtle-dove	C	A	C
<u>Geopelia placida</u>	Peaceful Dove	C	A	C
<u>Ocyphaps lophotes</u>	Crested Pigeon	A	A	S
<u>Cacatua roseicappilla</u>	Galah	A	A	U
<u>Cacatua galerita</u>	Sulphur-crested Cockatoo	C	C	MC
<u>Platycercus eximus</u>	Eastern Rosella	A	A	C
<u>Psephotus haematonotus</u>	Red-rumped Parrot	C	A	C
<u>Cuculus pyrrhophanus</u>	Fan-tailed Cuckoo	C	C	C
<u>Podargus strigoides</u>	Tawny Frogmouth	C	A	C
<u>Hirundapus caudacutus</u>	White-throated Needletail	C	C	-
<u>Ceyx azureus</u>	Azure Kingfisher	MC	MC	-
<u>Dacelo novaeguineae</u>	Laughing Kookaburra	A	A	C
<u>Hirundo neoxena</u>	Welcome Swallow	C	A	C
<u>Cecropis ariel</u>	Fairy Martin	C	A	C
<u>Anthus novaeseelandiae</u>	Richard's Pipit	A	A	C
<u>Coracina novaehollandiae</u>	Black-faced Cuckoo-shrike	C	A	C
<u>Eopsaltria australis</u>	Eastern Yellow Robin	C	A	C
<u>Pachycephala rufiventris</u>	Rufous Whistler	C	A	C
<u>Rhipidura fuliginosa</u>	Grey Fantail	C	A	C
<u>Rhipidura leucophrys</u>	Willie Wagtail	A	A	C
<u>Malurus cyaneus</u>	Superb Fairy-wren	MC	A	C
<u>Sericornis frontalis</u>	White-browed Scrubwren	C	A	C
<u>Acanthiza chrysorrhoa</u>	Yellow-rumped Thornbill	A	A	C
<u>Acanthiza nana</u>	Yellow Thornbill	C	A	C
<u>Acanthiza lineata</u>	Striated Thornbill	MC	A	C
<u>Climacteris leucophaea</u>	White-throated Treecreeper	MC	A	C
<u>Anthochaera chrysoptera</u>	Little Wattlebird	MC	C	C
<u>Manorina melanocephala</u>	Noisy Miner	C	A	C
<u>Lichenostomus chrysops</u>	Yellow-faced Honeyeater	C	A	C
<u>Phylidonyris nigra</u>	White-cheeked Honeyeater	U	A	C
<u>Pardalotus substriatus</u>	Striated Pardalote	C	A	A
<u>*Passer domesticus</u>	House Sparrow	A	A	C
<u>Emblema temporalis</u>	Red-browed Firetail	C	A	C
<u>*Sturnus vulgaris</u>	Common Starling	A	A	A
<u>*Acridotheres tristis</u>	Common Myna	C	A	C
<u>Grallina cyanoleuca</u>	Australian Magpie-lark	C	A	A
<u>Artamus cyanopterus</u>	Dusky Woodswallow	C	A	C
<u>Cracticus torquatus</u>	Grey Butcherbird	C	A	MC
<u>Gymnorhina tibicen</u>	Australian Magpie	A	A	C
<u>Strepera graculina</u>	Pied Currawong	C	A	C
<u>Corvus coronoides</u>	Australian Raven	C	A	C

Notes for Appendix 2:

Status:

Australian [A] Status from MacDonald⁷

N.S.W. [N] Status from Morris et al⁸

County of Cumberland [CoC] from Hindwood and McGill⁹

A denotes Abundant

C denotes Common

MC denotes Moderately Common

U denotes Uncommon

7 "Birds of Australia." by MacDonald, K., A.H. and A.W. Reed, Sydney, 1973.

8 "Handlist of birds in New South Wales." by A.K.Morris, A.R.McGill and G.holmes New South Wales Field Ornithologists Club, Sydney 1981

9 "The Birds of Sydney." by Hindwood, K.A. and A.R. McGill, The Royal Zoological Society of N.S.W., Sydney, 1958.

APPENDIX 3: HERPETOFAUNA KNOWN FROM OR NEAR PART LOT 43

SCIENTIFIC NAME	COMMON NAME
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AMPHIBIANS

<u>Litoria verreauxii</u>	Verreaux Tree Frog
* <u>Limnodynastes tasmaniensis</u>	Spotted Grass Frog
<u>Limnodynastes peronii</u>	Brown-striped Frog
* <u>Ranidella signifera</u>	Common Eastern Toadlet
* <u>Uperoleia marmorata</u>	Yellow-spotted Toadlet

REPTILES

<u>Chelodina longicollis</u>	Long-necked Tortoise
<u>Diplodactylus vittatus</u>	Wood Gecko
<u>Pygopus lepidopus</u>	Common Scalyfoot
* <u>Amphibolurus barbatus</u>	Bearded Dragon
* <u>Amphibolurus muricatus</u>	Jacky Lizard
<u>Varanus varius</u>	Lace Monitor
<u>Cryptoblepharus barbatus</u>	Eastern Small-eyed Skink
* <u>Ctenotus robustus</u>	Eastern Striped Skink
<u>Ctenotus taeniolatus</u>	Copper-tailed Skink
<u>Lampropholis delicata</u>	Garden Skink
* <u>Lampropholis quichenoti</u>	Eastern Grass Skink
<u>Lampropholis mustelina</u>	Weasel Skink
<u>Sphenomorphus quoyii</u>	Eastern Water Skink
* <u>Tiliqua scincoides</u>	Eastern Blue-tongued Lizard
<u>Rhampotyphlops nigrescens</u>	Blind Snake
<u>Furina diadema</u>	Red-naped Snake
* <u>Pseudechis porphyriacus</u>	Red-bellied Black Snake
<u>Pseudonaja textilis</u>	Eastern Brown Snake
<u>Vermicella annulata</u>	Bandy Bandy
<u>Demansia psammophis</u>	Yellow-faced Whipsnake

* Species sighted during survey of Lot 43

ANNEXURE C

GROUNDWATER SURVEY

READYMIX
LONDONDERRY SAND PLANT
TORKINGTON ROAD, LONDONDERRY - NSW
APRIL 1993

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1.0 BACKGROUND

Sand mining has been carried out in the Londonderry area for many years. Mining operations relating to the Readymix Group and P.B. White currently comprise about 4 square kilometres in an area adjacent to Rickards Road. Sand is won over a depth of 3 to 5 metres with a maximum depth of excavations about 8 metres. Excavations normally intersect the water table and seepage is directed through a system of drains to the south east.

Current proposals include the mining of Portion 43 however some concern has been expressed by local residents and other interested parties that excavations may impact the water table to the extent that local flora may be effected. In particular, Portions 157, 158 and 159 immediately south of the Readymix site are protected by Permanent Conservation Order 649 (PCO).

Mackie Martin & Associates (groundwater engineers and earth scientists) have been commissioned by Taylor Thomson Whitting Pty. Ltd. to assess the potential impact of the continuing sand excavation operations. Groundwater related studies completed to-date have included field testing for hydrologic properties of the sands, monitoring of local groundwater movements, and development of a computer based model of the local groundwater system to assess impact. A scheme involving emplacement of a clay 'dross' curtain within the Readymix site has been tested by computer simulation and shown to be an appropriate technique for managing groundwater levels locally. The contained report provides a summary of activities to date.

2.0 AVAILABLE DATA

The Readymix mining licence covers some 400ha at Londonderry, about 4 kilometres south of Richmond and 7 kilometres north of Penrith - refer to Figure 1. Sand mining has continued on the tenure for many years with sand being won from relatively shallow depths.

The regional water table is presently impacted within the mining operations area by excavations which induce seepage, and by ponding which initiates recharge back to the water table. Seepage reduces to negligible levels during low rainfall periods while during wet periods, local and regional water tables rise, often to surface.

2.1 Geomorphology

In general, the Londonderry region has low topographic relief and the investigation area is located on a shallow rise east of Castlereagh Road. On the western side of Castlereagh Road a chain of ponds and swampy ground called Yarramundi Lagoon parallels the Nepean River. In the south east part of the area, a creek drains higher land to the south where extensive clay deposits occur. A few hundred metres further east near Torkington Road, a south-east flowing creek is apparently the major drainage for the sand mines.

2.0 Rainfall and Evaporation

Rainfall infiltration across the site provides the mechanism by which groundwater fluctuations occur. In developing an appreciation of likely impact of sand mining on the groundwater regime, the relationships between intensity, frequency and distribution needs to be understood as part of the overall infiltration process.

Although rainfall is not gauged at the site, long term continuous rainfall data has been recorded by the Bureau of Meteorology at the Richmond Air Base 1951-1992. The nearest pan evaporation records are also available from the Richmond Air Base from 1970-1992. Summary statistics of monthly rainfall and mean daily pan evaporation are shown in Table 1. Average annual rainfall is 805mm.

TABLE 1. SUMMARY OF RAINFALL AND EVAPORATION DATA

MONTH	MEAN RAINFALL (mm)	MEDIAN RAINFALL (mm)	MEAN NO. OF RAIN DAYS	PAN EVAPORATION (mm/day)
JAN	97	76	11	6.4
FEB	99	78	11	5.5
MAR	93	71	11	4.5
APR	63	47	9	3.4
MAY	61	29	8	2.1
JUN	57	34	8	1.8
JUL	35	24	6	2.1
AUG	44	21	7	3.1
SEP	42	31	8	4.2
OCT	71	57	10	5.4
NOV	75	58	10	5.9
DEC	68	51	10	7.2

In general, the region has a summer dominated rainfall with the maximum median monthly rainfalls occurring between January and March. This is also the period of highest surface evaporation. In the cooler months, April to August, rainfall and evaporation levels are much lower.

2.2 Groundwater Recharge and Evapotranspiration

The effective groundwater recharge and evapotranspiration across the area is a function of prevailing geological and soil moisture conditions, site interception and infiltration/runoff characteristics, drainage and vegetative cover. Soil moisture conditions will determine the effective component of rainfall that enters the groundwater system. Rainfall characteristics, evaporation (due to radiation and wind) and transpiration (due to vegetation) in the area will determine the way these conditions are developed. Groundwater recharge can occur after the soil moisture deficit (induced by plant transpiration), has been satisfied by rainfall infiltration or as direct infiltration to the groundwater system through macro pores in the soil zone (i.e. such as in sandy or gravely soils).

Transpiration characteristics vary with differing vegetation types and root depths. Grasses typically have a shallow root depth and thus have a limited depth of soil from which they can draw moisture during periods between rainfall events. In extended dry periods grasses may transpire all of the available soil moisture in their root zones at which point they wilt and die. In contrast to shallow rooted grasses, phreatophytic and deep rooted plants such as eucalyptus seek out the water table and may draw water directly from groundwater storage.

3.0 GEOLOGY

Sand deposits in the Londonderry area comprise Quaternary aeolian sands reworked as fluvial deposits and are called the Agnes Banks Sand. Sands vary from clean white leached deposits to limonite coated quartz sand containing appreciable clay. The maximum thickness of the sand is generally of the order 3 to 5 metres. The Miocene Londonderry Clay, which comprises clay and consolidated sand, underlies the Agnes Banks Sand and out crops to the south and east. Logs of samples taken during drilling of the test bores (Appendix A) support an increasing clay content near the base of the sand. The Lowlands Formation comprising more permeable silty sand, gravels and cobbles, occurs along the Nepean River course to the west.

Previous investigations of the region have also noted the presence of an indurated layer of 'coffee rock' in parts of the PCO and at about 1 metre below the ground surface. This material occurs normally as a secondary deposit and is often patchy. Perching of the water table can occur at this level.

3.1 Hydrogeology

Shallow aquifers in the region are dominantly rainfall driven. Rain infiltrates the shallow sands and migrates downward, eventually being deflected at the water table and at less permeable zones. Horizontal flow is then established with regional gradients and flow directions being controlled by topography.

The Yarramundi swamps act as both a source and a sink for the groundwater system - during rainy periods the water levels in the ponds will rise and force downward seepage while during drought periods the swamps will offer increased evaporation potential thus removing water from the aquifer system.

A continuous water level recorder was installed in a bore constructed by MMA and groundwater fluctuations were monitored over several months - refer to Figure 2. The groundwater table in the investigation area has a seasonal fluctuation in the order of 2 metres. Rainfall recharge to the aquifer is rapid, with groundwater levels observed to rise 0.3 metres within hours of a storm, this rapid response being typical of unconfined aquifers. After a recharge event the groundwater table recesses at a rate of 0.007 m/day due to transpiration from phreatophytes together with baseflow discharge to ponds, rivers and excavations in the area.

4.0 FIELD TESTING

Investigative drilling has been carried out to assess the transmission capacity of sand and to determine the geometry of the water table. Seven bore sites were drilled using reverse air circulation drilling equipment in the south-east part of the study area along the northern boundary of PCO and adjacent to the proposed Readymix excavations. The depth of the bores ranged from 5 to 7 metres with termination generally in low permeability clays or silty clays. Dual piezometers were installed at different depths at 4 of the sites to record differences in aquifer recharge and flow at different levels in the aquifer. Locations of bores are shown in Figure 1 while drilling details and geotechnical logs are provided in Appendix A. All bores have been cased with slotted 40mm PVC piezometers, fitted with geofabric shrouding to reduce sand ingress.

Formations penetrated by drilling comprise shallow sands with variable amounts of silt and clay to a depth of about 5 metres, the clay content generally increasing at depths greater than 3 metres. An indurated 'coffee rock' layer has been previously reported at about a metre below the surface however significant induration was not detected in the present survey although dark coloured sands evident in a few bores may correlate laterally to coffee rock.

Standing water table elevations were measured at each bore and injection tests undertaken to determine the (horizontal) transmission capacity of sands. Depths to standing water were in the range of 1 to 2 metres although the water table has been noted to break surface during periods of heavy rainfall. Some perching may also occur in areas of pronounced induration. The groundwater surface generally parallels the surface topography.

All test data has been analysed for hydraulic properties using computer based sensitivity analysis techniques and estimates of hydraulic properties and other relevant data are given in Table 1. The average estimated transmissivity is approximately 1kl/day/m.

Table 1. SUMMARY OF BOREHOLE AND TEST PUMPING DATA

Bore No	Drilled Depth (m)	Bore Radius (m)	Bore Collar Elev. (mAHD)	Depth to SWL (m)	SWL Elev. (mAHD)	Estimated transmissivity (kl/day/m)
1	7.0	0.033	29.5	2.2	27.3	0.27
2	5.0	0.056	28.1	0.8	27.3	0.30
3	5.0	0.056	25.9	0.9	25.0	1.36
4	5.0	0.056	27.5	0.8	26.7	0.77
5	5.5	0.056	28.9	1.0	27.9	1.23
6	7.0	0.056	29.7	1.8	27.9	1.89
7	5.0	0.056	30.0	1.5	28.5	0.55

Note : SWL = standing water level
transmissivity = bulk aquifer transmissivity

5.0 NUMERICAL MODELLING

Assessment of local impact on the water table due to excavation is difficult to achieve using classical analytical hydrogeological approaches because of spatial variations in land elevation, vegetation cover and the location of the excavations, rivers and lagoons. Such classical methods generally assume aquifer homogeneity and are more applicable to the interpretation of localised aquifer response.

The use of a numerical model can overcome the difficulties inherent classical analytical approaches because it is possible to accurately simulate regional conditions by introducing spatial and temporal variability (e.g. variations in aquifer transmissivity, pumping demand, etc.). The development of a numerical model also facilitates sensitivity analyses which define the dominant parameters and mechanisms. A model can be used to highlight areas where further data should be generated in order to allow for greater predictive accuracy.

5.1 Model Design

Several numerical modelling strategies can be adopted and in the present study, a finite element approach has been utilised as this method offers a high level of flexibility in simulating complex geometries relating to aquifer extent, stream courses, excavations, water reservoir ponds etc.

The model requires a discretisation of the overall area (domain) into triangular elements defined by nodal points at their vertices. The number of elements defined in a model is determined by the spatial variations developed in aquifer properties and the expected hydraulic accuracy and computability can restrict the overall number of elements chosen. Hence fineness of the elemental grid is varied.

A model grid comprising 500 triangular elements defined by 265 nodal points has been designed (Figure 3). It extends from the limit of sands just east of Yarramundi Lagoon to the approximate eastern extremity of the sand extraction region to the east a distance of 1 to 2km beyond existing excavations. Limits of the model to the north and south have similarly been aligned with the sand extent.

The aquifer is simulated as a two dimensional unconfined or phreatic aquifer exposed to gravity drainage. A one layer scheme has been utilised to represent permeable unconsolidated sediments.

5.2 Model Boundary Conditions

Boundary conditions are those conditions applied to a model grid which act to constrain imposed hydraulic stresses generated through pit excavations, pumping etc. These boundaries generally take the form of defined heads along creeks, defined pit levels or fluxes at specific node points which remain fixed for a specified duration of time, rainfall infiltration's etc.

For steady state simulation of the aquifer, the ponds have been assigned fixed heads equivalent to the approximate water level elevations at these locations while rising heads or seepage type conditions have been assigned to the creeks and sand bed extremities.

5.3 Aquifer Properties

Hydraulic properties have been assigned for each element in the model. These properties include sand transmission capacity (permeability) and specific yield. Transmission capacity determined from borehole testing has been interpolated locally and assigned to most of the region underlain by the sand. Marginally lower values are assigned to the more silty areas while significantly lower values have been assigned to clays developed east and south of the sand deposits.

Specific yield or effective porosity is the active storage component within the model which constrains the time taken for changes in water levels due to imposed stresses. Values of 15% (allowing for retention) have been assigned to the aquifer.

5.4 Model Calibration

The calibration of a numerical model is a trial and error process that requires adjustment of model variables to achieve an empirical matching between model response and measured field conditions. The input of high quality data should resolve to a model of high accuracy and relatively straight forward calibration. Input of known parameters, such as boundary conditions are not subject to adjustment during the tuning process. Unknown or estimated quantities like transmission capacities, storativities and rainfall infiltration's, are regarded as variable and subject to adjustment.

The calibration process involved generation of a steady state water table surface according to field determined aquifer properties. Transmission capacities and rainfall infiltration were adjusted on a trial and error basis until modelled water table geometry reasonably matched measured field conditions. The amount of rainfall that recharges the groundwater system is a function of the surface geology, topography, evaporation, evapotranspiration, and numerous other factors. The accurate calculation of infiltration requires long term monitoring of the various components but for estimation of pit inflows, it is sufficient to approximate contributions and to undertake sensitivity analysis as a means of checking likely estimation errors.

One dimensional soil budget modelling was also employed to simulate rainfall recharge and evaporation losses from the groundwater regime following an average rainfall event. Various vegetation types were considered and calculated fluxes were assigned to elements over the model grid dependant on the representative land use types. Recharge calculations were derived in the course of calibrating the model using empirical infiltration and crop coefficients with average monthly pan evaporation data for several vegetation types including:

- grassland
- phreatophytic eucalyptus forest
- open water bodies

The results of one dimensional soil moisture modelling have been incorporated into the more regional two dimensional aquifer model to form the basis of the transient calibration. The resulting calibrated model water table is shown at Figure 4.

The calibrated model produces the following model water balance budget:

Model average rainfall infiltration (Based upon mean annual)	150 kl/day
---	------------

Balanced by

Seepage from model to western boundary.:	100 kl/day
Seepage to existing excavations and ponds:	25 kl/day
Seepage to creeks at south-east:	25 kl/day

Departures in this balance will occur for increased rainfall or drought periods.

6.0 MODELLED IMPACT OF EXCAVATION

Readymix proposes to excavate sands below the water table and to landscape final excavations with a system of watercourses. As a result of seepage of water into the excavated regions, the water table in regions surrounding the sand mines will be impacted to some extent. To determine the impact, finished contours for reshaped mine areas have been assigned within the model and the water table permitted to relax to a stable position.

A number of model scenarios have been tested to establish the sensitivity of the water table in the PCO and Nature Reserve. Figure 5 shows the modelled water table after excavation. Modelling indicates that excavation up to the edge of the conservation zone will lower the water table by about 0.7 metres near the southern boundary of the conservation zone, and by about 0.5 metres several hundred metres into the nature reserve to the south of the PCO.

The excavation model produces the following model water balance budget:

Model rainfall infiltration:	150 kl/day
------------------------------	------------

Balanced by:

Seepage to western boundary. :	80 kl/day
Seepage to existing excavations and ponds:	20 kl/day
Seepage to creeks at south-east:	20kl/day
Seepage into proposed excavations:	30 kl/day

6.1 Dross Curtain

While groundwater levels throughout the area are not expected to be impacted significantly, some decline in the average position of the water table can be expected. As a means of minimising impact on local groundwater tables, a low permeability dross (clay) curtain installed between the proposed excavations and the PCO and through the thickness of aquifer sands will impede groundwater flow from the conservation area to the Readymix site. The degree to which groundwater levels will be maintained on the PCO side if the curtain is dependant on the width and hydraulic conductivity of the curtain. The optimum width of the dross curtain has been assessed analytically by solving appropriate hydraulic equations.

$$Q = K A \cdot dh/dl$$

where	dl	= width of dross curtain	(m)
	dh	= head difference between each side of curtain	(m)
	K	= hydraulic conductivity of curtain	(m/day)
	A	= area of curtain normal to flow	(m ²)
	Q	= rate of groundwater flow	(kL/day)

The flow rate Q has been determined from numerical modelling to be in the order of 30 kL/day for average climatic conditions over an approximately 200 metre section adjacent to the PCO and the cross sectional area normal the flow direction is calculated at 600 m². The proposed curtain will be a silty clay mix and using an empirical value for clay/dross mix, the curtain should have a hydraulic conductivity K of the order of 0.0001 m/day. A required curtain width to maintain water levels in the PCO is calculated at 0.6 metres based upon maintenance of a 0.7 metre head difference across the curtain. Doubling the permeability of dross material necessitates a doubling of curtain width to maintain head conditions. The modelled impact of excavations with the dross curtain installed is shown in Figure 6.

Installation of a clay curtain can be undertaken using conventional backhoe and slurry technology.

7.0 SUMMARY REMARKS

The Londonderry area is underlain by a perched water table contained in the Agnes Banks Sand which is between 3 to 5 metres thick. The water table fluctuates about 2 metres seasonally and often breaks surface due to excessive groundwater recharge during periods of excessive rain.

The proposed Readymix excavation has the potential to lower average groundwater levels in the adjacent Permanent Conservation Order by up to 0.7 metres close to the excavation. The magnitude of the groundwater impact will decrease southward and away from the excavation, and will be less than 0.5 metres within the Nature Reserve. This impact is not likely to impede the process of rainfall infiltration and maintenance of soil moisture at shallow depths - rain will continue to permeate the sands and to migrate downwards to the water table, which will adopt an average position of about 0.5 metres lower than present.

While this is unlikely to impact the PCO, it is possible to manage water levels and to reduce input by installing a clay curtain and impeding graduation seepage.

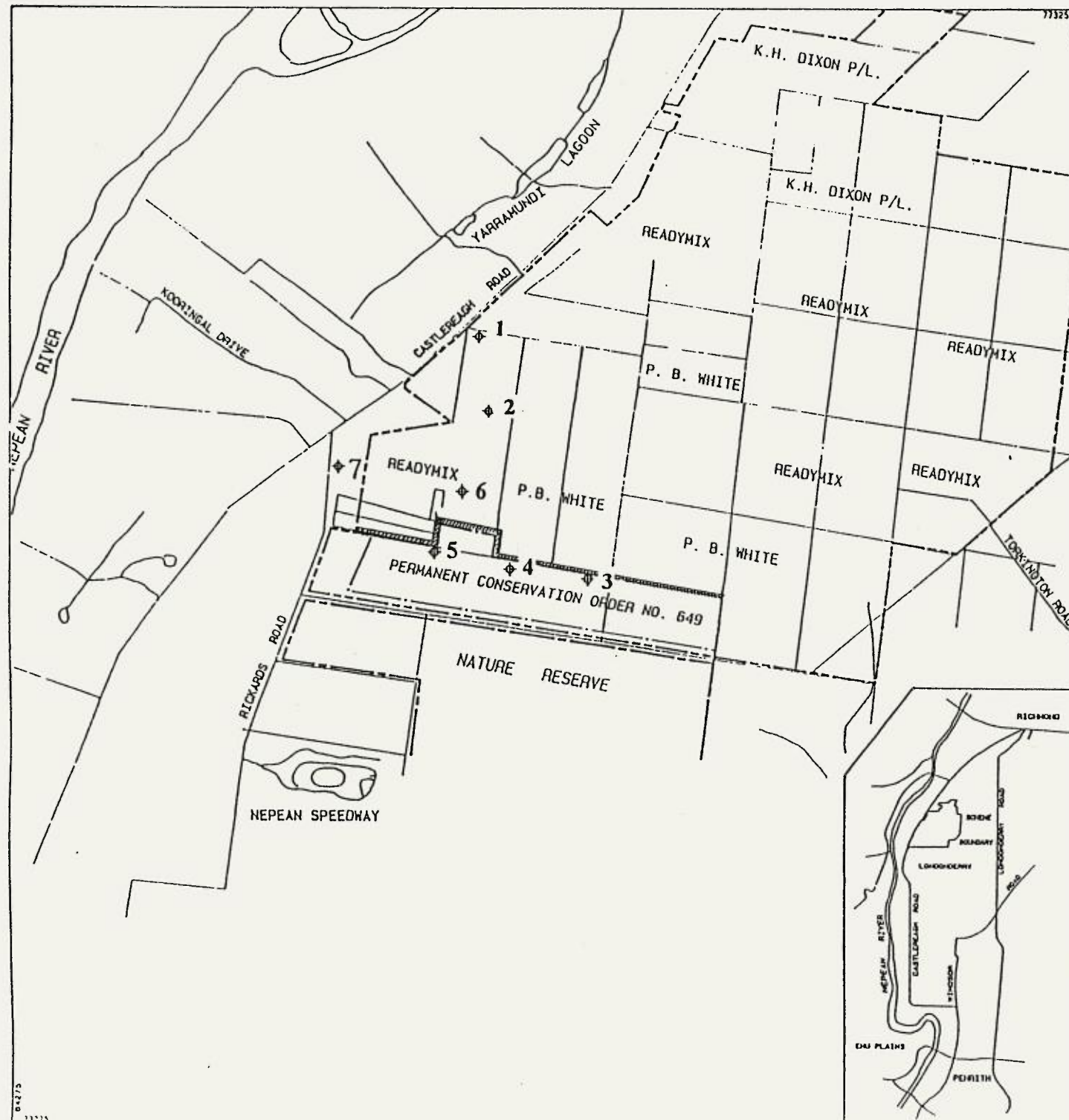
A 0.6 metre wide dross (clay) curtain is proposed between Readymix excavations and the Permanent Conservation Order which will act to isolate the groundwater regime in the PCO from the effects of mining. The dross curtain will be 2 to 5 meters deep (to the base of the sand) and will extend along the 1500 metres marking the northern boundary of the PCO within the Readymix lease. The curtain will act to maintain groundwater levels in the PCO area.

Other regional impacts on the sand aquifer attributed to excavations, have been assessed as relatively minor from computer modelling efforts.

Mackie Martin & Associates Pty Ltd.
April 1993

REFERENCES

Townley, L.R., (1990) Description of and user's manual for a multi layered finite element aquifer flow model AQUIFEMN.



READYMIX FARLEY GROUP NSW
LONDONDERRY GROUNDWATER SURVEY
ON BEHALF OF
TAYLOR THOMSON WHITTING PTY. LTD.

LEGEND:

- SCHEME BOUNDARY
- NATURE RESERVE BOUNDARY
- CONSERVATION ORDER BOUNDARY
- PROPOSED CROSS CURTAIN
- ◆ TEST BORES

NOTE:

INSET SHOWS REGIONAL SETTING



0 500 1000 M

ORIGINAL SCALE 1:15000

LOCALITY PLAN

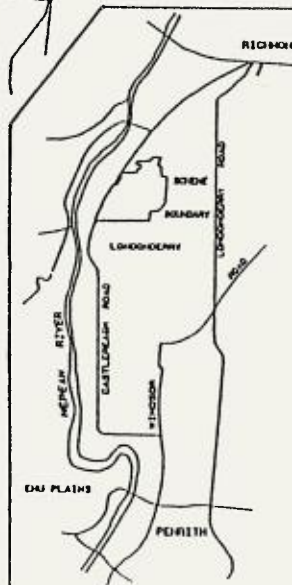


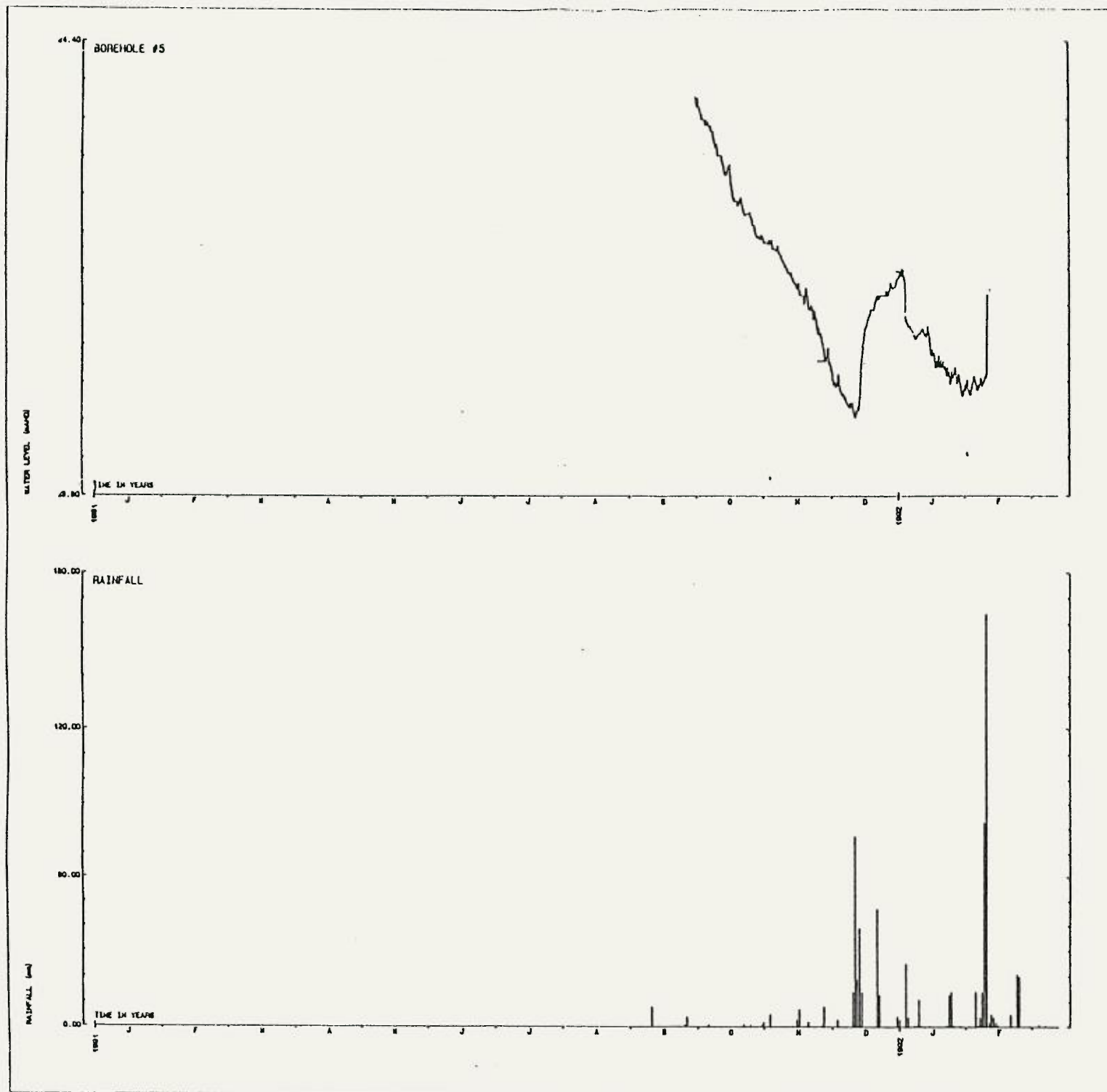
Figure 1

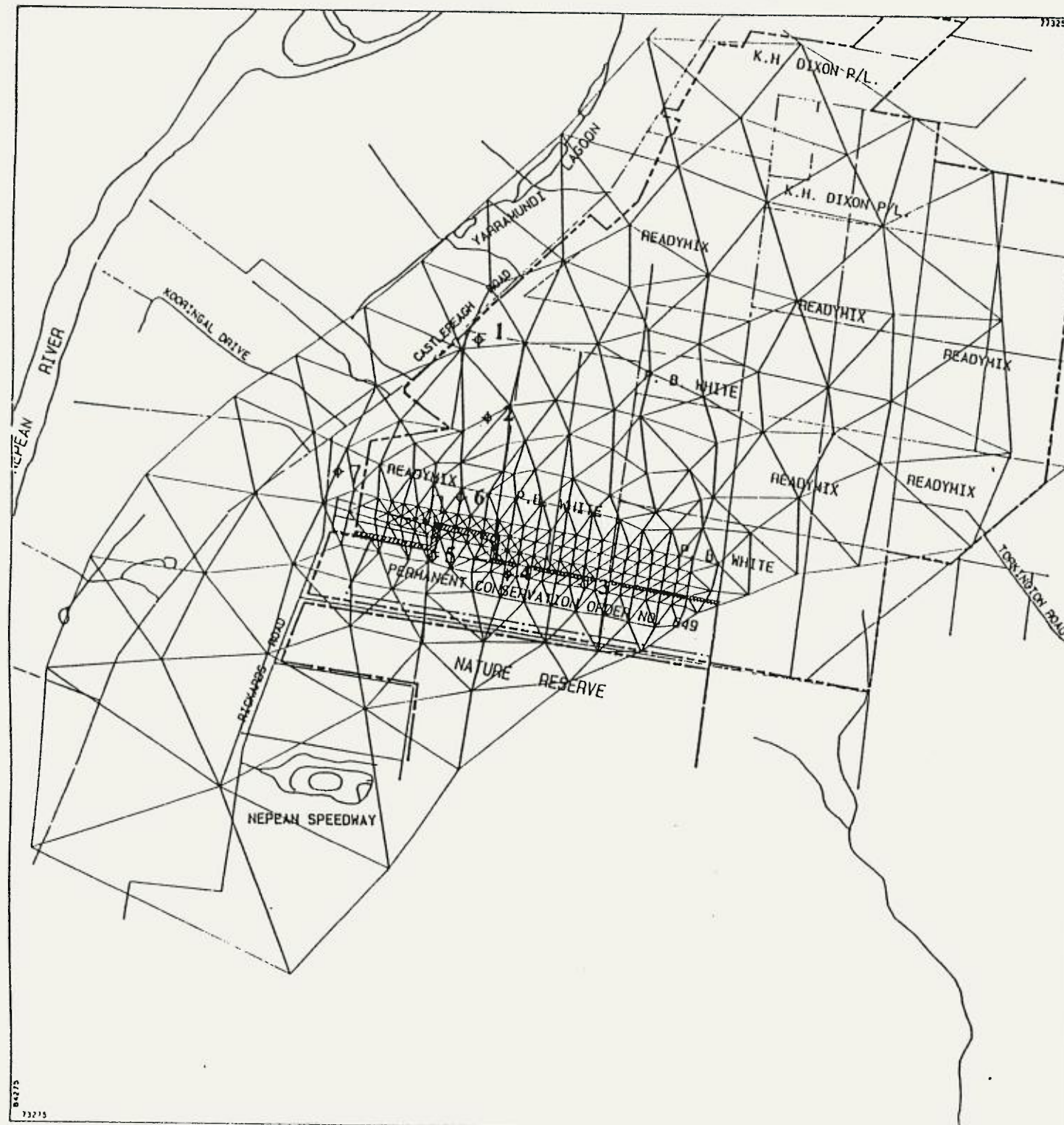
CSR READYMIX LTD.
LONDONDERRY SAND PLANT
GROUNDWATER STUDY

- NOTES:
1. ALL HYDROGRAPHS PLOTTED BY BOREHOLE NUMBER
 2. WATER LEVELS ARE GIVEN IN METRES (WD)
 3. RAINFALL DATA COLLECTED FROM RICHMOND WEATHER STATION
 4. LEVELS RECORDED BY RESIDENT DATA LOGGERS

HYDROGRAPH FOR LD5-2

Figure 2





READYMIX FARLEY GROUP NSW
 LONDONDERRY GROUNDWATER SURVEY
 ON BEHALF OF
 TAYLOR THOMSON WHITTING PTY. LTD.

LEGEND:

- SCHEME BOUNDARY
- NATURE RESERVE BOUNDARY
- CONSERVATION ORDER BOUNDARY
- PROPOSED CROSS CURTAIN
- ◆ TEST BONES

NOTE:

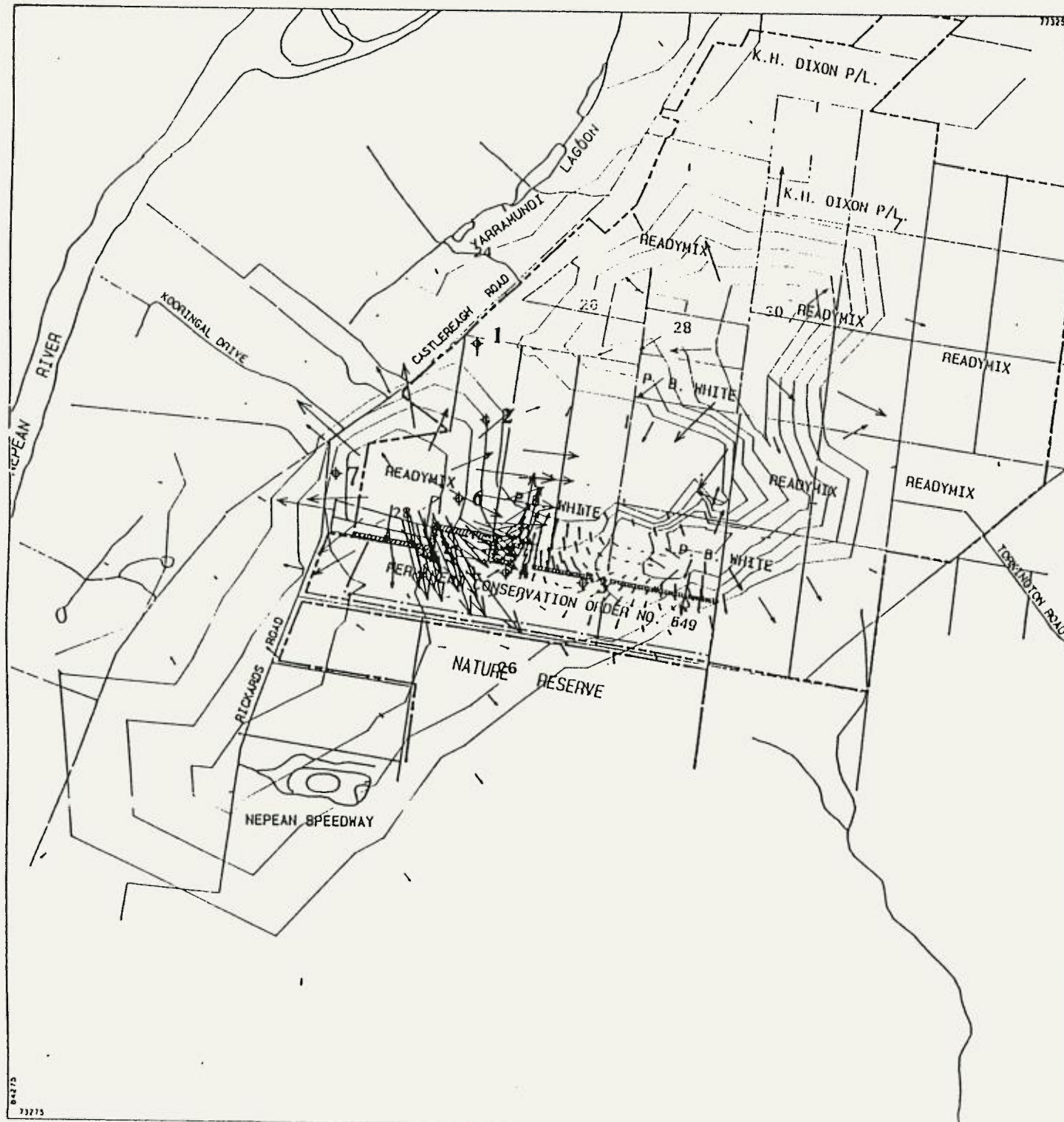
INSET SHOWS REGIONAL SETTING



0 600 1000 M
 ORIGINAL SCALE 1:15000

MODEL GRID

Figure 3



READYMIX FARLEY GROUP NSW
LONDONDERRY GROUNDWATER SURVEY
ON BEHALF OF
TAYLOR THOMSON WHITTING PTY. LTD.

LEGEND:

- SCHEME BOUNDARY
- NATURE RESERVE BOUNDARY
- CONSERVATION ORDER BOUNDARY
- PROPOSED DROSS CURTAIN
- ◆ TEST BORES

NOTE:

INSET SHOWS REGIONAL SETTING



ORIGINAL SCALE 1:15000
VECTOR SCALE → 0.1 m/day

MODELLED WATER TABLE
PRIOR TO EXCAVATIONS

Figure 4



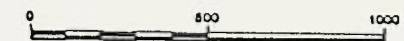
READYMIX FARLEY GROUP NSW
LONDONDERRY GROUNDWATER SURVEY
ON BEHALF OF
TAYLOR THOMSON WHITTING PTY. LTD.

LEGEND:

- SCHEME BOUNDARY
- NATURE RESERVE BOUNDARY
- CONSERVATION ORDER BOUNDARY
- PROPOSED DROSS CURTAIN
- ◆ TEST BORES

NOTE:

INSET SHOWS REGIONAL SETTING



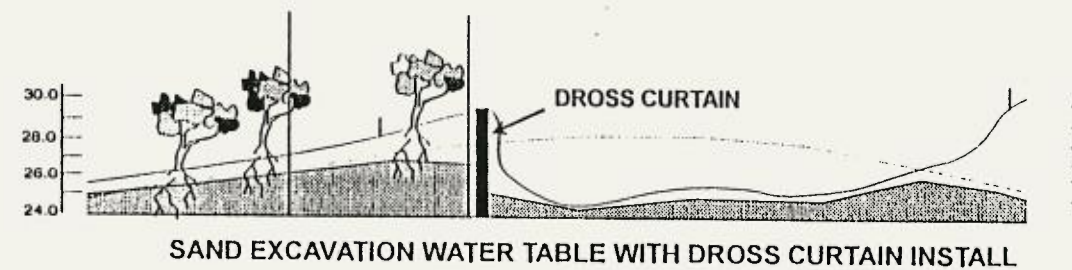
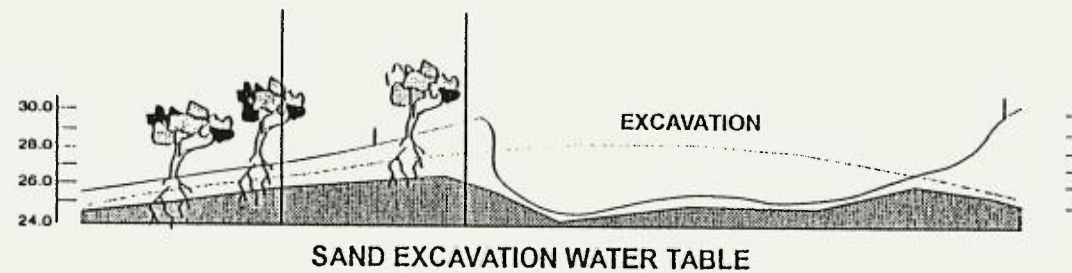
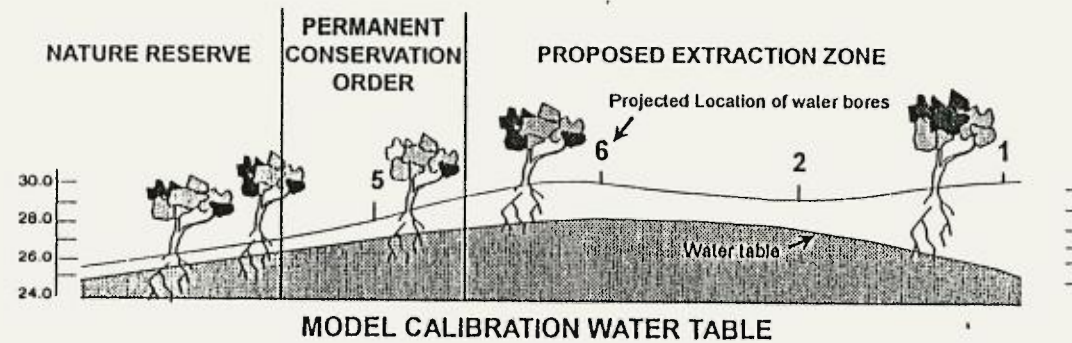
ORIGINAL SCALE 1:15000

VECTOR SCALE → 0.1 m/day

MODELLED WATER TABLE
AFTER EXCAVATION

Figure 5

CROSS SECTIONS SHOWING GROUNDWATER IMPACTS OF EXCAVATION



30 times vertical exageration

Figure 7

APPENDIX A
BORE LOGS

BORE COMPLETION DETAILS -LD1_1

READYMIX - AGNES BANKS

STRATIGRAPHIC DESCRIPTION	LOG	DEPTH	DETAILS
0 			

READYMIX - AGNES BANKS

STRATIGRAPHIC DESCRIPTION	LOG	DEPTH	DETAILS
0 SAND, dry, moderately dense, brown medium grained, subangular grains, some organic material and silt some well cemented gravels (sand, f-m) becoming moist SAND, moist, very dense, m-c grained, orange brown, well cemented ('Coffee Rock') SAND, moist, dense, orange brown, medium grained, subangular grains, with some clay CLAYEY SAND, moist, dense, reddish brown, medium grained, with some silt becoming wet	mBGL 0.0 0.1 0.9 1.75 1.8 2.2 3 4.0 4.9 TD	mBTC 0.0 0.10 0.4 2.05 5.0 BOC 50 mm ID Steel 32mm Class 9 PVC Casing PVC Screen	GENERAL INFORMATION Location : AGNES BANKS, N.S.W Driller : Engin. Exploration Rig Type : EDSON 2000 Date Drilled : 6/3/92 Coordinates : 286080mE 6276082mN Casing R.L. : 30.53 mAHQ Top of Casing : 0.10 mAGL COMPLETION NOTES Screen Type : In-line Material : Class 9 PVC Diameter : 52 mm Slots : 17 per 100 mm Open Area : % FILTER PACK MATERIAL Collapsed Soil from 3.0m to 5.0mBTC CEMENT DETAILS Surface Casing Cemented from 0.0m to 0.4mBTC Bentonite Seal 2.5m to 3.0mBTC HYDRAULIC DATA Top of Aquifer : 2.0mBGL Static W.L.: 2.05mBTC Product Level : Test Pumped: Test Start : Discharge : Duration : Drawdown : FIELD WATER ANALYSIS pH : Temp.: Conductivity : NOTES Mackie Marlin & Associates GROUNDWATER ENGINEERS DRAWN A.P. DATE 24-Apr-92

BORE COMPLETION DETAILS -LD2_1

READYMIX - AGNES BANKS

STRATIGRAPHIC DESCRIPTION

LOG

DEPTH

DETAILS

0 SILTY SAND, dry, loose, grey-brown
medium grained, subangular grains.
SAND, dry, orange brown, medium grained.
becoming moist, yellow brown, coarser.

mBGL

mBTOC

0.0

0.0
0.1

0.1

0.3

0.4

0.6

50 mm ID Steel
32mm Class 9 PVC

1.1

VC Screen

1.6 TD

1.7 BOC

GENERAL INFORMATION

Location : AGNES BANKS, N.S.W
Driller : Engin. Exploration
Rig Type : EDSON 2000
Date Drilled : 6/3/92
Coordinates : 286040mE 6275682mN
Casing R.L. : 30.24 mAHQ
Top of Casing : 0.1 mAGL

COMPLETION NOTES

Screen Type : In-line
Material : Class 9 PVC
Diameter : 32 mm
Slots : 17 per 100 mm
Open Area : %

FILTER PACK MATERIAL

Collapsed Soil
from 0.7m to 1.7mBTOC

CEMENT DETAILS

Surface Casing Cemented
from 0.1m to 0.5mBTOC
Bentonite Seal 0.5m to 0.7mBTOC

HYDRAULIC DATA

Top of Aquifer : 2.0mBGL
Static W.L. : 1.1 mBTOC
Product Level :
Test Pumped:
Test Start :
Discharge :
Duration :
Drawdown :

FIELD WATER ANALYSIS

pH : Temp. :
Conductivity :

NOTES



Mackie Marlin & Associates
GROUNDWATER ENGINEERS

DRAWN AP

DATE 24-Apr-92

READYMIX - AGNES BANKS

STRATIGRAPHIC DESCRIPTION	LOG	DEPTH	DETAILS
0 SILTY SAND, dry, loose, grey-brown medium grained, subangular grains SAND, dry, orange brown, medium grained becoming moist, yellow brown, coarser becoming wet SAND, moist, very dense, m-c grained, orange brown, well cemented ('Coffee Rock') SILTY SAND, wet, dense, orange brown, with minor dark brown clay CLAYEY SAND, wet, dense, yellow brown, with some silt becoming moist, grey clay layers, orange brown mottling	mSGL mBTC 0.0 0.1 0.3 0.6 1.5 1.7 2 2.1 2.8 3 TO 3.1 BOC 50mm ID Steel 32mm Class 9 PVC PVC Screen	GENERAL INFORMATION Location : AGNES BANKS, N.S.W Driller : Engin. Exploration Rig Type : EDSON 2000 Date Drilled : 6/3/92 Coordinates : 286050mE 6275683mN Casing R.L. : 30.16 mAHQ Top of Casing : 0.10 mAGL COMPLETION NOTES Screen Type : In-line Material : Class 9 PVC Diameter : 32 mm Slots : 17 per 100 mm Open Area : % FILTER PACK MATERIAL Collapsed Soil from 1.9m to 3.0mBTC CEMENT DETAILS Surface Casing Cemented from 0.0m to 0.4mBTC Bentonite Seal 1.50m to 1.90mBTC HYDRAULIC DATA Top of Aquifer : Static W.L. : 1.02mBTC Product Level : Test Pumped: Test Start : Discharge : Duration : Drawdown : FIELD WATER ANALYSIS pH : Temp.: Conductivity : NOTES	
MA Mackie Martin & Associates GROUNDWATER ENGINEERS DRAWN AP DATE 24-Apr-92			

READYMIX - AGNES BANKS

STRATIGRAPHIC DESCRIPTION	LOG	DEPTH
SAND, dry, moderately loose, brown m-c grained, subangular grains.	mBGL 0.0 0.6	mBTC 0.0 0.10 0.4 50 mm ID Steel 32mm Class 9 PVC
becoming moist, with some well cemented fine gravels	1.8	1.25 1.8
SILTY SAND, wet, moderately dense, brown, coarse grained, with minor clay	2.3 TO	PVC Screen 2.4 BOC
		DETAILS
		GENERAL INFORMATION Location : AGNES BANKS, N.S.W Driller : Engin. Exploration Rig Type : EDSON 2000 Date Drilled : 6/3/92 Coordinates : 285511mE 6275529mN Casing R.L. : 30.28 mAHD Top of Casing : 0.10 mAGL
		COMPLETION NOTES Screen Type : In-line Material : Class 9 PVC Diameter : 32 mm Slots : 17 per 100 mm Open Area : %
		FILTER PACK MATERIAL Collapsed Soil from 0.9m to 2.3mBTC
		CEMENT DETAILS Surface Casing Cemented from 0.0m to 0.4mBTC Bentonite Seal 0.5m to 0.9mBTC
		HYDRAULIC DATA Top of Aquifer : Static W.L.: 1.25mBTC Product Level : Test Pumped: Test Start : Discharge : Duration : Drawdown :
		FIELD WATER ANALYSIS pH : Temp.: Conductivity :
		NOTES
		Mackie Martin & Associates GROUNDWATER ENGINEERS
		DRAWN A.P. DATE 24-Apr-92

READYMIX - AGNES BANKS

STRATIGRAPHIC DESCRIPTION	LOG	DEPTH
SAND, dry, moderately loose, brown m-c grained, subangular grains.	mBGL 0.0	mBTC 0.0 0.10 0.4 50 mm ID Steel 32mm Class 9 PVC Casing
becoming moist, with some well cemented fine gravels	0.6	
SILTY SAND, wet, moderately dense, brown, coarse grained, with minor clay	1.8	1.26
SAND, moist, very dense, m-c grained, orange brown, well cemented ('Coffee Rock')	2.7	2.6
SILTY SAND, moist, dense, with minor grey clay layers	PVC Screen	
SANDY CLAY, firm, moist, orange brown	3.5 TO	3.6 BOC
DETAILS		
GENERAL INFORMATION		
Location : AGNES BANKS, N.S.W. Driller : Engin. Exploration Rig Type : EDSON 2000 Date Drilled : 6/3/92] Coordinates : 285511mE 6275525mN Casing R.L. : 30.24 mAHD Top of Casing : 0.10 MAGL		
COMPLETION NOTES		
Screen Type : In-line Material : Class 9 PVC Diameter : 32 mm Slots : 17 per 100 mm Open Area : %		
FILTER PACK MATERIAL		
Collapsed Soil from 2.7m to 3.6mBTC		
CEMENT DETAILS		
Surface Casing Cemented from 0.0m to 0.4mBTC Bentonite Seal 2.3m to 2.8mBTC		
HYDRAULIC DATA		
Top of Aquifer : Static W.L.: 1.26mBTC Product Level : Test Pumped: Test Start : Discharge : Duration : Drawdown :		
FIELD WATER ANALYSIS		
pH : Temp.: Conductivity :		
NOTES		
MA Mackie Martin & Associates GROUNDWATER ENGINEERS		
DRAWN A.P.	DATE 24-Apr-92	

BORE COMPLETION DETAILS - LD8

READYMIX - AGNES BANKS

STRATIGRAPHIC DESCRIPTION	LOG	DEPTH	DETAILS
	0.0 0.0 0.10 0.4 50 mm 10 Steel 32mm Class 9 PVC Casing 3.3 PVC Screen 4.2 TD 4.3 BOC mBGL mBTC		GENERAL INFORMATION Location : AGNES BANKS, N.S.W Driller : Engin. Exploration Rig Type : EDSON 2000 Date Drilled : 6/3/92 Coordinates : 286147mE 6275641mN Casing R.L. : 27.67 mAH0 Top of Casing : 0.10 mAGL COMPLETION NOTES Screen Type : In-line Material : Class 9 PVC Diameter : 32 mm Slots : 17 per 100 mm Open Area : % FILTER PACK MATERIAL Collapsed Soil from 3.1m to 4.3mBTC CEMENT DETAILS Surface Casing Cemented from 0.0m to 0.4mBTC Bentonite Seal 2.8m to 3.2mBTC HYDRAULIC DATA Top of Aquifer : Static W.L.: Product Level : Test Pumped: Test Start : Discharge : Duration : Drawdown : FIELD WATER ANALYSIS pH : Temp.: Conductivity : NOTES
0			
SILTY SAND, dry, moderately loose, m-c grained, subangular grains, with a trace of clay			
becoming moist, slightly clayey			
less clayey, slightly silty			
SANDY CLAY, moist, firm to hard, grey with orange brown mottling, with a trace of silt			



Mockie Martin & Associates
GROUNDWATER ENGINEERS

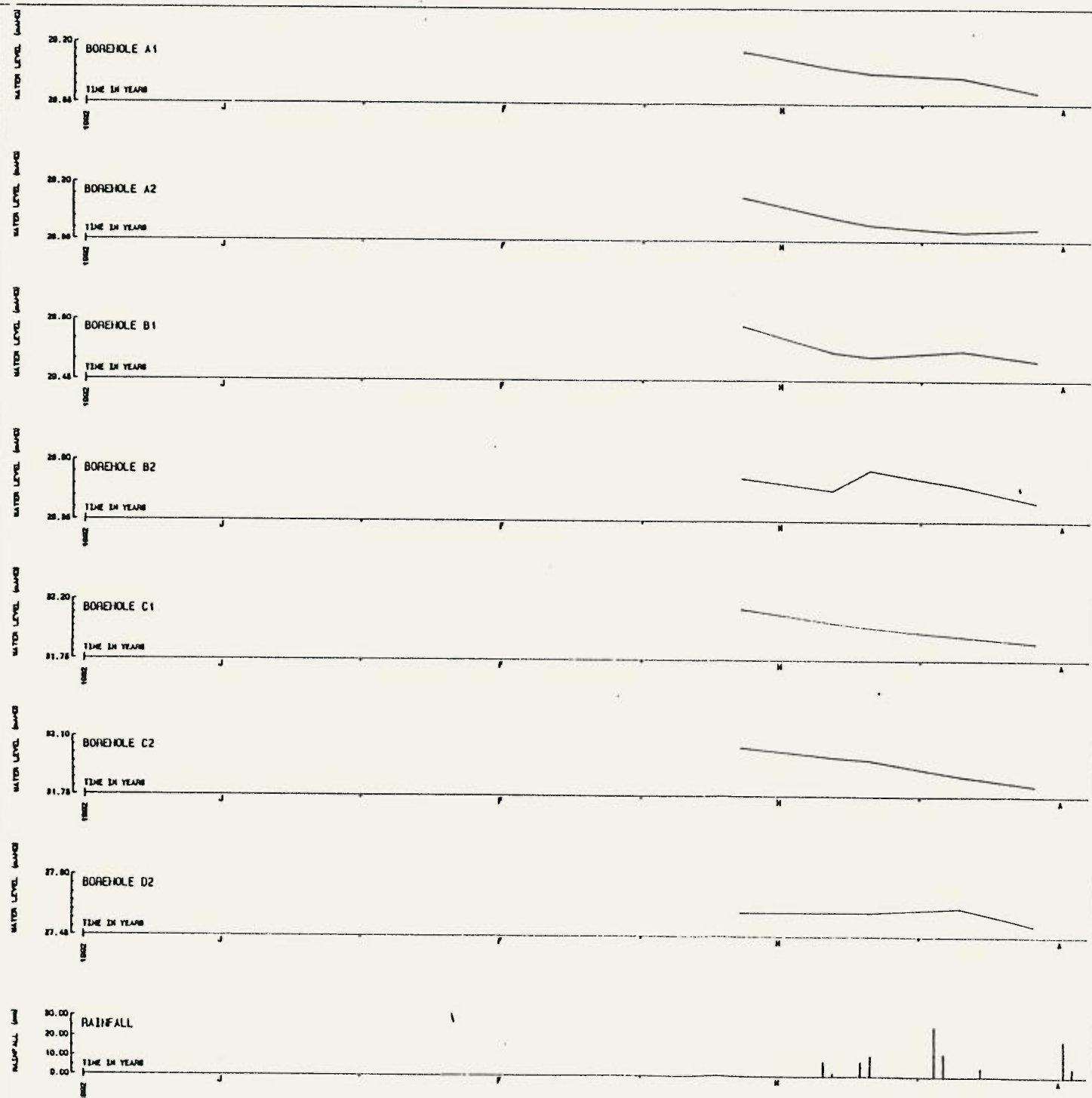
DRAWN A.P.

DATE 24-Apr-92



APPENDIX B
GROUNDWATER HYDROGRAPHS

CSR READYMIX LTD.
LONDONDERRY SAND PLANT
GROUNDWATER STUDY



NOTES:

1. ALL HYDROGRAPHS PLOTTED BY BOREHOLE NUMBER
2. WATER LEVELS ARE GIVEN IN METRES (AMD)
3. RAINFALL DATA COLLECTED FROM RICHMOND WEATHER STATION

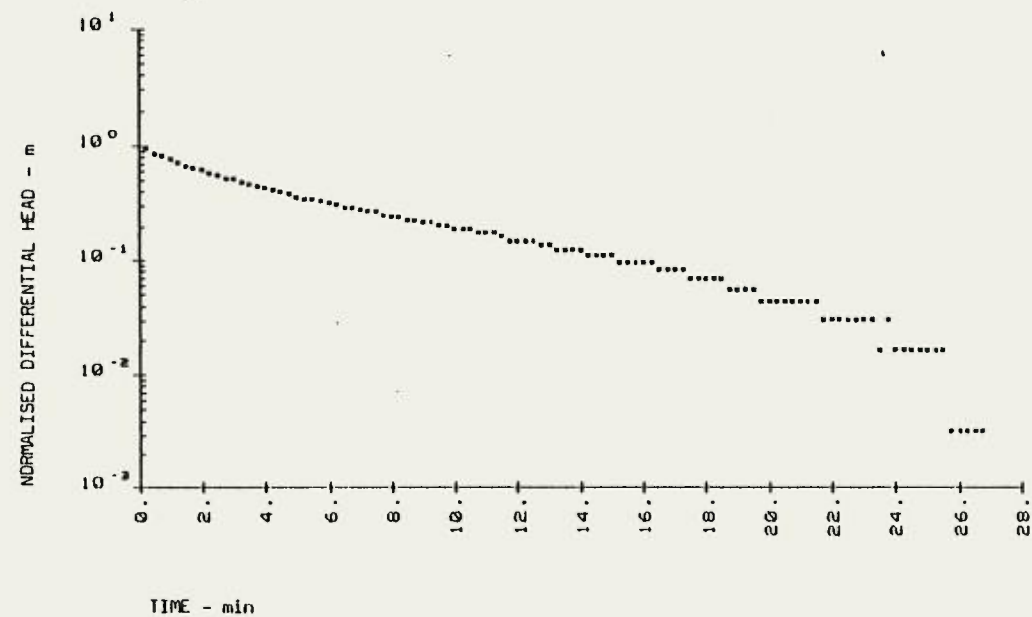
GROUNDWATER LEVELS

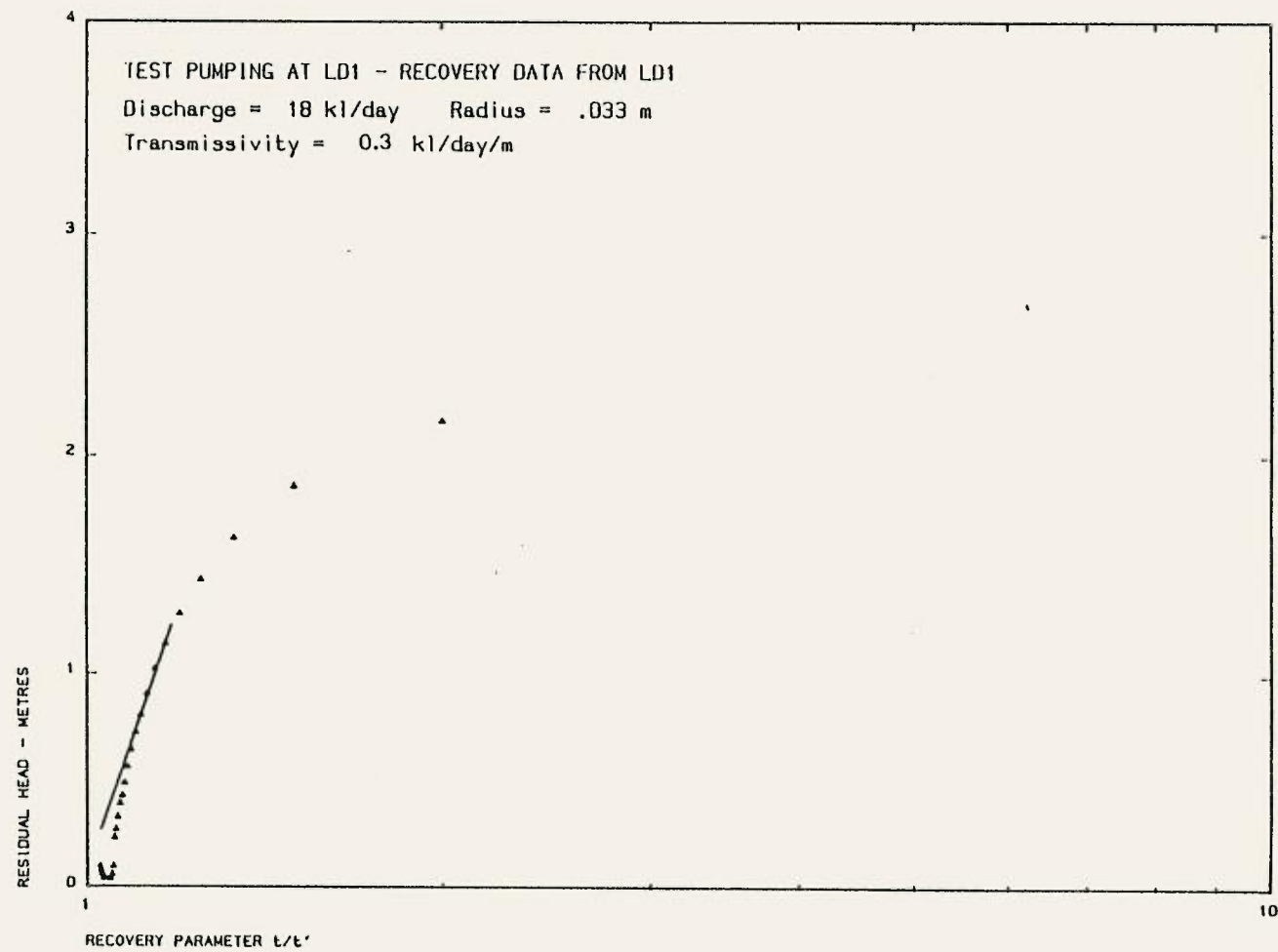
APPENDIX C
HYDRAULIC TESTS

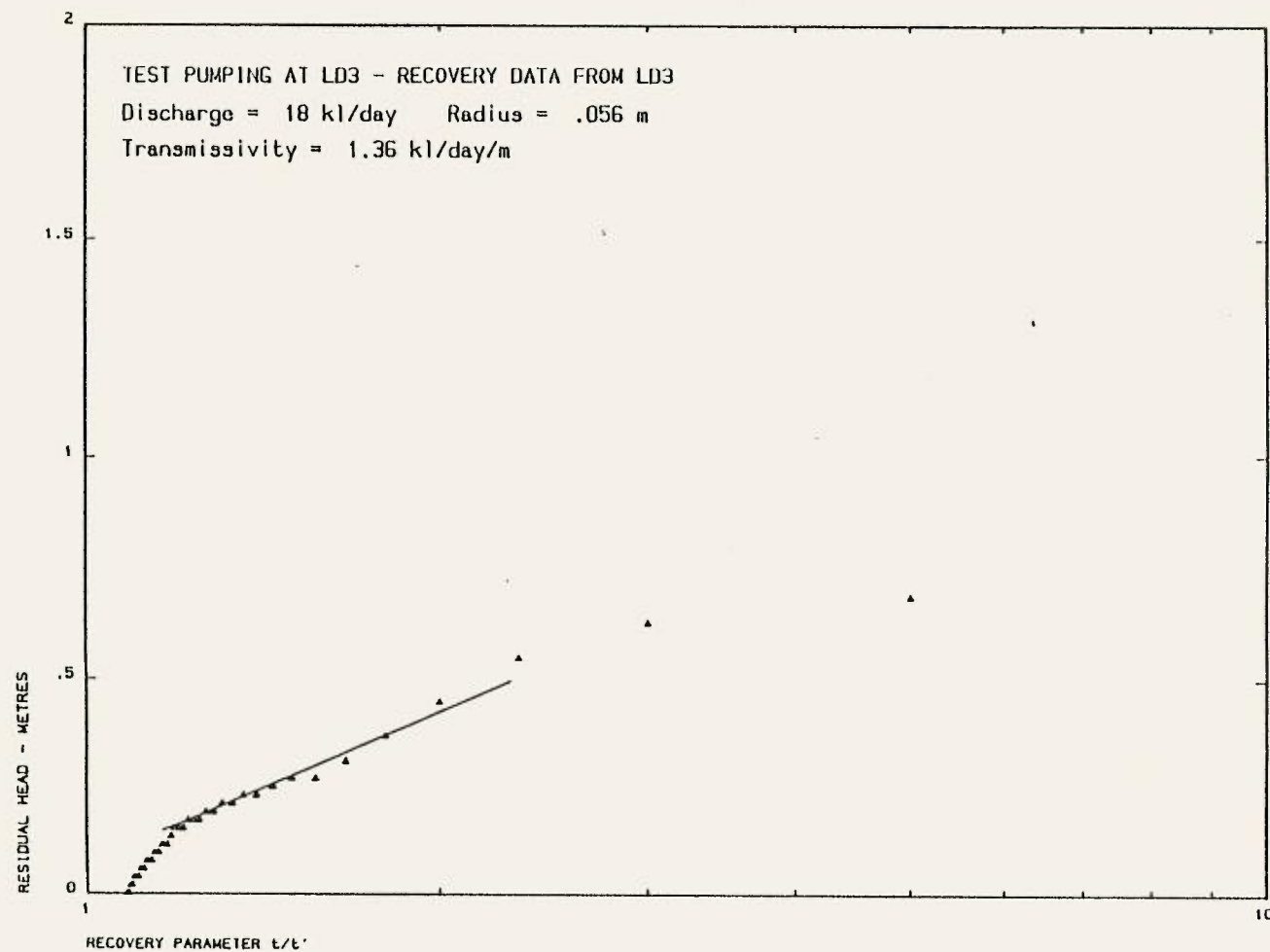
SLUG TEST AT BORE LD1

Radius = 0.033m

Transmissivity = 0.3 kl/day/m



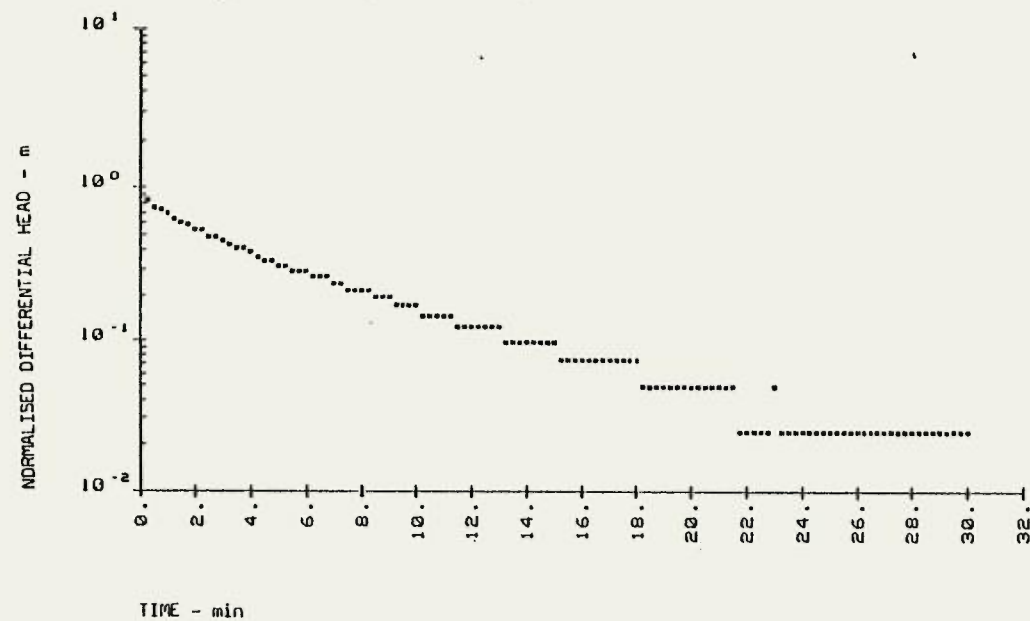


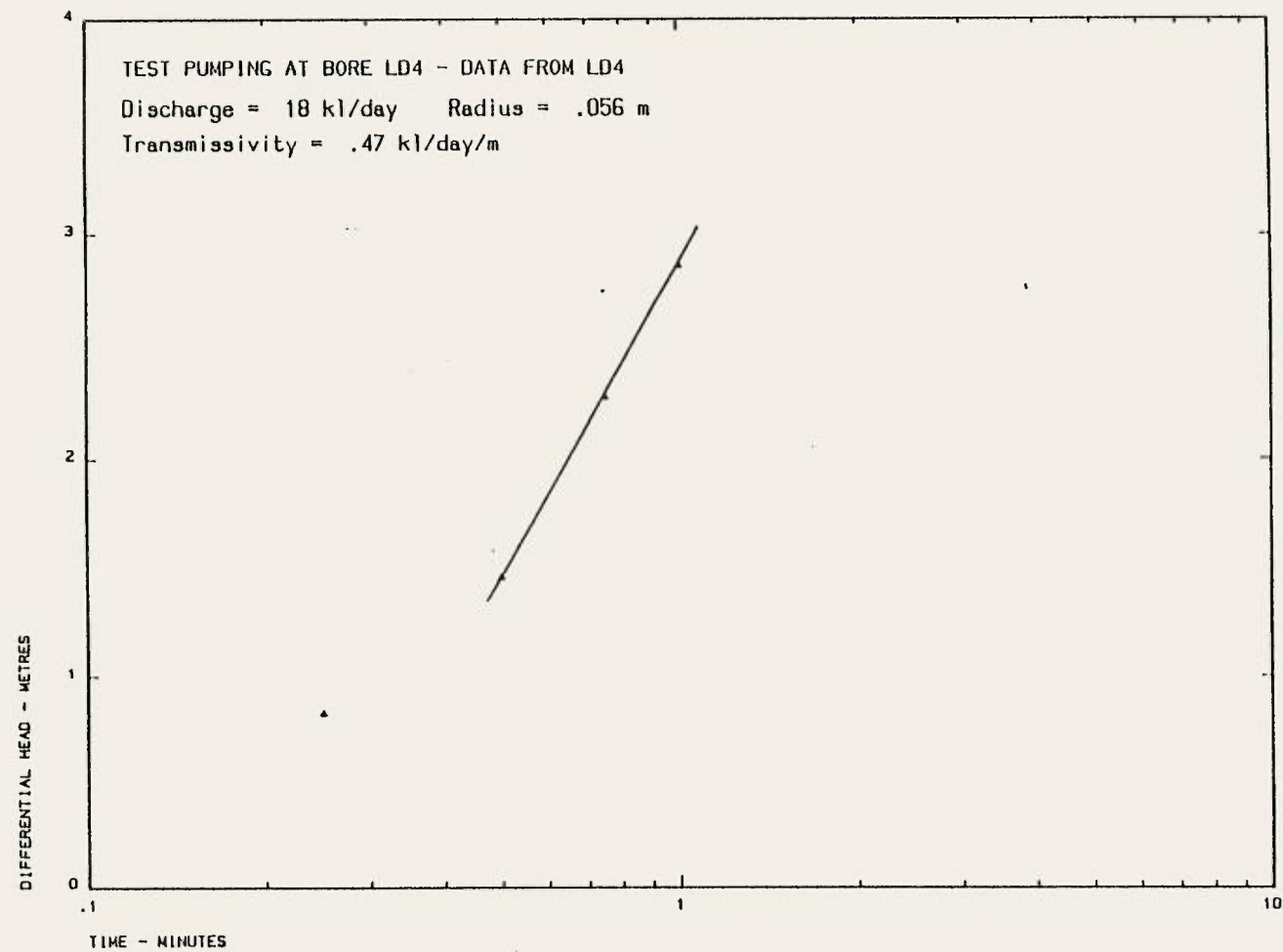


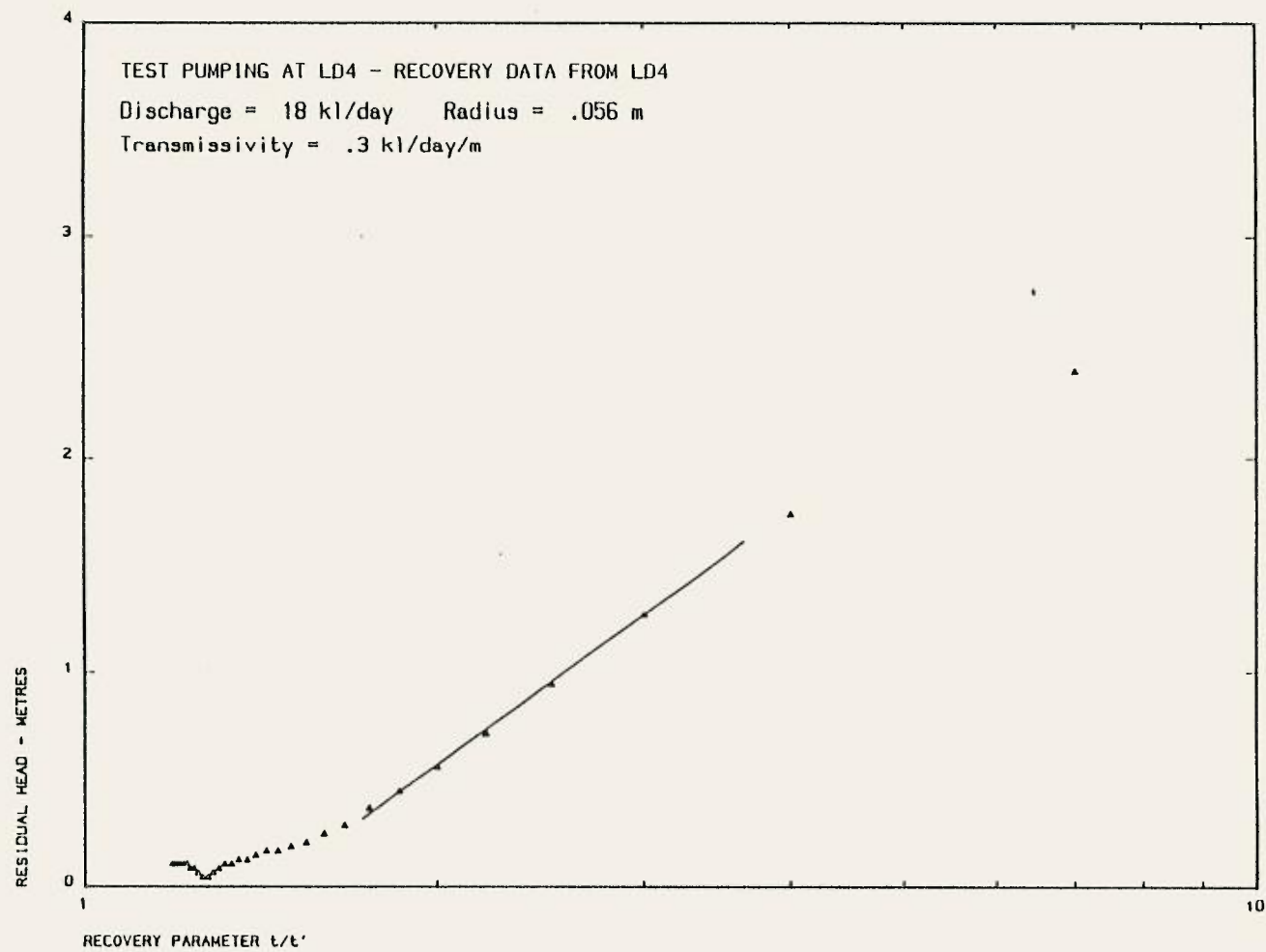
SLUG TEST AT BORE LD2

Radius = 0.056 m

Transmissivity = 0.3 kl/day/m



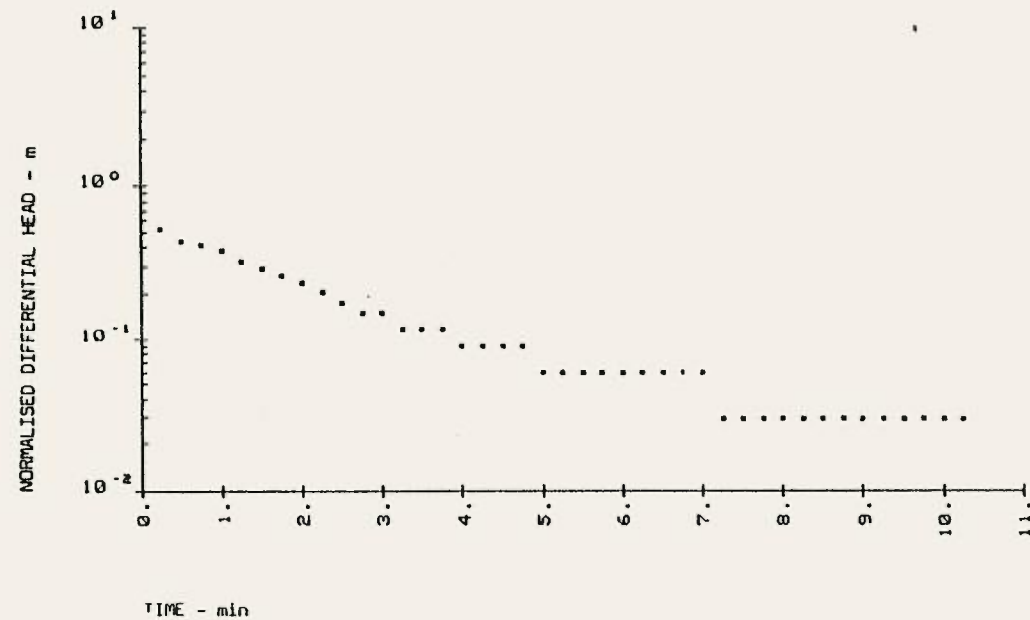




SLUG TEST AT BORE LD5

Radius = 0.056m

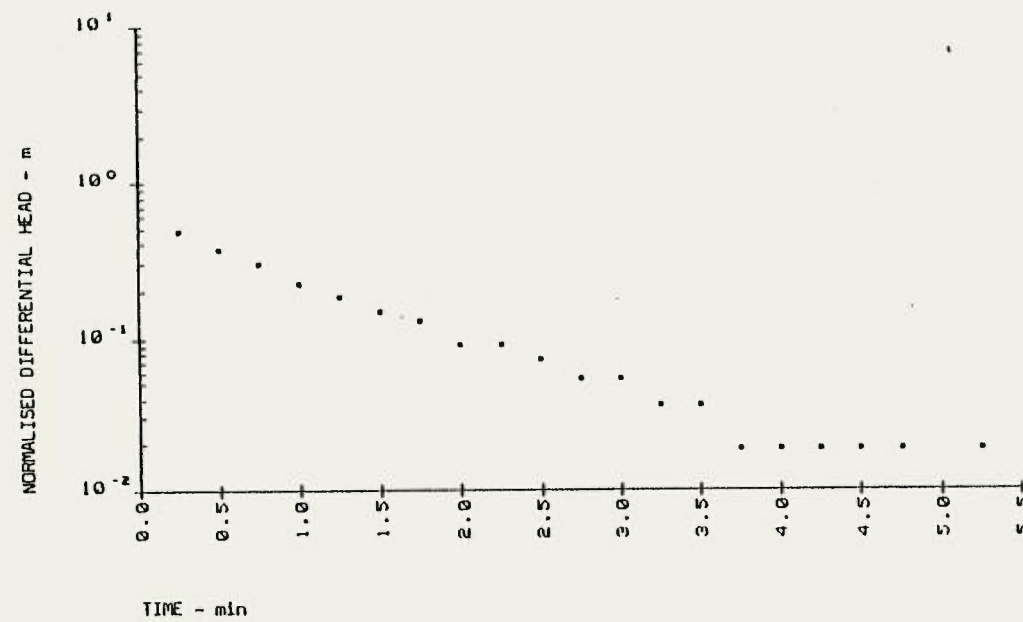
Transmissivity = 1.23 kl/day/m



SLUG TEST AT LD6

Radius = 0.056m

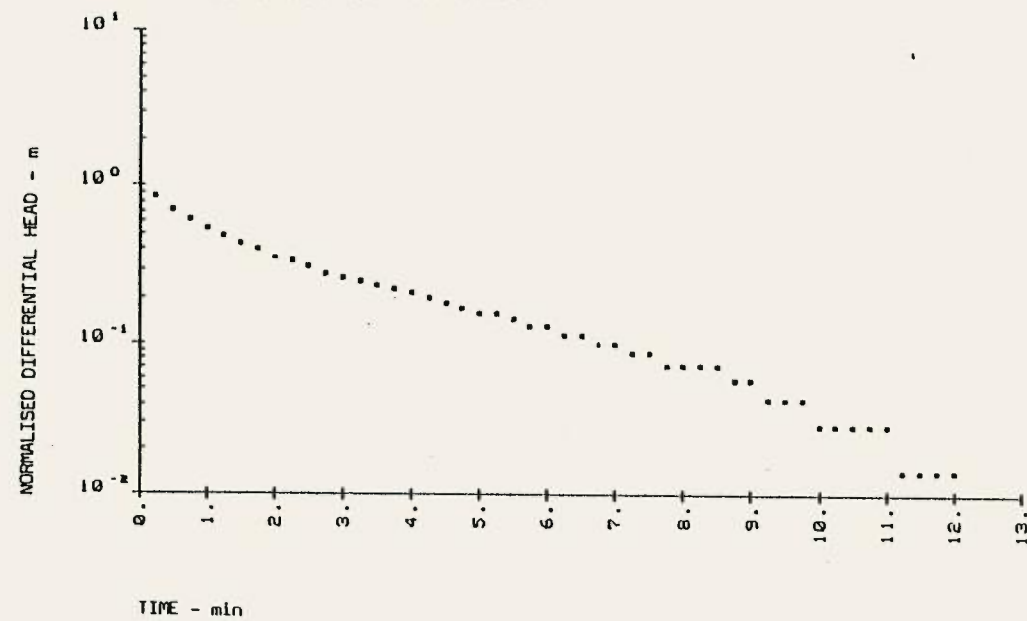
Transmissivity = 1.9 kl/day/m



SLUG TEST AT BORE LD7

Radius = 0.056 m

Transmissivity = 0.6 kl/day/m



ANNEXURE D

NOISE SURVEY

RICHARD HEGGIE ACOUSTICS PTY LTD

CONSULTING ACOUSTICAL ENGINEERS

P.O. Box 204 (Bundamba) Leeton

Renmark, NSW, 2060

Telephone (02) 411 7022

REPORT 483-R1

17 March, 1983

Taylor Thomson Whitting
Consulting Engineers
48 Chandos Street
ST LEONARDS, NSW, 2065

Attention: Mr. K. Vos

Dear Sirs:

RESULTS OF AN AMBIENT NOISE SURVEY
LONDONDERRY SAND EXTRACTION - SITE 1
K. H. DIXON PTY. LIMITED

1. INTRODUCTION

This report presents the results of an early morning noise survey carried out on Wednesday 9 March, 1983.

The purpose of the investigation was to establish the levels and character of existing ambient noise in the vicinity of the proposed Sand Extraction Site at Londonderry (Portions 157 (part), 158, 159 and Lot 1).

Measurements were also carried out on Thursday 3 March, 1983 to determine the typical maximum levels of noise emission from equipment proposed to be used on the site for sand extraction and removal.

The instrumentation and techniques employed for the ambient noise investigation were fully in accordance with the requirements of the following Australian Standards:

AS 1055-1978, "Noise Assessment in Residential Areas"

AS 1259, Part 2-1976, "Sound Level Meters Type 2, Precision".

The instrumentation included a Bruel & Kjaer Precision Sound Level Meter Type 2218 and Statistical Noise Level Analyser Type 4426. Calibration of the instrumentation was checked at regular intervals throughout the measurement periods with a Bruel & Kjaer Type 4220 Pistonphone or Type 4230 Acoustic Calibrator.

All instrumentation is described (with serial numbers) in Section 5 at the end of this report.

Weather conditions during the survey are described on the table of measurement results in Appendix I.

2. MEASURING LOCATIONS

Three reference measuring locations were selected around the site:

<u>Location</u>	<u>Description</u>
A	On northern verge of corner at eastern end of Brooks Lane (approx. 460 m from Castlereagh Road).
B	Eastern verge of Rickards Road - southern boundary of Residential Lot 4 (approx. 200 m from Castlereagh Road).
C	Western verge of Rickards Road - northern boundary of Lot 16 (approx. 600 m from Castlereagh Road).

The noise environment at these locations is generally representative of the existing ambient noise at the nearest potentially exposed residences around the extraction site.

3. SURVEY RESULTS - AMBIENT NOISE

3.1 Results

Statistical noise levels were measured over 10 minute sampling periods between 5.30 am and 8.30 am on Wednesday 9 March, 1983 (analyser set to 0.1 sec sample rate, FAST response, instantaneous sampling).

The detailed measurement results for each reference location are set out in Appendix I, along with the times of measurement and comments regarding noise sources and subjective impressions.

Where a particular noise source was audible at a location, an attempt was made to identify and locate the source and to measure typical maximum noise levels during its occurrence. These results are also reported in the comments column in Appendix I.

3.2 Definition of Terms

The statistical noise level, LN (percentile level), is the A-weighted sound pressure level (FAST response) exceeded for N per cent of the measurement time interval. The L10 is normally regarded as the 'average maximum' noise level. The L90 is the 'average minimum' level, often referred to as the 'minimum background level' for noise impact assessment purposes.

The equivalent continuous sound level, Leq, is the value of the A-weighted sound pressure level of a continuous steady sound that, over the measurement interval, has the same mean square sound pressure as the varying sound under consideration.

4. MEASUREMENT RESULTS - EQUIPMENT

Certain items of equipment, similar to the following, are proposed to be used during sand extraction and removal:

FRONT END LOADER - Clark Michigan Model 175B, Serial No. 427B-105-ASC

BULLDOZER - Caterpillar Model D7E, Serial No. 48A7534

Indicative levels of noise emission from these vehicles were determined generally in accordance with AS 2012-1977, "Method for Measurement of Airborne Noise from Agricultural Tractors and Earthmoving Machinery."

Each test was carried out with the vehicle stationary, and with the throttle held at maximum governed RPM or typical maximum operating RPM.

The measurement results were as follows:

<u>Item</u>	<u>Direction</u>	<u>Distance</u>	<u>Level</u>
FRONT END LOADER	rear (engine)	7.5m	88 dBA
FRONT END LOADER	rear (engine)	30 m	76 dBA
FRONT END LOADER	side	7.5m	88 dBA
FRONT END LOADER	side	30 m	76 dBA
BULLDOZER	front (engine)	7.5m	88 dBA
BULLDOZER	front (engine)	30 m	77 dBA

It is proposed to use an off-road truck (20t) to transport sand from the extraction site to a processing plant, via a roadway inside the Management Scheme area.

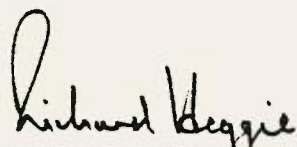
Although no measurements of the specific vehicle were carried out, the typical maximum noise emission level for vehicles of this size and type is in the order of 85 dBA at 7.5 m.

5. INSTRUMENTATION

The instrumentation used for these investigations was as follows:

<u>Type Number</u>	<u>Serial Number</u>	<u>Item Description</u>
2218	784634	Bruel & Kjaer Precision Integrating Sound Level Meter
1613	765888	Bruel & Kjaer Octave Filter Set
4165	815776	Bruel & Kjaer 12.5 mm Air Condenser Microphone
4426	694008	Bruel & Kjaer Statistical Noise Level Analyser
2619	715213	Bruel & Kjaer Preamplifier
4165	870257	Bruel & Kjaer 12.5 mm Air Condenser Microphone
4220	757082	Bruel & Kjaer Pistonphone Calibrator
4230	685752	Bruel & Kjaer Acoustic Calibrator
UA0237	--	Bruel & Kjaer Windscreens

Yours faithfully,



RICHARD HEGGIE ACOUSTICS PTY. LTD.

Existing Ambient Sound Levels - Sand Extraction Site 1 (Rickards Road area)

APPENDIX I

Survey Details: Wednesday morning, 9.3.83, fine, clear, still, 18 to 22 degrees C.

<u>Time</u>	<u>Measurement Results (dBA)</u>					<u>Comments</u>
	<u>L1</u>	<u>L10</u>	<u>L50</u>	<u>L90</u>	<u>Leq</u>	
<u>Location A</u> - Eastern end of Brooks Lane (approx. 460 m from Castlereagh Road)						
5.32-5.42	55	47	42	40	46	Vehicles on Castlereagh Road. Maximum levels of trucks 53 dBA. Steady diesel driven pump noise at water pond to SE, and from irrigation pump on farm to NW, across Castlereagh Road. Diesel vehicle noise started from S and SE about 5.40. Insects. Birds.
6.04-6.14	53	50	44	43	46	Vehicles on Castlereagh Road. Steady diesel pump noise from SE and NW still audible. Front end loader noise peaks from Dixon Sands site audible at 6.05 at 54 dBA. Insects. Birds.
7.03-7.13	52	45	41	37	46	Traffic flow on Castlereagh Road. Diesel pump to SE no longer audible. Irrigation pump still audible. Scraper at Dixon Sands audible occasionally. Insects. Birds.
8.00-8.10	62	56	48	45	52	Traffic flow on Castlereagh Road dominating. Diesel vehicles audible from gravel quarry to NW. Scraper on ridge at Dixon Sands 51 dBA to 55 dBA. Insects. Birds. Diesel pump from SE audible.
<u>Location B</u> - Rickards Road - Southern boundary of Residential Lot 4 (approx. 200 m from Castlereagh Road)						
5.15-5.25	57	52	39	33	47	Occasional vehicles on Castlereagh Road. Maximum levels of trucks 56 dBA to 60 dBA. Cars in the order of 50 dBA. Birds. Insects.
6.36-6.46	61	51	45	40	54	Steady diesel noise from east. Traffic on Castlereagh Road. Reversing alarms and vehicle diesels just audible from east. Birds. Insects.
8.23-8.33	64	52	42	38	56	Castlereagh Road traffic dominating. Some diesel noise and reversing alarms just audible from east. Steady diesel no longer audible. Birds. Dogs. Insects.

APPENDIX I (Continued)

<u>Time</u>	<u>Measurement Results (dBA)</u>				<u>Leq</u>	<u>Comments</u>
	<u>L1</u>	<u>L10</u>	<u>L50</u>	<u>L90</u>		
<u>Location C</u> - Rickards Road - Northern Boundary of Lot 16 (approx. 600 m from Castlereagh Road)						
5.50-6.00	51	43	37	33	40	Steady diesel noise from east. Occasional vehicles on Castlereagh Road. Birds. Dogs. Insects.
7.16-7.26	68	57	42	38	57	Steady diesel noise from east. Traffic on Castlereagh Road. Hercules aircraft flyover, maximum level approximately 70 dBA. Some vehicles on Rickards Road. Dogs. Birds.

Extension of ambient noise survey Londonderry sand extraction.

Measurements were conducted at Locations D and E to conclude providing ambient noise levels in the vicinity of the proposed extractive areas. Similar instrumentation and reference to Australian Standards and SPCC criteria ensured consistency with the earlier survey - Annexure B.

Noise attenuation study

In determining the levels of noise from the extractive operations at closest residences to Lot 43 and Portion 189, due allowance is made for several attenuating factors. Due to site conditions peculiar for the areas involved - i.e. soft ground cover, use of 3-4m high bund walls as visual and acoustic barriers and flat topography - a series of tests were conducted. A Terex FEL with environmental muffler fitted (standard equipment for Readymix) was located at varying distances (30m - 300m) from the bund wall. With the FEL on maximum engine revs (approx 2100rpm), noise measurements were conducted at 60 metres on the other side of the bund wall. This being the closest location of any residence.

The table below summarises the findings of the attenuation study.

Location of Terex FEL	Noise levels at 60m on residence side of wall
300m	40 dBA
200m	42 dBA
100m	42 dBA
30m	50 dBA

Remarks

This study indicates that the combined effects of attenuation will reduce the average maximum levels (L10A) of extractive equipment to levels generally within 5dBA of existing background noise levels (L90A). Further control measures are indicated in the body of the EIS for the occasion where the above criteria may be exceeded. In the extractive zone of 80m - 30m from the bund wall the noise emissions may at times exceed the criteria by 3dBA. This may have a 'minor' impact but can be readily removed using the control measures in Section 5.3.

R.T. Benbow
M.A.A.S.

Existing Ambient Sound Levels

14th August, 1984.

Location F - Wiltshire Road adjacent to Lot 189 and closest residence.

	<u>L1</u>	<u>L10</u>	<u>L50</u>	<u>L90</u>	<u>Leq</u>	<u>Comments</u>
6.20 - 6.40am	53.8	44.8	39.3	37.0	43	Vehicles on Castlereagh Road Diesel vehicle noise from S. and W. Birds, insects, roosters.

Location G - 10m off Castlereagh Rd adjacent to property boundary and near church of England building.

	<u>L1</u>	<u>L10</u>	<u>L50</u>	<u>L90</u>	<u>Leq</u>	<u>Comments</u>
6.50 - 7.10am	72	62.5	51.5	44	62.7	Vehicles on Castlereagh Road. Planes circling, insects, birds, farm animals.

Weather conditions during measurement periods were suitable with minimum wind and clear sky.

ANNEXURE E

TOPSOIL/OVERBURDEN SURVEY



SOIL/OVERBURDEN CONDITIONS:

**Londonderry/Agnes Banks
Sand Manangement Area, Part Lot 43.**

Report to:

**Taylor Thomson Whitting Pty. Ltd.
48 Chandos St. St Leonards NSW 2065.
Per: Readymix Group.
Torkington Rd Londonderry.**

By:

**Sydney Environmental & Soil Laboratory Pty. Ltd.
"Loch Maree House" 237 Pennant Hills Rd
NSW 2120
ph: 980 6554**

1.0 General Observations.

Lot 43, Londonderry/Agnes Banks Sand Manangement Area was briefly surveyed by Sydney Environmental & Soil Laboratory on 17-5-91 as part of the Soil Conservation Service of NSW requirements for preliminary site investigations.

A large proportion of this stagnant alluvial plain is natural bushland of coastal sclerophyll (open, low woodland). Only about 1/3 of the site in the northern end of the site is cleared and currently used for recreational purposes

(pony club). Relief is very low and slope is level to very gently inclined. Landform element is essentially a raised backplain, it could even be part of a very wide levee between Hawkesbury river and its backplain.

Soils are uniformly very coarse and relatively undifferentiated.

2.0 Soil Properties.

Soils across the site were essentially showing the same form although depth of horizons can vary. A generalised soil profile appeared as follows-

Table 1 Generalised Soil Profile

Horizon	Depth mm	Texture	Colour
A1	0-150	Sand	Brownish Grey 7.5YR 4/1
A2	150-300	Sand	Lht Brownish Bleached Grey 7.5YR 7/1
B 1	300-750	Sand	Dull orange 7.5 YR 7/3
B1/B2	750-1000	Gravelly Sand	Bright Brown Coffee Rock Brown Mottle layer
B2	> 1000	Sand	Brown

Profile is classified according to Northcote (Northcote 1973) as Uc 1.21 and in the Podzol Group showing only colour as pedological organisation. Seive analysis (See Appendix) reveals only the slightest accumulation of silt and clay in the B1 horizon compared with those horizons above and below. Sand is predominantly medium and coarse sand.

Chemical properties are shown in Appendix. The tests reveal universally acidic conditions with a lack of any salinity or sodicity anywhere in the surface with some occurrence of sodicity with depth. Bioaccumulated elements like potassium and calcium are adequate in the surface of the undisturbed bushland site (Site 1) but calcium is very deficient at depth. This emphasises the importance of calcium conservation to this vegetation/soil association. In Site 2 (the grassed Pony Club area) there is obvious accumulation of calcium and phosphorus perhaps as a result of pasture improvement or as a result of nutrient pollution from horses.

Despite low calcium levels in Site 1 the material could not be classified as highly erodible because of the coarse nature of the sands. For the same reason Emerson stability tests are not relevant since no structure exists.

3.0 Recommendations

Since we are not familiar with the exactly what material is to be removed in the proposed mining operation we will outline only those materials that need to be avoided. Topsoil stripping should remove the top layer of greyish brown sand to about 150mm for stockpiling as topsoil. This is the coarsest textured material and contains a seed bank and organic matter store. Two separate stockpiles should be made keeping topsoil from the bushland area separate from the Pony Club area which is turfed. The latter contains high nutrient levels and weed seed populations that may interfere with any native plant regeneration proposals after completion of mining. While constructing stock piles lime the material at 500g/cubic metre to prevent any tendency for the small fines content to disperse. With these coarse materials there is really no restriction on stockpile height at its angle of repose.

Because of the differences in nutrient levels between the bushland area and the cleared Pony Club area it would be wise to keep the two areas in separate stockpiles and respread afterwards on separate areas.

Layers below this topsoil will probably be selectively mined and the only layer that should be stripped and kept separate as a Subsoil stockpile is the layer of weakly aggregated "coffee rock" appearing as a dark orange gravelly material at between 500mm and 1000mm over the whole site.

When reinstating profiles after mining place the Subsoil material first and then spread the topsoil layer on top of this. Whatever the nature of the post mining subgrade this procedure will ensure that a natural progression of texture from coarser in the surface to relatively finer with depth is followed hence best reflecting the natural hydrology of the pre-mining surface.

With the raised phosphate levels of the Pony Club area weed invasion of the newly placed materials is a potential problem if native plant regeneration is desired. This topsoil may be used in area where turf or playing fields are to be constructed and the low nutrient level material from the Bushland areas kept for native tree and shrub regeneration areas.

To encourage rapid attainment of a natural nutrient distribution profile Murate of potash could be applied to all replaced topsoils at 300kg/ha which along with the lime which has been added to stockpiles as they were constructed, will mimic the bioaccumulation evident in the pre-mined surface. Any areas to be grassed could have No 17 lawn food at 500kg/ha prior to sowing.

4.0 Summary.

Relatively undifferentiated sandy podzols show spacial variability only in the depth of horizons and in markedly different nutrient levels related to past use of one area as a Pony Club.

Given the flatness of the site, the coarse nature of the material, and the lack of clay in the soil mantle stripped soil materials will not present a severe erosion hazard. Despite this, treatment of stockpiled topsoil with lime is advised to completely eliminate any dispersibility of the small clay fraction

When reinstating profiles ensure that coarser material (topsoil) overlays any finer material and apply potassium to all areas to best mimic the premixed condition.

References:

McDonald R.C. et al. 1984. *Australian Soil and Land Survey. Field Handbook*. Inkata Press Melbourne.

Northcote K.H. (1973) *A Factual Key for the Recognition of Australian Soils*. CSIRO Rellim Technical Publications. Adelaide SA.

APPENDIX: Test Results.

Client: Readymix Pty. Ltd.
 Londonderry

Sample: Site 1 0-100mm

Date: 28-5-91

TEST	Result	
Code	1285	
pH in water	4.6	very acidic material
pH in CaCl ₂	3.6	highly acidic
Salinity mS/cm	0.04	very low salts
Chlorides ppm	19.6	

*Soluble Cations

	meq/100g	ppm	
Sodium	0.03	6.4	
Potassium	0.02	6.2	
Calcium	0.00	0.0	low Ca
Magnesium	0.01	1.5	

* Soluble plus Exchangeable Cations

	meq/100g	ppm	% of CEC	
Sodium	0.05	11.5	5.8	very slightly sodic
Potassium	0.08	29.3	15.5	good
Calcium	0.21	42.0	55.3	low Ca
Magnesium	0.14	17.1	33.7	high Mg

* Sum of Exchangeable Cations

0.4

* Cation Exchange Capacity (CEC)

0.4

* Ca/Mg ratio

1.5 low

* Nutrient

	ppm	
Phosphorus	4.5	low P
N as ammonium	10.9	
as nitrate	3.6	low N
Sulphate	84.0	high S
Iron	45.0	low Fe

A very acidic material low in calcium. Slight sodicity and magnicity would ordinarily render the material highly erodible but the coarse nature of the material means that it will not be highly erodible and will not benefit much from the addition of calcium.

Nevertheless stockpiled material should be limed during construction at 500g/cubic metre. After respeading onto mined areas an application of No 17 lawn food at just 500kg/ha will enhance grass cover and regrowth of native species.

Client: Readvmix Pty. Ltd.
 Londonderry
 Sample: Site 1 500mm

Date: 28-5-91

TEST	Result	
Code	1286	
pH in water	5.4	slightly acidic
pH in CaCl ₂	4.7	very low
Salinity mS/cm	0.01	
Chlorides ppm	4.9	

*Soluble Cations

	meq/100g	ppm	
Sodium	0.00	0.9	
Potassium	0.00	0.0	
Calcium	0.00	0.0	
Magnesium	0.00	0.5	all low

* Soluble plus Exchangeable Cations

	meq/100g	ppm	% of CEC
Sodium	0.02	4.6	16.0 sodic
Potassium	0.02	5.9	15.0 OK
Calcium	0.00	0.0	0.0 very low Ca
Magnesium	0.01	1.2	6.0 low

* Sum of Exchangeable Cations

0.0

* Cation Exchange Capacity (CEC)

0.1

* Ca/Mg ratio

0.0 very low

* Nutrient

	ppm	
Phosphorus	4.0	low
N as ammonium	5.7	
as nitrate	2.8	low
Sulphate	61.0	plenty
Iron	16.0	low

This is a very sandy material. Ordinarily these cation relationships would lead to a severe erosion hazard but due to the exceedingly low clay content erosion is not really a problem. I believe that this material will be the layer that is actually mined but if not then some attempt to reinstate this material first and then 100mm of the topsoil on top of it should be made.

No precautions are necessary before stockpiling this material.

Client: Readymix Pty. Ltd.
 Londonderry
 Sample: Sites 2 & 3 Topsoil 0-100mm
 Date: 28-5-91

TEST	Result	
Code	1288	
pH in water	5.3	acidic
pH in CaCl ₂	4.6	low pH
Salinity mS/cm	0.04	no salts
Chlorides ppm	2.8	

*Soluble Cations

	meq/100g	ppm	
Sodium	0.01	2.3	
Potassium	0.04	14.0	
Calcium	0.01	2.4	low Ca
Magnesium	0.01	1.0	

* Soluble plus Exchangeable Cations

	meq/100g	ppm	% of CEC
Sodium	0.04	9.2	2.4 OK
Potassium	0.13	48.8	7.2 OK
Calcium	0.48	96.0	38.0 low
Magnesium	0.20	24.4	15.6 OK

* Sum of Exchangeable Cations

0.8

* Cation Exchange Capacity (CEC)

1.2

* Ca/Mg ratio

2.4 good

* Nutrient

	ppm	
Phosphorus	15.5	elevated
N as ammonium	4.7	
as nitrate	2.2	low N
Sulphate	69.0	OK
Iron	37.0	low Fe

It is surprising that the P level is higher at 300mm than at 100mm in this soil. This is probably due to leaching of this element downward after application of superphosphate and/or horse manure. Again erodibility is low despite the low calcium level. It would assist rapid revegetation if lime at 500g/cubic metre were added as stockpiles of topsoil are created.

Client: Readvmix Pty. Ltd.
 Londonderry
 Sample: Site 2 300mm

Date: 28-5-91

TEST	Result	
Code	1287	
pH in water	6.0	pH good
pH in CaCl ₂	5.1	
Salinity mS/cm	0.02	no salts
Chlorides ppm	0.0	

*Soluble Cations

	meq/100g	ppm	
Sodium	0.00	0.9	
Potassium	0.01	3.9	
Calcium	0.00	0.0	low Ca
Magnesium	0.00	0.5	

* Soluble plus Exchangeable Cations

	meq/100g	ppm	% of CEC	
Sodium	0.02	4.6	5.3	slight sodicity
Potassium	0.05	19.5	13.3	good
Calcium	0.21	42.0	70.0	good
Magnesium	0.08	9.8	25.3	good

* Sum of Exchangeable Cations

0.3

* Cation Exchange Capacity (CEC)

0.3

* Ca/Mg ratio

2.6 good

* Nutrient	ppm	
Phosphorus	61.5	high P
N as ammonium	1.9	
as nitrate	3.2	low N
Sulphate	66.0	good
Iron	18.0	low Fe

This area has obviously been limed and superphosphated at some stage in the past. It needs nothing in the way of ameliorants but it may be better to keep this material separate from the low nutrient natural bush areas (Site 1) as these high nutrient levels may discourage natural regeneration of bushland if that is what is required. The coarse nature of the material and good calcium level means that erosion is not a problem.

SEIVE ANALYSIS REPORT

Client: Readymix Pty. Ltd.

Sample: Londonderry Extention

Date: 28-5-91

Size Fraction mm	% by weight			
Sample	100mm	350mm	500mm	1000mm
> 4	0	0	0	0
2-4	0	0	0	0
1-2	2.4	1.9	2.1	1.6
0.5-1	42.3	35.5	36.9	33.3
0.25-0.5	38.9	44.8	40.6	45.4
0.1-0.25	8.2	8.9	8.7	9.9
< 0.1	8.2	8.9	11.7	9.8

Note the very coarse nature of the soil with peak particle size distribution in the medium and coarse sand fractions. Fines (<100um) contents are all very low minimising any erosion risk. Note the very slight peak in fines fraction at the 500mm depth which is the top of the B horizon. This is normal for soils showing profile development.

ANNEXURE F

ARCHAEOLOGICAL SURVEY

AN ARCHAEOLOGICAL SURVEY WITHIN THE
AGNES BANKS/LONDONDERRY AREA

Prepared for Taylor Thomson Whitting Pty Ltd

on behalf of

K. H. Dixon and Readymix Farley

by J. L. Kohen
School of Biological Sciences
Macquarie University

February, 1984.

INTRODUCTION

This report was prepared for Taylor Thomson Whitting Pty Ltd on behalf of K. H. Dixon and Readymix Farley, and summarises the results of two days fieldwork carrying out archaeological surveys of areas proposed for sand extraction at Agnes Banks, as listed below:

Lot 1, DP 500175, DP 584928; Lot 2, DP557070; Lot 4, DP 528257; Lot 6, DP 232448; Lot 43, DP 585210; Pors 189; Part of Pors 190 and 191, Brooks Lane, Wiltshire Road and various non-public reserved roads.

The total area surveyed was approximately 75 ha.

ENVIRONMENTAL SETTING

The area surveyed is situated approximately 2 km east of the Nepean River on a pleistocene sand sheet of alluvial and aeolian origin (Gobert, 1978). The sand is several meters thick, and in places gravel lenses are found, probably continuous with the gravels found in the present bed of the Nepean and Hawkesbury Rivers. It has been suggested that the sand may in fact be the remnants of a source bordering dune system on the eastern boundary of what was an enlarged body of water near the junction of the Grose and Nepean Rivers.

The sand supports a distinct vegetation, very similar to plant associations normally found in coastal dune systems (Benson, 1981). It is mainly open woodland, with the dominant tree species being Eucalyptus sclerophylla. The area between the river and Agnes Banks contains swamps and lagoons (e.g. Yarramundi Lagoon), while to the east is found open woodlands and dry sclerophyll forest growing on earlier alluvial deposits, possibly of tertiary age (Walker and Hawkins, 1957). Freshwater swamps are sometimes found at Agnes Banks in the swales between the dunes, but the original internal drainage patterns have been disturbed by sand extraction.

The rich array of plant and animal foods and lithic resources within a few kilometers of the survey area would have been attractive to Aboriginal bands.

REGIONAL ARCHAEOLOGY

Archaeological investigations have been carried out in the surrounding areas, particularly over the last four years.

At Jamisons Creek on Emu Plains, an Aboriginal campsite on a sandy substrate was found which had been occupied for 7000 years (Kohen, 1981). Between Penrith and Castlereagh, almost 50 sites and isolated finds have been recorded, suggesting intensive Aboriginal use of the Nepean River area (Kohen, 1983). Two rockshelters on Shaws Creek, only a few km west of Agnes Banks, show long histories of occupation, one containing an

archaeological deposit which was dated to in excess of 13,000 years old (Kohen et al, 1981; Stockton, 1973).

At Agnes Banks, only one site had been previously recorded, and this, coded AB/1 (Agnes Banks 1), was near the entrance to Readymix Farley's sand extraction area at the junction of Brooks Lane and Wiltshire Road, within the boundary of the present survey. The artifacts located and collected were a chert core, a retouched chert flake, and a chert waste flake. These artifacts were eroding from the sand in an exposed cutting and on the road nearby (Kohen, 1983).

DESCRIPTION OF SURVEY AREA

For ease of description, the survey area has been divided into three zones:

Zone A, K. Dixon's present plant and adjacent areas,

Zone B, the eastern section consisting of por 189 and parts of 190 and 191, and

Zone C, the southern area owned by Readymix Farley, por 43.

Zone A

Archaeological visibility over most of this area was poor. The paddocks north and east of Brooks Lane were covered with high grass and other vegetation, making surveying very difficult. In the area containing the existing sand mining plant, sand and soil are stockpiled, making the original ground surface only rarely visible. Vehicle and foot tracks are found along the boundaries of this zone, and they were all examined for artifacts.

Zone B

This area was almost entirely undisturbed vegetation, consisting of open woodland and some swampy areas dominated by Melaleuca thymifolia. Most of the tracks which run through this zone were becoming overgrown. At the western end of the zone, an area of approximately 2000 square metres had been burnt, and the ground surface was clear of litter.

Zone C

This zone consisted of two quite distinct environments. The northern part of the area is cleared, with low grass cover and moderately good archaeological visibility. The southern area is relatively undisturbed woodland vegetation with a number of horse riding tracks passing through it. Between these two areas runs a drainage channel, which, in several places, has been diverted to feed into small dams.

SURVEY METHOD

Each zone was surveyed on foot, with two people walking along each transect. Transects followed all tracks and roads, and

where tracks did not occur a straight line bearing N-S or E-W was used. This provided the maximum coverage with the maximum possibility of locating sites within the time available. The transects are shown in figs. 2-4.

Whenever an artifact was found, the surrounding area was examined in detail. If no others were found, the location was noted on the 1:4,000 base map, the size and nature of the artifact recorded, and the transect continued. If more artifacts were found, the distance between artifacts was also recorded, and a National Parks and Wildlife site card was completed.

THE SITES

Aboriginal artifacts were found at seven locations during the survey, and were coded AB/2 - AB/8 (AB/1 being the site already recorded). Of the total of eight locations, one is a major site (more than 30 artifacts), two are minor sites (between 2 and 30 artifacts), and 5 are isolated finds. Sites 1 to 6 occur in Zone A, sites 7 and 8 occur in Zone C, and no artifacts were found in Zone B.

AB/1

Site already recorded at the junction of Brooks Lane and Wiltshire Road. It contains one chert core, one chert scraper and a chert waste flake. The chert is almost certainly obtained from the gravel beds in the river to the west.

AB/2

This is an isolated find of a retouched chert flake ("scraper") in the middle of Wiltshire Road, 110 metres east of the junction with Brooks Lane.

AB/3

One utilised chert flake and two chert waste flakes on the track which runs between the fence and the mined area to the east of the house on Brooks Lane. One flake was found near the south-east corner of the fence, and the other two were found together 70 m to the north.

AB/4

This is an isolated find of a chert flake on the track which runs parallel with Brooks lane. The flake was directly under the fence, south of the house.

AB/5

This is a major site, with 47 stone artifacts located, consisting of one core "scraper", two steep "scrapers", two sharp "scrapers", three concave "scrapers", two utilised flakes, two broken uniface pebble tools, and thirty five waste flakes. The

uniface pebble tools were made of basalt, and all of the other tools were made of chert. Twenty eight waste flakes were chert, five were silcrete, and two were quartz. The waste flakes included a number of small blades.

The site is located around the base of a stockpile of sand on the northern edge of the Dixon plant on Lot 4. Artifacts were found on the track all the way around the base of the stockpile, although there appears to be a greater concentration on the northern side. The entire area is severely disturbed, with sand extraction and stockpiling occurring over an area of several thousand square meters. There is a considerable amount of exposure and reburial of material, for several artifacts which had been observed on the first day the surveys were conducted had been covered by sand and other deposits by the following week.

AB/6

This is an isolated find of a chert flake on the artificial mounded track leading to the sand plant. This flake is several metres above the original ground level, and could have come from anywhere in the immediate vicinity.

AB/7

This is an isolated find of a steep chert "scraper" two metres south of the drainage ditch which divides the cleared from the vegetated areas in Zone C.

AB/8

Five metres south of a dam located inside the fence line in the western half of Zone C was a utilised chert flake which had been broken into two pieces. The pieces were found approximately one meter apart.

DISCUSSION

There is no doubt that the Aborigines used the resources associated with the sand deposits. A large number of food plants have been recorded in the area, including Macrozamia spiralis, Leucopogon spp., Monotoca scoparia, Styphelia laeta, Scaevola ramosissima, Persoonia spp., and a number of orchids and lillies with edible tubers. The woodland habitat would have also supported a substantial population of small animals and reptiles before contact.

The distribution of artifacts suggests that

1. most artifacts in the area are probably covered by at least a few centimeters of sand. All the artifacts recovered were on roads and tracks where the surface was disturbed.
2. there is probably a low density of artifacts across the area, many of which are isolated discarded tools.
3. most of the major site AB/5 is probably now buried under the stockpile of sand, and the rest destroyed by earlier sand

extraction.

4. AB/1-4 and AB/6 may represent activity areas peripheral to the main site at AB/5.
5. AB/5 is probably not a general campsite, but a specific activity site. With over 25% of the artifacts recovered being tools ("scrapers", choppers, and utilised flakes), it probably represents a woodworking site.
6. the site at AB/5 is late holocene, and probably less than 2000 years old. The closeness of the artifacts to the surface, the presence of over 10% silcrete in the assemblage (silcrete increases in local assemblages in the last 3000 years), the lack of patination on the chert flakes, and the presence of microblades all suggest that it is late holocene in age.

Although the area to the north of AB/5 is now destroyed for sand extraction, the adjoining vegetated zone to the east consists of Melaleuca swamps. The swamp may well have been the attraction for the Aborigines who camped on the slight rise overlooking it.

ABORIGINAL COMMENT

The results of this survey have been discussed with Mr. Gil Saunders, the Sites Officer for the Indigenous Peoples Council. He has indicated that the sites located in this survey are of no special significance to the local Aboriginal community, but recommended that the artifacts located should be collected before development takes place.

CONCLUSION AND RECOMMENDATION

All Aboriginal relics in New South Wales are protected by law, and permission must be obtained from National Parks and Wildlife Service before any artifact or site can be damaged or destroyed. I would therefore recommend that permission be sought from the Director that, in line with the wishes of the local Aboriginal community, the artifacts located during this survey be collected, after which time the development be allowed to proceed.

It is possible that older sites are buried in the sand, and could therefore not have been detected during this survey. Other recent sites may also occur within the survey area. The only major site located, AB/5, is grossly disturbed, and therefore of little scientific or cultural value. However, should any further sites be located as the development proceeds, the appropriate action would be to notify National Parks and Wildlife Service immediately.

REFERENCES

- Benson, D. 1981. Vegetation of the Agnes Banks Sand Deposit, Richmond, New South Wales. *Cunninghamia* 1 (1): 35-37.
- Gobert, V. 1978. Proposed nomenclature for the Cainozoic sediments of the Penrith-Windsor area. *Quarterly Notes of the Geological Survey of N.S.W.* 32: 1-9.
- Kohen, J. 1981. Excavations and Surface Collections at an Aboriginal Campsite at Emu Plains, NSW. Unpublished report lodged with National Parks and Wildlife Service.
- Kohen, J. 1983. Surveys and Surface Collections in the Western Cumberland Plain: 1982-83. Unpublished report lodged with National Parks and Wildlife Service.
- Kohen, J., E.D. Stockton and M.A.J. Williams. 1981. Where Plain and Plateau Meet: Recent excavations at Shaws Creek Rockshelter, Eastern New South Wales. *Australian Archaeology* 13: 63-68
- Stockton, E.D. 1973. Shaws Creek Rockshelter: Human Displacement of Artefacts and its Significance. *Mankind* 9: 112-117.
- Walker, P. and C.A. Hawkins. 1957. A Study of River Terraces and Soil Development on the Nepean River, N.S.W. *Proc. Roy. Soc. N.S.W.* 91: 67-84.

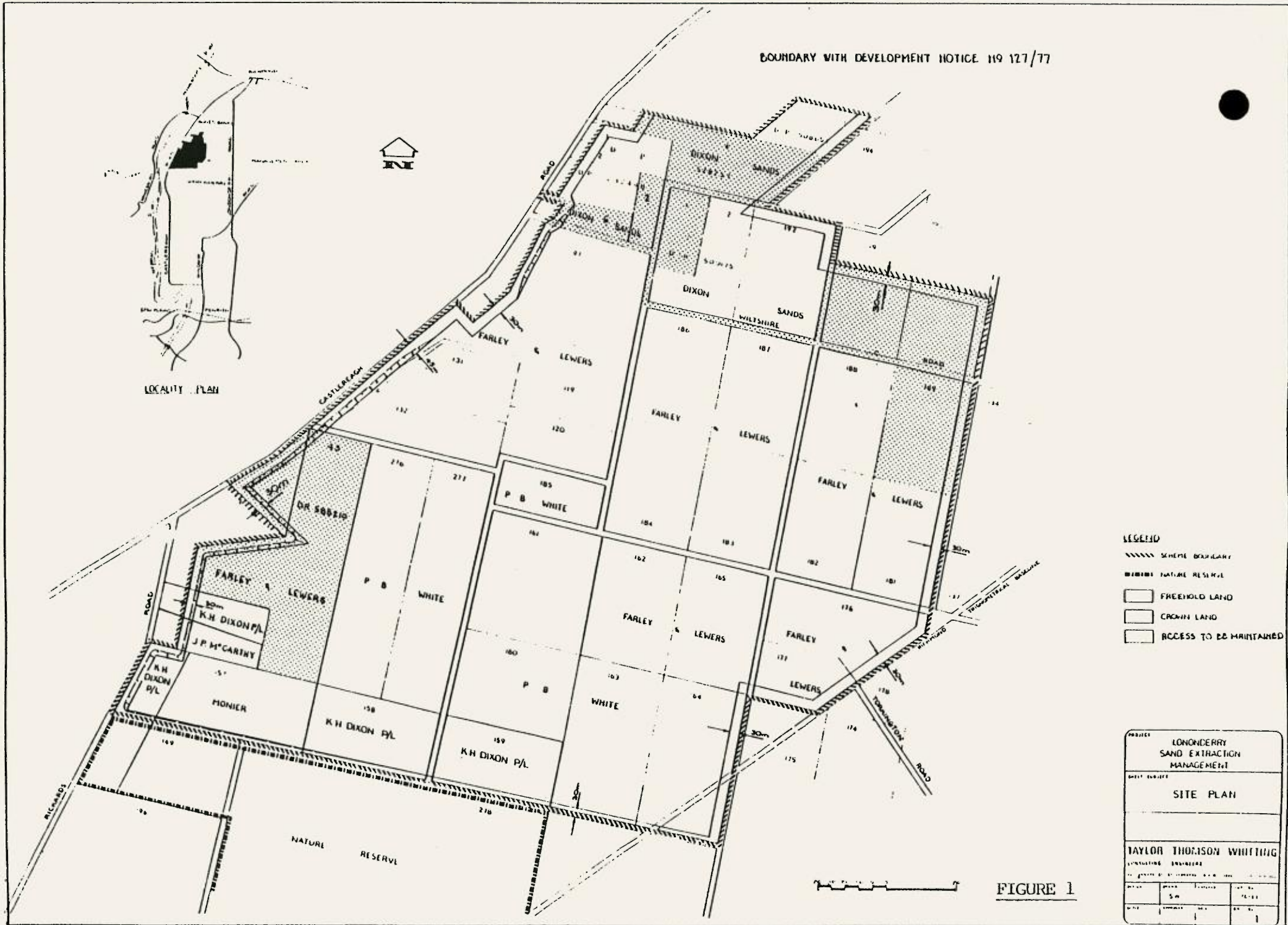
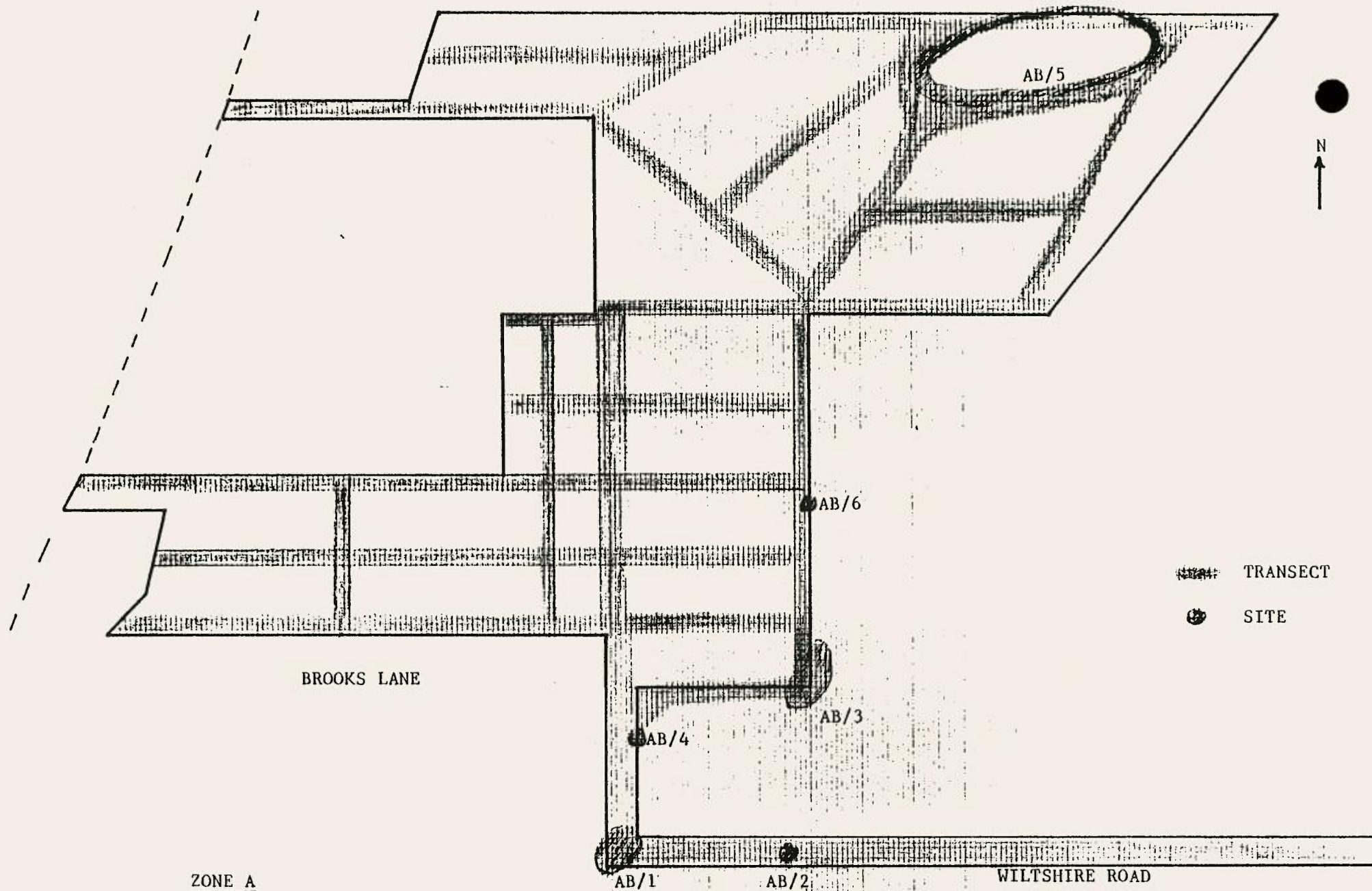
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FIGURE 1



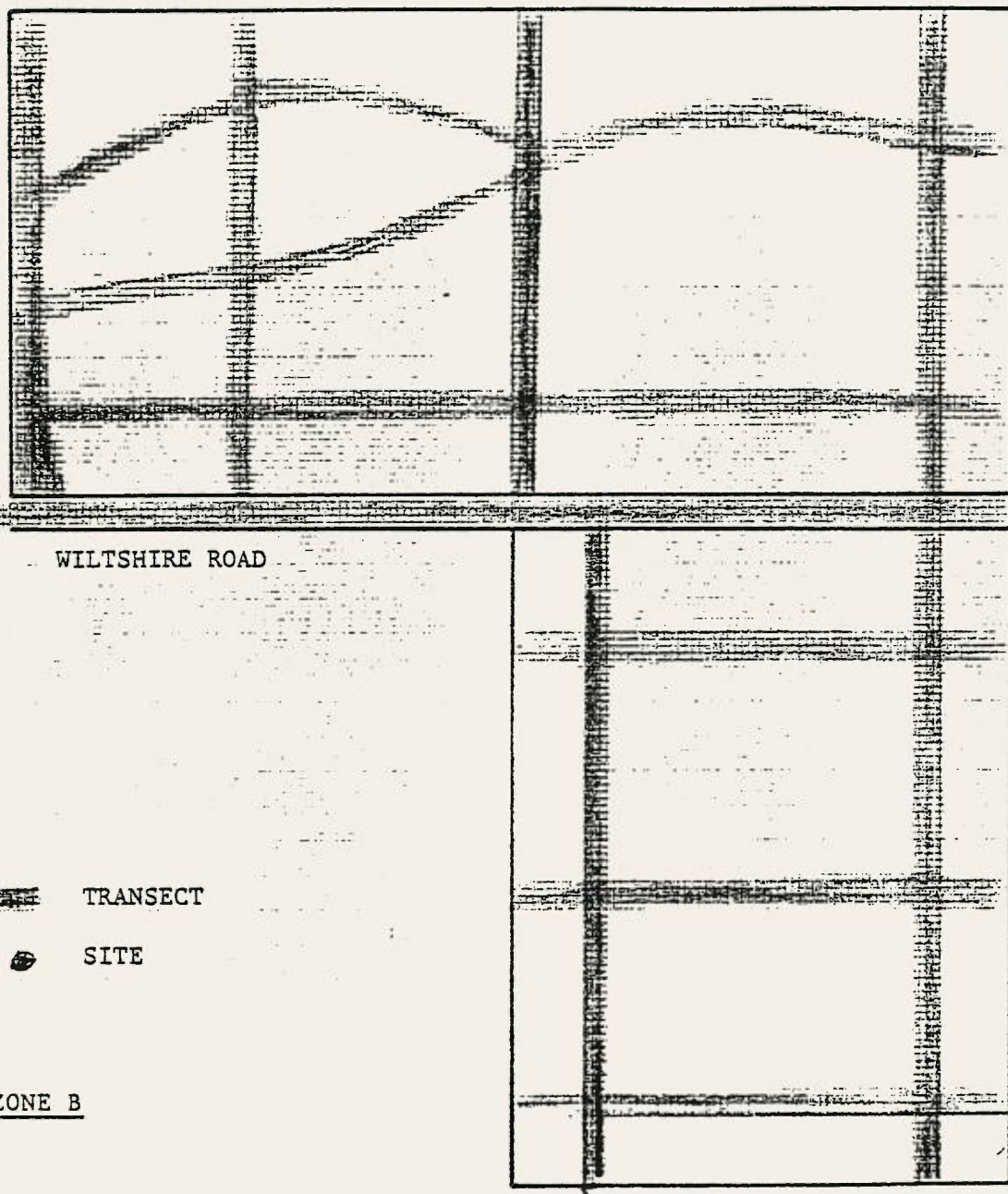
ARCHAEOLOGICAL SURVEY: AGNES BANKS AREA - FEBRUARY, 1984

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FIGURE 2

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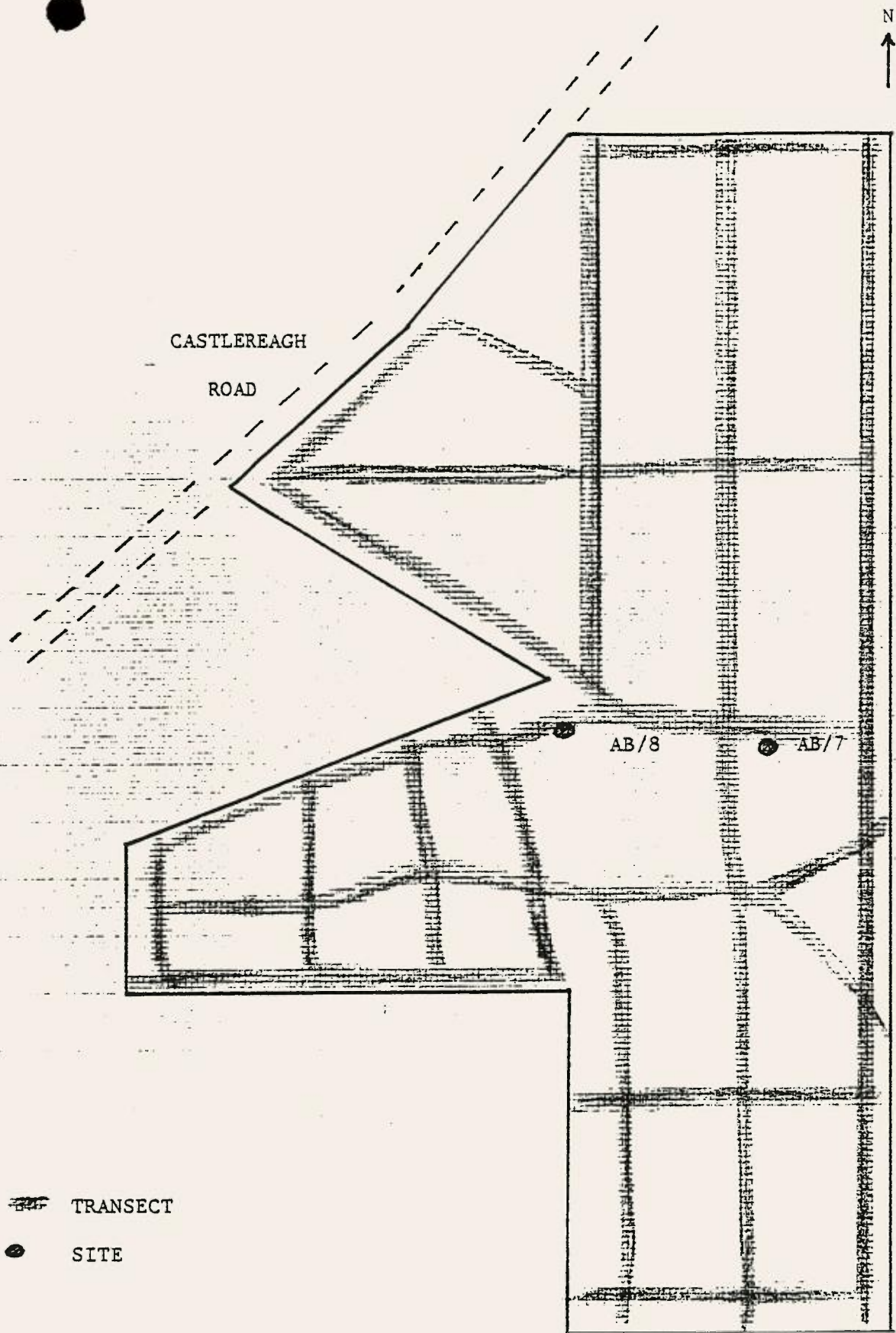


ARCHAEOLOGICAL SURVEY: AGNES BANKS AREA - FEBRUARY, 1984

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FIGURE 3

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ZONE C

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FIGURE 4

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