BENALE PTY LTD

NARRIKUP EXPORT ABATTOIR CONSULTATIVE ENVIRONMENTAL REVIEW

ALAN TINGAY & ASSOCIATES
EVANGELISTI & ASSOCIATES (AUST) PTY LTD
WATER TECHNOLOGY AUSTRALIA

OCTOBER 1995

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REPORT NO: 95/21

AN INVITATION TO COMMENT ON THIS CONSULTATIVE ENVIRONMENTAL REVIEW

This Consultative Environmental Review (CER) describes a proposal for an Export Abattoir at Narrikup near Albany.

The CER describes the proposal and its likely effect on the environment in accordance with the requirements of the Environmental Protection Act, 1986.

The Environmental Protection Authority (EPA) invites people to make a submission on this proposal.

The CER is available for public review for four weeks from 30 October, 1995 to 27 November, 1995.

After receipt of comments from Government agencies and from the public, the EPA will prepare an Assessment Report with recommendations to the Government, taking into account issues raised in public submissions.

Why write a submission?

A submission is a way to provide information, express your opinion and put forward your suggested course of action - including any alternative approach.

It is useful if you indicate any suggestions you have to improve the proposal.

All submissions received by the EPA will be acknowledged. Submissions will be treated as public documents and may be quoted in full or in part in each report unless specifically marked confidential.

Submissions may be fully or partially utilised in compiling a summary of the issues raised or where complex or technical issues are raised, a confidential copy of the submission (or part of it) may be sent to the proponent.

The summary of issues is normally included in the EPA's Assessment Report.

Why not join a group?

If you prefer not to write your own comments, it may be worthwhile joining a group or other groups interested in making a submission on similar issues.

Joint submissions may help to reduce the work for an individual or group, while increasing the pool of ideas and information.

If you form a small group (up to ten people) please indicate all the names of the participants. If your group is larger, please indicate how many people your submission represents.

Developing a submission

You may agree or disagree with, or comment on, the general issues discussed in the CER or the specific proposals. It helps if you give reasons for your conclusions, supported by relevant data. You may make an important contribution by suggesting ways to make the proposal environmentally more acceptable.

When making comments on specific items in the review document:

- clearly state your point of view;
- indicate the source of your information or argument if this is applicable; and
- suggest recommendations, safeguards or alternatives.

Points to keep in mind

By keeping the following points in mind, you will make it easier for your submission to be analysed:

- Attempt to list points so that the issues raised are clear. A summary of your submission is helpful.

- Refer each point to the appropriate section, chapter or recommendation in the CER.

- If you discuss different sections of the CER, keep them distinct and separate, so there is no confusion as to which section you are considering.

- Attach any factual information you wish to provide and give details of the source. Make sure your information is accurate.

Remember to include:

- your name,
- your address,
- the date, and
- whether you want your submission to be confidential.

The closing date for submissions is:

Monday, 27 November 1995.

Submissions should be addressed to:

Environmental Protection Authority
8th Floor, Westralia Square
141 St George's Tce
PERTH WA 6000

Attention: Dr Victor Talbot

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SUMMARY

1. Introduction

This Consultative Environmental Review (CER) describes and analyses the environmental implications of an export abattoir which will be located on a property on Settlement Road, Narrikup, within the Shire of Plantagenet and close to the town of Albany in Western Australia.

The environmental assessment concludes that the proposed abattoir will have no significant environmental impacts in terms of noise, odour, water supply, or on the quantity or quality of water in Mill Brook which flows through the site, provided that it is constructed and operated in accordance with the specifications described in this CER.

2. Benefits

The Narrikup Export Abattoir will provide significant benefits at the local, regional, state and national levels. These benefits include the creation of 350 - 400 direct jobs, most of which will be available to local people; the generation of income and revenue through wages, taxes, purchase of stock and payments for services; and export earnings.

3. The Abattoir Site

The site chosen for the abattoir comprises two adjacent lots with a total area of about 425ha, located 28km south of Mt Barker and 20km north of Albany. The site is zoned Rural and an application for rezoning to a Special Site within the Rural zone has been made. Most of the land has been cleared for agricultural purposes, but there are stands of remnant vegetation on hillocks and along Mill Brook. The site was selected primarily because it offered an abundant supply of groundwater which is more than capable of providing the requirement for process water of 210, 000m^3 per year. In addition, the site is large enough to accommodate all the abattoir facilities including wastewater treatment ponds and areas for the establishment of pasture and tree plantations (wood lots) with adequate separation distances from neighbouring houses to allow for the effective management of noise and odour.

4. Description of the Abattoir

The Narrikup Export Abattoir will have the capacity to process one million sheep and 50,000 cattle each year. It will include stockholding areas, lairage yards, the abattoir itself, a rendering plant for processing animal wastes, a fellmongery for the removal of wool from sheepskins, and a pickling plant for defleeced skins. In addition, there will be wastewater treatment ponds and areas allocated for pasture and wood lots which will be irrigated with treated wastewater.

The abattoir will operate from 7.00am to 4.00pm from Monday to Friday each week, for 210 days each year (ten months). The abattoir will not operate for two months during winter. The transport of stock to the abattoir and of produce to either the Port of Albany or the Port of Fremantle for export, will involve approximately 30 truck movements (15 trucks) each day, from the west along Settlement Road, and 26 truck movements (13 trucks) each day from the east. This represents about three truck movements along Settlement Road to the west of the site and three truck movements along Settlement Road to the east of the site each hour between 7.00am and 4.00pm. This level of traffic is not considered to be significant. Trucks will not arrive at the site during the night.

In addition, there are likely to be between 200 and 400 cars arriving at the plant between 6.30am and 7.00am and leaving between 4.00pm and 4.30pm. Settlement Road will need to be upgraded to accommodate these traffic levels.

5. Environmental Issues

5.1 Site Layout

The layout of the abattoir has been designed to:

- Protect and retain remnant stands of natural vegetation on the site,
- Ensure adequate separation distances for the control of odour between the wastewater treatment ponds and rendering plant and neighbouring houses, and
- Ensure adequate uptake of nutrients in the treated wastewater by the irrigated pasture and wood lots and by the soil in order to minimise the potential for nutrient flows into Mill Brook.

5.2 Construction

Standard construction management practices will be used by contractors in order to control dust and noise emissions.

5.3 Noise

An assessment prepared for this CER by Herring Storer Acoustics indicates that noise levels associated with traffic to and from the abattoir will comply with current Department of Main Roads policy. In addition, the noise from the abattoir itself also will comply with the requirements of the Noise Abatement (Neighbourhood Annoyance) Regulations, 1979.

5.4 Groundwater Supply

Groundwater Technology Australia Pty Ltd conducted a study of groundwater availability and quality on the abattoir site which concluded that the required 1000m^3/day of groundwater could be supplied without any significant lowering of the watertable either on-site or beyond the property boundaries. This specialist study involved the installation of monitoring bores and pump testing from a production bore.

5.5 Wastewater Treatment

The wastewater treatment system for the abattoir will comprise screening and dissolved air flotation (DAF) to remove fat and solids, then passage of the liquid effluent through a series of anaerobic and aerobic treatment ponds. The level of biological oxygen demand (BOD), total suspended solids, and nutrients will be progressively reduced in these ponds through the action of bacteria and algae.

Specific design criteria for the wastewater treatment system are included in the CER. These criteria specify the types of equipment for primary treatment, and the dimensions of the wastewater treatment ponds in order to provide conservative organic loads and hydraulic retention times. This approach will ensure the quality of treated wastewater is acceptable for on-site disposal by irrigation.

5.6 Wastewater Disposal

Treated wastewater from the abattoir will be disposed of on-site by irrigation of pasture and tree crops. The area to be irrigated and the rate and methods of application of the treated wastewater have been specifically designed to ensure adequate uptake of nutrients, to minimise runoff, and to prevent accumulation of salts in the soil profile. The irrigated areas will occupy 140ha and will comprise 40ha of kikuyu/white clover pasture and 100ha of fast-growing eucalypts planted at a density of 1500 trees per hectare. Each year irrigation of the kikuyu/white clover pasture will be rotated so that 20ha is irrigated, with the remainder left to absorb nutrients from the application of treated wastewater in the previous year.

Prior to irrigation, the final treated wastewater will have concentrations of 85mg/l of total nitrogen and 30mg/l of total phosphate. The annual flow rate is estimated at 210,000m^3 per year, which at the indicated concentrations will contain 18 tonnes of nitrogen and 6.3 tonnes of phosphorus.

The nitrogen uptake rate of pasture crops under irrigation is 480kg/ha/year, of dry pasture 175kg/ha/year, and of eucalypts is 90kg/ha/year. The rates of phosphorus uptake are 56kg/ha/year, 20kg/ha/year and 2kg/ha/year respectively. The capacity of nutrient uptake by the irrigation areas is therefore:

Nitrogen

Irrigated pasture	480kg/ha/yr x 20ha =	9.6 tonnes per year
Dry pasture	175kg/ha/yr x 20ha =	3.5 tonnes per year
Trees	90kg/ha/yr x 100ha =	9.0 tonnes per year

Total		= 22.1 tonnes per year

Phosphorus

Irrigated pasture	56kg/ha/yr x 20ha =	1.1 tonnes per year
Dry pasture	20kg/ha/yr x 20ha =	0.4 tonnes per year
Trees	2kg/ha/yr x 100ha =	0.2 tonnes per year

Total		= 1.7 tonnes per year

The application rate of nutrients to pasture and woodlots will be dependent on a number of factors and will vary during the year. As a result, the rates will be determined by an agronomist during the detailed design stage of the wastewater disposal system.

The balance of the phosphorus load not taken up by the crops will be absorbed by the soil in the irrigation areas. These soils will be amended with red mud gypsum to achieve a phosphorus absorption potential of 400kg/ha/m.

5.7 Solid Waste

Solid waste will comprise approximately 200t of faecal material annually from the lairage yards. This will be either sold or given away as fertiliser, or will be disposed of in an approved landfill. As a result, the nutrients in the material will be removed from site and will make no contribution to the nutrient load on the site.

5.8 Odour

There are two main components of the abattoir that have the potential to generate significant odours; the anaerobic treatment ponds and the rendering plant. However, odours can be controlled through appropriate design and management. The anaerobic ponds will be designed to ensure that they adequately handle the predicted BOD loading and to ensure that a crust forms rapidly following commissioning and is maintained thereafter. A dual pond system will also enable occasional cleaning operations to be managed effectively. The anaerobic ponds will also be more than 4m in depth in order to limit odour emissions. Odorous gases produced at the bottom of these ponds have to migrate to the surface before they can enter the atmosphere. The greater the distance between the bottom and top of the pond, the longer is the retention time, and this allows the upwardly migrating gases to be metabolised by anaerobic bacteria with consequent reduction in the potential for odour.

The rendering plant will be designed and operated in accordance with the Environmental Code of Practice for Rendering Plants developed by the EPA, Meat and Allied Trades Federation, and the CSIRO Meat Research Laboratory. The general principles of odour management in the Code of Practice may be summarised as follows:

- A minimum separation distance downwind to the nearest residence of 1000m should be provided.
- The plant should be screened with vegetation and well maintained.

- The operation and management should be based on a management plan which specifies raw materials, rendering processes, materials handling, environmental control measures, and the management of waste materials.
- Vehicles should be kept clean, well painted and well maintained.

The environmental control practices referred to in the above summary are specified in detail in the CER.

6. Environmental Monitoring

It is recognised that the performance of the abattoir will need to be monitored in order to confirm that it is meeting the environmental design objectives described in this CER, and that it is conforming with environmental conditions and regulations. Benale Pty Ltd therefore will implement a monitoring program for the Narrikup Export Abattoir which will provide ongoing information on noise levels, water levels and quality in abstraction bores, soil salinity, and water quality in Mill Brook. The monitoring program will commence prior to commissioning of the abattoir in order to provide data on baseline existing conditions. The information collected will be provided in the form of an annual environmental monitoring report which will be submitted to the Shire of Plantagenet and to the Department of Environmental Protection, and will be made available to the public.

7. Commitments

A series of commitments is made by Benale Pty Ltd at the end of the CER. These commitments confirm that the abattoir will be built and operated according to the principles of Best Practice Management and Technologies as described in the CER. It is expected that these commitments will be converted to conditions by the Minister for Environment if environmental approval for the Narrikup Export Abattoir is granted.

1. INTRODUCTION

1.1 Structure of the Consultative Environmental Review

This Consultative Environmental Review (CER) is intended to provide a comprehensive and easy to read description of a proposed export abattoir at Narrikup to the south of Mt Barker in the Shire of Plantagenet. The information contained in the CER has been prepared in accordance with Guidelines issued by the Environmental Protection Authority (EPA) of Western Australia and includes the following sections:

- An introduction which provides background information to the proposal, details of the proponent, a description of the purpose of the CER and of the environmental impact assessment process in Western Australia, and details of the consultation program which has been implemented to inform the public of the proposal.
- A brief discussion of the economic and employment benefits of the proposal.
- A description of the process which led to the selection of the particular site for the abattoir at Narrikup.
- A description of the abattoir and its major components.
- A description of all inputs required by the abattoir such as livestock, water, electricity and gas, and of the volumes required and sources and routes of supply.
- An analysis of the environmental considerations and environmental management procedures involved in the establishment and operation of the abattoir including such matters as site development impacts, atmospheric emissions, noise, and liquid and solid waste disposal.
- A description and analysis of the transport of livestock to the abattoir site, and of product for export.
- A discussion of the social implications of the proposal.
- A list of commitments by the proponent which relate to the establishment and operation of the abattoir.

A guide describing how to make a written submission on the CER to the EPA is also included together with a summary, a list of relevant references, and technical appendices relating to water supply, liquid waste treatment and wastewater disposal, and drainage management.

1.2 Background

The proposal involves the establishment of an abattoir at Narrikup 28km south of Mt Barker: transport of livestock to the abattoir from locations throughout the lower south-west of Western Australia and the transport of products off-site. The various locations are shown in Figure 1.

It is intended that construction of the abattoir will commence early in 1996 and that production will start during 1997 with full output by the end of that year. The works will have a design capacity to process one million sheep and 50,000 cattle each year.

The site selected for the abattoir was chosen as it is capable of providing all of the water requirements from on-site groundwater resources and because it is strategically located for the receival of livestock and for export of product. The proximity to Albany and Mt Barker is also considered ideal in terms of supplying the workforce requirements.

In order for the abattoir to be established, it is necessary for the proponent to acquire planning approval from the Shire of Plantagenet and the Ministry for Planning as the location must be zoned as a Special Site. The proponent must also acquire environmental approval for the abattoir in accordance with the provisions of the Environmental Protection Act, 1986. This CER in effect is the application for environmental approval and will provide the basis for the assessment of the proposal by the Environmental Protection Authority (EPA).

1.3 Proponent

The proponent for the Narrikup Abattoir is:

Benale Pty Ltd
Lot 1 Yarrandale Rd
DUBBO NSW 2830

The postal address is:

Benale Pty Ltd
P.O. Box 784
DUBBO NSW 2830

Benale Pty Ltd is part of the Fletcher group of companies.

1.4 Purpose of the Consultative Environmental Review

The purpose of the CER is to provide a comprehensive account of the Narrikup Export Abattoir and related activities in sufficient detail to enable all features which may have environmental implications to be identified and described. These features include such matters as potential emissions in the form of noise, dust and odour; the management of liquid and solid waste streams; and the transport of large numbers of livestock and product.

The CER is required to provide an analysis of the environmental implications in order to determine whether the abattoir will meet established environmental standards and requirements, and also an account of management procedures which will be adopted to ensure that environmental performance will be satisfactory throughout the life of the project.

The full scope of the CER is specified by Guidelines issued by the EPA. These Guidelines are provided in Appendix 1.

The CER also provides the basis for an assessment of the proposed abattoir by the Department of Environmental Protection (DEP) and then by the EPA which is required to provide advice on the proposal to the Minister for Environment. The assessment process is described in the next section.

1.5 CER Assessment Process

The environmental impact assessment process in Western Australia is specified by the Environmental Protection Act, 1986 and is illustrated in the flow chart presented in Figure 2. The Act requires the proponent (in this case Benale Pty Ltd) to notify the DEP/EPA of any proposal which may have significant environmental implications. The DEP/EPA then determines whether the proposal should be formally assessed. If a decision is made for a formal assessment, the DEP/EPA requires the proponent to prepare a detailed account of the environmental implications in a report such as the present CER.

After the CER has been prepared, it is reviewed by the DEP to ensure that it provides sufficient detail and a comprehensive coverage of issues. When this has been established, the CER is released for a public review period. In the present case, this public review period extends for four weeks. During this period any person may make a written submission to the DEP/EPA on any aspect of the proposal. At the end of the public review period, a summary of submissions is supplied to the proponent by the DEP and a response is sought to those submissions.

The DEP then begins its assessment of the development proposal taking into account the CER, the public submissions, the response by Benale Pty Ltd to the submissions, and any other relevant information.

The EPA then considers the advice of the DEP and publishes a final analysis of the proposal in the form of an Assessment Report. The Assessment Report includes recommendations to the Minister for Environment as to whether the proposal is acceptable and what conditions should be imposed in order to ensure satisfactory environmental performance. Ultimately, the Minister for Environment decides whether the project should proceed and sets legally binding conditions.

Interested parties can appeal to the Minister about the content of the EPA Assessment Report or any of its recommendations during a specified appeal period.

The environmental assessment process is designed to enable members of the public to obtain details of the proposal and to formally comment on any matters of interest to them. These inputs are required within the specified public review period and are considered by the DEP/EPA together with technical assessments provided by expert staff at the DEP. The public is encouraged to provide written comments to the DEP/EPA as part of the environmental assessment process. Details of the public review period for the Narrikup Export Abattoir proposal and advice on how to make a submission are provided at the beginning of this CER.

The environmental assessment process also enables State Government agencies to consider in detail the implications of development proposals. These considerations are based on technical assessments of the nature and extent of changes to the existing natural and social environment, of proposed management strategies designed to control or limit adverse changes, and of monitoring programs designed to document and analyse the effectiveness of such strategies.

1.6 Relevant Legislation

The Narrikup Export Abattoir will be subject to the provisions of legislation of the Commonwealth of Australia and of Western Australia. The pertinent legislation is diverse and includes:

Aboriginal Heritage Act, 1972-1980
Environmental Protection Act, 1986
Environment Protection (Impact of Proposal) Act, 1974
Local Government Act, 1960-1973
Occupational Health and Welfare Act, 1984
Rights in Water and Irrigation Act, 1914
Soil and Land Conservation Act, 1945-1982
Town Planning and Development Act, 1928-1972
Waterways Conservation Act, 1976
Wildlife Conservation Act, 1950-1979.

In particular, the abattoir will require approvals to operate from several Government Departments as follows:

- Shire of Plantagenet - which is responsible for rezoning the land from Rural to a Special Site.
- Water Authority of Western Australia (WAWA) - which licenses the abstraction of groundwater.
- The Health Department of Western Australia - which controls the operation of abattoirs as noxious industries under the Health Act, 1911.
- Environmental Protection Authority - which issues a works approval for construction following environmental approval by the Minister for Environment, and which may also issue licenses for the disposal of wastes.

- Albany Waterways Management Authority - which has legal responsibilities relating to the bed, banks or foreshore (including foreshore vegetation) of all water courses within its catchment.
- The Commonwealth Department of Primary Industry - which, through its export inspection services, has power to approve the site, the condition of buildings, and the abattoir operations generally.

1.7 Public Consultation Program

1.7.1 Objectives

An extensive public consultation program was undertaken by Benale Pty Ltd before and during the preparation of the CER.

The main objectives of the public consultation program were:

- to ensure that the public was informed of all aspects of the abattoir proposal,
- to identify community concerns and environmental/social issues surrounding the proposal, and
- to inform Government agencies of all aspects of the proposal.

These objectives were addressed through a series of meetings with Government agencies, local interest groups, and individuals.

1.7.2 Meetings

Meetings were essentially held in two stages. The first round of meetings was held after the project was first announced. The second stage was conducted during the preparation of the CER.

The following meetings have been held with interested parties and individuals during the course of the public consultation program:

November 1994	Project Manager Mr Brian May discussed matters related to the project with many individuals after initial announcement of the project in November 1994.
December 1994	The Hon. Monty House (Minister for Primary Industry; Fisheries) chaired a public meeting attended by approximately 200 people.
February 1995	Site meeting involving Department of Agriculture, Department of Conservation and Land Management (CALM), Great Southern Development Commission (GSDC), and local Land Care groups.

March 1995	Meeting at Shire of Plantagenet offices involving concerned residents, DEP, and three members of the EPA board. A site visit was also undertaken by the DEP and EPA.
Friday 16 June 1995	Proponent conducted a site meeting for all interested parties and adjacent landowners. Meetings were also held with the Shire of Plantagenet, the GSDC, the Meatworks Liaison Committee and the Government Officers Technical Advisory Group (GOTAG). GOTAG comprises individuals representing the Department of Agriculture, CALM, Ministry for Planning, WAWA, and the Albany Waterways Management Authority (AWMA). An officer of the DEP was also present.
27-28 June 1995	An officer of the DEP visited the proponent's Dubbo Abattoir to assess managerial and operational systems.
16-17 August 1995	A series of meetings was held with landowners: Mr & Mrs Weycott, Mr & Mrs Woodward, Mr J Liddiard, and Mr & Mrs Ravenhill. Meetings were also held with WAWA, Department of Agriculture, AWMA, Main Roads Department (MRD), GSDC, Meatworks Liaison Committee, and the Rainbow Coast Regional Council.

1.7.3 Issues Raised During the Public Consultation Program

The main issues raised during the public consultation program are listed below. This list presents a summary of the issues raised during the program. The issues are not presented in any order of frequency or perceived importance:

- Wastewater management
- Nutrient management
- Noise from plant
- Odour
- Traffic
- Land price fall
- Dust generation
- Road upgrade
- Noise from traffic

- Difficulty in moving dairy cows across the main access roads into the abattoir (the need for an underpass).

2. BENEFITS OF THE PROJECT

Since the closure of the Metro Meats Abattoir at Albany, there has been a sustained effort involving State Government agencies and the combined local authorities of the Town of Albany, Shire of Albany, and Shire of Plantagenet, to establish a new abattoir in the Albany region. The proposed Narrikup Export Abattoir offers this opportunity.

The benefits of the project will be substantial at the regional level, particularly in terms of providing a market for livestock producers, and in terms of local employment. At the national level, the abattoir will generate significant export earnings each year and the Federal Government will also receive revenues from company tax, personal income tax from the workforce, and other taxes and duties. Similarly the State of Western Australia will receive direct payments from the project, for example in the form of payroll tax. At the local level the project will pay rates to the Shire of Plantagenet.

At the regional level, the abattoir will have the capacity to receive up to one million sheep and 50,000 cattle per year and will produce an equivalent number of carcasses or volume of produce for export. The abattoir is expected to source livestock from throughout the Albany region and beyond so there is the potential for farmers to benefit throughout a very large area. If export is through Albany then the Albany Port Authority will also receive increased revenues from shipping and other charges.

The abattoir is also expected to create 350-400 direct jobs and more than 90% of these will be available to local people. Additional jobs will be created through flow-on effects throughout the region and particularly at Albany and Mt Barker, where most of the workforce is expected to live. The number of additional jobs created by such multiplier effects is expected to exceed the number directly employed at the abattoir and the total employment generated by the project could be in the order of 1000 jobs.

3. THE LOCATION OF THE ABATTOIR

3.1 Location

The proposed site for the abattoir is on Lot 4 of Location 5215 and Location 5216 Settlement Road, Chorkerup (see Figure 3). The lots cover an area of about 425ha and are within the Shire of Plantagenet approximately 28km to the south of Mt Barker, 20km to the north of Albany, and 11km south-east of the Narrikup townsite.

3.2 Site Selection

In regional terms, the Albany-Mt Barker area is considered to be favourable for the location of an export abattoir as it is within economic transport distance of a large area of agricultural land from which livestock can be sourced, and it is close to a port.

The actual site for the abattoir was selected because an abundant supply of groundwater is available at the location. There is significant demand for water use in the abattoir and having an on-site supply is cost efficient compared to delivery from the regional water supply.

Alternative sites are hypothetically available at both the Down Road and Yerriminup Industrial Sites in the Shires of Albany and Plantagenet respectively. These sites are zoned for Industrial Use and various initiatives have been taken to ensure that they are suitable for a wide range of industries including an abattoir (Alan Tingay & Associates, 1993a, b). However, neither of the industrial sites has the potential to provide substantial volumes of groundwater for an abattoir and water supply would have to be sourced from the Albany-Mt Barker pipeline operated by WAWA. The purchase of scheme water would add significantly to the operating costs of the proposed abattoir and could make it uneconomic. This is the main reason Benale Pty Ltd deemed the existing industrial sites as unsuitable despite their strategic location and zoning.

The Narrikup site is also considered suitable as it has the following features:

- Sufficient land to provide suitable separation distances between surrounding houses and ponds.
- Soil conditions suitable for the disposal of treated wastewater by irrigation of forage crops and woodlots and uptake of any residual nutrients.
- Sufficient areas for the establishment of fodder crops and tree plantations for irrigation.
- Established access through the regional road network.
- An adjacent electricity supply.

3.3 Current Zoning and Re-zoning Requirements

The land lies within the Shire of Plantagenet, immediately north of the boundary with the Shire of Albany. It is currently zoned Rural under the Shire of Plantagenet Town Planning Scheme (TPS) No. 3, as is the surrounding land. A 2.6305ha Drainage Reserve is located immediately north of Lot 4, and houses are situated on Location 5212, and Part Location 5215. The surrounding lots vary in area from 50ha to 300ha and average about 200ha.

Under the terms of the Shire of Plantagenet TPS No. 3, the Shire Council may permit a site which is zoned Rural to be used for an abattoir after the proposed use has been advertised for public comment. Once the Shire Council has given its approval, the locations will be designated as a Special Site for use for an abattoir in the Rural zone.

3.4 Current Use of the Site

The abattoir site is currently owned by Mr Doug Russell, but Benale Pty Ltd has an option to purchase subject to approvals being granted to proceed with the proposed abattoir. The locations are used for grazing about 200 head of beef cattle and for hay and oat crops used for fodder.

3.5 Climate

The Narrikup area is within 10km of the Albany Airport Meteorological Station where detailed weather data has been recorded since 1968.

The area has a warm temperate climate with wet winters and dry summers. The climate is mainly influenced by the sub-polar pressure belt, which provides a continuing pattern of high and low pressure systems and associated polar cyclonic fronts which move eastwards across the southern portion of Australia. These rain-bearing cold fronts provide most of the seasonal rainfall in the area as the pressure belts shift towards the equator in winter and the south pole in summer.

There is a distinct rainfall period from April to September, with the highest average monthly rainfall of 123mm occurring in July. However, some rain was recorded in every month up to 1990 since records began in 1968. The average monthly rainfall from December to March is 26.4mm.

Pan evaporation is highest from November to March and averages between 4.4mm/day and 6.7mm/day, compared with only 2mm/day to 3mm/day for the remainder of the year.

Temperatures are highest in January and lowest in August. The average summer maximum is 22.9°C while the average minimum is 15.8°C. During winter the average maximum is 16.2°C and the average minimum is 9.0°C.

Strong winds are common and there is only a small number of calm days. Low pressure cells dominate winter patterns causing mainly westerly winds, whilst the dominant high pressure systems of summer generally cause easterly winds. Afternoon winds in summer, however, tend south to south-easterly due mainly to seabreezes. Figure 4 presents seasonal wind roses measured at Albany Airport at 0900 hours and 1500 hours.

3.6 Geology

The abattoir site lies on strata of the Tertiary Plantagenet Group. These rocks lie in the Bremer sedimentary basin and sit unconformably over gneissic rocks of the Albany-Fraser Province.

Drill hole data collected to the east of Mill Brook indicate that the geology of the site comprises Pallinup Siltstone underlain by pale grey felsic gneiss.

The Pallinup Siltstone is described by Muhling and Brakel (1985) as a unit of Late Eocene age (approximately 45 to 40 million years before present) that is of shallow marine origin. It consists of siltstones, clayey/silty sandstones, and spongolite.

On the abattoir site the Pallinup Siltstone was intersected in all holes drilled for groundwater testing purposes, and is present as a relatively thick sequence (up to 42m) of intercalated sands and silts, spongolite, and greenish well-sorted glauconitic sands that rest unconformably on the gneissic basement. It is representative of the unfossiliferous claystone-siltstone-sandstone sequence described by Morgan and Peers (1973) as an inland shallow-water facies equivalent of the Pallinup Siltstone.

The rocks lowermost in the stratigraphic column of the abattoir site are the Proterozoic gneisses (about 2600 to 650 million years before present) of the Albany-Fraser Province. Where intersected in drill holes the gneiss forms an undulating basement surface comprising a pale grey felsic gneiss, containing mainly quartz, feldspar and biotite.

3.7 Soils

3.7.1 Description

Three soil units are shown on the Mount Barker-Albany soils map of Churchward *et al.* (1988) for the abattoir site. These soil units are named:

- Redmond,
- Dempster, and
- S6 Minor Valley Type.

The Redmond and Dempster soil units are described as possessing duplex profiles and developing on siltstone and sandstone basements. The duplex profiles are characterised by a sandy surface, a bleached A_2 horizon, a yellow mottled clay B horizon and a layer of lateritic gravel or duricrust between the A and B horizons.

The Redmond soil unit was mapped by Churchward *et al.* (1988) as covering most of the abattoir site (Figure 5) and this was confirmed by data from a series of auger holes excavated by Alan Tingay & Associates in 1995 over the site (Figure 6). However, the presence of the Redmond Soil unit on the western side of Mill Brook, as mapped by Churchward *et al.* (1988), was not confirmed by the more recent work. A typical profile of the Redmond Soil Unit on site comprises:

- A 1cm to 2cm thick black sandy humic layer,
- A 5cm to 20cm thick grey well-sorted fine quartz sand (A_1 Horizon)
- A 10cm to >110cm thick bleached well-sorted fine white quartz sand (A_2 Horizon),
- A 10cm to >90cm thick lateritic gravel horizon of variable induration, and
- A 100cm to 120cm thick light orange/brown gravel and clay rich sand (B Horizon).

For each of the auger sites a composite soil sample was collected and sent to Analytical Reference Laboratories (ARL) for Phosphorus Retention Index (PRI) analysis. Results are listed in Table 1A. These data were then compared to the classification system outlined by Allen and Jeffrey (1990) (see Table 1B).

TABLE 1A
Phosphorus Retention Indices (PRI) for Soil Samples Collected from the Export Abattoir Site, Narrikup

Sample Nbr	PRI	Sample Nbr	PRI
SNA 1	4.0	SNA 8	100
SNA1A	16.6	SNA 9	184
SNA 2	4.0	SNA 10	5.8
SNA 2A	55.4	SNA 11	1.7
SNA 3	>900	SNA 12	<1
SNA 4	25.3	SNA 20	4.3
SNA 5	9.6	SNA 21	>900
SNA 6	<1	SNA 22	7.4
SNA 7	1.9	SNA 23	40.1

TABLE 1B
Soils Classification Using Phosphorus Retention Indices (after Allen Jeffrey, 1990)

PRI	CLASSIFICATION
<2	very weakly adsorbing or desorbing
2-5	weakly adsorbing
5-20	moderately adsorbing
20-70	strongly adsorbing
>70	very strongly adsorbing

Samples with "strongly adsorbing" and "very strong adsorbing" classifications are from topographically higher areas where the A_1 and A_2 Horizons are not as thickly developed. Conversely, samples that have "very weakly adsorbing or desorbing" and "weakly adsorbing" classifications are mostly situated in lower areas, where development of the A_1 and A_2 Horizons is more extensive.

According to Churchward *et al.* (1988) the Dempster soil unit is present in a small semi-circular pod on the western side of Mill Brook abutting the southern boundary. A typical profile consists of light grey brown to light brownish grey fine sand A horizons, often with lateritic gravel, some laterite boulders, and yellow and brown mottled clay B Horizons. The presence of the Dempster soil unit also was not confirmed during recent drilling and soil mapping.

The S6 Minor Valley soil type is described by Churchward *et al.* (1988) as forming in narrow v-shaped valleys that are incised in sedimentary rocks (i.e. Pallinup Siltstone). The soils comprise sandy, yellow duplex soils on valley slopes and deep sands on narrow swamp floors. This soil type is confined to a narrow band encompassing Mill Brook and a small stream to the west of Mill Brook (Figure 5).

3.7.2 Soil Drainage

The infiltration rates of soils at five locations on the site (Figure 6) have been assessed as part of the studies associated with this CER (Groundwater Technology Australia Pty Ltd, 1995). The sites selected included the principal soil types found on the property. The results, shown in Table 2, demonstrate that the soils are permeable and very well drained, with infiltration rates generally two orders of magnitude greater than those found in surface soils at the WAWA wastewater disposal site near the Albany Airport.

TABLE 2
Infiltration Rates

Sample Number	Average Co-efficient of Permeability (m/Sec)
NAIF - 1	2.4×10^{-5}
NAIF - 2	5.6×10^{-5}
NAIF - 3	1.4×10^{-5}
NAIF - 4	6.4×10^{-5}
NAIF - 5	4.0×10^{-5}

3.8 Groundwater

A specific study was commissioned to determine the availability of groundwater on the site for supply to the abattoir (Groundwater Technology Australia Pty Ltd, 1995). The results of this study are provided in Appendix 2.

In summary, the study involved drilling three bores to bedrock (51m, 38m and 38.5m in depth respectively) and one test production bore to a depth of 25m. Figure 6 indicates the locations of these bores. The bores generally encountered surface sand and laterised sediments in the first 0.25m to 1.5m below the surface and then leached sands, silts and clays of the Plantagenet Group. Depth to groundwater varied from 3.6m to 13.5m and averaged 8.3m in the four boreholes drilled.

All of the bores intercepted layers of fine sand below siltstone which yielded significant groundwater supplies. The greatest thickness of sand was 23m, starting 13m below ground level in BH7. This area therefore was chosen as the location of the test production bore.

Groundwater was pumped from the production bore for a trial period of 24 hours during which the groundwater levels were monitored. The pumping rate of 300m^3/day did not produce any significant drawdown in nearby monitoring wells. Computer modelling of the effects of abstracting 1,000m^3/day to supply the abattoir also indicated that there would be minimum impact on groundwater levels beyond the property boundaries (Figure 7). The study therefore concluded that supply of 1,000m^3 of groundwater per day to the abattoir from on-site groundwater resources was readily achievable.

Salinity levels in the groundwater ranged from 1690mg/L to 2720mg/L TDS, and the level of salinity increased with the depth from which groundwater was abstracted. The groundwater study concluded therefore that a series of bores should be inserted into the upper, fresher section of the groundwater aquifer to supply water to the abattoir. McFarlane et al, (1995) reported groundwater salinity in this upper part of the aquifer to be between the maximum desirable value for human consumption (500mg/L or 90mS/m) and the maximum permissible value (1,500mg/L or 270mS/m). A similar range of salinity values was recorded in the upper part of the aquifer on the neighbouring property to the west. A conductivity of 246mS/m was also recorded in Millbrook. Groundwater provides baseflow to Millbrook throughout the year.

Further information about the use of treated wastewater from the abattoir for irrigation of wood lots and pasture on the site is provided in Section 5.9.2 of this CER.

Detailed information on groundwater abstraction and the effects of irrigation on groundwater levels is provided in Appendix 2.

3.9 Topography

The Narrikup Abattoir site is situated on a very gently undulating plain which comprises part of a dissected plateau. The site itself comprises a suite of broad, low undulating hillocks, ridges and spurs that are bisected by the valley of Mill Brook which is aligned south-south-east (Figure 8).

There is an overall slope on the site to the south-south-east. Mill Brook enters the northern edge of the site at an elevation of about 92m ASL, flows through the site for approximately 1.93km, and exits across the southern boundary at an elevation of about 80m ASL. The difference in elevation gives an approximate overall gradient of the site of about 1:160.

The hillocks mostly form broad, gently sloping prominences that on average rise about 5m to 10m above the surrounding area. Slope gradients on the hillocks tend to be relatively low with most between 1:25 and 1:45. Several of the hillocks are covered by remnant vegetation.

The steepest gradients on the site are associated with slopes to Mill Brook. These are often around 1:10, but may be as high as 1:6 and as low as 1:20.

3.10 Mill Brook

The abattoir site is located in the upper catchment of Mill Brook which flows into Oyster Harbour. The locations of the brook and its major tributaries are shown in Figure 9. The brook traverses the central part of the abattoir site and then flows about 18km to Oyster Harbour. Most of the catchment area of Mill Brook has been developed for agriculture.

3.11 Vegetation

The abattoir site is situated within the Narrikup Vegetation System as defined by Beard (1981). The dominant vegetation type in this system is a low to medium density Marri (*Eucalyptus calophylla*) Woodland.

However, a large proportion of the site has been cleared of original vegetation for farming purposes, and stands of remnant native vegetation are now confined to the tops of hillocks and ridges and to the banks of Mill Brook. The Mill Brook channel is also lined by bunch grasses and reeds. Stands of Tasmanian Blue Gum (*Eucalyptus globulus*) planted in rectangular-shaped plots for erosion and stock protection purposes are also scattered throughout the property.

The remnant vegetation includes areas that contain species listed as rare and endangered (*Banksia brownii*, *B. goodii* and *Eucalyptus goniantha goniantha*) under the provisions of the Wildlife Conservation Act, 1950-1979. These areas are situated along the southern boundary of the property and within the vegetation lining Mill Brook.

3.12 Vertebrate Fauna

There are three main types of habitat for vertebrate fauna on the proposed abattoir site. These are:

- Areas of remnant vegetation,
- Mill Brook, and
- Pasture land.

It is considered that the remnant vegetation and Mill Brook are likely to support the most species while the pasture will provide a niche for a few birds.

A survey of vertebrate fauna on the site has not been made because the abattoir has been designed so that the remnant vegetation and Mill Brook will not be affected. Therefore, the important habitats and the fauna they support will be retained.

Areas of pasture will also remain but some existing pasture will be converted to tree plantations. These will provide a new additional habitat for some bird species.

4. DESCRIPTION OF THE PROPOSED ABATTOIR

4.1 Site Plan

The layout of the Narrikup Export Abattoir and associated facilities is shown in Figure 10. The abattoir itself and holding areas for livestock occupy a relatively small part of the north-east sector of the site. To the immediate north and west of the abattoir buildings is a series of ponds which will be used for the various stages of wastewater treatment. The treated wastewater will be diverted from the final treatment pond located to the south-west of the abattoir building to irrigate forage crops and tree plantations on-site.

Further information on the disposal of treated wastewater by irrigation and uptake of nutrients by forage crops and tree plantations is provided in Section 5.9.2.

4.2 Abattoir Process Description

4.2.1 General

The proposed Narrikup Export Abattoir will be designed to process one million sheep and 50,000 cattle each year. The abattoir will operate from 7.00am to 4.00pm, Monday to Friday, for a total of 210 days per year. There will be a 10 week shut-down over winter which coincides with a period of low sheep supply. The shut down will provide opportunities for plant maintenance and will reduce the demand for groundwater. Most importantly, however, the production of wastewater will cease at a time when evaporation rates are lowest and rainfall in the region is highest.

The abattoir will process about 4,800 sheep per day and about 240 cattle per day, to produce roughly 160t of meat. Currently it is envisaged that the sheep and cattle will be processed in the manner described below.

4.2.2 Sheep Processing

Live Sheep Receival and Holding

Sheep delivered to the abattoir will be placed in open holding yards. These yards will be grassed with kikuyu/white clover for forage and irrigated. Residence time in the yards may be up to two days if the sheep are "hollow" and need feeding prior to slaughter. Mostly, however, the sheep will be moved quickly (within a day) into the lairage yard to await slaughter. Stocking rates in the holding yards (paddocks) and lairage yards will comply with industry standards. If necessary the size of the holding paddocks can be increased by reducing the area of the proposed woodlots on the property (Figure 10). Any such modification would be examined by an agronomist to ensure that nutrient uptake rates would remain static or increase above those described in Section 5.9.2.

The lairage yard will be an elevated, roofed building with a wire floor capable of holding one day's kill (approximately 4,800 sheep) in a number of pens. The lairage yard will cover 2,500m^2 (50m x 50m) and it will be maintained near capacity by transferring sheep from the open holding yards as others are moved to the slaughter line. The wire floor of the lairage yard will allow droppings to pass through onto a concrete pad which will be bunded and cleaned regularly. The manure will be processed and sold or given away as fertiliser so that the nutrients are exported from site.

Drinking water will be provided in both holding and lairage yards. Sheep will be moved by one or two individuals and a number of experienced dogs.

Abattoir

Sheep will pass via a chute to the slaughter line from an elevated area where they will be stunned using high voltage (800v) stimulation. The sheep will then be slaughtered using the Hal-Al technique, although slaughter for other markets will also be possible.

The slaughter line will be a standard inverted dressing type, capable of processing 10 sheep per minute. It will use two-stage pelt pulling (shoulder and final), face skinner, auto hock cutter and an evisceration table with automatic wash. An above-floor stainless steel trough will be used for blood harvesting and a multi-pan system with automatic washing will be used for evisceration. Edible offal will be recovered adjacent to the kill line where it will be washed, drained and packed. An auto carcass wash cabinet will be installed for use only when sheep are classified as dirty (not a standard procedure).

Carcasses will pass from the slaughter floor into a "drying room" chiller where they will be held prior to boning. There are two boning lines - "hot" and "cold". Carcasses allocated for "hot" boning will be held in the drying room for only about three hours prior to boning, whilst those allocated for "cold" boning will be held overnight for chilling. In both cases carcasses will be broken down by "Bullsaw" (large) into primals before being boned by cut. The meat will then be packaged and sent to a carton freezer prior to despatch by refrigerated container. A small cold store will be incorporated into the design of the abattoir to hold partial loads prior to despatch. A maximum of six refrigerated containers will be packed with mutton for shipment each day.

All paunches separated on the slaughter floor will be split, washed, and frozen for pet food using a plate freezer. The contents of each paunch and the wash water used for cleaning will pass to the inedible offal area for primary screening before entering the paunch effluent stream or being passed to the rendering plant.

Casings removed on the slaughter line will receive a primary wash prior to being packed and frozen for transhipment to the Dubbo plant owned by RJ Fletcher and Co., where they will be further processed prior to export.

All inedible offal will be conveyed from the slaughter line by gravity chute to a trommel type washer screen and then to a Simo pump for transfer to the rendering plant.

Condemned carcasses from the slaughter line will drop directly to the Simo pump for transfer to the rendering plant.

Rendering Operations

The rendering plant will be designed to produce meat meal, blood meal, and tallow using a dry rendering process. The plant will be fed by inedible offal and condemned carcasses transferred via a Simo pump from the slaughter line. Fleshings, trotters and face pieces will be transferred from the slaughter line using a forklift whilst bones and fat from the boning room will be transferred by trailer. Screenings from parts of the wastewater system will also be rendered. All of the material for rendering will be placed in the raw materials bin prior to passing through a pre-breaker into the cooker. The materials will then be centrifuged, pressed, milled, and screened to produce meat meal and tallow. The tallow will be polished through a polishing centrifuge and collected in a tank prior to despatch.

Blood from the slaughter line will be pumped directly to a continuous in-line coagulator in the rendering plant. It will then be centrifuged prior to passing into a surge bin before being dried in a ring drier. Meat meal and blood meal will pass directly to separate shipping containers after processing.

Fellmongering

Skins removed from sheep on the slaughter line will fall directly from the puller to a skin bay below the floor. They will then be fleshed prior to transport by trailer to the fellmongery. Fleshings will be directed to the rendering plant. Skins with a wool length of less than about 35mm (short skins) will be transferred directly from the fellmongery to the pickling shed for salting. All other skins will be sprayed with acetic acid, sweated in humidifiers on racks, and then passed by hand through a stripping machine to remove the wool. Liquid wastes will pass to the wastewater system.

Defleeced skins will be sent to the pickling plant whilst the wool will be baled and eventually transported to RJ Fletcher & Co.'s woolscouring plant at Dubbo for further processing.

Pickling Plant

Upon arrival at the pickling plant, defleeced skins from the fellmongery will be agitated in a sodium sulphide liming solution. They will then be placed in a sulphuric acid based pickling solution before being rinsed and placed on pallets for transport. Spent pickling solution will pass to the wastewater system.

4.2.3 Cattle Processing

Live Cattle Receival and Holding

Cattle will be received and held separately from the sheep. Holding yards for cattle will be grassed with kikuyu/white clover and irrigated. Additional feed and water will also be provided. The animals will be moved within two days from the open holding yards into the lairage yard prior to slaughter. The cattle lairage yard will lie under the same roof as the sheep lairage yard and will be constructed in a similar manner. It will occupy about 12m x 12m and will be continually replenished with stock from the yards as animals are drawn off for slaughter. Faeces will fall through the mesh floor to collect with other droppings. This material will be removed off-site on a regular basis.

Abattoir

Cattle will pass from the lairage yard to a stunning box, where they will be electrically stunned before being discharged onto a dry landing area. The animal will then be shackled and hoisted to the bleeding rail for sticking, weasand clipping, and low voltage stimulation (for accelerated conditioning). The mechanised rail system will move the suspended carcass down the dressing line where the horns and muzzle will be removed. This will be followed by first and second leg clearing operations, udder removal, bung tying, flanking operations and foretrotter removal. Hides will be removed using a downward hide stripper. Heads will then be severed and hooked onto a head rail before being washed and prepared for inspection.

The carcass will then be eviscerated, with food offal being separated for cleaning and packing, non-food offal being separated for pet food, and condemns passing down a chute for transfer with any condemned carcasses to the rendering plant.

Following evisceration the carcass will be split evenly through the backbone. Remaining food offal (kidneys, tails) will then be removed and the material despatched to the offal packing area. Sides will be trimmed, washed, weighed, and graded before passing to the boning room.

As with the sheep carcasses, hot and cold boning will be employed for beef. A mechanised rail system will be used. Boning operations will commence on the foreshank/neck and work up the side to remove the various cuts and bones as the sides pass along the rail. The removed cuts will pass on for trimming. Fat and bones from this operation will be chuted below for conveyance to the rendering plant.

Trimmed meat will be bulk packed into plastic-lined cartons and sent to the carton freezer prior to stamping and despatch by refrigerated container. About two containers will be filled with beef daily. Therefore, the total daily meat production from the abattoir (sheep and cattle) will be eight refrigerated containers.

The offal processing area will be located off the boning room and will receive offal from the slaughter line. Food offal will be washed, trimmed, and packed to export requirements.

All non-food offal will be passed to the non-food offal area from the slaughter floor. Here it will be cleaned and packed prior to freezing on the plate freezer and despatch for pet food. Paunch contents will be flushed into the effluent stream or passed to the rendering plant.

Rendering Operations

All inedible offal, trimmings, and condemns will pass from the beef processing line to the rendering plant. Blood collected on the slaughter line will be piped directly to the rendering plant where it will join blood from the sheep slaughter line.

Rendering operations for beef by-products will be the same as for the sheep.

Hides

Hides will be trimmed of excess fat and stabilised prior to despatch for tanning.

4.3 Utilities

4.3.1 Water Supply

It has been assumed for planning purposes that the Narrikup Export Abattoir will require a maximum of 1,000m^3 of water each day. The annual water requirement (210 days) therefore is 210,000m^3. These amounts are based on knowledge of requirements at the Dubbo Abattoir operated by the proponent and also on figures from abattoirs in Western Australia.

Alan Tingay & Associates (1993a), in a review of abattoir water requirements, indicated that the processing of cattle typically requires 5.3m^3 of water per tonne of live weight killed. The average live weight of cattle is 0.36t/head. Therefore, the water required each year to process 50,000 cattle at the Narrikup Export Abattoir is:

$$50{,}000 \times 0.36 \times 5.3 \quad = \quad 95{,}400\text{m}^3$$

Similarly, the average amount of water required to process sheep is 2.5m^3/t and a sheep weighs 0.04t on average. The volume of water required each year to process one million sheep is therefore:

$$1{,}000{,}000 \times 0.04 \times 2.5 \quad = \quad 100{,}000\text{m}^3$$

The estimated annual water requirement is therefore 195,400m^3. The assumed demand of 210,000m^3 each year is deliberately conservative and has been used for the assessment of groundwater to ensure that an adequate supply of water is available.

The groundwater assessment, described in Section 3.8 of this CER and included in Appendix 2, concluded that this amount of water could be supplied from on-site resources without any deleterious effect on Mill Brook or on other existing or potential groundwater users in the area.

4.3.2 Sewage Disposal

Sewage originating from the workforce ablution facilities may be treated by a dedicated wastewater treatment system such as an aerobic treatment unit (ATU) or a conventional septic tank system. The effectiveness (in terms of site nutrient loads) and cost of each system will be assessed in association with advice from the Health Department of Western Australia prior to any decision relating to the choice of a system for the abattoir.

Large capacity ATUs are available such as the bioMAX system. Such systems typically have the following components:

- Anaerobic chamber - for primary settlement and anaerobic treatment.
- Aeration chamber - for aerobic treatment.
- Clarification chamber - for sludge settlement and removal.
- Disinfection chamber - for contact with chlorine.
- Pump out chamber.

Usually, the effluent from the pump out chamber is directly discharged to a suitable irrigation area. However, at the proposed abattoir the discharge will be directed to the aerobic pond of the abattoir wastewater treatment system. This treatment system is described in detail in Section 5.8.3.

A recent issues paper published by WAWA (1994) states that alternative wastewater treatment systems provide a safe and reliable alternative to conventional reticulated sewerage and associated large centralised wastewater treatment plants.

All ATUs are required to meet standards of the Health Department of Western Australia and to be approved by that Department and the Local Authority. They also must be licensed by the DEP if they treat more than 20m^3/day. It is likely that any such unit at the proposed abattoir will treat between 40m^3/day and 50m^3/day.

4.3.3 Electricity Supply

The proposed abattoir will require approximately 2,500kVa of electrical power. A 22,000 volt power line is located 300m to the east of the abattoir site boundary and this will be upgraded. Initial discussions have been held with Western Power to negotiate electricity supply.

4.3.4 Gas

Requirements for gas will be met by on-site storage. This storage will be built to the necessary design and regulatory standards (AS 1596).

4.4 Transport

4.4.1 Transport Routes

The location of the abattoir in relation to the regional road network is shown in Figure 11. It is considered that the majority of the workforce will travel to and from the abattoir via Albany Highway and Settlement Road. Similarly, all meat from the abattoir will be transported via Settlement Road and then Albany Highway either to the Port of Albany or north to Perth and the Port of Fremantle. If the Port of Albany is the destination, the trucks will use Hanrahan Road and Princess Royal Drive to access the harbour.

Trucks delivering livestock to the abattoir will arrive from both the west and east. From the west, the route again will be via Albany Highway (from both north and south) and then Settlement Road. From the east, the main route will be via Hassell Highway, Kalgan-Napier Road, Chester Pass Road, and Jackson Road to the abattoir. Jackson Road will be upgraded to encourage its use by heavy vehicles instead of other local roads between Chester Pass Road and the abattoir.

4.4.2 Traffic Levels

It is assumed that the majority of livestock delivered to the abattoir will be transported by large stock haulage vehicles. Initially, only about 400 to 500 sheep per day will be delivered but this number will increase in the first 6 to 12 months to the full capacity of the abattoir of about 4,800 sheep and 240 cattle each day.

About 400 sheep will be carried by each truck. Therefore, at full production, 12 trucks per day will be required for delivery of sheep. This means 24 truck movements to and away from the abattoir.

Similarly, at full production, 240 cattle per day will need to be delivered to achieve the target of 50,000 cattle processed each year. About 40 cattle can be carried in each truck. Therefore 6 truck deliveries will be required each day or 12 truck movements to and away from the abattoir.

It is estimated that 80% of trucks delivering sheep will come from areas east of the abattoir and will return in that direction, while 20% will come from the west. This represents 20 truck movements per day from the east and four truck movements per day from the west.

In contrast, it is estimated that 80% of cattle trucks will come from areas to the west of the abattoir and 20% from the east. This represents 10 truck movements per day from the west and two truck movements per day from the east.

Trucks will also be used for transport of products from the abattoir. The approximate number of truck movements involved will be four carrying skins and pelts to and from the east, and 16 to and from the west carrying meat in refrigerated containers to cold storage either at the Port of Albany or the Port of Fremantle and returning empty each day.

The total number of truck movements from each direction therefore will be as follows:

• From the west:	Sheep	4
	Cattle	10
	Products	16

	Total	30 Truck movements
• From the east	Sheep	20
	Cattle	2
	Products	4

	Total	26 Truck movements

The trucks will arrive at and depart from the abattoir over a period of 9 hours each day between 7.00am and 4.00pm. Therefore, there will be about 3 truck movements from and to the west per hour each day and about 3 truck movements per hour to and from the east.

The delivery of meat in refrigerated containers to the port may occur in batches for direct loading onto ships rather than by a daily operation. The ships are likely to load between 20 and 60 containers and it will take a semi-trailer to transport each container. Therefore, between 40 and 120 truck movements could be required from and back to the abattoir on a continuous basis in this scenario. If it is assumed that the maximum number of 120 truck movements occurs during the daytime (i.e. 7.00am to 7.00pm) then this represents 10 truck movements an hour. This would be in addition to the 14 truck movements per day involved in the transport of sheep and cattle to the abattoir from the west. The total number of truck movements from the west therefore would be 134 per day or a maximum of about 11 per hour for one day.

It is emphasised that campaign hauling of meat, if it occurs, will only be on occasional days when a ship is in port.

In addition, the 350- 400 employees will drive to work each day, arriving between 6.30am and 7.00am and will depart between 4.00pm and 4.30pm. Most of these workers are expected to use Albany Highway and Settlement Road. The number of cars likely to be involved is between 200 and 400 depending on how much car pooling occurs.

4.5 Project Life Span

There are no reasons why the Narrikup Export Abattoir should not continue to operate indefinitely given favourable economic circumstances and stock supply.

5. ENVIRONMENTAL ISSUES

5.1 Site Use and Layout

The abattoir will process agricultural produce and the main beneficiaries will be farmers in the south-west region who will have a local market for their sheep and cattle thus saving significant transport costs. Therefore, it is appropriate that the abattoir is sited in an agricultural area. This appropriateness is indicated by the fact that an abattoir is a permitted use in areas zoned Rural in the Shire of Plantagenet TPS No. 3.

The layout of the abattoir has been designed specifically to minimise the potential for off-site environmental effects. In particular, the separation distance between the abattoir and wastewater treatment ponds and nearby houses was a major factor in determining the site plan shown in Figure 10. A minimum distance of 700m separation has been provided. This may be compared to the separation distance of 500m from wastewater treatment ponds to the nearest house recommended by the Victorian Environmental Protection Authority (VEPA) for the control of odour. Similarly, the rendering plant associated with the proposed abattoir will be 1100m from the nearest house. This distance conforms with the separation recommended by VEPA for control of odour from such plants and by the WA Environmental Code of Practice for Rendering Plants developed by the EPA, the Meat & Allied Trades Federation and the CSIRO. The recommended separation distance of 1,000m is independent of prevailing wind conditions and is considered a conservative figure.

However, it is considered that the wastewater treatment ponds, rendering plant, and other facilities associated with the abattoir will not be significant sources of odour, as odour control will be a priority of their design and operation. This is further described in Section 5.13.3.

The disposal of treated wastewater by irrigation of fodder crops and tree plantations also has been designed specifically to minimise the potential for nutrient flows into Mill Brook. This is further described in Section 5.9.2.

5.2 Vegetation and Fauna

The proposed abattoir will not have a significant impact on vegetation or vertebrate fauna. The site plan has been designed so that none of the remnant vegetation will be disturbed as this vegetation provides the most diverse fauna habitats. Mill Brook, which also has potential value to fauna, similarly will not be affected by the proposal.

5.3 Construction

5.3.1 Dust

There is the potential for dust to be generated during earthworks associated with construction of the abattoir, particularly during dry summer conditions. Therefore, the proponent will require all contractors responsible for earthworks to manage and suppress dust using water trucks or other forms of water spray. There will be no unstable areas within the abattoir site following construction as roads and other surfaces will either be paved or will be planted for pasture, fodder crops, or tree plantations.

5.3.2 Noise

Noise will be generated during the construction period, particularly by earthmoving machinery. All construction contractors will therefore be required to manage noise levels within acceptable limits. The management measures will include restriction of construction activities to daylight hours (7.00am to 7.00pm Monday to Friday, and 8.00am to 7.00pm on weekends) and a requirement that noise from stationary equipment such as generators does not exceed 85dB(A) at a distance of one metre.

5.3.3 Disposal of Construction Wastes

All contractors employed on the abattoir site during the construction phase will be required to collect and dispose of wastes in accordance with the requirements of the Shire of Plantagenet.

5.3.4 Environmental Management During Construction

The management and supervision of construction activities with respect to dust, noise, and waste collection and disposal, will be the responsibility of the contractors engaged to build the abattoir. The Shire of Plantagenet and residents living close to the abattoir site will be provided with a contact phone number for a person nominated by Benale Pty Ltd who will have the responsibility to respond to and resolve any complaints regarding environmental issues associated with construction of the abattoir.

5.4 Traffic Implications

5.4.1 Traffic Density

The number of truck movements to and from the proposed abattoir from the west and east is not large. Therefore there is not likely to be any disruption of traffic on the roads used. There is also not likely to be any significant disturbance to people living close to the roads given both the low traffic levels and the daytime hours of operation.

However, it is recognised that some road upgrading will be needed to provide safer driving conditions for transport to and from the abattoir and for other road users. Preliminary discussions have occurred between representatives of Benale Pty Ltd and the Albany office of the Main Roads Department (MRD) to identify desirable road improvements, and these will be finalised during the assessment of this CER. The potential improvements include:

- Turning lanes on Albany Highway into Settlement Road.

- Turning lanes on Chester Pass Road into Jackson Road.

- Increasing the width of seal and improving the depth of pavement and drainage on Settlement Road between Albany Highway and the abattoir. This may require an increase in the width of the road reserve. At present, Settlement Road has a sealed width of 5.6m, nominal 150mm gravel pavement depth, and table drains in a 20m wide road reserve. It is probable that any upgrade would include an increase in the sealed width of the road to 7m with a 1m gravel shoulder each side and an increase in the depth of pavement to 300mm. An increase in the road reserve of about 10m may also be required to accommodate revegetation.

- A general upgrade of Jackson Road from Chester Pass Road to the abattoir site, including improvements to corners and drainage, and sealing the road to the same specifications as outlined above.

The car traffic to and from the abattoir in the morning and afternoon will be substantial but confined to relatively short periods of time. The level of service provided by Albany Highway is not likely to be affected by these traffic levels as it is a major road. However, traffic levels will be increased significantly on Settlement Road and there is the potential for interference with existing local use of that road.

Two issues are recognised in this respect, namely the use of Settlement Road by the local school bus and cattle crossings on the road. In the morning, the traffic to the abattoir is not likely to coincide with the school bus as the shift will start at 7.00am. The bus normally passes through the area between 7.30am and 7.45am and travels from Jackson Road west along Settlement Road to Albany Highway. Therefore, it will be travelling in the opposite direction to the workforce traffic. A milk collection truck also passes through the area daily between 7.30am and 9.30am west along Settlement Road.

In the afternoon, there is more potential for the school bus and abattoir worker traffic to coincide between 4.00pm and 4.30pm. However, the bus will be travelling east along Settlement Road in the afternoon in the opposite direction to the majority of workers who will be leaving the abattoir site and travelling west to Albany Highway.

There are two farms on Settlement Road between Albany Highway and the abattoir site which has land on both sides of the road. However, only one has the need for a regular cattle crossing. The car traffic to the abattoir could effectively prevent use of this crossing for 30 to 45 minutes before 7.00am and after 4.00pm each day, or alternatively, cows crossing the road at these times could significantly delay workers travelling to and from the abattoir. The number of truck movements during the rest of the day is not large and therefore is not likely to create any conflicts in road use.

Benale Pty Ltd recognises the potential for delays at this crossing and has had discussions on the issue with the Minister for Agriculture, the Department of Agriculture and the land owner. Further discussions are required to identify the best option for minimising the potential for disruption but the proponent is confident that an effective resolution will result.

5.4.2 Traffic Noise

An assessment of the implications of traffic associated with the abattoir in terms of noise levels has been made by Herring Storer Acoustics (see Appendix 3). The traffic scenarios considered were as follows:

1. From the west - 30 truck movements per day between 0700 hours and 1600 hours.
2. From the east - 26 truck movements per day between 0700 hours and 1600 hours.
3. From the west - 300 light vehicles between 0630 hours and 0700 hours and between 1600 hours and 1630 hours.
4. From the west (occasionally) - 120 truck movements per day between 0700 hours and 1900 hours.

Scenario 4 above relates to campaign haulage of meat products to a port site for direct loading onto a ship in berth. This is an option which may occur instead of progressive transport of meat to a cold store at the port to await the arrival of a ship. The noise levels associated with these scenarios are listed in Table 3.

TABLE 3
Narrikup Abattoir Predicted Noise Levels At 50m from Road Traffic

SCENARIO	SOUND LEVEL dB(A)	
	L_{10} 1 Hour	L_{10} 18 Hour
1	51	38
2	49	35
3	61	51
4	56	44

There are currently no statutory regulations that govern road traffic noise. However, the Department of Main Roads has a policy that traffic noise at residential locations should be restricted to an L_{10} 18 hour of 63dB(A) wherever practicable. The DEP considers that this level should be 58dB(A) wherever practicable. The DEP also considers that instantaneous (maximum) levels should not exceed 80dB(A) but preferably should be closer to 65dB(A) (R. Langford pers. comm., 1995).

The predicted traffic noise levels associated with all of the above scenarios are less than the criteria suggested by the DEP of an L_{10} 18 hour of 58dB(A).

The higher noise level of 61dB(A) for Scenario 3 is associated with the two 30 minute periods each day when workers are driving to or from the site.

All trucks licensed for road use must comply with noise levels between 81 to 87dB(A) at a distance of 7.5m when in motion and stationary levels of 93 to 103dB(A) at 1m. This is equivalent to noise levels ranging from 65 to 71dB(A) at a distance of 50m. These levels are well within the instantaneous (maximum) level of 80dB(A) suggested by the DEP.

5.5 Noise from the Abattoir

An appraisal of noise associated with the abattoir operations has been made for this CER by Herring Storer Acoustics (see Appendix 3).

The abattoir will be regulated under the Environmental Protection Act, 1986 and specific regulations of the Noise Abatement (Neighbourhood Annoyance) Regulations, 1979. These regulations define acceptable noise levels at houses close to an industry based on the existing noise environment. For example, the noise regulations stipulate that a higher noise level is acceptable within a commercial or urban area than in a rural environment.

The abattoir site is zoned Rural but special uses such as an abattoir are allowable provided that they are approved by the local authority. Areas where commercial operations are allowable fall within Category B2 of the Noise Abatement (Neighbourhood Annoyance) Regulations, 1979. A worst-case noise level (night time) of 45dB(A) is acceptable for Category B2. However, it is considered that a lower worst-case noise level is more appropriate in this instance given that the area is at present entirely rural with no other industries nearby.

Therefore, the abattoir will be designed to ensure that the noise levels fall within Category A2 of the regulations. The maximum noise levels for Category A2 are as follows:

Monday to Friday 0700-1900 hours	45dB(A)
Monday to Friday 1900-2200 hours	40dB(A)
Weekends and Public Holidays 0700-2200 hours	40dB(A)
Always 2200-0700 hours	35dB(A)

As the abattoir will operate only on a daytime shift from Monday to Friday, the relevant maximum noise level is the first on the above list, namely 45dB(A).

Predicted noise emissions from the abattoir are based on actual measured levels of an existing abattoir in Western Australia. The levels were measured at a distance of 200m from the acoustic centre of the operating abattoir under downwind (i.e. worst-case) conditions and indicated an overall noise level of 52dB(A). There is the possibility of tonal components in the noise, particularly at 125Hz and 50Hz.

These measured levels indicate that the abattoir, if considered as a point source of noise, has a sound power level of approximately 105dB(A). Based on this sound power level, the sound pressure levels at various distances under downwind conditions are as follows:

200m	52dB(A)
400m	46dB(A)
800m	40dB(A)
1600m	34dB(A)
3200m	29dB(A)

The house closest to the proposed abattoir building is at a distance of 1100m and the next closest is 1800m away. At these distances, the noise levels based on the above measurements and calculations would be 36 and 33dB(A) respectively. These are the maximum predicted levels.

However, as there is likely to be a tonal component to the noise, an additional 5dB(A) must be added to these predicted noise levels in accordance with the requirements of the noise regulations. The maximum predicted noise level at the nearest house is therefore 41dB(A). This level is less than the Category A2 criteria from Monday to Friday 0700-1900 hours of 45dB(A).

Therefore, the noise appraisal concludes that the proposed abattoir can comply with the Noise Abatement (Neighbourhood Annoyance) Regulations, 1979. A further, more detailed assessment of noise will be made at the design stage of the abattoir to ensure that the total noise emission does not exceed a total sound power level of 110dB(A) and that no tonal characteristics exist. In order to achieve this, most plant such as refrigeration units and compressors will be located inside enclosures, and cooling towers and condensing units may require discharge silencers.

5.6 Light Spill

The Narrikup Export Abattoir will not have extensive external lighting, as it will not be operational at night. Security and safety lights will be installed, but it is not expected that these will generate noticeable off-site light spill, particularly as the abattoir will be partially screened by irrigated and rainfed tree plantations. Nearby houses are also located at some distance from the abattoir buildings.

However, if any light is considered to be a nuisance to surrounding landowners, it will either be shrouded or relocated to an acceptable position.

5.7 Groundwater Supply

The on-site assessment of groundwater resources by Groundwater Technology Australia Pty Ltd (1995), and subsequent computer modelling of groundwater abstraction on the aquifer, indicate that 1,000m^3 of groundwater can be supplied daily without any significant lowering of the water table on-site or beyond the property boundaries. Therefore, it is considered that groundwater supply has no significant implications for water flows in Mill Brook or for groundwater use by others in the vicinity of the abattoir.

5.8 Wastewater Treatment

5.8.1 Wastewater Characteristics

Abattoir wastewater consists of settleable and suspended solids that are largely biodegradable. It contains no heavy metals or toxic compounds but does contain small quantities of inorganic material such as salt. The biological materials in the wastewater comprise mainly fat and protein derived from meat tissue, blood, waste tallow, yard washing and gut contents. As a result, the wastewater is made up of a colloidal dispersion of fat and protein together with soluble materials such as blood.

The general characteristics of abattoir wastewater depend largely on processing efficiency and management practices in relation to water and waste usage. The CSIRO lists a typical abattoir wastewater analysis as follows:

Temperature approximately	35°C to 37°C
pH	7
BOD	2,000mg/L
Total Solids	3,500mg/L
Suspended Solids	2,000mg/L
Total Fat	1,700mg/L
Total Nitrogen	150mg/L
Total Phosphorus	30mg/L

BOD, or Biochemical Oxygen Demand, is a measure of the amount of organic material in the wastewater which requires oxygen for decomposition. The oxygen is obtained from dissolved oxygen in the water which may be replenished from the air or by photosynthesis by aquatic plants if these are present. If wastewater with a high BOD was discharged directly to a natural water system, the availability of dissolved oxygen in that water system could be reduced as a result of the decomposition of the incoming organic material. In turn, this could stress or kill aquatic life which is also dependent on that oxygen supply. Direct discharge of such wastewater is therefore not appropriate and treatment to reduce BOD levels is required.

For abattoir wastes, Total Suspended Solids (TSS) is also a measure of the amount of organic material which is present in the wastewater stream.

Abattoir wastewater is rich in nutrients particularly nitrogen. The nitrogen is in the form of ammonia, generally from animal urine, and organic nitrogen. Blood and protein-rich material such as muscle also contains nitrogen. Phosphorus is present in animal tissue and blood. Another large source of phosphorus is phosphate-based detergents which are used in the abattoir for cleaning.

The elements of nitrogen and phosphorus are usually referred to collectively as nutrients. Nutrients are essential for life but high nutrient levels in natural waterways can promote extensive algae and larger plant (macrophyte) growth. These eutrophic conditions can lead to the death of aquatic organisms, including fish and waterbirds, and can cause odour and other problems associated with the decomposition of algae.

Similarly, the discharge of excessive amounts of nitrate, ammonia, or organic nitrogen onto land may result in more nitrate being available than can be taken up by plants or lost by denitrification. This could lead to nitrate contamination of groundwater, and the water could become unfit for human or animal consumption.

Therefore, abattoir wastewater must be treated in order to reduce BOD, TSS and nutrients to levels which have little or no effect on the environment.

5.8.2 Wastewater Treatment Systems - Background Information

The treatment of wastewater from abattoirs and associated industries is a sequential process comprising a number of integrated stages. The main stages are:

- Minimisation of water use through good plant design.
- Primary treatment in which fats and solids are removed.
- Secondary treatment in which bacteria and algae break down the organic matter.

An efficient system for treatment of abattoir wastewater would comprise in-series, primary treatment by screening and dissolved air flotation (DAF) to remove solids, and secondary treatment comprising an anaerobic pond, a low rate aerobic pond and an aerobic maturation pond. Once the wastewater had passed through this system it would then be suitable for disposal by irrigation of pasture and/or tree plantations.

The components of this treatment system are described in more detail below.

Primary Treatment

Effective primary treatment is very important since inadequate treatment at this stage would allow large quantities of solids to enter the first ponds in the secondary treatment system. These solids would settle to form a sludge layer on the base of the ponds. Subsequent bacterial breakdown of the solids would liberate large quantities of nitrogen (as ammonia ions) and phosphate into their liquid phase, which would adversely affect the efficiency of the system.

Large quantities of nutrients may also be introduced into the ponds if blood recovery in the abattoir is not efficient. Raw blood is extremely high in nitrogen and phosphate, due to its considerable protein content (15% by weight). Therefore, efficient blood recovery in the abattoir is required in order to reduce the nutrient load on the wastewater treatment system.

In modern abattoirs, the production of both solid waste and the release of blood is limited as most of the by-products which are not suitable for human consumption are further processed at a rendering plant (on-site or off-site) to useable products such as animal feed, tallow, and blood meal. This means that the nutrients are transported off-site as products. If a rendering plant is not available however, the solids can be disposed of to an approved land fill site. The solids which are periodically removed from the wastewater treatment ponds also may be used as a soil conditioner.

In excess of 90% fat and 70% solids can be recovered by using stationary and rotating wedgewire (contra shear) screens followed by DAF. The DAF system involves saturating a portion or all of the effluent feed with air at 250 to 300kPa pressure. The water is held at this pressure for between 30 seconds to three minutes in a detention tank and then released to atmospheric pressure in the flotation tank. This sudden reduction in pressure releases microscopic air bubbles which attach themselves to oil and suspended particles. The bubbles float to the surface to form a froth layer which is removed continuously by mechanical skimmers.

Secondary Treatment

Secondary treatment of abattoir wastewater commences once solids have been separated and the wastewater is discharged into a series of anaerobic and aerobic ponds. These are described below:

Anaerobic Ponds

The term "anaerobic" means that no oxygen is present, i.e. the biological oxygen demand in the wastewater is high enough for all of the dissolved oxygen to be consumed. In these ponds a proportion of the organic wastes in the wastewater is destroyed by bacteria which can survive in anaerobic conditions.

Anaerobic treatment ponds are ideal for abattoir effluent which has high influent BOD (2,000mg/L), nutrients, a temperature of 40°C, and sufficient fat to form a natural scum and insulation layer on the surface of the pond. The treatment system is simple to construct and operate, and commonly achieves 80% reduction in both BOD and Suspended Solids.

Anaerobic treatment is a two step process as follows:

- Soluble organic materials are converted by bacteria to volatile acids, carbon dioxide, hydrogen, bacteria cells and other products.
- Volatile acids (primarily acetic acid) and other products are converted to methane and CO_2 by methane-producing bacteria.

As maximum bacterial growth occurs at 35°C (methane bacteria grow best between 15°C and 38°C), the design of the pond must cater for variations in atmospheric temperature throughout the year, particularly in southern Australia where lower temperatures will slow bacterial activity in winter. The temperature of effluent from abattoirs helps in this regard since it is in the vicinity of 40°C. The maintenance of this warm temperature in the anaerobic pond is assisted by pond depth (4m to 7m), a small surface-to-volume ratio and the insulating surface scum that forms over the pond. The scum also assists in reducing odour. A pH range of 6.4 to 7.8 (preferably 7.0 to 7.2) is also important to the proper operation of anaerobic ponds.

Aerobic (Low Rate) Ponds

Aerobic ponds are large shallow ponds (depth up to 1.5m) in which both algae and bacteria further break down organic matter. In these ponds the amount of oxygen available for bacteria is maximised. Oxygen enters the liquid through atmospheric diffusion and is also produced by algae through the process of photosynthesis. The nutrients and carbon dioxide released by the bacterial action are, in turn, used by the algae. The algae assist in stabilising the pond since they use carbon dioxide, sulphates, nitrates, phosphates, water and sunlight to synthesise their own organic cellular matter and give off oxygen. However, algae also can be a nuisance and therefore their abundance is controlled.

The algae do not remove nitrogen or phosphorus to any significant extent since when the algae die they release their organic matter back into the pond.

Aerobic Maturation Ponds

Maturation ponds are designed to provide continuing aerobic treatment while the wastewater is stored awaiting disposal by irrigation of crops or wood lots. In southern Australia it is important to be able to store treated effluent for extended periods during winter rather than to use it for irrigation as plant growth is reduced and evapotranspiration is low at this time. The biological mechanisms operating in these ponds are similar to those operating in other aerobic ponds. Residual biological solids in the effluent are attacked by bacteria and ammonia is converted to nitrate using the oxygen supplied from surface re-aeration and from algae.

Maturation ponds generally have a minimum depth of about 600mm at the end of summer and may be up to 2,000mm deep at the end of winter. The depth is designed to provide sufficient holding capacity while still maintaining aerobic conditions in the pond. Maintenance of aerobic conditions is assisted by the low loading rates of incoming effluent. For example, BOD loading from low rate aerobic ponds typically is only 50mg/L to 100mg/L. It is common to achieve a further 60% to 80% reduction of BOD in a maturation pond and if retention times are long enough, significant reductions in nitrogen are also possible. A retention time of 18 to 20 days is suggested as the minimum period required for satisfactory operation.

5.8.3 Wastewater Treatment at the Narrikup Export Abattoir

Design

The design of the wastewater treatment system for the Narrikup Export Abattoir will conform with recommendations contained in the CSIRO Meat Research Laboratory and University of Queensland publication "Abattoir Wastewater and Odour Management". Calculations used to determine pond sizes and nutrient management techniques are based on an effluent loading of 1,000m^3/day for 210 working days per year. Total daily effluent flows from all parts of the plant are illustrated in Figure 12, and indicate that an assumed effluent loading of 1,000m^3/day is conservative. The abattoir will also operate on a single day shift and shut down during the winter months of June and July for maintenance. This will have the added benefit of producing no wastewater at a time when temperatures are lowest and precipitation is highest.

The proposed abattoir is similar to the proponent's existing abattoir at Dubbo in New South Wales and the wastewater treatment systems are equivalent.

The wastewater treatment strategy proposed for the Narrikup Export Abattoir is illustrated in Figure 13 and comprises primary treatment using screens and a DAF unit, and secondary treatment using two anaerobic ponds in parallel, two aerobic ponds in series, and a single aerobic maturation pond. Wastewater from the aerobic maturation pond will be used to irrigate forage pasture and wood lots. The predicted performance of the proposed wastewater treatment strategy is illustrated in Figure 14.

The calculations used to determine pond sizes, hydraulic retention times, and loading rates within ponds are presented in Appendix 4.

Primary Treatment

The most effective primary treatment methods will be employed at the Narrikup Export Abattoir so that the recovery of fats and solids will be maximised. To accomplish this, both stationary and rotating wedge wire (contra shear) screens will be employed. At the Dubbo Abattoir the most effective screens have an aperture of 0.5mm.

The DAF unit will be purchased from specialist manufacturers and will be designed to meet specific criteria, such as the air-to-solids ratio, water recycle ratio, and loading/residence time (see Table 4). A single DAF unit with a surface area of 14m^2, a diameter of 2m, and a depth of 3m will provide a 20 minute residence time based on a recycle ratio of 1:3 for an effluent discharge averaging 125m^3/hr. This discharge figure relates directly to the number of hours that the facility would be operating over 210 days/year. Operation of the DAF unit will be completely automatic. The outlet will be connected to the distribution piping system and varying demand will automatically be adjusted by the inlet flow regulating valve which will maintain a constant level in the flotation tanks. The backwashing system will be automatically operated by a clear well level control and timer.

It is considered that fat recovery in excess of 90% and solids recovery in excess of 70% will be achieved by the operation of the wedgewire screens and the DAF unit.

The performance of the DAF unit will be examined weekly by monitoring of the inflow and outflow effluent and only trained staff will be assigned to DAF system duties. Should the DAF system malfunction however, the remainder of the wastewater treatment system (including the tertiary maturation pond) have been designed to absorb the deficiency for up to three months.

TABLE 4
DAF Design Criteria

Parameter	Range
Pressure (kPa)	300 to 400
Air to Solids ratio (kg/kg)	0.3 to 0.6
Residence Time (min)	15 to 25
Recycle (%)	<120%
Surface Hydraulic Loading (m^3/m^2/hr)	9 to 12

Secondary Treatment

Anaerobic Ponds

Anaerobic ponds will be used at the Narrikup Export Abattoir because of their ability to greatly reduce both BOD and suspended solids from inflowing wastewater. According to

Reed *et al.* (1985) in climates where the average yearly temperature equals 20°C, the following design criteria should yield a BOD removal of 50% or better:

- Volumetric organic loading up to 300gm BOD/m^3/day.
- Hydraulic retention time of approximately 5 days.
- Depth between 2.5m and 5m.
- Influent temperature between 30°C and 40°C.

The CSIRO (Newsletter 91/4), however, recommends hydraulic retention times (HRT) of 10 to 12 days and organic loads of 200 to 300kg BOD/1,000m^3 of pond volume.

Two anaerobic ponds will be constructed and used in parallel at the Narrikup Export Abattoir. Each of these ponds will have a volume of 15,000m^3. During normal operation, 500m^3 of wastewater will be delivered to each pond each day. The incoming wastewater will have an estimated BOD level of 1,500mg/L which means that a total of 750kg of BOD will be delivered to each pond daily. This represents a BOD loading of 50kg/1,000m^3 of pond volume. Similarly, the hydraulic retention time of each pond will be 30 days (15,000 ÷ 500).

The estimated BOD level of 1,500mg/L for inflowing wastewater is lower than the CSIRO figure of 2,000mg/L for general abattoir wastewater because the Narrikup Export Abattoir will be using a DAF unit. Such units are capable of reducing the BOD and suspended solids in inflowing wastewater by approximately 25%. The CSIRO figure is based only on the removal of gross solids by screening not on the use of a DAF unit.

The design performance of the pond therefore greatly exceeds the criteria recommended by the CSIRO.

During the initial phases of operations at the abattoir it will only be possible to properly operate one aerobic pond because of low wastewater volumes. However, as wastewater volumes increase to their maximum another pond can be phased in to operation. There will also be short periods during normal operations when a single anaerobic pond may be used while the other pond is being cleaned. In this case the full 1,000m^3 of wastewater from the abattoir will be delivered to the pond each day. The total amount of BOD delivered will be 1,500kg and the BOD loading will therefore be 100kg/1,000m^3 of pond volume. Again, this is well within the design criteria recommended by the CSIRO.

A conservative approach has been adopted in the design of the treatment ponds in order to allow for the following potential operational problems:

- Inevitable short circuiting,
- Reduction in pond volume due to storage accumulation, and
- Shock loads.

The design should result in a BOD reduction of at least 75% in winter.

Scum formation on the surface of the ponds is very important for containing odour emissions. Therefore, it will be accelerated during commissioning by at least one of the following:

- Use of raw effluent initially.
- Straw or hay on the surface.
- An artificial cover, such as biodegradable plastic.

Polystyrene floats or ropes may also be used to restrict wind-induced scum movement.

The predicted concentrations of various contaminants in the effluent leaving the anaerobic ponds are listed in Table 5. These effluent concentrations are based on data from the Dubbo Abattoir since the design specifications proposed at Narrikup are similar to those currently being utilised at Dubbo.

TABLE 5
Anaerobic Pond Performance

CONTAMINANT	INFLUENT (mg/L)	EFFLUENT (mg/L)
BOD	1500	375
COD	2000	500
TKN	200	200
NH_3-N	50	200
TP	40	50

The performance of the anaerobic ponds at Narrikup will be further ensured by the following features:

- The ponds will be lined with at least 300mm of compacted clay or a non-permeable plastic membrane layed between layers of clean sand.

- At least 600mm of internal freeboard will be provided to prevent overflow of the embankments on both ponds.

- The capacity of the anaerobic pond with solids accumulated in the bottom, to a maximum depth equivalent to one third of the volume of the pond, will provide for a wastewater retention time of not less than 10 days (normally it will be 30 days).

- The wastewater inlet to the anaerobic pond will be at least 2.5m below the surface. The pond outlet will be trapped by a T-piece to prevent the surface crust being transferred to subsequent ponds.

- An unbroken layer or crust of solids will be maintained across the entire surface.

- Hydrated lime or sodium hydroxide will be added to the anaerobic ponds in order to limit odour if volatile organic acid concentrations rise. This treatment will continue until the pH in any part of the pond is not less than 7.0.

- Sludge from the anaerobic ponds will only be disposed of in an approved manner under controlled landfill conditions to the satisfaction of the local authority.

- The two anaerobic ponds will be designed to allow one pond to be drying out and the dried sludge to be removed, while the other is in use.

Aerobic (Low Rate) Ponds

According to Reed *et al.* (1995) in climates where the average yearly temperatures equal 20°C, the following design criteria for aerobic treatment ponds should yield a BOD removal of 80% or better:

- Volumetric organic loading up to 120kg BOD/ha/day.
- Hydraulic retention time of approximately 10 days.
- Depth between 1.0m and 1.5m.

The CSIRO suggests that a BOD design loading of 45kg to 90kg/ha/day of pond surface is satisfactory, with higher values being suitable for warm climates in northern Australia and lower values recommended in southern Australia. It also recommends that at least two ponds be constructed in series in order to minimise short circuiting and to enhance retention times, which should be at least 15 to 20 days per pond.

For the Narrikup Export Abattoir, a 40 day hydraulic retention period equates to an overall pond volume of 40,000m^3 since 1,000m^3 of wastewater is generated per day. Given a BOD loading of 375mg/L in the wastewater passing into the aerobic ponds from the anaerobic ponds and a surface area of 40,000m^2 for the aerobic ponds, this results in a BOD loading of about 95kg/ha/day.

At Narrikup however, two low rate aerobic ponds in series are proposed with dimensions of 190m x 190m x 1m depth and an overall volume of 70,000m^3. With these dimensions the BOD loading in the aerobic ponds will be 54kg/ha/day. This is significantly lower than the loading recommended by the CSIRO.

It is considered that the design should result in a BOD reduction of at least 90% in winter. This reduction is conservative as the retention time in the two aerobic ponds will be in the order of 70 days.

A second approach to the design of aerobic treatment ponds involves the use of plug flow hydraulics and first order removal rate equations developed by Wehner and Wilhelm (1956) and Thirumurthi (1974). Calculations using these equations are included in Appendix 4, and indicate BOD reductions of 90% are achievable using HRTs from 32 to 42 days.

The USEPA sponsored studies in the late 1970s which investigated nitrogen loss from aerobic ponds. The studies confirmed that nitrogen removal is possible through losses to the atmosphere and the removal of biomass. Nitrogen removal is related to pH, detention time, and temperature in the pond system. Calculations involving these factors are included in Appendix 4. The results indicate that nitrogen reductions of 20% are achievable.

To ensure optimum performance, the aerobic ponds will be:

- Surrounded by a bank or bund of not less than 0.5m to prevent the entry of stormwater runoff.

- Lined with at least 250mm of compacted clay or a non-permeable plastic membrane layered between layers of clean sand.

- Provided with at least 600mm of freeboard to prevent overflow of the embankments.

Aerobic (Maturation) Pond

The maturation pond at the abattoir will be used to polish the lightly loaded effluent coming from the low rate aerobic ponds, and most importantly as a reservoir from which wastewater will be irrigated to pasture and wood lots.

Calculations based on the work by Reed *et al.* (1995) suggest that in climates where the average yearly temperature approximates 20°C the following design criteria for maturation ponds should yield BOD and TN removal of 70% and 20% respectively:

- Volumetric organic loading up to 15kg BOD/ha/day.
- Hydraulic retention time of approximately 20 days.
- Depth between 1.0m and 1.5m.

For the Narrikup Export Abattoir to achieve a hydraulic retention time of 20 days, the maturation pond would need to have an overall volume of 20,000m^3 because of the 1,000m^3 discharge of wastewater per day. It is proposed, however, that the maturation pond for the abattoir Narrikup will have an average depth of 1.5m and an area of 300m x 300m to provide a total volume of 135,000m^3. This will result in an organic loading of 3kg BOD/ha/day which is significantly lower than the figure from Reed *et al.* (1995). It is also estimated that the actual HRT of the maturation pond would be in the order of 135 days, consequently providing a dead storage capacity for 4.5 months. This duration is more than sufficient to implement any remedial measures should there be any malfunctions in the treatment system. This design should result in a BOD reduction of at least 70% in winter which, in keeping with all other design calculations, is a conservative figure.

As for the aerobic (low rate) pond analysis and design, a mathematical model analysis was also undertaken for BOD and TN removal. These calculations are included in Appendix 4. The results indicate BOD and TN reductions of 70% and 30% respectively are achievable utilising HRTs from 70 to 118 days.

To ensure optimum performance and protect groundwater, the maturation ponds will be:

- Surrounded by a bank or bund of not less than 0.5m to prevent the entry of stormwater runoff.

- Lined with at least 300mm of compacted clay.

- Provided with at least 600mm of freeboard to prevent overflow of the embankments.

5.9 Wastewater Disposal

5.9.1 Background Information

Once wastewater has been treated it may either be re-used or disposed of in the environment where it re-enters the hydrologic cycle. World wide, the most common means of disposal of treated wastewater is by discharge and dilution into rivers or the ocean. There is, however, another means of disposal which is becoming more popular because of its beneficial use in farming. This method is known as land application and involves the controlled application of wastewater to crops. Water applied to pasture or wood lots is taken up by the plants and used for growth. Some of the water also evaporates or is evapotranspirated by plants to the atmosphere. Nutrients in the water will also be taken up by the plants and used for growth or may be retained in the soils. Application rates can be calculated to ensure that the groundwater system is not contaminated with excessive nutrients.

There are three types of land disposal systems, all of which use the natural physical, chemical, and biological processes within the soil, plant, and water matrix to provide further treatment of the wastewater. The Slow Rate (SR) and Rapid Infiltration (RI) processes use the soil matrix for treatment after infiltration of the wastewater. The major difference between these processes is the rate at which the wastewater is loaded onto the site. The Overland Flow (OF) process uses the soil surface and vegetation for treatment, with the treated effluent collected as runoff.

SR systems are the predominant form of land treatment of municipal and industrial wastewater because they involve the lowest loading rates and can be applied to the widest range of soil types. The technology employed is similar to that of conventional agricultural irrigation.

The SR system is capable of removing organic nitrogen, ammonia nitrogen, nitrate nitrogen, and phosphorus.

Organic nitrogen associated with the suspended solids in wastewater is removed by sedimentation and filtration. Solid phase organic nitrogen may be incorporated directly into soil humus which consists of very large, complex organic molecules containing carbohydrates, protein, protein-like substances, and lignins. Some organic nitrogen is hydrolysed to soluble amino acids that may undergo further breakdown to release ionised ammonia.

Ammonia nitrogen may follow several pathways in natural systems. Soluble ammonia can be removed by volatilisation directly into the atmosphere as ammonia gas. This removal pathway is relatively minor (less than 10%). Most of the ammonia reacts on soil particles and charged organic particles. Adsorbed ammonia is available for uptake by vegetation and micro-organisms or for conversion to nitrate nitrogen through biological nitrification under aerobic conditions.

Nitrate may be taken up by vegetation but this only occurs in the vicinity of the root zone during active growing periods. To actually achieve nitrogen removal from the system by plant uptake, the vegetation must be harvested. If vegetation is left in the system, the nitrogen contained in the vegetation will be recycled and will re-enter the system as organic nitrogen.

Nitrate is also removed by biological denitrification and subsequent release of gaseous nitrous oxide and molecular nitrogen into the atmosphere.

The major phosphorus removal processes in natural treatment systems are chemical precipitation and adsorption, although plants do take up small quantities. The phosphorus, which occurs mainly in the form of orthophosphates, is adsorbed by clay minerals and certain organic soil fractions in the soil matrix. Chemical precipitation with calcium (at neutral to alkaline pH values) and iron or aluminium (at acid pH values) occurs at a slower rate than adsorption, but is equally important.

Adsorbed phosphorus can be held tightly and is generally resistant to leaching. Although the phosphorus adsorption capacity of soils is finite, it is quite large even in sandy soils. The degree of phosphorus removal achievable by a natural system depends on the degree of wastewater contact with the soil matrix and the Phosphorus Retention Index (PRI) of the soil. Soils with low PRIs can be amended by the addition of lime, clay, and/or red mud gypsum (a by-product of bauxite alumina processing).

Crop selection is very important in the SR disposal process as different crops remove different amounts of nitrogen, allow different wastewater infiltration rates, and have different economic values. Other selection characteristics of importance include evapotranspiration rates, water tolerance, salinity tolerance, and ease of management (minimal cultivation and harvesting requirements). Forage or tree crops are generally considered to be most suitable in all of these respects.

5.9.2 Disposal of Treated Wastewater from Narrikup Export Abattoir

A slow rate irrigation system will be used to dispose of the wastewater from the maturation pond. The design of the system follows the methodology described by the USEPA Manual (1981), EPA Victoria (1991); and Metcalf and Eddy (1991). The system is illustrated in Figure 15.

Most slow rate systems are limited either by hydraulic or nitrogen loading rates. The hydraulic loading rates at Narrikup were investigated as part of the study by Groundwater Technology Australia (1995) which is included in Appendix 2 of this CER. The water budget produced indicates that the slow rate system as proposed is not limited by hydraulic load. Nitrogen is the only limiting design factor.

The proposed land treatment and disposal system incorporates the following elements:

- 40ha of spray irrigated kikuyu/white clover pasture (holding yards). This area has been designed to achieve:
    - limited runoff in most years. The runoff is collected by a small holding dam and applied to wood lots as required, and
    - uptake of nitrogen and phosphorus from the wastewater applied.

- 100ha of wood lots of fast growing Eucalypts, slow rate irrigated by an automatic irrigation system. This area has been designed to achieve:
  - no runoff from storing greater than 1 in 2 year average recurrence intervals,
  - full uptake of nitrogen from the wastewater applied,
  - adsorption by soils of all of the phosphorus from the wastewater applied onto the soils, and
  - downward percolation of water from the root zone at the rate necessary to maintain salinity in the root zone at a sustainable level.
- 35ha of rainfed trees, planted downslope from the irrigated pasture and wood lots. These trees will take up and transpire the volumes of water expected to percolate downwards and/or laterally from the pasture and wood lots. They will also impede and take up any excess surface runoff that may occur.

Layout of the system is shown in Figure 10. It should be noted however, that there is sufficient flexibility in the system to allow some interchange of forage crops for woodlots if necessary, and that the crops may vary depending on specialist advice (economic and agricultural) during site development.

In order to achieve the controlled removal of nutrients off-site, the kikuyu/white clover pasture will be harvested and sold off-site, or used for short term grazing. Long term grazing will not be allowed as grazing on effluent disposal areas does not achieve optimum nutrient utilisation. Short term grazing, however, will occur on occasions when sheep received at the abattoir are "hollow" and require grazing and water intake for between one and two days before slaughter. A portion of the nutrients contained in this feed will be returned to the soil through defecation. However, the remainder will be retained in the sheep and removed at the end of the grazing period as paunch, which will be processed in the rendering plant and ultimately mostly removed from site.

The areas used for short term sheep grazing will be carefully monitored to determine nutrient utilisation and to ensure the soil structure is not adversely affected. Irrigation will assist soil stability and ensure that the vegetation cover is maintained. Mechanical aeration of the soil, and other measures to maintain adequate infiltration capacity, will also be applied. Furthermore, the entire forage area will not be irrigated each year and nor will it be continually stocked thus allowing some areas to be fallow on an annual basis. Therefore, the applied nutrients will be used by dry land and irrigated crops in rotation.

It is envisaged that the wood lots will be planted with a combination of *Eucalyptus globulus*, *E. dunii* and *E. grandis* at a density of 1,500 trees/ha. In terms of the water balance produced by Groundwater Technology Australia (1995), forage crops are able to take up all of the wastewater produced by the abattoir (Appendix 2). However, forage crops, unless they can be sold off-site, can to some extent result in the recycling of some nutrients. Wood lots, on the other hand, need to be irrigated for between 5 and 7 years before they are ready for harvesting. The harvesting procedure involves the removal of the tree including its foliage from the site and thus all of the nutrients that have contributed to the biomass of the tree are removed permanently. In addition, wood lots provide visual screening of the abattoir.

The wood lots will be planted in lines with two rows, 2m apart, and a width space of 5m between each pair of rows. This will promote rapid early growth, and ease of access for irrigation, inspection and harvesting. It is expected that the trees will be harvested in rotation so as to maintain the high nitrogen uptake of younger trees. It is expected that the harvested trees will be chipped and exported for paper pulp.

Nutrients in the wastewater from the maturation pond will have estimated concentrations of 85mg/L for total nitrogen and 30mg/L for total phosphorus. At an annual flow rate of 210,000m^3/yr, the total nutrient load from the abattoir after primary and secondary treatment will be 18,000kg total nitrogen and 6,300kg total phosphorus.

The fodder crops have a nitrogen uptake of 480kg/ha/yr under irrigation but it is assumed conservatively that the uptake will be 240kg/ha/yr as the crops will be subjected to short term grazing by sheep (Reed et al., 1995). The uptake for dry land or non-irrigated pasture is 175kg/ha/yr and for irrigated eucalypts it is 90kg/ha/yr (Reed et al., 1995). The total nitrogen uptake each year, given these rates and the crop areas, is 17,300kg as shown in Table 6. This total uptake is a conservative estimate as it does not allow for losses due to volatilisation and denitrification especially from understorey weeds within the wood lots. Furthermore, should any nitrogen migrate downslope from the woodlots, the rainfed trees in these areas will have sufficient capacity to intercept these loads.

The phosphorus uptake rates for fodder and wood lots and the annual total phosphorus uptake are also shown in Table 6. The overall total uptake of phosphorus is 1,720kg which is substantially less than the annual load in the irrigation water of 6,300kg.

TABLE 6
Land Treatment Nutrient Uptake

Crop	**Area**	**Nutrient Uptake Rates**		**Nutrient Uptake**	
		TN (kg/ha/yr)	**TP (kg/ha/yr)**	**TN (kg)**	**TP (kg)**
kikuyu/white clover (irrigated)	20	240	56	4800	1120
kikuyu/white clover (dryland)	20	175	20	3500	400
Eucalyptus (irrigated)	100	90	2	9000	200
			TOTAL	**17300**	**1720**

Therefore, 4,580kg/yr of phosphorus will accumulate in the soil, provided the PRIs of soils in the area are sufficiently high to absorb the phosphorus. Chemical analyses of the soils in these areas show low to very high PRIs and it is considered, therefore, that the soils are capable of taking up this excess phosphorus (Table 1A). However, in keeping with the conservative design approach the irrigation areas will be amended to a depth of

400mm with 25% red mud gypsum (RMG). This will increase the phosphorus absorption capacity of the soil to approximately 400kg/ha/m, and will provide a theoretical life of 50 years before any increase in phosphorus is detectable in the groundwater (Appendix 4).

In the unlikely event that the performance of the RMG or the storage capacity of the soil prove to have been overestimated, the proponent may elect to replace some woodlots with forage crops/pasture, or may undertake chemical precipitation of nutrients in the maturation pond.

Red mud gypsum is available from stockpiles at Alcoa (Pinjarra) provided suitable indemnity arrangements are prepared between Alcoa and the proponent (D. Glenister, pers. comm., 1995).

The application rate of nutrients to pasture and woodlots will be dependent on a number of factors (such as evapotranspiration and rainfall) and will vary during the year. An approximation of the application rates is presented in Tables 4 and 5 of Appendix 2. Precise rates will be determined by an agronomist during the detailed design stage of the wastewater disposal system and will be reassessed regularly on an ongoing basis during the operation of the abattoir.

5.9.3 Irrigation with Subhaline Water

The assessment of on-site water availability and quality by Groundwater Technology Australia (1995) suggests that a series of shallow bores will be able to supply the abattoir water requirements and that the salinity level of the water will be less than that measured in the test bore (see Section 3.8). Analyses of the groundwater samples collected on-site demonstrate that sodium chloride is the principal component of the TDS content.

The water supply, after it has been used for process requirements and has passed through the wastewater treatment system, will be used for irrigation of pasture crops and tree plantations (wood lots). The salinity in the water will not be affected significantly by process use or wastewater treatment. The pickling plant wastewater (which has a high TDS content) will be diluted when it joins the abattoir wastewater stream and it can therefore, be assumed that the level of salt in the groundwater is the level of salt which will be applied to the irrigation areas.

The specialist study by Groundwater Technology Australia (1995) has investigated whether there is any significant potential for salt accumulation in the soil profile over time, and concludes that with appropriate application rates of treated wastewater to irrigated pasture, and a combination of treated wastewater and groundwater irrigation for the wood lots, the residual nitrogen in the wastewater will be adequately taken up by the crops, while at the same time there will be adequate leaching of water through the soil profile to prevent accumulation of salt.

The specialist study also concludes that the superficial soils which have been selected for crop irrigation on the site have low potential for salt accumulation. This is because:

- They have low existing salt levels,

- They are well drained, and
- They have low clay content, which means that the salinity of the irrigation water will not reduce permeability through chemical interaction with the soil.

The infiltration rates of the soil profiles on the abattoir site, for example, are substantially greater than those at the site selected by WAWA for irrigation of tree plantations with treated wastewater near the Albany Airport.

To ensure that enough irrigation water is leached through the superficial soil layer to prevent build-up of salt and to ensure the survival of the crops, the specialist study has estimated that leaching rates of 38% and 25% respectively will be required for pasture and wood lots. At the same time, the application rates must not be too high, or the crops will not be able to take up sufficient nitrogen from the treated wastewater, and excess nitrogen may be leached through the soil profile. In order to prevent this, it is estimated that the irrigation or loading rates should be 0.43m per year for pasture, and 0.17m per year for wood lots (Appendix 2). More water can be applied to the pasture because these crops have higher nitrogen uptake capacity than the wood lots, but lower evapotranspiration rates. The pasture therefore takes up the nitrogen and allows excess water to leach through the soil profile to attain the necessary leaching rate.

In contrast, wood lots have relatively low capacity for nitrogen uptake, but high evapotranspiration rates. This means that if treated wastewater was applied at a rate which ensured nitrogen uptake, the water would be used by the trees but the necessary leaching rate may not be achieved. In order to ensure that this does not happen, groundwater may need to be applied to the wood lots in combination with treated wastewater so that there is excess water and adequate leaching.

It should be noted, however, that the specialist report concludes that screening of bores higher in the aquifer will produce better quality water and that this will mean a lower leaching factor will be required.

The above estimates of loading rates for woodlots are based on mature trees. In the initial stages the nitrogen uptake of younger trees will be less and the loading rates will need to be lower. Therefore, it will also be necessary to irrigate existing woodlots and/or additional pasture areas until the new plantings are established.

5.9.4 Down Stream Effects of Wastewater Irrigation

The slow rate irrigation plan for the Narrikup Export Abattoir has been designed using very conservative assumptions with respect to BOD loadings, hydraulic retention times, nutrient uptake by irrigated plants, and soil amendment with red mud gypsum.

The location of the irrigation areas also has been carefully selected to provide significant separation from Mill Brook and buffer plantations of rainfed trees. It also takes into account potential surface drainage and steep terrain on the site.

Therefore, it is considered that there is very little potential for adverse impacts, from either surface or sub-surface inflows of treated wastewater with elevated nutrient levels on Mill Brook or downstream users of Mill Brook.

5.10 Layout of the Wastewater Treatment and Disposal System

The wastewater treatment and disposal system for the Narrikup Export Abattoir will have two major components, namely treatment ponds, and slow rate irrigation pastures and wood lots. The dimensions of these components have been determined by the calculations described in preceding sections of this CER. The proposed layout of the components at the site is illustrated in Figure 10. This layout takes account of various constraints as follows:

- A minimum distance of 500m is required from the abattoir to the nearest house.
- The need to locate the irrigation areas away from water courses (mainly Mill Brook).
- Steep terrain.
- Remnant vegetation (including rare and endangered species).
- Existing plantation timber.

The abattoir buildings (including the rendering plant, fellmongery, etc.) are located in the central eastern part of the site, where they are more than 1.0km from the nearest residence. The buildings have also been located so that it will be possible to gravity feed wastewater to the treatment ponds. The maturation pond is located centrally, for ease of irrigation, in a natural depression. The wood lots are arranged to provide screening of the site and are also located as far from the central creekline as possible to keep irrigated water and nutrients away from Mill Brook. In addition, rainfed wood lots border the irrigated wood lots to provide a buffer against surface and sub-surface migration of water and/or nutrients into the creek. This is in addition to the significant buffer of natural vegetation which will remain along the creekline.

Irrigated forage crops are located strategically so that any major runoff will migrate via natural drainage lines to a holding dam constructed near the central portion of the eastern boundary of the site. In keeping with the conservative approach to all aspects of wastewater management at the site, the dam and forage crops are provided with a buffer of rainfed trees to ensure that off-site migration of wastewater or nutrients is prevented.

5.11 Stormwater Management

Stormwater at the site will be managed in a responsible and effective manner. The management will involve the following:

- "Clean" stormwater will be diverted around most contaminated sites such as lairage yards and will be retained in a non-polluted form. This will include the use of banks to divert overland flow and enclosed pipe systems to convey runoff from clean areas such as building roofs, carparks, and paved areas. This runoff will be disposed of in an infiltration retention basin.

- Stormwater runoff from areas such as the lairage yards and the irrigated forage pasture areas will be directed to, and stored in, the holding dam shown in Figure 10. The stored runoff will be irrigated onto the wood lots as necessary.

- Nutrient enriched water will go through the full wastewater treatment process. This includes stormwater that is collected from areas on which blood, treatment compounds, and other effluents are present.

An erosion and sediment control plan will be implemented during the construction phase. This will include, if necessary, construction of temporary erosion control measures, design of rehabilitation works, and scheduling of construction works so as to avoid conditions likely to promote erosion.

Both the wastewater and stormwater generated from the proposed Narrikup Export Abattoir have been designed for zero discharge. Except for the stormwater generated from extreme storm events, no surface discharge will occur from the site into existing watercourses.

5.12 Management of Solid Wastes

5.12.1 Types of Solid Wastes

Solid wastes will be generated throughout the abattoir and include bones, flesh, fat, paunch material, faeces, de-woolled skins, and head pieces. Most of this waste will be processed through the rendering plant after being directed there from the point of generation, either automatically or by dedicated trailers. Easily rendered material includes bones, flesh and fat. Paunch material, reject de-woolled skins, and head pieces will be directed to a batch cooker prior to joining the normal rendering process.

Solid wastes trapped by screens and scrappers in the wastewater treatment system will be recovered and also processed through the rendering plant.

The only substantial solid waste requiring disposal will be faeces that collect below the lairage yards. Based on production at other facilities, it is estimated that 200t of sheep and cattle faeces will accumulate annually.

5.12.2 Disposal of Solid Wastes

A number of options exist for disposal of faeces collected from the lairage yards. These include:

- Removal to an approved landfill.

- Sale or giving away as a fertiliser.
- Treatment on site to produce a pelletised fertiliser for sale.

Any of these methods will effectively remove nutrients from the site. However, it is also desirable that the material be removed on a regular basis to prevent odour generation. In this respect, sale of untreated material may be unsuitable unless some form of covered hardstand is used to hold the material until it was sold.

Currently, it is envisaged that the proponent will construct an organic fertiliser production plant within the abattoir complex. This plant will include a hammer milling operation and a pelletising machine. The pellets will be elevated up a cooling tower by conveyor and dropped to a bagging machine. The pelletised organic fertiliser would then be sold off-site.

The only potential problem involving solid wastes relates to plant malfunction. If, for example, the rendering plant or fertiliser production plant suffered an unscheduled shut down, solid waste would accumulate and require alternative disposal. It is estimated that 25t to 30t of solid waste could be generated annually from such events. This waste would have to be removed to an approved landfill as it was generated.

There will also be an occasional requirement to remove accumulated residues from the treatment ponds. These wastes also will be removed from the site and disposed of in an approved landfill.

5.13 Odour

5.13.1 Potential Sources of Odour

There is the potential for significant odour to be generated from two main components of the abattoir, namely the rendering plant and wastewater treatment ponds. However, it is possible through appropriate design and operational procedures to minimise odour to a level where there is little potential for any nuisance off-site.

5.13.2 The Rendering Plant

In order to ensure that odour is not a nuisance, the proposed Narrikup Export Abattoir will be designed and operated in accordance with the Environmental Code of Practice for Rendering Plants. This Code of Practice was developed by the EPA, Meat and Allied Trades Federation (WA Division), and the CSIRO Meat Research Laboratory.

The general principles of odour management in the Code of Practice may be summarised as follows:

- A minimum separation distance down wind to the nearest residence of 1000m should be provided.

- The plant should be screened with vegetation and well maintained.

- The operation and management should be based on a management plan which specifies raw materials, rendering processes, materials handling, environmental control measures, and the management of waste materials.
- Vehicles should be kept clean, well painted and well maintained.

The basic control practices referred to in the above general principles, which are applicable to the Narrikup Export Abattoir, are as follows:

- Receival of animal matter:
    - All rendering raw material should be kept in holding facilities of sufficient capacity and rendered expeditiously.
    - The rendering plant should be capable of processing all raw materials during each working day, allowing adequate time for cleaning plant and for essential maintenance.
    - In the event of a prolonged plant breakdown, arrangements should be made to take any raw materials to another rendering works if the total raw materials on site cannot be processed within 24 hours.
    - Receival and storage bins may need to be fitted with covers and the bins exhausted to the afterburner, chemical scrubber, boiler combustion air or other suitable facilities.
    - Receival and storage bins may need to be designed so that they can be cleaned with high pressure hot water at least once each day and drained to the wastewater treatment system.
    - Receival and storage bins may need to be designed to prevent the accumulation of any liquid or solid waste and the waste drained or pumped from the sump on a continuous basis.
    - The raw materials screw conveyors should be fitted with covers and the enclosed space exhausted to the after burner or chemical scrubber, boiler combustion air or other suitable facilities.
    - The hogger may need to be totally enclosed and exhausted to the after burner or chemical scrubber.
- Cookers/Condensors
    - The steam discharge from the cooker should pass to an interceptor or knock-out pot and the exhaust vapours discharged to a condenser, and all the non-condensable gases should pass to an after burner, chemical scrubber, boiler combustion air or to other suitable facilities.

  - A surface condenser should be used to minimise water consumption and effluent quantity.

  - The condensate from the condenser should be piped to discharge beneath the surface of a wastewater pond or water seal and not be exposed to the atmosphere.

  - The condensate should be cooled so it leaves the condenser at a temperature of less than 60°C.

  - Cookers, condensors and their associated duct work and especially the seals at either end of the cooker agitator should be inspected regularly for evidence of wear and leaks, and replaced if excessive leakage is observed.

- Cooker Discharge Expellers and Presses:

  - The meal discharge hopper from the batch cooker may need to be covered or shrouded and the discharge screw conveyor fitted with covers and both exhausted to the after burner, chemical scrubber, boiler and/or other suitable facilities.

  - The tallow pressers may need to be enclosed or exhausted to the afterburner or chemical scrubber, boiler and/or other suitable facilities.

  - The ducting from the cooker discharge conveyor and the tallow pressers to the odour control equipment should be designed to enable easy access for cleaning, and the cover should be self sealing.

- Meal Conveyors, Mill and Storage Hoppers:

  - The mill and conveyors should be enclosed and exhausted to the after burner, chemical scrubber, boiler and/or other suitable facilities.

- Ring Driers for Drying Blood:

  - The exhaust gases from the dried blood collection cyclone may need to be ducted to a fabric filtered dust collector and exhausted to an after burner, chemical scrubber, boiler and/or other suitable facilities.

- Whole Building Exhaust Treatment

  - Depending on the extent to which control measures are considered necessary, it may be more efficient to exhaust the entire building rather than ducting air away from individual plant components. Under these circumstances the building should be sealed to the extent that a slight negative pressure can be maintained. Exhaust facilities should be installed to maintain the negative pressure and convey the gases for scrubbing if required.

Maintenance is also an important component of odour control and the Code of Practice recommends a maintenance schedule which includes the following:

- Details of the routine cleaning operations for plant and equipment.
- Identification of the equipment and facilities necessary for environmental control.
- Details of the routine preventative maintenance program for the equipment.
- Details of steps to be taken in the event of the failure of an important environmental control facility during production.

Further recommendations on maintenance and cleaning are as follows:

- The performance of all environmental control equipment should be monitored regularly. Regular checks should be made of operating conditions and an operational log should be kept to record performance and routine maintenance. Vapour leaks and/or localised odours should be reported to maintenance staff.
- Lines of supply of spare parts for critical environmental control equipment should be established and maintained. Critical spare parts not readily available at reasonable notice should be kept on hand.
- All floors and walls should be designed for ease of cleaning, avoiding crevices and sharp corners to prevent the accumulation of any putrescible matter. Floor drainage design should ensure that wastewater from spillage and clean up only discharges to the wastewater disposal system.
- All electrical fittings, wiring and switches in wet areas should be waterproofed and designed to allow all equipment to be washed down with hot water.
- Factory floors, raw material holding bins and transfer facilities, operating equipment and any other plant and equipment that comes into contact with the rendering raw material should be washed down regularly. A strong alkaline detergent should be used if necessary to properly clean plant and equipment.
- Rendering product holding bins/tanks and transfer facilities should be cleaned at regular intervals (although not necessarily daily). Sale products should not be allowed to accumulate in holding facilities. Pressers, hammer mills and other processing equipment should also be cleaned regularly.
- Floor drains, sumps and save-all systems should be kept free of accumulated solid matter.
- Equipment which may require disassembly for maintenance should be located to facilitate the discharge of drainage and washings to wastewater treatment facilities.

As noted above, Benale Pty Ltd will comply with the Environmental Code of Practice for rendering plants in the design and operation of the Narrikup Export Abattoir and, as required by the Code, will prepare a maintenance schedule and will allocate responsibility for maintenance and odour control to specific personnel.

5.13.3 Wastewater Treatment Ponds

The potential for odour from wastewater treatment ponds can be effectively controlled with the following measures:

- Careful design of the anaerobic ponds.
- Avoidance of overloading the anaerobic ponds with BOD.
- Creating conditions which facilitate the formation of a crust on the anaerobic ponds.
- Use of dual pond systems so that individual ponds can be cleaned out as required.

The anaerobic ponds of the proposed abattoir have been conservatively designed to ensure that they adequately handle the predicted BOD loading and to ensure that a crust forms rapidly following commissioning and is maintained thereafter. The dual pond system will also enable the occasional cleaning operations to be managed effectively.

The anaerobic ponds will also be 5m in depth in order to limit odour emissions. Odorous gases produced at the bottom of the ponds have to migrate to the surface before they can enter the atmosphere. The greater the distance between the bottom and top of the pond, the longer is the retention time and this allows the upwardly migrating gases to be metabolised by the anaerobic bacteria with consequent reduction in the potential for odour.

5.14 Separation Distances

Separation distances of 500m and 1000m respectively are recommended between wastewater treatment ponds and rendering plants, and the nearest houses for odour control purposes (see Section 5.1). Therefore, the layout of the abattoir has been designed to provide these separation distances from existing houses.

The recommended separation distances, however, are only guidelines and are based on a conservative approach to odour management. They are not intended to be absolute requirements.

The best approach to odour management is to design and operate the wastewater treatment ponds and rendering plant so that the potential for odour is minimised. The approach adopted for the Narrikup Export Abattoir is described in Section 5.13.3. The dispersion of any odour is also dependent on wind conditions. Light winds will disperse odour most effectively whereas stronger winds tend to dispel odour. The direction of the wind also is an important factor in determining whether odour is dispersed towards neighbouring houses.

At Narrikup, light wind conditions are not common as shown by the wind roses for Albany Airport in Figure 4. Southerly to south-easterly winds (which would have the greatest likelihood of dispersing odour from the abattoir towards neighbouring houses) also tend to occur mainly in summer and are associated with relatively strong sea breezes.

Therefore, it is considered that the potential for odour from the Narrikup Export Abattoir to be noticeable beyond the boundaries of the site is low. Nevertheless, Benale Pty Ltd will check for detectable odour at the site boundaries during light wind conditions. Checks will also be made if any complaints are received about offensive odours. The information from this boundary monitoring will be entered into a record book and will be provided to the Shire of Plantagenet and the DEP as part of the annual environmental monitoring program described in Section 6.

5.15 Decommissioning of the Abattoir

If the abattoir permanently ceased operations, there would be the potential that the site, buildings and wastewater treatment ponds could be used by another animal processing or similar industry. If this does not occur, then the proponent will ensure that all buildings are dismantled and all materials, plant and equipment are removed from the site. The property would then be converted to agricultural use in compliance with requirements of the DEP and the Department of Agriculture.

5.16 Social Implications

The Narrikup Export Abattoir will have significant positive social implications in the Albany Region through the creation of jobs, by providing a local market for farm produce, and through general economic stimulation.

At the local level, the abattoir has been designed so that it will not cause negative environmental impacts in terms of noise, odour, groundwater availability, and water quality and quantity in Mill Brook. The implications to neighbours and to downstream users of Mill Brook, therefore, should be acceptable.

It is acknowledged that traffic levels on Settlement Road will be heavy at certain times of the day when the workforce is travelling to and from the abattoir site. This may cause some inconvenience to other users of Settlement Road at these times. However, it is the intention that Settlement Road will be upgraded to provide an acceptable level of service to all users at all times.

6. ENVIRONMENTAL MONITORING

6.1 Introduction

The site for the Narrikup Export Abattoir has been selected, and the abattoir itself has been designed, to ensure that the environmental implications are acceptable. The rationale for site selection and design are described in Section 3 of this CER.

It is recognised, however, that the actual performance of the abattoir will need to be monitored in order to confirm that it is meeting the environmental design objectives, and that it is conforming with environmental conditions and regulations. Benale Pty Ltd therefore will implement a monitoring program for the Narrikup Export Abattoir to provide ongoing information on noise levels, water levels and water quality in abstraction bores, soil salinity, and water quality in Mill Brook. These monitoring programs will commence prior to commissioning of the abattoir in order to provide data on baseline existing conditions. The information collected will be provided in the form of an annual environmental monitoring report to the Shire of Plantagenet and to the DEP. It will be made available to the public through the Shire offices and through the Albany Public Library.

Details of the monitoring program are provided below.

6.2 Noise Monitoring

Measurement of environmental noise levels will be made prior to the commencement of site works for the abattoir, following start-up of abattoir operations, and one year after start-up. The operational monitoring will cover peak activity periods. Noise levels will be measured on the boundary of the abattoir site, close to nearby houses in order to provide information on potential received levels of noises at these residences.

If the monitoring indicates that the abattoir is complying with the noise regulations, further monitoring will only occur if there is a significant change in the abattoir operations, or if there are complaints about noise emissions.

If the monitoring indicates that regulations are being exceeded, then further noise assessments will be made to determine the main sources of noise, and corrective action will be taken. Further noise monitoring will occur to confirm that the corrective action has been effective.

6.3 Monitoring of Groundwater Abstraction

The water level in the groundwater production bores, in a series of monitoring bores installed close to the production borefield, in selected irrigated pasture and wood lot areas, and in two monitoring bores which will be installed near the eastern boundary of the site, will be measured once a month during the life of the project. This monitoring program will provide information on groundwater levels and any drawdown effects on the water table.

Water samples will also be collected from representative production and monitoring bores down slope from ponds and irrigation areas on a monthly basis, and will be analysed for TDS and nutrient levels. This will provide early warning of any nutrients leaching from ponds or irrigation areas.

6.4 Monitoring of Soil Salinity

Samples of surface soils will be collected from depths of 10cm, 50cm and 100cm below representative irrigated pasture and wood lot areas during late summer (February-March) each year. These soil samples will be analysed for TDS and nutrient levels.

This monitoring program will provide information on the effectiveness of nutrient uptake by pasture and tree crops, and on any salt accumulation in the soil profile.

6.5 Monitoring of Mill Brook

Water samples will be collected from Mill Brook, upstream of the abattoir operations where Mill Brook enters the site, and close to the southern boundary. Samples will be collected monthly and analysed for TDS and nutrient levels. Flow rates will also be measured at the same time at each site.

This monitoring program will provide information on the quality of surface water in Mill Brook as it enters the abattoir site and as it leaves the site.

7. SUMMARY OF COMMITMENTS

A number of commitments are made in this section by Benale Pty Ltd regarding the construction and operation of the Narrikup Export Abattoir. These commitments are intended to provide assurance that the Narrikup Export Abattoir will be built and operated in accordance with the description provided in this CER and therefore that the environmental performance of the abattoir will be as described.

It is expected that the commitments will be converted by the Minister for Environment into conditions which will apply to the project under the provisions of the Environmental Protection Act, 1986.

The commitments are as follows:

- Benale Pty Ltd will ensure that the Narrikup Export Abattoir is designed and constructed in accordance with the descriptions provided in this CER. (Timing - prior to and during construction).

- Benale Pty Ltd will ensure that the construction and operation of the Narrikup Export Abattoir conforms with environmental conditions and regulations as determined by the Minister for Environment. (Timing - prior to construction and during the life of the project).

- Benale Pty Ltd will continue to liaise with local communities, local authorities, and government agencies to provide information about the Narrikup Export Abattoir. (Timing - prior to construction and during the life of the project).

- Benale Pty Ltd will implement an environmental monitoring program as described in this CER in order to provide information relating to noise levels, odour, soil conditions, and the quality of groundwater, treated wastewater, and water in Mill Brook. The monitoring program will be implemented in consultation with the Department of Agriculture and the Albany Waterways Management Authority and the results will be provided to these authorities, the Shire of Plantagenet and to the DEP and will be made available to the public. (Timing - throughout the life of the project).

- In the unlikely event that the environmental monitoring program indicates that the Narrikup Export Abattoir may be contributing significant nutrients to groundwater or to Mill Brook, Benale Pty Ltd will undertake specific studies to determine the cause and will take whatever corrective action is necessary to remedy the situation. (Timing - throughout the life of the project).

- Benale Pty Ltd will ensure that the design of the rendering plant complies with the Environmental Code of Practice for Rendering Plants (1991) published by the EPA. The detailed design of the plant and operating procedures will be supplied to the DEP for their approval. (Timing - prior to construction).

- Benale Pty Ltd will prepare a noise assessment as part of the detailed design of the Narrikup Export Abattoir in order to confirm that the total noise emission does not exceed a total sound power level of 110dB(A) and that no tonal characteristics exist. The results of this noise assessment will be provided to the DEP for their approval. (Timing - prior to construction).

- Benale Pty Ltd will ensure that all solid waste from the Narrikup Export Abattoir is either converted to a useful product such as fertiliser or that it is disposed of in an approved manner. (Timing - throughout the life of the project).
- Benale Pty Ltd will provide shrouding for lights or other means of light attenuation if any bright lights at the Narrikup Export Abattoir are prominently visible from nearby residences or roads. (Timing - throughout the life of the project).
- Benale Pty Ltd will ensure that the wastewater treatment ponds are designed and operated in accordance with the principles described in this CER in order to ensure that the potential for odour generation is minimised. The company will also implement regular checks at the site boundary during light wind conditions to determine whether odour is detectable. The results of these tests will be documented and provided to the Shire of Plantagenet and the DEP. (Timing - before construction and during the life of the project).

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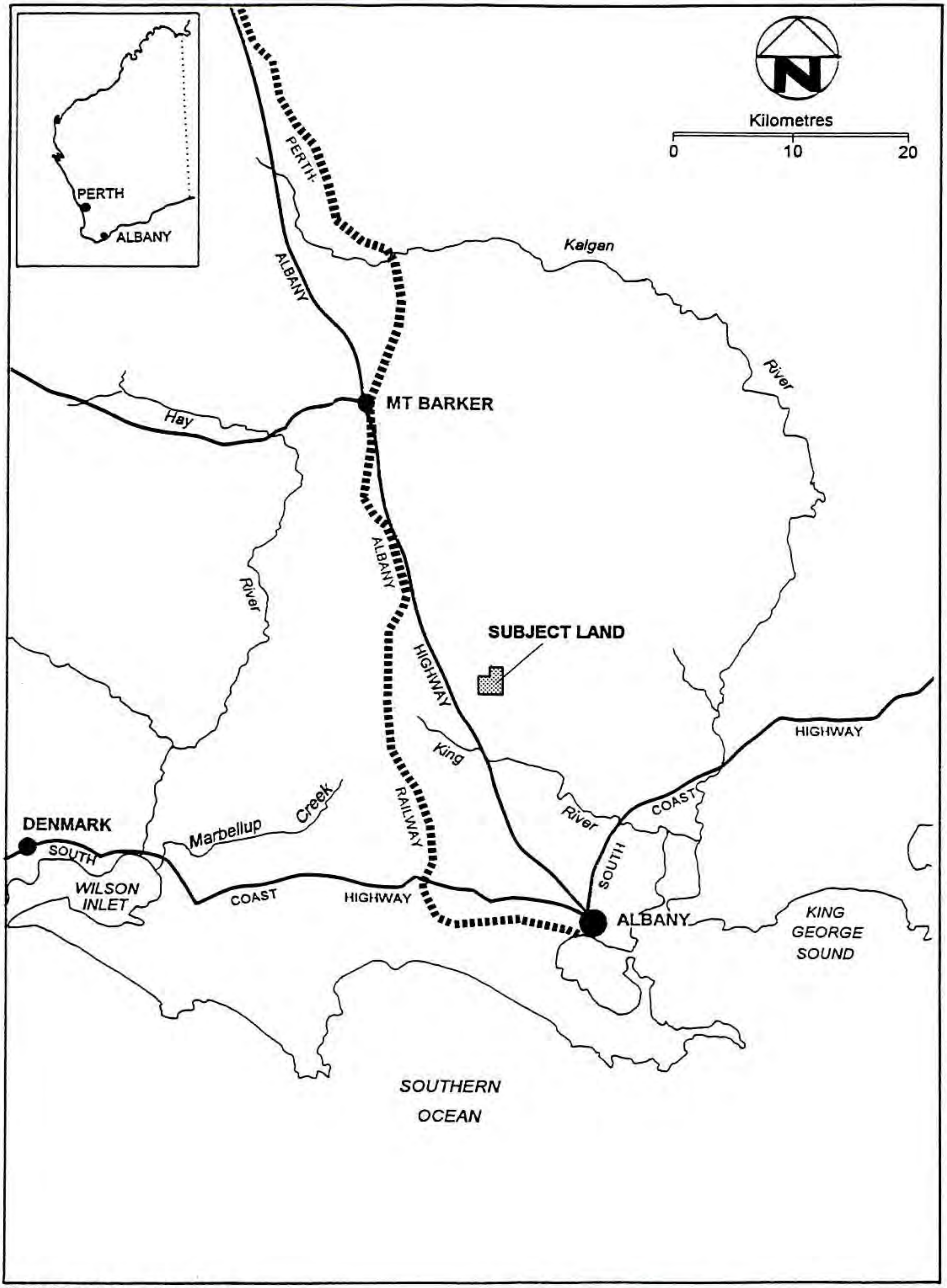
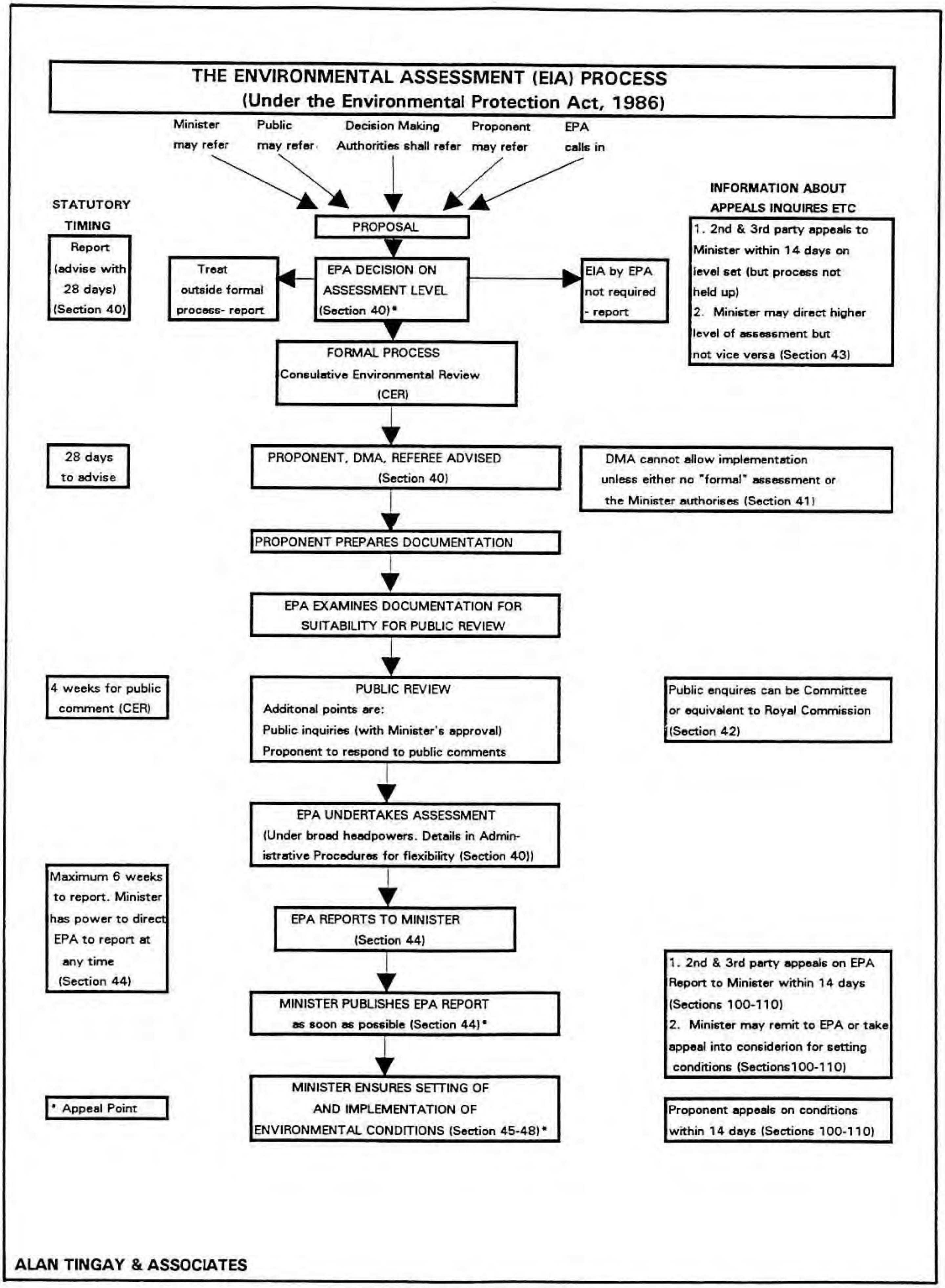
FIGURES

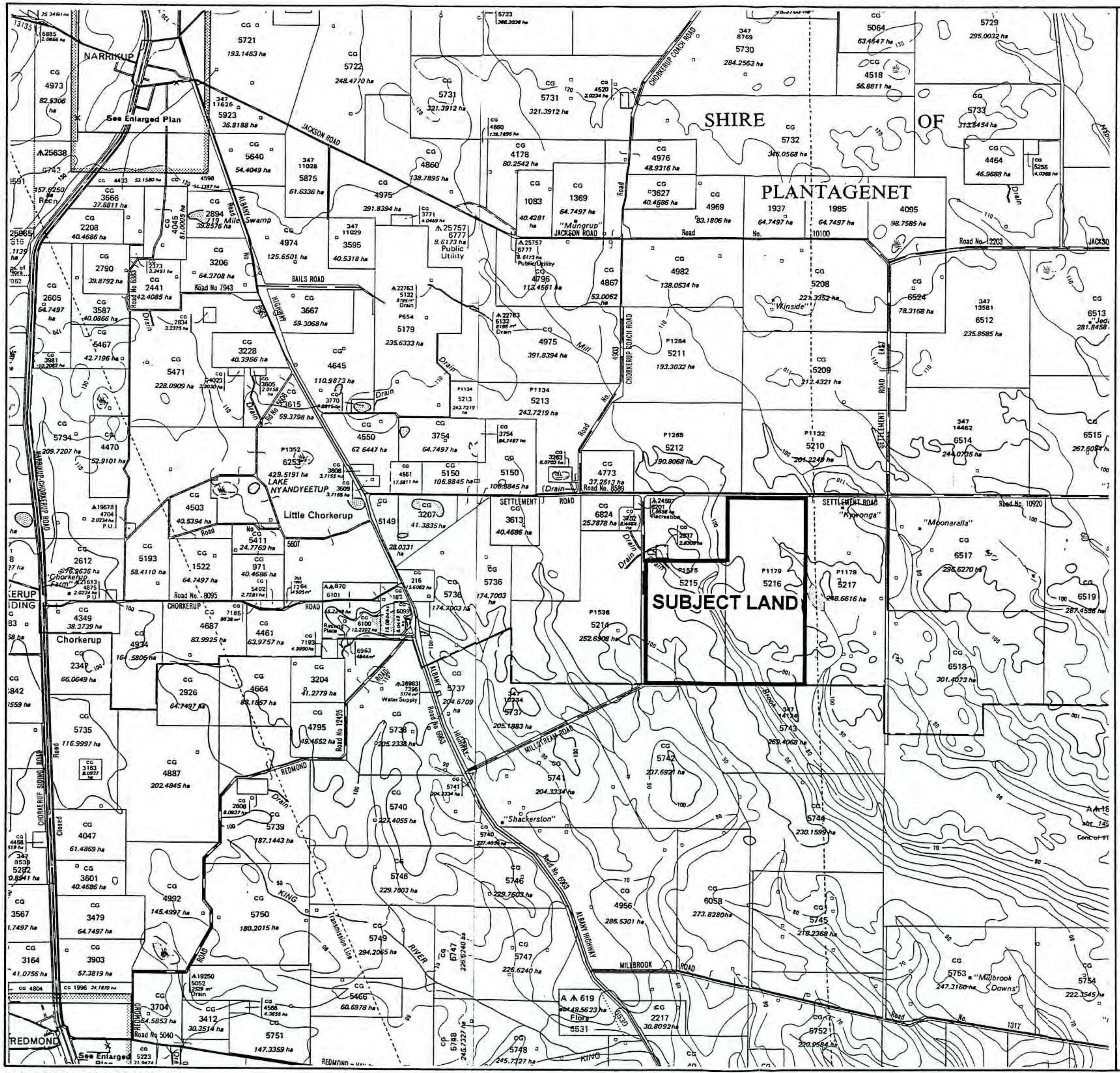


ALAN TINGAY & ASSOCIATES

EXPORT ABATTOIR SITE, NARRIKUP
REGIONAL LOCATION MAP
FIGURE 1



THE CONSULTATIVE ENVIRONMENTAL REVIEW (CER) PROCESS
FIGURE 2



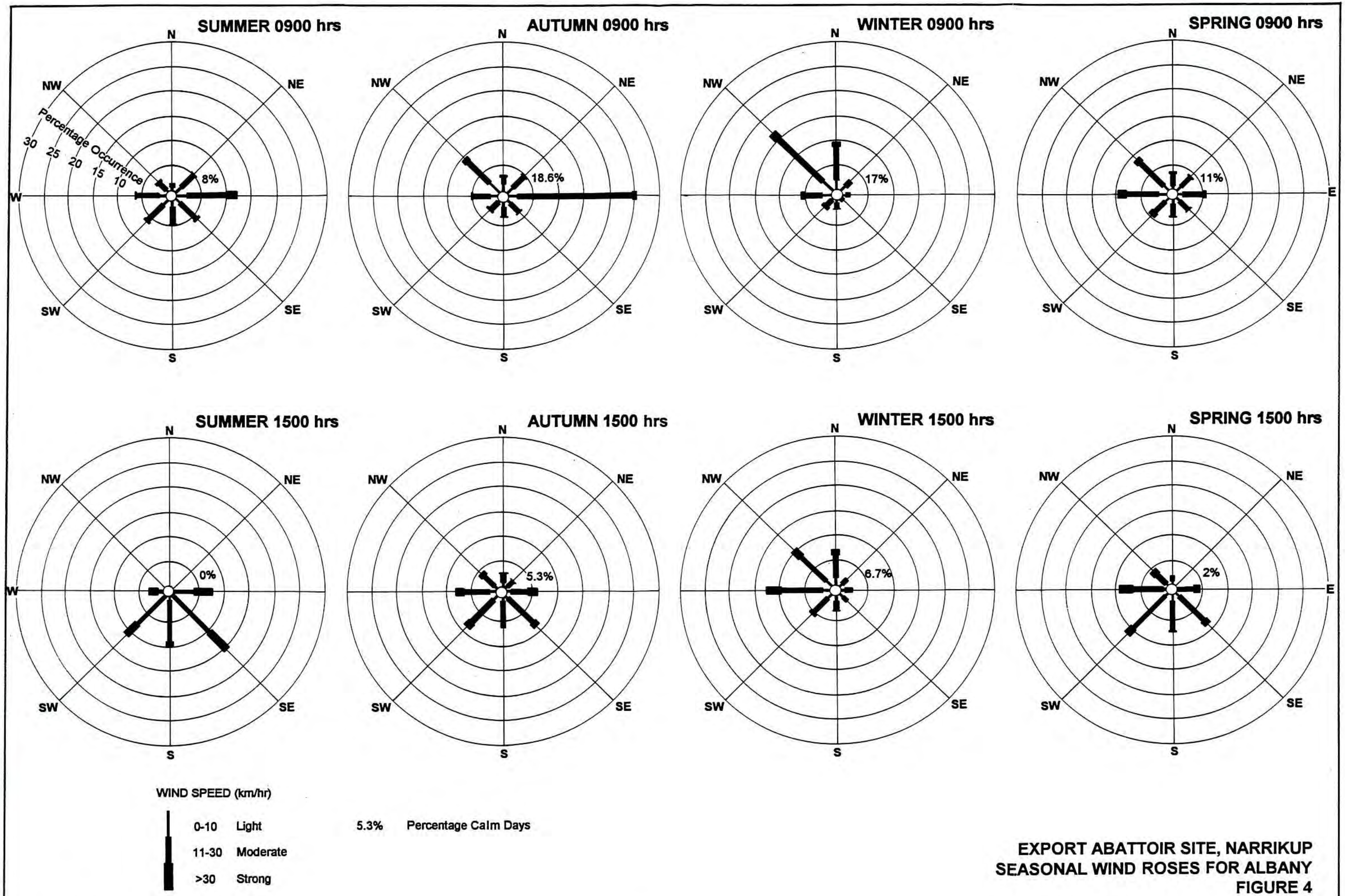
Kilometres

0 2

SCALE 1:50,000

EXPORT ABATTOIR SITE
PT. LOT 5215 & LOT 5216, NARRIKUP
CADASTRAL BOUNDARIES & SURROUNDING LAND USE
FIGURE 3

ALAN TINGAY & ASSOCIATES



EXPORT ABATTOIR SITE, NARRIKUP
SEASONAL WIND ROSES FOR ALBANY
FIGURE 4

N

metres

0 500

SCALE 1: 10,000

LEGEND

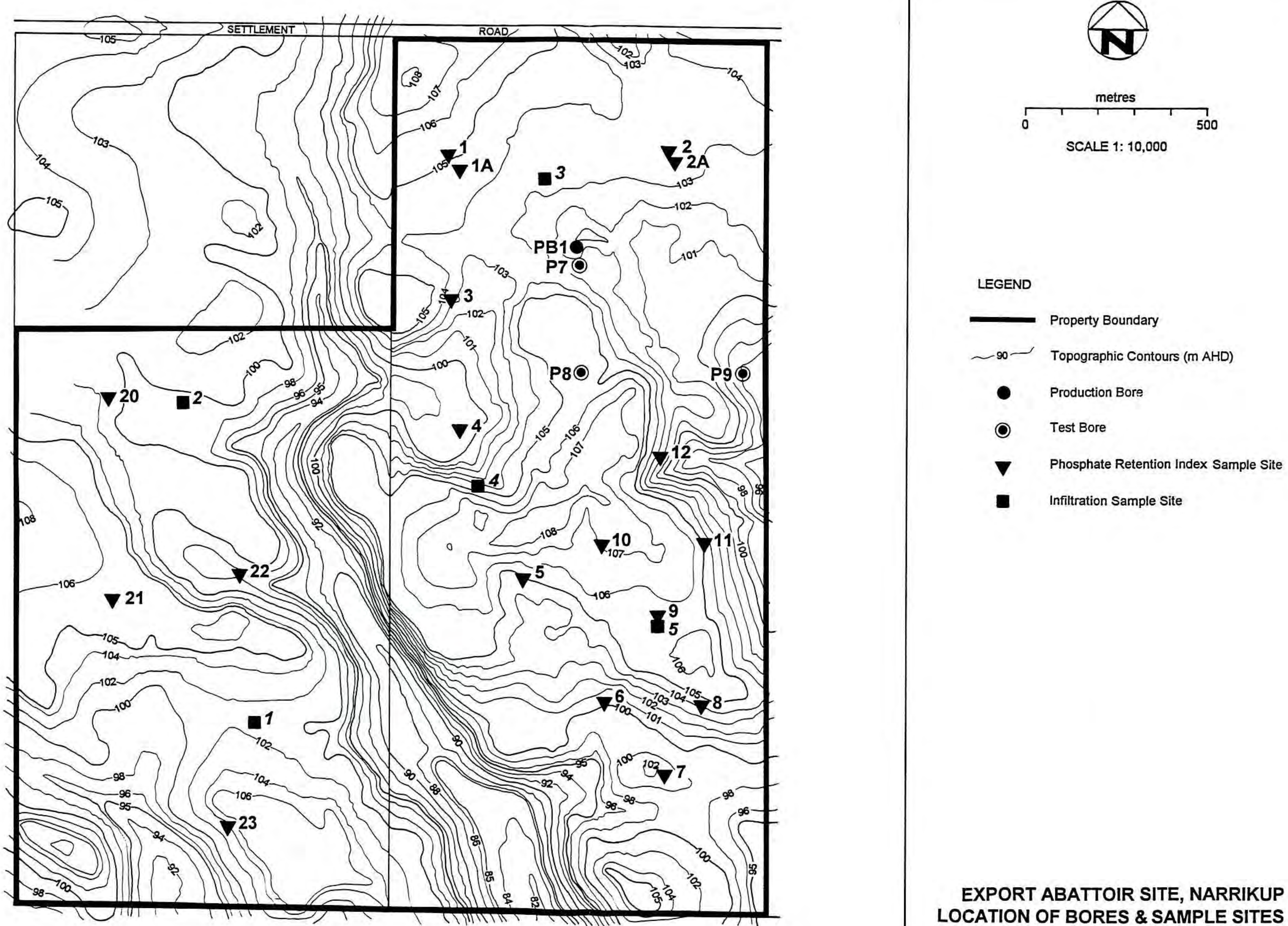
▬ Property Boundary

▨ Redmond Soil Unit

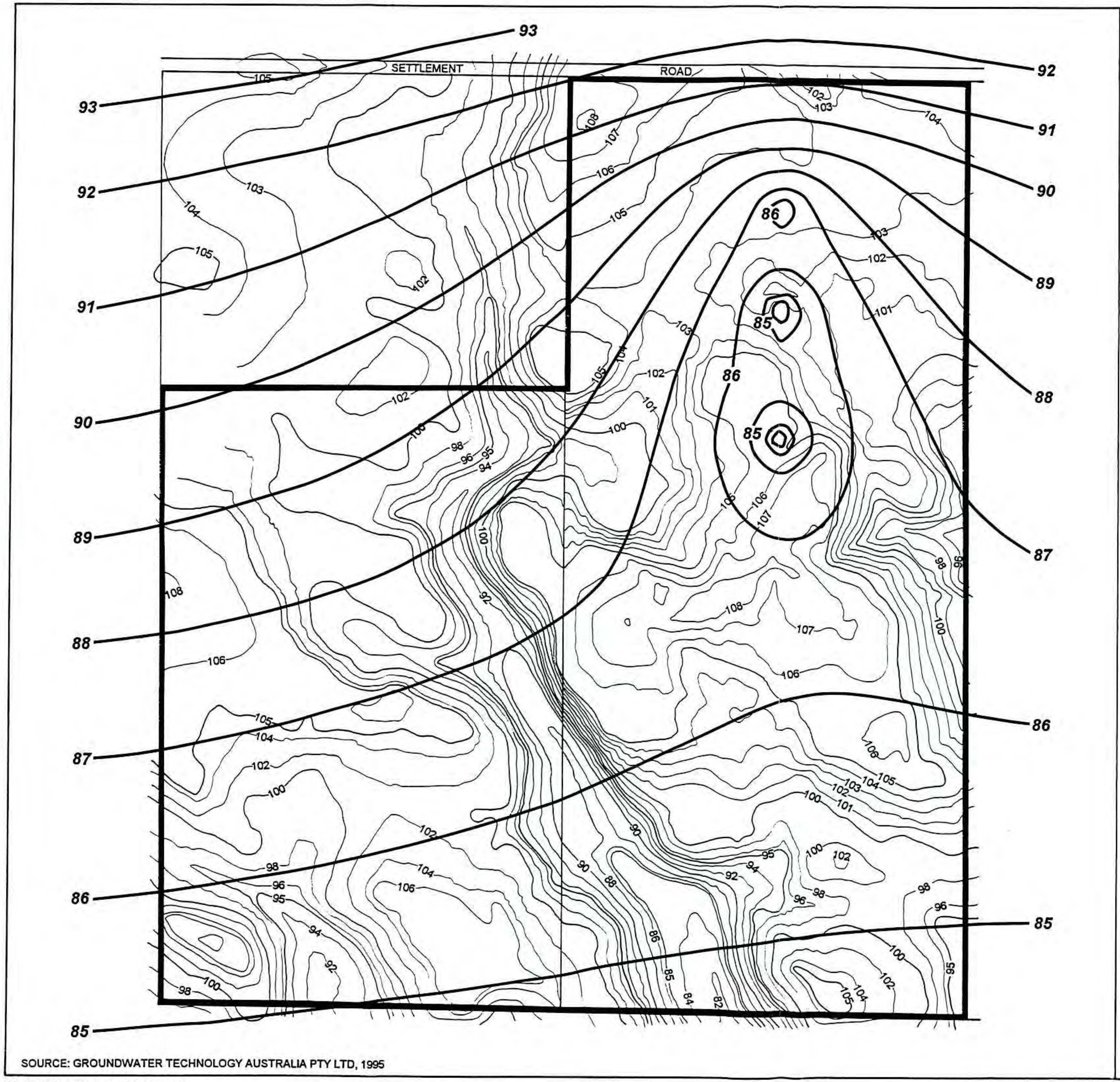
▨ Dempster Soil Unit

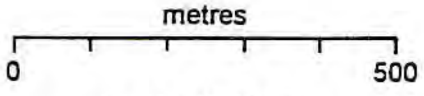
▨ S6 Minor Valley Soil Type

EXPORT ABATTOIR SITE, NARRIKUP
SOILS MAP
FIGURE 5



EXPORT ABATTOIR SITE, NARRIKUP
LOCATION OF BORES & SAMPLE SITES
FIGURE 6





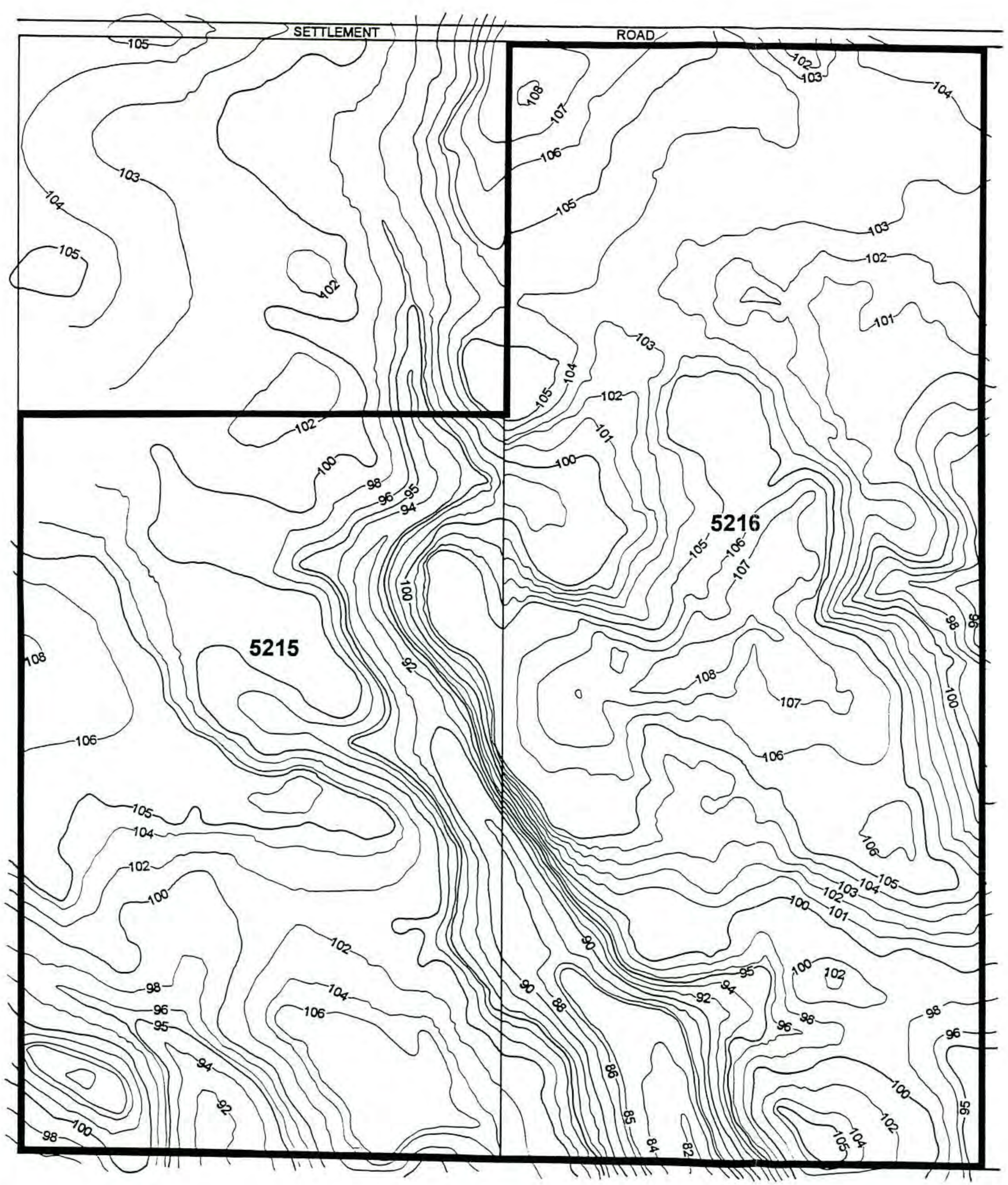
SCALE 1: 10,000

LEGEND

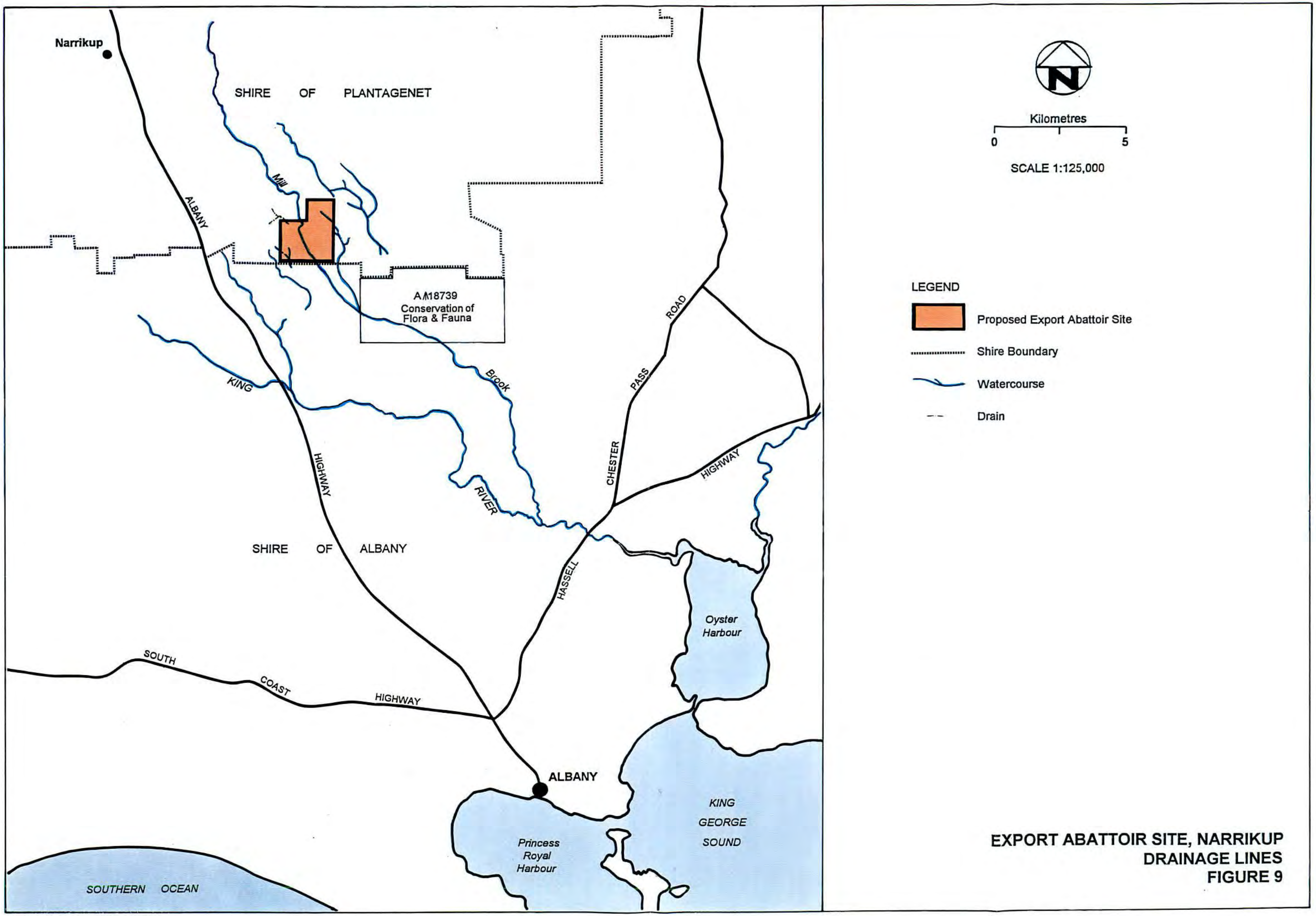
▬	Property Boundary
90	Topographic Contours (m AHD)
88	Steady State Groundwater Flow (m AHD)

NARRIKUP EXPORT ABATTOIR SITE
HYDRAULIC CONTOURS UNDER PUMPING CONDITIONS
FIGURE 7

SOURCE: GROUNDWATER TECHNOLOGY AUSTRALIA PTY LTD, 1995



EXPORT ABATTOIR SITE, NARRIKUP
TOPOGRAPHIC CONTOURS
FIGURE 8

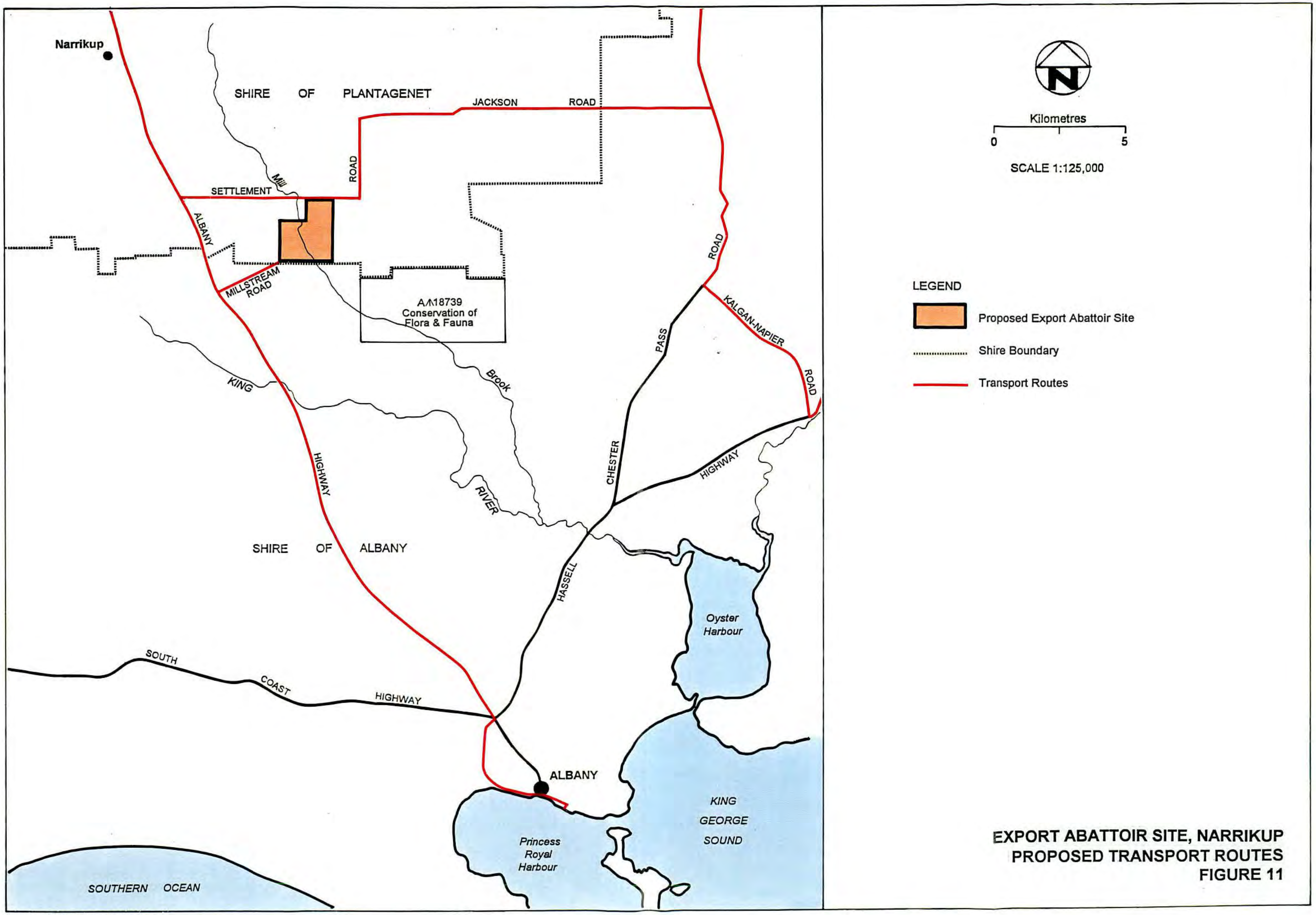


EXPORT ABATTOIR SITE, NARRIKUP
DRAINAGE LINES
FIGURE 9

ALAN TINGAY & ASSOCIATES

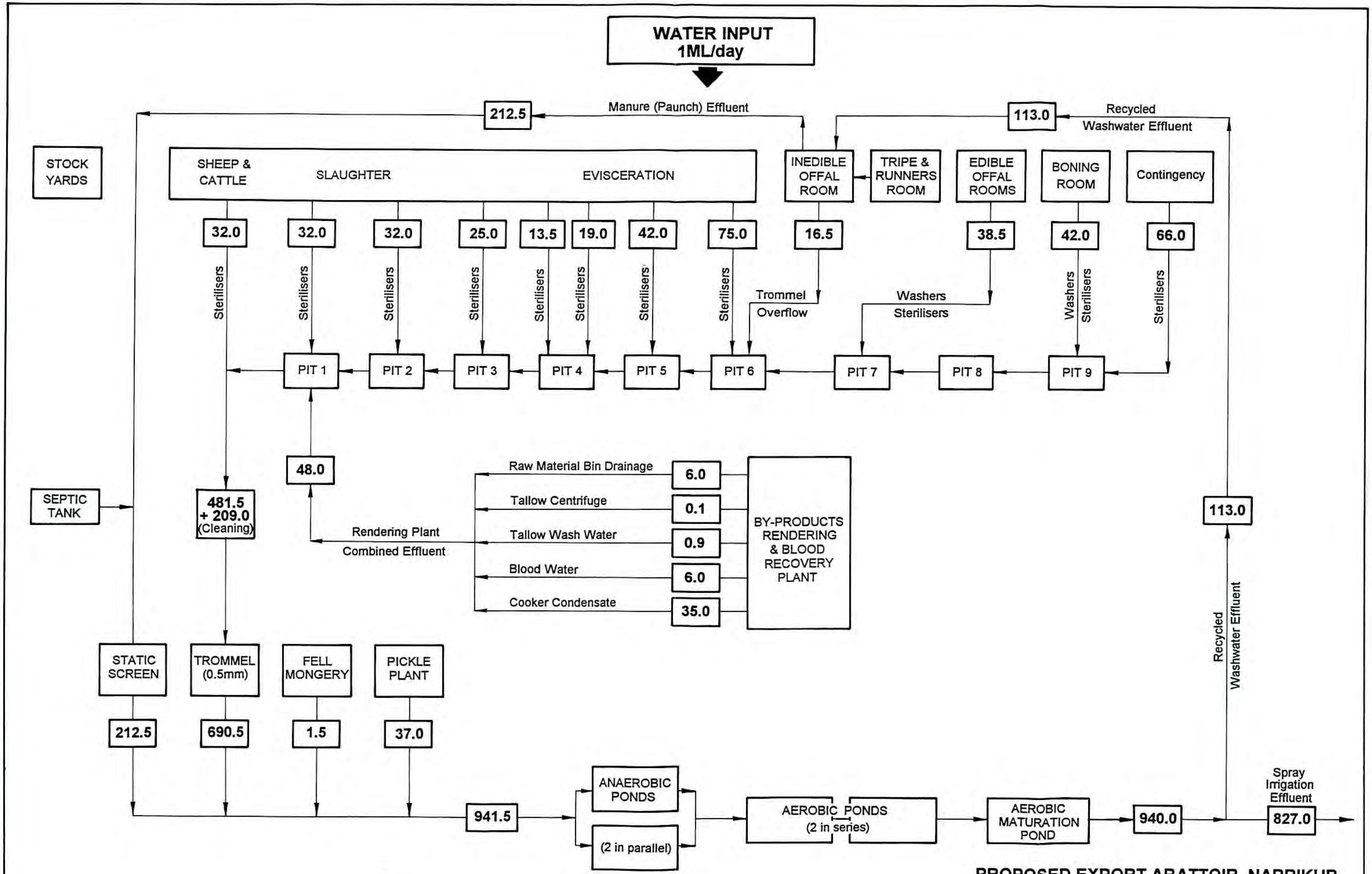
EXPORT ABATTOIR SITE, NARRIKUP
PLANT LAYOUT & REMNANT VEGETATION
FIGURE 10

ALAN TINGAY & ASSOCIATES

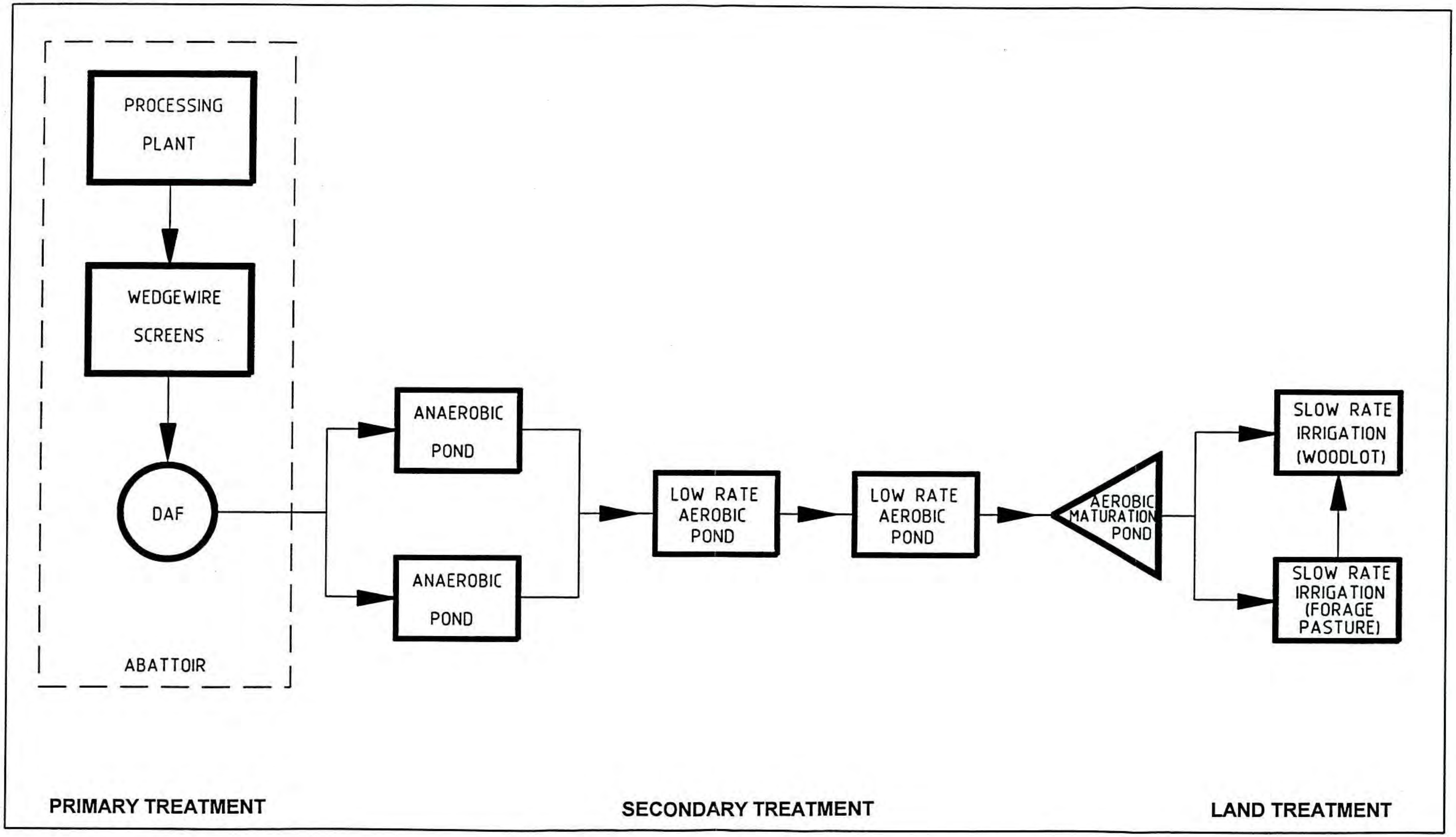


EXPORT ABATTOIR SITE, NARRIKUP
PROPOSED TRANSPORT ROUTES
FIGURE 11

ALAN TINGAY & ASSOCIATES

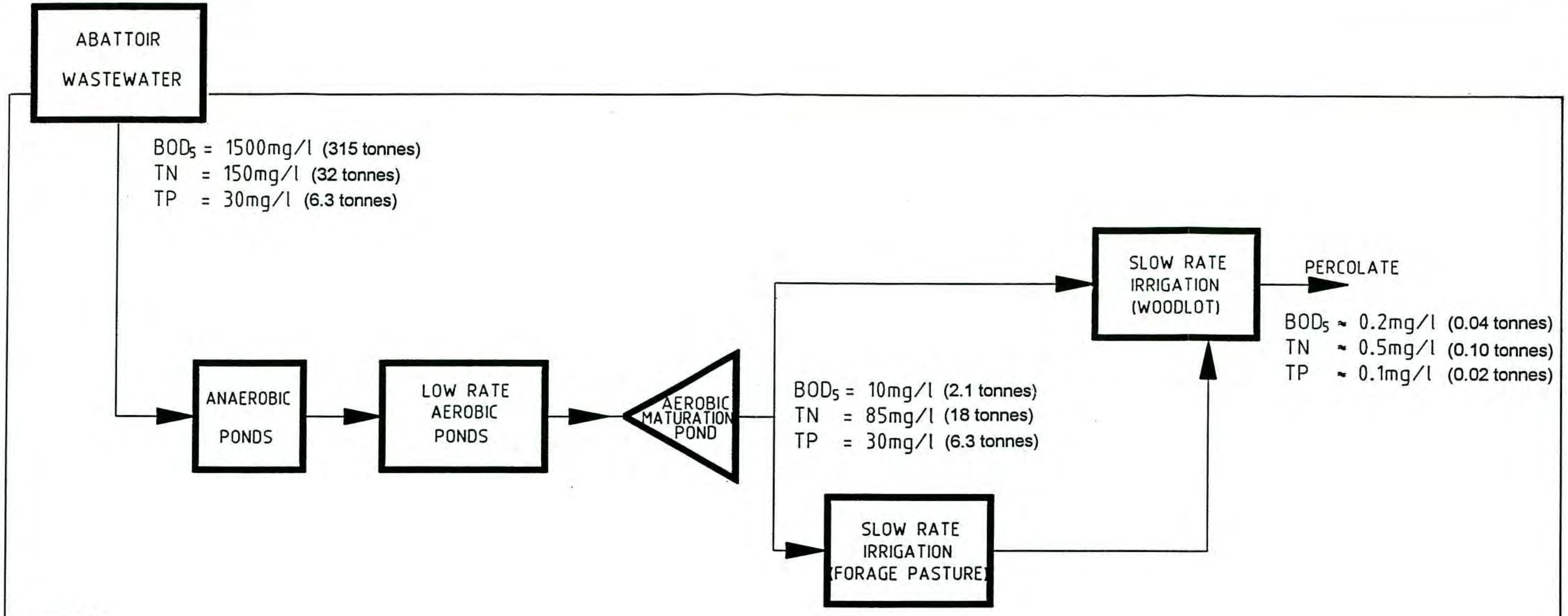


PROPOSED EXPORT ABATTOIR, NARRIKUP
TOTAL DAILY EFFLUENT FLOWS (kL/day)
FIGURE 12



NARRIKUP EXPORT ABATTOIR
WASTEWATER TREATMENT SYSTEM
FIGURE 13

SOURCE: EVANGELISTI & ASSOCIATES, 1995



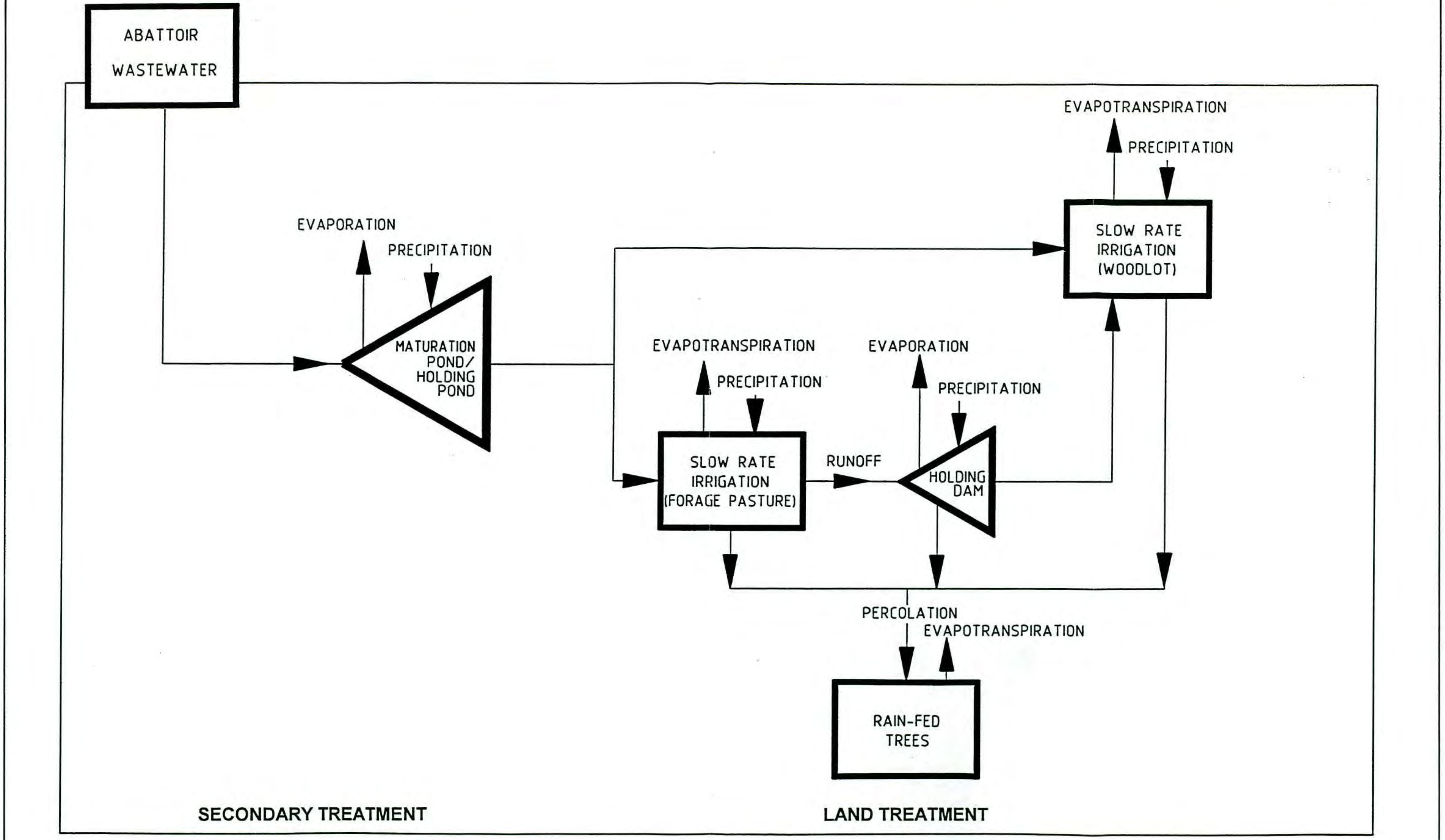
HYDRAULIC RETENTION TIME (DAYS)	30	40	135	-	-
ΔBOD (%)	75 (Winter)	90 (Winter)	70 (Winter)	95	95
ΔTN (%)	0 (Winter)	20 (Winter)	30 (Winter)	50	50
ΔTP (%)	0	0	0	30	70

SECONDARY TREATMENT **LAND TREATMENT**

NOTE: Nutrient Loads based on 210,000m^3/annum of wastewater

NARRIKUP EXPORT ABATTOIR
PREDICTED PERFORMANCE OF
WASTEWATER TREATMENT STRATEGY
FIGURE 14

SOURCE: EVANGELISTI & ASSOCIATES, 1995



NARRIKUP EXPORT ABATTOIR
LAND TREATMENT FLOW DIAGRAM
FIGURE 15

SOURCE: EVANGELISTI & ASSOCIATES, 1995

APPENDICES

APPENDIX 1

GUIDELINES FOR THE CER

Department of Environmental Protection

Mr Brian May
Combined Asset Services
PO Box 842
ALBANY WA 6330

Your Ref
Our Ref 18/95
Enquiries Mr F Browne

Dear Brian

GUIDELINES FOR THE PROPOSED NARRIKUP ABATTOIR

Further to our earlier discussions regarding the above proposal, please find enclosed the final guidelines for preparation of the Consultative Environmental Review (CER) assessment documentation.

These guidelines have been prepared after extensive review of the draft guidelines by the Environmental Protection Authority, State and Local Government Authorities as well as yourself.

Wherever possible, the comments received from these authorities were incorporated into the guidelines. Not all comments were able to be included in the final guidelines. This is because the comments have to fit in with the overall Environmental Protection Authority objectives relating to environmental impact assessment.

Evaluation Officers from the DEP would be happy to be of assistance should you require any further clarification of the guidelines, and during the drafting of the CER.

Evaluation officers would also appreciate the opportunity to review a draft of the CER, prior to final submission.

Should you require any further assistance or information, please contact Mr Floyd Browne on (09) 222 7142 or Dr Victor Talbot on (09) 222 7073.

Yours sincerely

V. Talbot

for R A D Sippe
DIRECTOR
EVALUATION DIVISION

31 March 1995

enc

cc: Shire of Plantagenet
Shire of Albany
Great Southern Development Commission
Ministry for Planning - Albany
CALM - Albany
Department of Agriculture - Albany
Main Roads Western Australia - Albany
Albany Waterways Management Authority - Albany
Water Authority of Westrern Australia - Albany
Geological Survey of Western Australia - Perth

Narrikup G/lines lett 310395 FBR

Guidelines for the Consultative Environmental Review (CER) on the proposal by Benalla Pty Ltd for the establishment of an Export Abattoir at Narrikup (28 kms south of Mount Barker)

These guidelines are to assist in identifying issues that should be addressed within the formal assessment process. They are not exhaustive and other relevant issues may arise during the preparation of the document; these should also be included in the assessment.

The CER should facilitate public review of the key environmental issues. It is intended to be a brief document; its purpose should be explained, and the contents should be concise and accurate as well as being readily understood. Specialist information and technical descriptions should be included where it assists in the understanding of the proposal. It may be appropriate to include ancillary or lengthy information in technical appendices.

The proponent is encouraged to consult with the appropriate authorities in relation to potential environmental impacts prior to formally submitting the document to the Environmental Protection Authority. Where specific information has been requested by a Government department or the local authority, this should be included.

The key environmental issues for the proposed site in order of priority appear to be:

- groundwater availability and hydrological impacts of groundwater abstraction on downstream users and ecosystems;
- potential impacts of wastewater irrigation and pond leakage on surface water courses, groundwater and the King River/Oyster Harbour catchment;
- wastewater treatment, solid waste disposal, and nutrient management methods;
- potential impacts of air emissions (dust, odours and noise) from plant, stock and transport activities on surrounding areas; and
- transport route selection.

1. SUMMARY

The CER should contain a brief summary of:

- salient features of the proposal;
- evaluation of alternative sites considered and a rationale for choosing the preferred site;
- description of the receiving environment if any waste is likely to be discharged or emitted, and an analysis of potential impacts and their significance;
- environmental monitoring and management programmes, and safeguards;
- environmental commitments covering all of the environmental issues which have the potential to cause problems; and
- conclusions.

2. INTRODUCTION

The CER should include an explanation of the following:

- identification of the proponent and responsible authorities;
- background and objectives of the proposal;
- brief details of the scope and timing of the proposal;
- relevant statutory requirements and approvals; and
- scope, purpose and structure of the CER.

3. NEED FOR THE PROPOSAL

The CER should examine the justification for the proposal, particularly in relation to the Mount Barker area. Broad costs and benefits of the proposal at a regional and State level could also be discussed.

4. EVALUATION OF ALTERNATIVES

The criteria used to evaluate alternative sites should be described and the rationale for choosing the preferred site.

5. DESCRIPTION OF PROPOSAL

The purpose of this section is to give the public a clear understanding of the environment for which the project is proposed. The physical elements of the plant at the proposed site should be described along with their functions. The inputs, outputs and by-products of each process should be explained.

The following issues should be addressed:

- overall concept of proposal;
- location, including cadastral information;
- adjacent land uses, including urban, recreational and conservation reserves;
- topography;
- natural drainage and downstream destinations;
- flora and fauna, including endangered species,
- process description - including a clear description of each stage of the process;
- identification of plant water supply sources;
- proposed livestock holdings at the site;
- infrastructure and auxiliary services at the proposed site (power and water usage, drainage, sewage) and the effect on local amenities;
- methods of solid and liquid waste disposal;
- noise and air quality buffer zones around the plant;
- increases in transport activities and transport route selection;
- operational timetable (eg seasonal influences) and hours of operation;
- development schedule for construction and commissioning;
- project lifetime; and
- potential of the surrounding local communities to absorb/provide construction and operational workforces (including capacity of local infrastructure).

6. ENVIRONMENTAL IMPACTS AND MANAGEMENT

The objective of this section is to synthesise all information and predict potential impacts of the proposal upon the environment. The CER should describe the overall effect on the environment of the abattoir operations at the proposed location. Impacts during construction and commissioning should be addressed separately from impacts of the plant once fully operational. Impacts should be quantified where possible, and criteria for making assessments of the significance of the potential impacts should be outlined. Compliance with relevant standards and statutes should be stated. The following potential environmental issues should be addressed:

Groundwater abstraction and wastewater disposal

- Hydrological impacts of groundwater abstraction on downstream users and ecosystems (eg wetlands, riverine ecosystems and the Mill Brook Nature Reserve);
- volumes and characterisation of solid and liquid wastes (including nutrients) and methods of disposal;
- area, volumes and materials of construction of wastewater treatment ponds;
- nutrient loading rates and methods of nutrient attenuation;
- a water and nutrient balance should be determined for the site as well as the pathways for surface and sub surface drainage;
- the nutrient and salt absorption capabilities of the soil as well as the long term impact of irrigated saline wastewater on soils, vegetation and groundwater;
- potential impacts of wastewater irrigation on: groundwater, downstream users of Mill Brook, and ecosystems in the Mill Brook catchment;
- mechanisms for protection of existing fringing and heritage listed vegetation;
- description of contingency plans for the management of the wastewater treatment and disposal system during periods when evaporation rates are low and where rainfall exceeds evaporation; and
- potential for water recycling and other environmentally acceptable beneficial uses.

Transport

- Transport issues may be addressed by a traffic management study. Such a study should also include input from the Shire of Plantagenet and Main Roads Western Australia.

Atmospheric emissions

- Atmospheric discharges and emissions, including noise, dust, odours and light-spill;
- there should be predictions of the levels of noise emissions from the abattoir and their potential impacts and management;
- effects of large scale stock movements at the site on land stability and subsequent erosion by irrigation and wind and rain.

Other

- There should be a mechanism for the future protection of buffer zones (eg Planning provisions); and
- identification of local benefits and compatibility with community goals and objectives should be stated.

It should be noted that the impacts of groundwater abstraction and wastewater management issues are likely to be key issues and therefore should be addressed in considerable detail. The proponent would have to demonstrate that groundwater abstraction is sustainable and potential impacts can be managed. A baseline database should be established such that potential impacts can be assessed in the future. This database should include an investigation of the hydrology of the area and the nutrient input and output from the site.

Discussion should also include identification of any odour producing processes (eg rendering plant and wastewater treatment) and details of the measures to be taken to control their impacts.

The CER should include an indication of the likely life of the project and preliminary plans for decommissioning the plant and rehabilitating the site.

7. MONITORING

The systems for the treatment and control of water, air and noise pollution will require monitoring to ensure that they are operating effectively and efficiently. A monitoring programme should address the following:

- the effectiveness of the wastewater treatment system;
- groundwater and surface water quality; and
- the effectiveness of odour control systems (eg afterburners or biofilters).

The parameters to be monitored and their frequency should be stated.

The proponent should provide details on environmental management in the event of:

- a breakdown in the wastewater treatment and disposal system;
- leakage of the effluent storage ponds;
- failures or breakdown of key elements of the plants pollution control equipment eg afterburners or biofilters; and
- pollution being detected outside the premises, such as water pollution, noise, odour and dust.

Procedures should be outlined for reporting the results of the monitoring of environmental impacts to the appropriate authorities.

8. PUBLIC CONSULTATION

A description should be provided of public consultation activities undertaken by the proponent in preparing the CER. This should outline the activities, the groups or individuals involved and the objectives of the activities. A summary of concerns raised should be documented along with how each of these concerns has been addressed.

9. COMMITMENTS

Value of a commitment

During the assessment of a project it is very important that the proponent is successful at conveying to the EPA, decision making authorities, the public and interest groups that it understands the environmental implications of its proposal. To give this level of security, the proponent is strongly advised to address all potential environmental impacts associated with the proposal in a thorough manner. One way in which this assurance can be given is for the proponent to give commitments covering all of the environmental issues.

The Authority is prepared to advise the proponents as how best to frame the commitments. In its assessment, the Authority attaches considerable weight to properly presented commitments and hence this helps to expedite the assessment process. It is not mandatory however, to make commitments, but to do so would clearly indicate to the public and the EPA that the proponent understands the environmental issues, has given them careful consideration and can confidently manage the proposal in a responsible manner.

Nature of a commitment

Where an environmental problem has the potential to occur the proponent should cover this potential problem with a commitment to rectify it. Where appropriate, the commitments should include:

- what is the nature of the work;
- who is responsible for the commitment and who will do the work;
- when and at what stages of development will the work be carried out;
- where will the work be carried out (if relevant); and
- to whose satisfaction the work will be carried out.

In addition, a standard commitment regarding decommissioning of plant and infrastructure and the rehabilitation of contaminated areas is requested by the Authority.

The trend for current and future developments is to promote the concepts of waste minimisation and recycling. The proponent should make commitments to minimising the generation of wastes and conduct on-going investigations of beneficial methods of disposal.

10. CONCLUSIONS

Conclusions of the overall impacts of the proposal, including the role of the ameliorative measures, should be stated together with an assessment of the environmental acceptability of the project.

Additional Information

Guidelines - A copy of these guidelines should be included in the document.

References - All references should be listed.

Appendices - Where detailed technical or supporting documentation is required, this should be placed in appendices.

Glossary - A glossary should be provided in which all technical terms, and unfamiliar abbreviations and units of measurement are explained in everyday language.

APPENDIX 2

HYDROGEOLOGICAL INVESTIGATION

GROUNDWATER
TECHNOLOGY

Groundwater Technology Australia Pty Limited
A.C.N. 003 931 057
3 Teakle Road, Osborne Park WA 6017
Telephone: (09) 244 2733 Fax: (09) 445 3222

HYDROGEOLOGICAL INVESTIGATION OF THE PROPOSED EXPORT ABATTOIR SITE SETTLEMENT ROAD, NARRIKUP, WESTERN AUSTRALIA

Prepared for:

Allan Tingay & Associates
35 Labouchere Road
SOUTH PERTH WA 6151

October 1995

Our Ref: W9202

GROUNDWATER TECHNOLOGY AUSTRALIA PTY LTD

Written/Submitted by:

John Throssell
Manager - Perth

TABLE OF CONTENTS

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APPENDICES

1.0 INTRODUCTION

This report evaluates the feasibility of abstracting groundwater at a rate of $1000m^3$ per day and the potential impact on neighbouring groundwater users and surface water features.

1.1 Previous Investigations

A hydrogeological investigation of the Settlement Road area was conducted in 1990-1991, by the Department of Agriculture (McFarlane et al, 1995), summarising the existing knowledge of the hydrogeology of the proposed abattoir site. The effect on groundwater levels of bluegum plantations by CALM in the winter of 1990 was addressed. It was concluded that although the Pallinup Siltstone has a low salt storage resulting in low groundwater salinities (averaging 1600 uS/cm), the fine-grained nature of the formation suggested problems associated with groundwater extraction due to the formations low hydraulic conductivity. Drilling conducted during the investigation was generally shallow and did not penetrate the full thickness of the water bearing formations underlying the sit e.

Extensive work into the identification and evaluation of waste water disposal sites and the irrigation of Bluegum plantations with waste water have been conducted near the Albany airport. In particular, the work by A.J. Peck and Associates on infiltration rates and hydrogeological responses to irrigation of wood lots has been referenced in this study.

2.0 SITE DESCRIPTION

2.1 Regional Physiography and Physical Environment

The topography of the Mount Barker - Albany area slopes gently south from the base of the Stirling Ranges to the coast and consists of three plains at different elevations. The area of investigation is located on the lowest plain and comprises alluvium sand and laterite overlying the Plantagenet Group. Isolated hills consisting of fresh granite and gneiss protrude from the general level of the plain and stand as erosion remnants of the original surface.

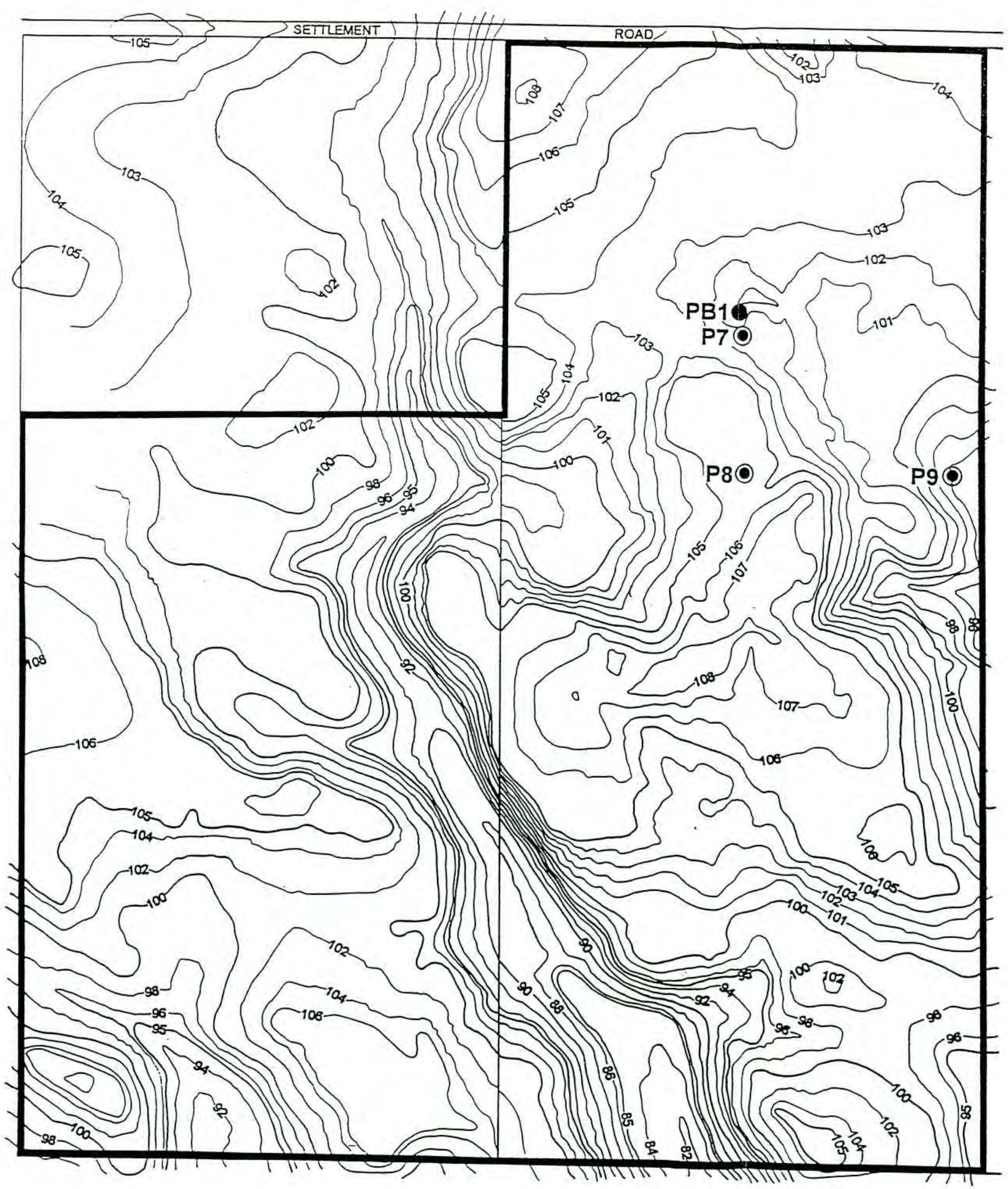
Vegetation of the Mount Barker - Albany area varies from jarrah forest in the west (jarrah, wandoo, marri and karri) to mixed mallee shrub heath in the east. Most of the area has been cleared for agriculture and is serviced by a network of sealed or graded dirt roads.

The Mount Barker - Albany area experiences warm to hot, dry summers and cool, wet winters. The average annual rainfall in Albany is 805mm and in Mount Barker is 1400mm (1966-1994).

2.2 Local Physiography and Physical Environment

The proposed Narrikup Abattoir site is located on the east side of Albany Highway, approximately 30 kilometres north of Albany. Settlement Road traverses the northern extent of the investigation area and the south, east and west sides of the investigation area are bounded by private properties. The investigation area covers an approximate area of 4.4 km^2 (Figure 1).

Landforms as described by McFarlane (1995), comprise level to very gently undulating plains (some with closed depressions, sumps and occasional sand-dunes), broad depressions, rises and gently inclined swampy valleys



N

metres

0 500

SCALE 1: 10,000

LEGEND

▬	Property Boundary
~90~	Topographic Contours (m AHD)
●	Production Bore
◉	Test Bore

GROUNDWATER TECHNOLOGY AUST.

3 TEAKLE ROAD
OSBORNE PARK
WA 6017
(09) 244 2733

SCALE: 1:10000

DRAWING DATE:

FILE:

SITE PLAN

CLIENT: ALLAN TINGAY AND ASSOCIATES

LOCATION: SETTLEMENT RD, NARRIKUP

DESIGNED: JST

DATA BY: JST

PROJECT NO.: W9202

FIG: 1

The investigation area is drained by Mill Brook Creek, which runs across the western half of the property and several ephemeral creeks, which have no defined channels and only flow in direct response to local rainfall. Headwaters for Mill Brook Creek originate from waterlogged depressions located in the northwestern section of the investigation area. Groundwater provides baseflow to the Mill Brook throughout the year.

Vegetation of the area consists predominantly of cleared pasture with scattered pockets of remnant vegetation and introduced bluegum plantings.

2.3 Regional Geology

The geology of the Mount Barker - Albany area was described by Morgan and Peers (1973) and is also referenced from the Geological Survey of Western Australia 1:250 000 geological series map compiled by Muchling and Brakel (1985).

The Mount Barker - Albany area is divided into four tectonic units: Yilgarn Block, Albany-Fraser Province, Stirling Range Formation and Bremer Basin. The Settlement Road area is located in the Albany-Fraser Province, which comprises Proterozoic gneiss, high-grade metamorphic rocks, and granitoid. Unconformably overlying these basement units, and of particular interest in this investigation, are sediments of the Late Eocene Plantagenet Group, comprising the Werillup Formation and the overlying Pallinup Siltstone (Cockbain, 1968).

The Werillup Formation as described by Muchling and Brakel (1985), is a sedimentary sequence of clay, siltstone, sandstone and lignite deposits which occur as broad sheets or distinct channels.

The occurrence of foraminifera assemblages, indicate a shallow, warm, marine depositional environment. The occurrence of lignite and non-marine clays indicate a coastal swamp depositional environment. The Werillup Formation is overlain by the Pallinup Siltstone with a transitional silty sandstone unit between the two formations.

The Pallinup Siltstone as described by Muchling and Brakel (1985), is an extensive marine deposit typically consisting of siltstone, glauconite, clay fine-grained clayey sandstone and white spongolite (siltstone with sponge spicules).

The formation is normally moderately to well consolidated with rocks appearing massive and structureless. Although the formation is usually unfossiliferous, there are sporadic molluscs, rare plant leaves, and some lenses rich in sponges. The Pallinup Siltstone was deposited in a shallow transgressive sea during a period of high sea-levels. The Pallinup Siltstone either conformably overlies the Werillup formation or unconformably overlies the basement.

2.4 Regional Hydrogeology

The Geological Survey of Western Australia records indicate that over 1000 bores, well and soaks have been completed in the Mount Barker - Albany area. Most of the bores provided small quantities of stock-quality water, which is used to supplement farm dams for stock water supplies. Only a few locations supplied large quantities of low-salinity water.

Hydrogeological investigations conducted on the Plantagenet Group sediments (Moncrieff - 1977), obtained limited quantities of stock-quality water from bores which were screened in the spongolite series, located within the Pallinup Siltstone. The best supplies were obtained from bores which were screened in sands located in the lower parts of the Werillup Formation.

Most of the local bores surrounding the proposed abattoir site are screened in the interbedded silt and siltstone deposits of the Pallinup Siltstone, which has been shown to be a good water bearing formation throughout the region, providing small quantities of domestic and stock quality water. Most bores appear to have been terminated when sufficient supplies have been intersected. There is little information available on the water bearing potential of the full Tertiary sedimentary sequence in the immediate area of the proposed abattoir site.

3.0 STUDY METHODOLOGY

3.1 Drilling Programme

The drilling programme was completed during the first week of May 1995. Drilling sites were chosen based on the proposed location of abattoir infrastructure and work carried out on the site by the Department of Agriculture. Drilling was undertaken at three locations. Each boring was subsequently completed as a piezometer (P7, P8 & P9). Based on the results of the test borings a production bore (PB1) was installed in the vicinity of piezometer P7. In order to obtain a comprehensive geologic profile of the investigation area, the three test borings were drilled to the basement rock. The top 15 metres of P7 was penetrated using air rotary drilling, all the remaining drilling was completed using mud rotary drilling. Drilling locations are illustrated in Figure 1 and the drilling logs are attached in Appendix A. Brief well construction details are as follows:

- P7 was drilled to 51 metres below grade (mbg) and screened from 45 to 51 mbg;
- P8 was drilled to 38.5 mbg and screened from 27.5 to 33.5 mbg; and
- P9 was drilled to 38.5 mbg and screened from 24.5 to 29 mbg.
- PB1 was drilled to 25 mbg and screened from 22 to 25 mbg. PB1 was constructed with 125mm Class 9 PVC casing with a 3.0 metre, 0.5mm slotted 132mm, stainless steel (312) well screen.

In general, piezometer P7 was screened in the top section of the weathered basement and piezometers P8 and P9 were screened at the base of the Tertiary sediments, above the weathered basement, in fine-grained, well sorted, sub-rounded sand with some silts and clays. The production bore PB1 was screened approximately 18.5 metres above the top of the weathered basement, in fine-grained well sorted, sub-rounded sand.

All four bores were developed by air lifting for 1 to 3 hours, and water samples were collected for field electrical conductivity measurements. Several days later, static water levels in the piezometers were recorded and the wells were purged and samples were collected for laboratory analysis.

3.2 Pumping Tests

Following the installation and development of PB1, pumping tests were conducted on the bore to determine aquifer characteristics. The tests consisted of a 2 hour multi-rate pumping test (5 May 1995), a 24 hour constant-rate pumping test (6-7 May 1995), and a 2 hour recovery test (7 May 1995

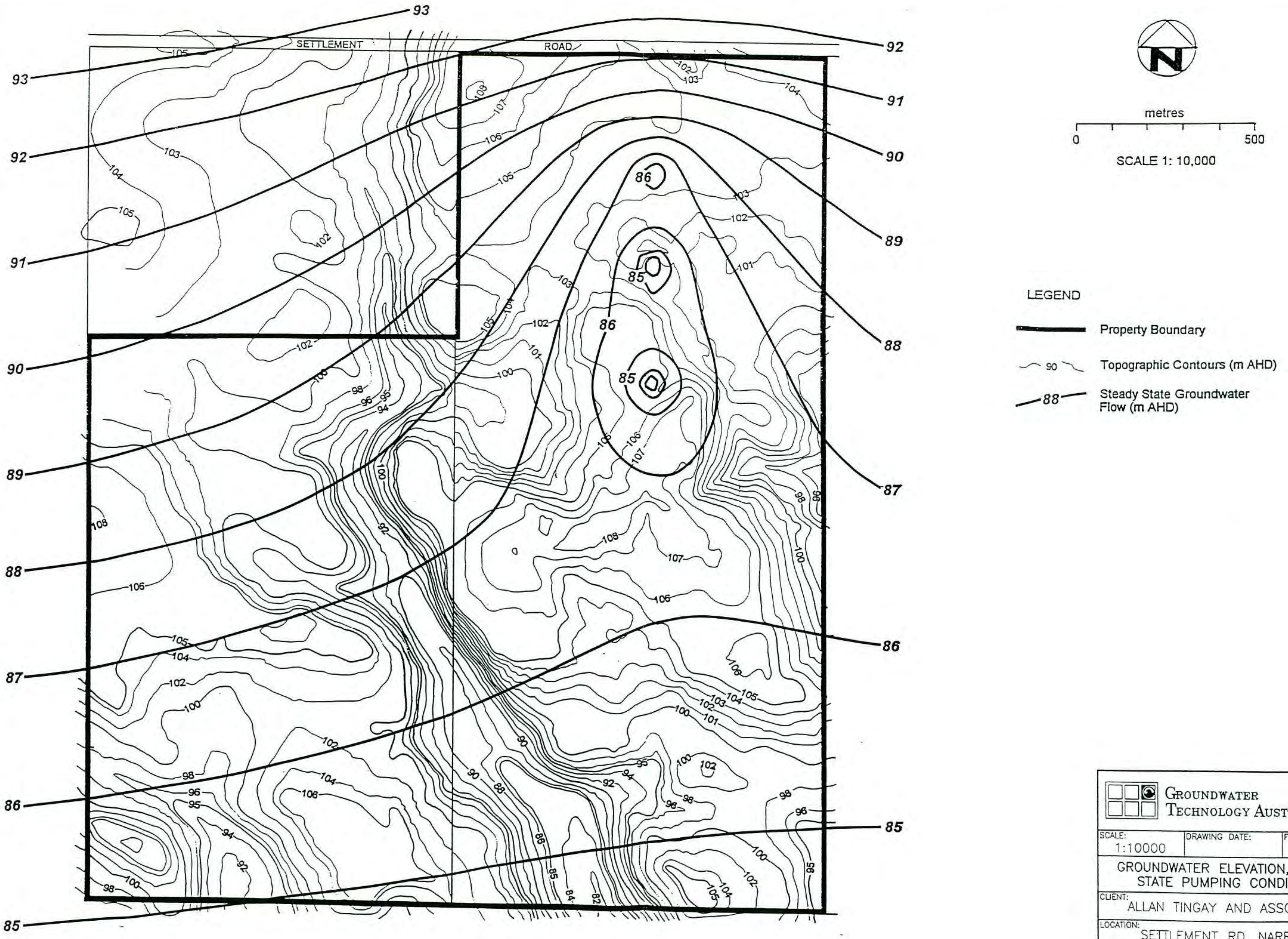
During the tests, flow rates were monitored using an orifice weir assembly and water levels were measured using an electric water level probe.

The multi-rate test conducted on production bore PB1 comprised four 30 minute stages at pumping rates of 100, 200, 300 and 400 kL/day. At the end of the last stage, drawdown had not fully stabilised and there was less than two metres of available drawdown. It was therefore decided to pump PB1 at a rate of 300kL/day during the 24 hour constant-rate test.

3.3 Groundwater Modelling

Based on the aquifer parameters determined from the pump tests, the modelling package "Flowpath" was used to simulate the response of groundwater levels to the abstraction of 1 ML per day from three production wells. The location of the three simulated production wells is illustrated in Figure 2. Flowpath is a steady state, two dimensional horizontal aquifer simulation model. It is a finite difference model allowing simulations of confined, leaky and unconfined flow. The following basic assumptions normally apply in groundwater modelling:

- Flow regions are of infinite extent in the longitudinal direction and of great extent in the lateral direction
- The aquifer can be characterised using homogeneous and isotropic material properties
- The groundwater flow is uniform and continuous in direction and velocity.
- Hydraulic properties of the aquifer do not vary with temperature or density of the groundwater.



LEGEND

Property Boundary

90 Topographic Contours (m AHD)

88 Steady State Groundwater Flow (m AHD)

GROUNDWATER TECHNOLOGY AUST.
3 TEAKLE ROAD
OSBORNE PARK
WA 6017
(09) 244 2733

SCALE: 1:10000
DRAWING DATE:
FILE:

GROUNDWATER ELEVATION, STEADY STATE PUMPING CONDITIONS

CLIENT: ALLAN TINGAY AND ASSOCIATES

LOCATION: SETTLEMENT RD, NARRIKUP

DESIGNED: JST
DATA BY: JST
PROJECT NO.: W9202
FIG: 2

4.0 INVESTIGATION RESULTS

4.1 Geology of the Proposed Abattoir Site

Drilling locations are shown in Figure 1. The lithology encountered during drilling is summarised in the drilling logs attached in Appendix A.

Surface sediments consist of a white, fine-grained sand, underlain by variably lateritised sediments of the Plantagenet Group. No laterite deposits were encountered at drilling location P8, which is topographically higher than the three other drilling locations.

Underlying the surface sediments at an approximate depth of 0.25 to 1.5 metres below grade, are leached sands, silts and clays constituting the Plantagenet Group. Drilling penetrated between 30m (P9) and 43m (P7) of Tertiary sediments. In general silts with varying amounts of clay and silts interbedded with siltstone were observed near the top of the section. Sands with varying amounts of silt and clay were observed in the bottom half of the section.

During the drilling of piezometer P7 and the production bore PB1, a pale yellow, lightweight porous rock with numerous vugs and solution channels was intersected between 12 and 13 metres below grade. Identified as the spongolite facies within the Pallinup Siltstone, it was not intersected at drilling locations P8.

Basement rock beneath the Tertiary sediments consists of a pale grey felsic (quartz-feldspar-biotite) gneiss.

No silty sandstone unit or lignite deposits typical of the Werillup Formation were intersected during the drilling programme. Based on the absence of these deposits and discussions with Department of Mines staff, it is concluded that the Werillup Formation does not exist in the investigation area and that the Pallinup Siltstone unconformably overlies the basement.

4.2 Hydrogeology of the Proposed Abattoir Site

Drilling at all three test bore locations intersected a promising sequence of fine sand below siltstone within the Pallinup Siltstone formation. Piezometer P7 was screened below the base of the fine sand interval, in the weathered basement zone and piezometers P8 and P9 were screened within the base of the fine sand interval.

Discharge rates were estimated during the development of piezometers P7, P8 and P9. Approximately 0.53 kL/day was air-lifted from piezometer P7 and 1.06 kL/day was air-lifted from piezometers P8 and P9. Although these discharge rates are low, discharge produced from these piezometers during air development was limited due to the small diameter of the casing. In general, results indicate that higher yields are available from the base of the fine sand interval than there is from the weathered basement zone.

The greatest thickness of sand was intersected in test bore P7, between 13 and 36 metres below grade. This location was subsequently chosen as the most prospective site for the production bore PB1. PB1 was drilled to a depth of 25 metres below grade and the screen set between 22 and 25 meters below grade, in the upper section of the fine sand sequence.

4.3 Pumping Test Results

Review of the multi-rate test data indicated that prior to each increase in discharge rate, drawdown in PB1 had generally stabilised.

During the constant rate test, drawdown data was collected from PB1 and from piezometers previously installed by the Department of Agriculture. Constant-rate pumping test data is attached in Appendix B. After 24 hours of pumping, there was a total drawdown of 7.1 metres in PB1.

Ideally in a pumping test, the pumping rate should be such that the aquifer is placed under significant stress. Analysis of the drawdown data will then allow aquifer parameters to be determined followed by predictions on the long term yield of the aquifer. In this case however, the bore was capable of producing such high flows, that the pumping test rate of 300 kL/day did not produce significant drawdown in the surrounding monitoring wells.

During the constant-rate pumping test of PB1, water levels in four monitoring well surrounding PB1 were monitored, in order to determine the effect of pumping on the water table in the vicinity of the production bore. Data obtained by measuring the drawdown in the surrounding monitoring wells will allow for both time-drawdown and distance-drawdown relationships to be determined. Therefore, calculations relating to average hydraulic conductivity, transmissivity and storage coefficient of the aquifer are more accurate and are representative of a larger area than the calculations made on the production bore alone.

Using the Jacob straight line method of analysis, aquifer transmissivity, which is the rate at which water is transmitted through a unit width of the aquifer, was calculated to be 110 m^2/day. Assuming a saturated thickness of 20m, the average hydraulic conductivity is estimated to be 5.5m/day. Because the slope of the drawdown curve is similar for the four pumping rates, the calculated transmissivity is likely to be conservatively low.

Following the constant-rate pumping test, recovery water levels were monitored in the production bore for two hours. Recovery data is attached in Appendix B. Analysis of the data yielded an aquifer transmissivity of 95m^2/day.

4.4 Modelling

As the pumping test rate of 300m^3/day did not produce significant drawdown in the monitoring wells, meaningful determination of aquifer parameters from the data is limited. However, knowing the extent and composition of the aquifer, valid assumptions can be made in modelling the long term effects of abstracting 1ML/day from the Narrikup site. The following data was derived from the pumping test results and used in the model:

- Water Table Gradient = 0.01
- Transmissivity (T) = 110m^2/day
- Hydraulic Conductivity = 4.75m/day
- Storage Coefficient (S) = 0.1

The modeling assumes that Mill Brook is in direct connection with the aquifer but does not take into account the rise in groundwater levels in response to rainfall that has been measured at this site.

Additionally, the potential recharge to the groundwater resulting from irrigation of pasture and the wood lots has not been accounted for in the modeling. The modelled abstraction rate of 1ML/day also represents the upper limit of predicted groundwater usage by the abattoir as production will cease for two months during the winter months for plant maintenance. Therefore, the results presented can be assumed to represent a worst case scenario.

Water table contours generated by the model (Figure 2) represent the steady state condition where the aquifer has reached equilibrium and no further decline in water levels is occurring. The contours show that at the down gradient or southern boundary of the property there is minimal impact on groundwater levels. There is also no apparent effect on the water table at properties to the north, east and west. The only visible effect that groundwater abstraction may have is a slight shift downstream of the emergence point of surface flow in Mill Brook and possibly a slight reduction in stream flow which would be noticed at the end of the summer months.

4.5 Groundwater Chemistry

During the development of piezometers P7, P8 and P9 and the production bore PB1, groundwater samples were collected for field electrical conductivity measurements. Groundwater collected from P9 recorded the highest conductivity value of 450 uS/cm. Groundwater collected from P7 recorded an electrical conductivity of 364 uS/cm and samples collected from P8 and PB1 recorded the lowest electrical conductivity values of 250 uS/cm. Based on these field electrical conductivity readings, it is evident that there is a significant increase in salinity with depth within the aquifer.

Groundwater samples were collected from PB1 at the beginning and end of the constant rate test. Additional groundwater samples were collected from piezometers P8 and P9. The samples were submitted for water quality analysis and the results are summarised Table 1. In all water samples sodium is the dominant cation and chloride is the dominant anion. Groundwater chemistry differs from that reported by McFarlane in that calcium concentrations are low suggesting that the spongolite is not making a significant contribution to yields from the production bore. However the chemistry is consistent with samples collected by Baddock (1995) from the spongolite in test wells near Esperance.

TABLE 1
WATER QUALITY ANALYSIS RESULTS

SAMPLE ID	PQL	UNITS	P8 7/05/95	P9 7/05/95	PB1 6/05/95	PB1 7/05/95
LABORATORY ID			**355**	**336**	**337**	**338**
Conductivity	2	uS/CM	3040	4770	3060	3110
pH	NA	NA	6.0	6.5	5.7	5.7
Total Dissolved Solids	2	mg/L	2620	2740	1690	1730
Total Hardness as $CaCO_3$	1	mg/L	160	300	155	155
Mass Balance:						
Anion Sum	NA	meq/L	NA	NA	27.4	27.6
Cation Sum	NA	meq/L	NA	NA	29.0	29.4
Difference	NA	%	NA	NA	6	6
Total Alkalinity as $CaCO_3$	1	mg/L	40	135	45	45
Calcium	0.05	mg/L	NA	NA	16.7	16.3
Magnesium	0.05	mg/L	NA	NA	45	46
Sodium	0.05	mg/L	NA	NA	518	522
Potassium	0.05	mg/L	NA	NA	9.9	10.6
Carbonate as $CaCO_3$	1	mg/L	ND	ND	ND	ND
Bicarbonate as $CaCO_3$	1	mg/L	40	135	45	45
Chloride	2	mg/L	NA	NA	875	895
Sulphate	5	mg/L	NA	NA	85	70
Nitrate as N	0.5	mg/L	NA	NA	ND	ND
Silicon	1	mg/L	NA	NA	23	25
Boron	0.5	mg/L	NA	NA	ND	ND
Fluoride	0.1	mg/L	NA	NA	ND	ND

PQL = Practical Quantitation Limits

ND = Not detected

NA = Not applicable

Our Ref: W9202NAR\BP1.TBL

General guidelines for salinity of irrigation water taken from the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZECC, 1992) are summarised in Table 2. Water quality from PB1 falls into the Class 3 or high salinity water. It should be noted that the soils at Narrikup are well drained and have a low salt content and the irrigation of this water onto forage crops and wood lots will not significantly compromise their growth. Additionally, better quality water may be available by setting screens higher in the aquifer. McFarlane (1995) reported an average groundwater conductivity of 1600uS/cm from shallow monitoring wells on the site. Because of the reduction in available drawdown in shallower bores, the water yield from each bore will be reduced, therefore a larger number of production bores will be required to supply 1ML per day.

4.5.1 Leaching Requirements

Where irrigation water contains soluble salts it is important that the build up of salt in the soil profile is prevented. Leaching of the soil profile to remove the salt can be provided by excess irrigation water or rainfall. The amount of water required for leaching is dependent on the salt tolerance of the vegetation or crop, and the salt content of the irrigation water. The leaching fraction is determined from the ratio of the conductivity of the irrigation water to the conductivity of drainage water that will result in a 50% reduction in crop yield. Values of 38% and 25% have been determined for irrigated pasture and woodlots respectively using drainage water conductivities of 8000uS/cm and 12000uS/cm. Therefore if the annual irrigation depth for the woodlots is 174mm, the leaching requirement is 43mm which is easily achieved by rainfall. Similarly, the irrigation depth for the pasture is 430mm with a resulting leaching requirement of 163mm which is also easily exceeded by rainfall.

4.5.2 Sodium Adsorption Ratio for Irrigation Water

Using the concentration of sodium, calcium and magnesium in the pumped groundwater samples, the sodium adsorption ratio of the waste water is estimated to be 15. Values over 10 can potentially cause dispersion of clay minerals in sodic soils thus reducing permeability. The concentration of other salts in the waste water stream and the low clay content of soils at Narrikup will negate any potential problems associated with elevated sodium concentrations.

TABLE 2
GENERAL GUIDELINES FOR SALINITY OF IRRIGATION WATER

CLASS	COMMENT	Electrical Conductivity (uS/cm)	TDS (mg/l)
1	Low-salinity water can be used with most crops on most soils and with all methods of water application with little likelihood that a salinity problem will develop. Some leaching is required, but this occurs under normal irrigation practices except in soils of extremely low permeability.	0-280	0-175
2	Medium-salinity water can be used if moderate leaching occurs. Plants with medium salt tolerance can be grown, usually without special measures for salinity control. Sprinkler irrigation with the more-saline waters in this group may cause leaf scorch on salt-sensitive crops, especially at high temperatures in the daytime and with low application rates.	280-800	175-500
3	High-salinity water cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required, and the salt tolerance of the plants to be irrigated must be considered.	800-2,300	500-1,500
4	Very high-salinity water is not suitable for irrigation water under ordinary conditions. For use, soils must be permeable, drainage adequate, water must be applied in excess to provide considerable leaching, and salt-tolerant crops should be selected.	2,300-5,500	1,500-3,500
5	Extremely high-salinity water may be used only on permeable, well-drained soils under good management, especially in relation to leaching and for salt-tolerant crops, or for occasional emergency use.	>5,500	>3,500

4.6 Soil Drainage

Infiltration rates for surface soils have been determined at five locations on the Russell property using the falling head method. The sites are representative of the various land uses associated with the abattoir development and the principal soil types found on the property. The values ranged between $1.4*10^{-5}$ and $6.4*10^{-5}$ are generally two orders of magnitude greater than the data for surface soils at the Albany waste water site reported by Peck & Associates (1991).

4.7 Waste Water Loading Rates

Maximum waste water loading rates have been determined for both irrigated pasture and irrigated wood lots. Calculations are based on those described by Reed et al (1995). Loading rates were calculated based on the hydraulic limitations of the soil and the requirement to minimise the leaching of nitrogen beyond the root zone. The results are summarised in Table 3. and the calculation sheets are attached in Appendix D.

TABLE 3
Waste Water Loading Rates

	Pasture	**Wood lots**
Hydraulic Limited Loading Rate	1.9m/year	2.3m/year
Nitrogen Limited Loading Rate	0.43m/year	0.17m/year

The data indicates that the application of waste water to both the irrigated wood lots and pasture will be limited by the crop capacity for nitrogen uptake. Higher application rates will result in leaching of nitrogen beyond the root zone leading to potential impact on the aquifer underlying the site. By comparison, waste water irrigation rates under typical conditions for the Albany Sewage land treatment scheme were estimated to be 0.8m/year (Peck, 1992). Nitrogen limitations were not a consideration at this site. The assumptions used in the determinations are deliberately conservative.

TABLE 4
Water Balance, Woodlots
All values in mm

Month	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Year
Rainfall		15	41	39	21	128	100	114	122	89	68	62	13	812
Effective P		12	36	30	16	108	81	92	103	74	57	48	9	666
Irrigation		26	19	19	12	9	7	7	7	10	15	17	26	174
Pan Evap		211	148	143	99	67	67	51	56	75	114	130	195	1356
ET		73	19	50	34	21	61	47	52	70	106	121	181	835
Drainage D		0	0	0	0	0	0	0	0	1	1	1	0	5
Storage S	356	321	357	355	349	446	473	524	582	595	560	503	356	

(i) Daily rainfall (P) and tank evaporation (EP) data from Bureau of Meterology

(ii) Effective P = 0.7* P(P<5 mm/d) 0.85 *P (P<15 mm/d) 0.9 *P (P>15 mm/d)

(iii) Max ET = EPan

(iv) ET = CF*EP*((S-SMIN)/(SCRIT-SMIN))*(ETFactor) where S is storage on previous day

(v) SMAX = 900mm

(vi) SCRIT = 450mm

(vii) SMIN = 300mm

(viii) D = KSAT*(exp(a(S/SMAX-1)) where KSAT is hydraulic conductivity at saturation

(ix) KSAT = 150mm/month

(x) a = 13.8

(xi) Crop Factor CF = 0.93

TABLE 5
Water Balance, Pasture
All values in mm

Month	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Year
Rainfall		15	41	39	21	128	100	114	122	89	68	62	13	812
Effective P		14	40	36	19	123	94	107	117	85	65	57	12	769
Irrigation		45	45	45	45	45	15	10	30	35	35	40	40	430
Pan Evap		211	148	143	99	67	51	54	56	75	114	130	195	1343
ET		65	21	100	69	47	36	38	39	53	80	91	141	779
Drainage D		0	0	0	0	0	43	43	43	43	43	6	6	229
Change in S		-6	64	-19	-5	121	30	36	64	24	-23	0	-95	
Storage S	36	30	94	75	70	155	155	155	155	155	132	132	36	
Runoff		0	0	0	0	16	10	16	44	4	0	0	0	90

(i) Daily rainfall (P) and tank evaporation (EP) data from Bureau of Meterology
(ii) Effective P = 0.9* P(P<5 mm/d) 0.95 *P (P<15 mm/d) 1.0 *P (P>15 mm/d)
(iii) Max ET = EPan
(iv) ET = CF*EP*((S-SMIN)/(SCRIT-SMIN))*(ETFactor) where S is storage on previous day
(v) SMAX = 175mm
(vi) SCRIT = 50mm
(vii) SMIN = 25mm
(viii) D = KSAT*(exp(a(S/SMAX-1) where KSAT is hydraulic conductivity at saturation
(ix) KSAT = 100mm/month
(x) a = 13.8
(xi) Crop Factor CF = 0.7

The calculations are based on mature trees, therefore there will be a period during the early operation of the irrigation system where nitrogen uptake capability of the wood lots will be reduced. Several possibilities are available to remove potential leaching of nutrients to the groundwater system. These include the establishment of the wood lots ahead of the abattoir facility and the irrigation of existing mature woodlots and additional pasture areas until the new plantings are established.

4.8 Water Balance

Monthly nitrogen limited loading rates based on variations in evapotranspiration have been calculated for the irrigated wood lots and pasture. These have been combined with published rainfall and evaporation data for typical conditions collected at the Albany Airport to develop a monthly water balance for irrigated pasture and wood lots. A spread sheet model adapted from that used by Peck (1992) has be used to simulate changes in soil water storage and drainage below the root zone. The data is summarised in Tables 4 and 5.

Nitrogen utilisation rates will vary with evapotranspiration therefore higher irrigation rates are possible during the summer months. The magnitude of drainage below the root zone is dependent on existing soil moisture conditions. As soil moisture has not been directly measured at the site, the estimates used by Peck (1992) for the Albany waste water treatment scheme have been used. The high evapotranspiration capacity of the wood lots and the low nitrogen uptake capacity results in relatively little drainage below the root zone.

Drainage below the irrigated pasture lots is greater due to the higher nitrogen uptake capacity which allows a higher waste water loading rate. The model has also predicted that some run off will occur. Although the model assumes that run off water will not enter the subsurface, in reality ponding may occur resulting in eventual percolation to the subsurface. Alternatively run off water will be intercepted by fringing wood lots and thus will ultimately contribute changes in subsurface storage.

Drainage beyond the pasture root zone will occur during the winter months and will be mostly due to rainfall. The modelling results presented in Table 5 indicate that irrigation rates are reduced during the winter months to minimise drainage beyond the root zone.

Total drainage below the pasture root zone will be 229mm most of which will occurs between June and October. This water can potentially reach the water table. During these same months an average total of 493mm of rain will fall and 125mm of waste water will be applied to the pasture.

Conservative parameters have been used in all calculations relating to waste water loading rates to ensure that there are no nutrients exported from the site via the groundwater system. To provide further security for surface waters in the area, the well field can be located near the pasture areas so that the capture zone of the well field can be used to control nutrient migration within the aquifer.

5.0 DISCUSSION

As outlined by McFarlane (1995), the available groundwater storage in the catchment containing investigation site, and the measured rise in groundwater levels in response to agricultural clearing, suggests that the water requirement of 1ML per day for the proposed abattoir is quite achievable. The limiting factors are the increase in salinity of the groundwater with depth in the aquifer, and the lower hydraulic conductivity in the upper, fresher section of the aquifer. Both these factors can be overcome by incorporating a larger number of lower yielding bores into the final design of the well field.

Modelling of the groundwater response to pumping has demonstrated that long term declines in the watertable are unlikely to be significant. When considering the potential increase in recharge due to irrigation, and the current measured rise in water levels, pumping is likely to have a stabilising effect on the water table.

A.J. Peck and Associates (1992) investigated the effects of irrigation of wood lots on groundwater as part of the planning study into the land treatment of Albany waste water. It was concluded that there would be no net change of groundwater recharge to deeper aquifers from waste water disposal when compared to estimated rates of drainage below pasture and native vegetation. Increased groundwater recharge resulting from clearing of native vegetation within the catchment has already been demonstrated at the Settlement Road site.

The water balance model indicates that the irrigation of wood lots will not significantly increase aquifer recharge. Greater drainage will occur below the irrigated pasture however the limited area of pasture will not contribute significantly to aquifer recharge. The potential for further rises in groundwater levels at the abattoir site will be balanced by the abstraction of process water.

The aquifer underlying the site provides base flow to Mill Brook. If the net impact of recharge and pumping is to stabilise rising groundwater levels at the site, flows in Mill Brook should also reflect this. Anecdotal evidence suggests that flows in Mill Brook have increased in response to rising groundwater levels in recent years.

Irrigation on the property will increase the moisture content of the superficial soils therefore there is the potential for increased overland flow during the winter months. This is demonstrated by the model which has calculated an annual total of 90mm of runoff from the irrigated pasture. The closure of the plant during the high rainfall months of July and August for maintenance, and the permeable surface soils at the site, should keep increases in overland flow to a minimum. The use of unirrigated wood lots as buffer zones down gradient of the irrigated pasture will also minimise any negative effects of increased runoff.

The salinity of the groundwater pumped during this investigation, though marginal, is suitable for abattoir purposes and the ultimate irrigation of fodder crops and bluegum wood lots. Based on the model results and the nitrogen limited loading rates, the leaching requirement of 38% for pasture will be met, however additional groundwater may have to be applied to the wood lots to meet the 25% leaching requirement. The low natural salt storage levels and the well drained nature of the superficial soils at the site will reduce the potential for salt accumulation. To minimise any long term effects of salt build up in the proposed effluent treatment ponds and the soil profile, it is recommended that the borefield be designed to abstract the higher quality groundwater from the upper section of the aquifer rather than relying on deeper high yielding bores that will produce marginal quality water.

6.0 REFERENCES

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APPENDIX A
DRILLING LOGS

GROUNDWATER
TECHNOLOGY
AUSTRALIA

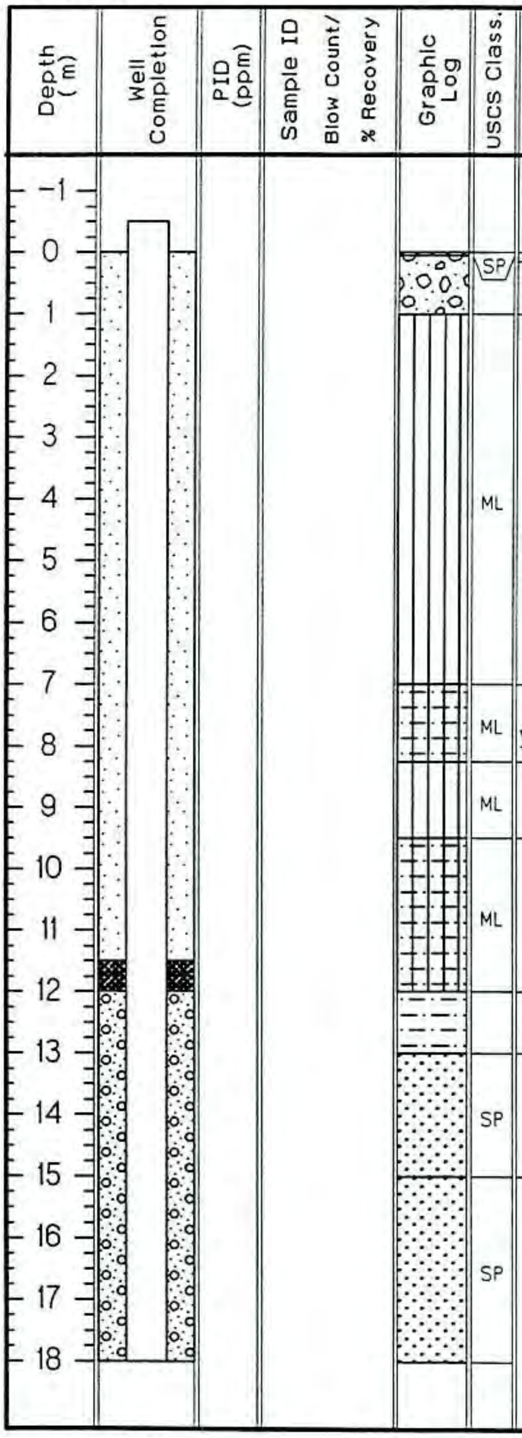
Drilling Log

Production Bore **PB1**

Project *Narrikup Abattoir* Owner
Location *Doug Russell's Farm* Proj. No. *W9202*
Surface Elev. Total Hole Depth *25.0 m* Diameter *205 mm*
Top of Casing Water Level Initial *8.0 m* Static
Screen: Dia *125 mm* Length *3.0 m* Type/Size *0.5 mm*
Casing: Dia *125 mm* Length *22.0 m* Type *Class 9*
Fill Material Rig/Core
Drill Co. *Albany Drilling* Method *Mud Rotary*
Driller *Carl Plug* Log By *David Donovan* Date *04/05/95* Permit #
Checked By *John Throssell* License No.

See Site Map
For Boring Location

COMMENTS:



Description
(Color, Texture, Structure)
Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%

White, fine-grained, well sorted, sub-rounded SAND.

Angular to rounded lateritic GRAVEL.

Orange SILT with trace (<10%) clay.

Pale orange SILT, interbedded with siltstone.

Orange SILT with trace (<10%) clay.

Pale orange SILT, interbedded with siltstone.

Spongolite FACIES.

Pale orange, fine-grained, well sorted, sub-rounded SAND with trace (<10%) silt and clay.

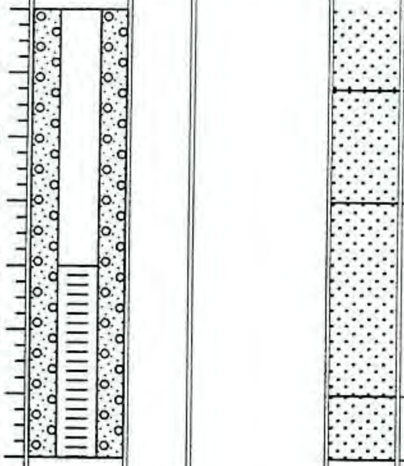
Greenish, fine-grained, well sorted, sub-rounded glauconitic SAND with trace (<10%) silt.

GROUNDWATER
TECHNOLOGY
AUSTRALIA

Drilling Log

Production Bore **PB1**

Project *Narrikup Abattoir* Owner
Location *Doug Russell's Farm* Proj. No. *W9202*



Depth (m)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
18 19						SP	
20 21						SP	Pale orange, fine-grained, well sorted, sub-rounded SAND with trace (<10%) silt.
22 23 24						SP	Orange, fine-grained, well sorted, sub-rounded SAND.
						SP	Pale yellow, fine-grained, well sorted, sub-rounded SAND.
25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41							END OF HOLE.

GROUNDWATER
TECHNOLOGY
AUSTRALIA

Drilling Log

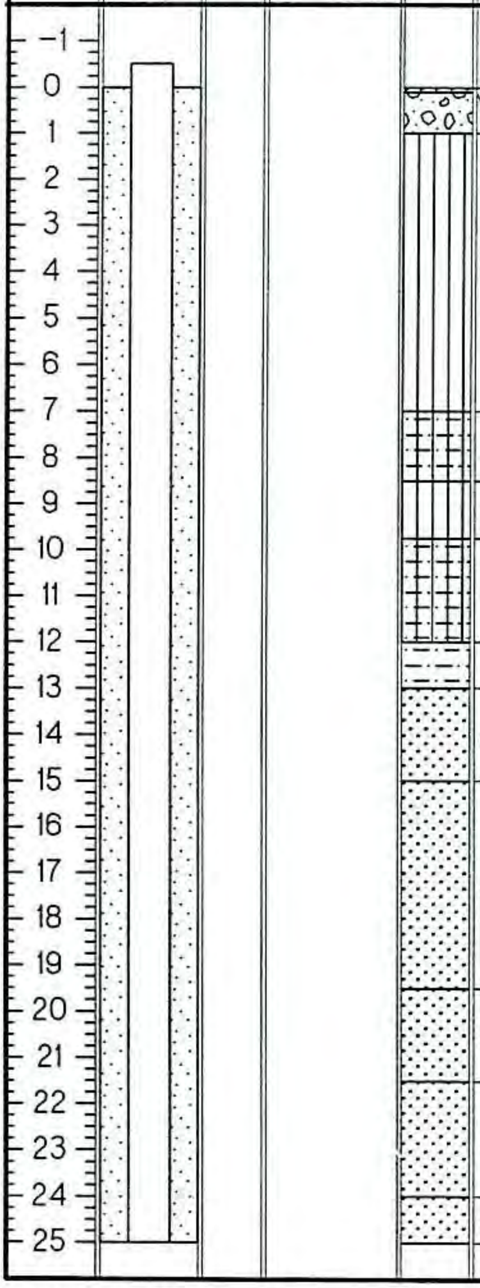
Test Bore **P7**

See Site Map
For Boring Location

COMMENTS:

Project *Narrikup Abattoir* Owner
Location *Doug Russells' Farm* Proj. No. *W9202*
Surface Elev. Total Hole Depth *51.0 m* Diameter *100 mm*
Top of Casing Water Level Initial *8.2 m* Static
Screen: Dia *50 mm* Length *6.0 m* Type/Size *0.5 mm*
Casing: Dia *50 mm* Length *45.0 m* Type *Class 18 PVC*
Fill Material Rig/Core
Drill Co. *Albany Drilling* Method *Mud Rotary*
Driller *Carl Plug* Log By *David Donovan* Date *01/05/95* Permit #
Checked By *John Throssell* License No.

Depth (m) | Well Completion | PID (ppm) | Sample ID | Blow Count/ % Recovery | Graphic Log



USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
SP	White, fine-grained, well sorted, sub-angular SAND.
	Dark brown, angular to rounded lateritic GRAVEL.
ML	Orange SILT with trace (<10%) clay.
ML	Pale orange SILT, interbedded with siltstone. ∇
ML	Orange SILT with trace (<10%) clay.
ML	Pale orange SILT, interbedded with siltstone.
	Spongolite FACIES.
SP	Pale orange, fine-grained, well sorted, sub-rounded SAND with trace (<10%) silt and clay.
SP	Greenish, fine-grained, well sorted, sub-rounded, glauconitic SAND with trace (<10%) silt.
SP	Pale orange, fine-grained, well sorted, sub-rounded SAND with trace (<10%) silt.
SP	Orange, fine-grained, well sorted, sub-rounded SAND.
SP	Pale yellow, fine-grained, well sorted, sub-rounded SAND.

jr lithlog i-dec.,93

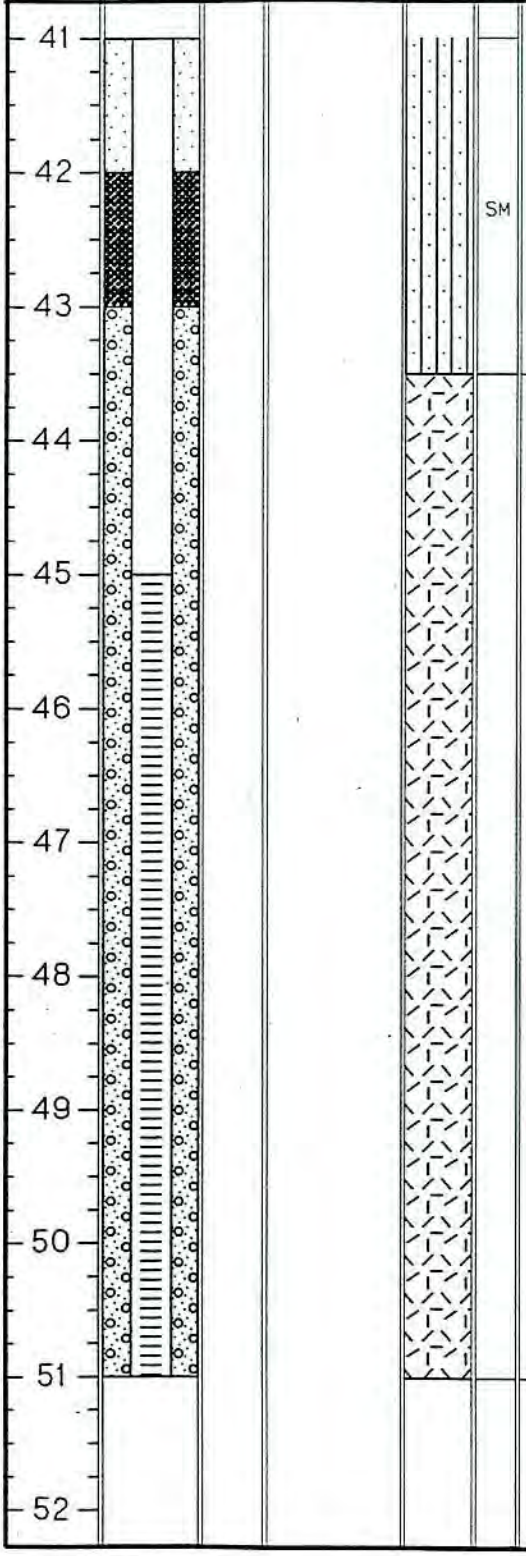
GROUNDWATER
TECHNOLOGY
AUSTRALIA

Drilling Log

Test Bore **P7**

Project *Narrikup Abattoir* Owner
Location *Doug Russells' Farm* Proj. No. *W9202*

Depth (m)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%



Pale grey felsic gneiss (quartz-feldspar-biotite). Weathered basement.

END OF HOLE.

jr lithlogi-dec.,93

GROUNDWATER TECHNOLOGY AUSTRALIA

Drilling Log

Test Bore **P8**

Project *Narrikup Abattoir* Owner

Location *Doug Russell's Farm* Proj. No. *W9202*

Surface Elev. Total Hole Depth *38.5 m* Diameter *100 mm*

Top of Casing Water Level Initial *13.5 m* Static

Screen: Dia *50 mm* Length *6.0 m* Type/Size *0.5 mm*

Casing: Dia *50 mm* Length *24.5 m* Type *Class 18 PVC*

Fill Material Rig/Core

Drill Co. *Albany Drilling* Method *Mud Rotary*

Driller *Carl Plug* Log By *David Donovan* Date *02/05/95* Permit #

Checked By *John Throssell* License No.

See Site Map For Boring Location

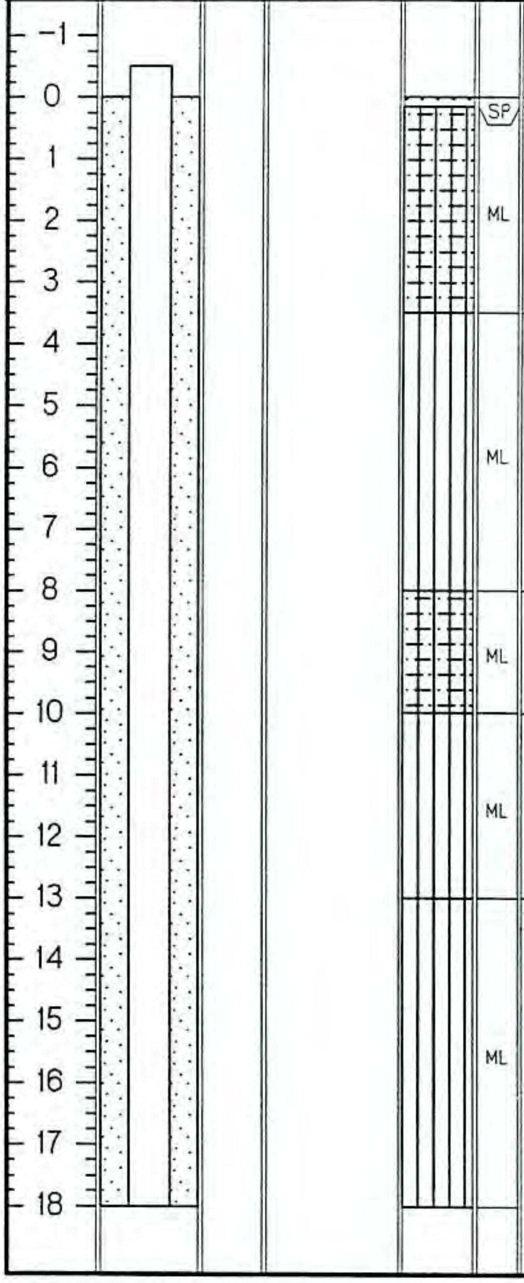
COMMENTS:

Depth (m) | Well Completion | PID (ppm) | Sample ID | Blow Count/ % Recovery | Graphic Log | USCS Class.

Description

(Color, Texture, Structure)

Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%



White, fine-grained, well sorted, sub-rounded SAND.

Orange SILT, interbedded with siltstone.

Orange SILT with trace (<10%) silt and clay.

Pale yellow SILT, interbedded with siltstone.

Orange SILT with trace (<10%) clay.

∇ Pale orange SILT with trace (<10%) clay.

jr lithlog i-dec.,93

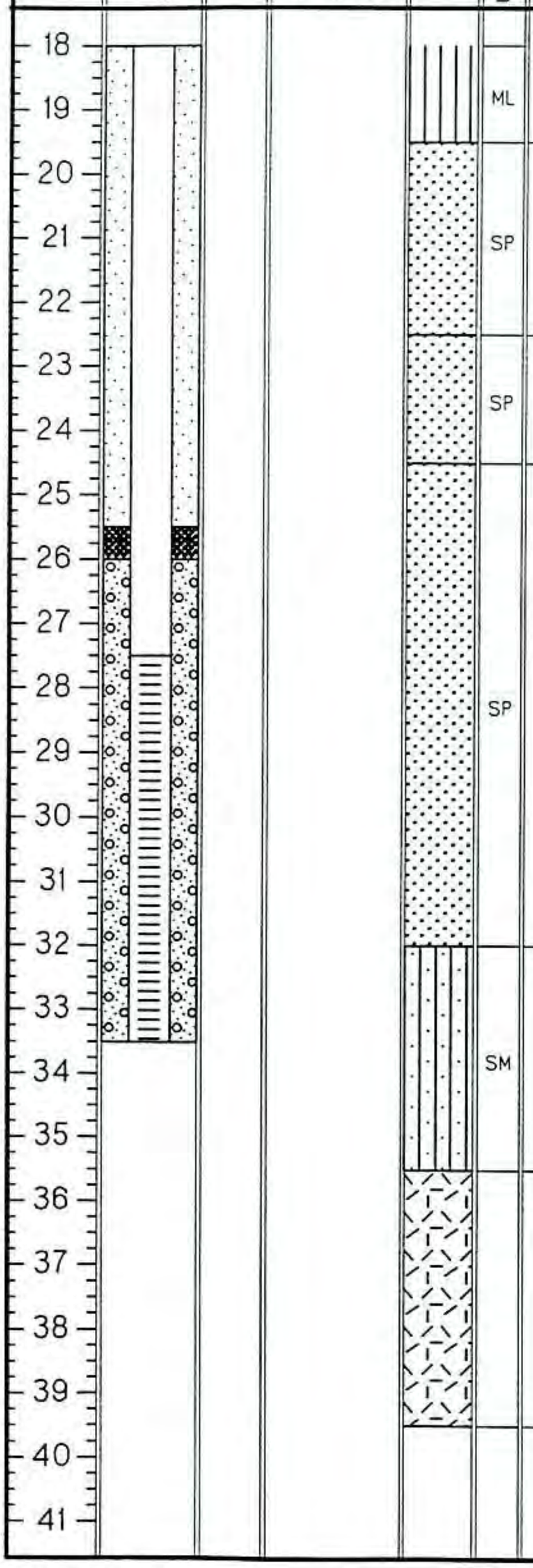
GROUNDWATER
TECHNOLOGY
AUSTRALIA

Drilling Log

Test Bore **P8**

Project *Narrikup Abattoir* Owner

Location *Doug Russell's Farm* Proj. No. *W9202*



USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
ML	
SP	Greenish, fine-grained, well sorted, sub-rounded glauconitic SAND with trace (<10%) clay.
SP	Orange, fine-grained, well sorted, sub-rounded SAND with trace (<10%) silt.
SP	Pale yellow, fine-grained, well sorted, sub-rounded SAND.
SM	Pale grey, fine grained, well sorted, sub rounded SAND with some (20-35%) silt and clay.
	Pale grey felsic gneiss (quartz-feldspar-biotite). Weathered basement.
	END OF HOLE.

jr lithlogi-dec.,93

GROUNDWATER
TECHNOLOGY
AUSTRALIA

Drilling Log

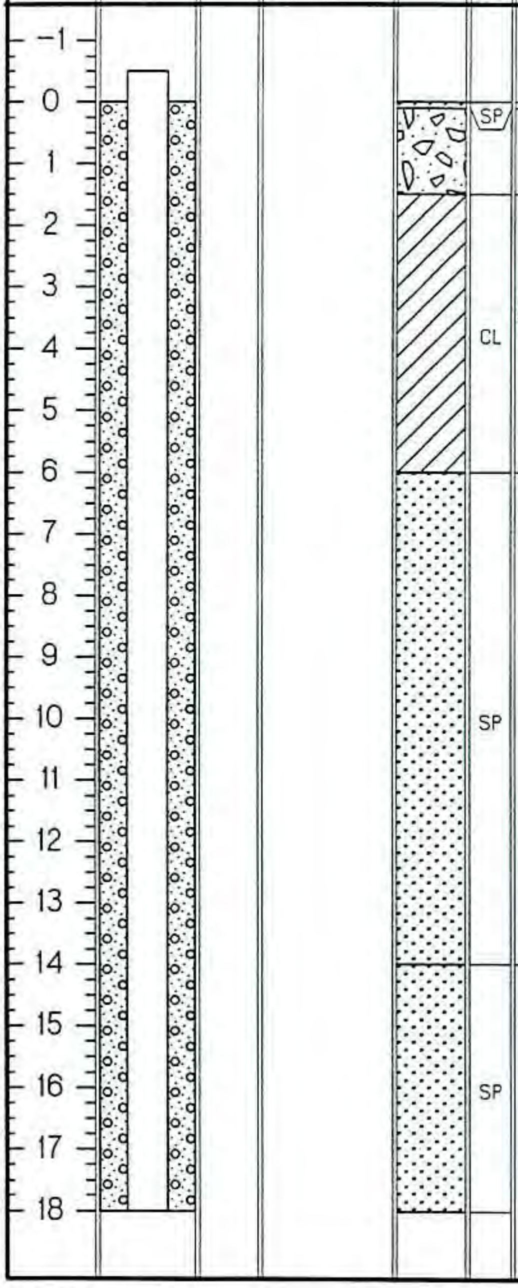
Test Bore **P9**

See Site Map
For Boring Location

COMMENTS:

Project *Narrikup Abattoir* Owner
Location *Doug Russell's Farm* Proj. No. *W9202*
Surface Elev. Total Hole Depth *38.5 m* Diameter *100 mm*
Top of Casing Water Level Initial *3.5 m* Static
Screen: Dia *50 mm* Length *4.5 m* Type/Size *0.5 mm*
Casing: Dia *50 mm* Length *24.5 m* Type *Class 18 PVC*
Fill Material Rig/Core
Drill Co. *Albany Drilling* Method *Mud Rotary*
Driller *Carl Plug* Log By *David Donovan* Date *03/05/95* Permit #
Checked By *John Throssell* License No.

Depth (m) | Well Completion | PID (ppm) | Sample ID | Blow Count/ % Recovery | Graphic Log | USCS Class.



USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%
SP	White, fine-grained, well sorted, sub-rounded SAND.
	Dark brown LATERITE.
CL	Pale yellow to white, high plasticity CLAY.
SP	Pale orange, fine-grained, well sorted, subrounded SAND with trace (10%) silt.
SP	Orange, fine-grained, well sorted, subrounded SAND.

jr lithlog i-dec.,93

GROUNDWATER
TECHNOLOGY
AUSTRALIA

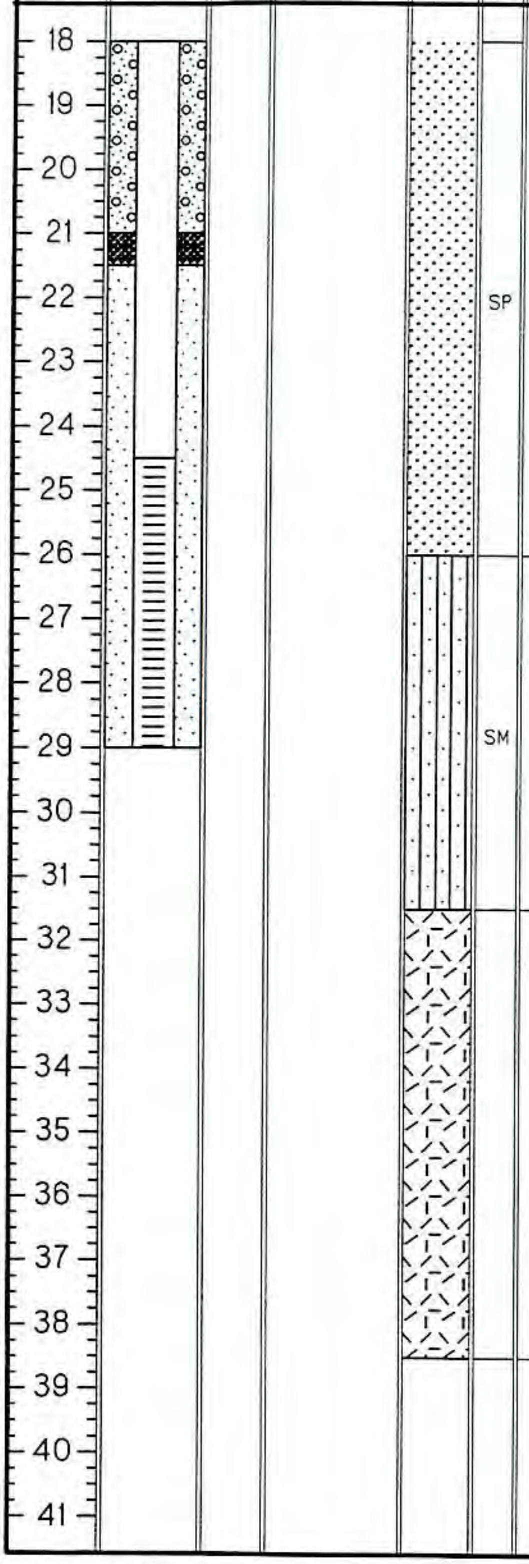
Drilling Log

Test Bore **P9**

Project *Narrikup Abattoir* Owner

Location *Doug Russell's Farm* Proj. No. *W9202*

Depth (m)	Well Completion	PID (ppm)	Sample ID	Blow Count/ % Recovery	Graphic Log	USCS Class.	Description (Color, Texture, Structure) Trace < 10%, Little 10% to 20%, Some 20% to 35%, And 35% to 50%



Pale yellow, fine-grained, well sorted, subrounded SAND with some (20-35%) silts and clays.

Pale grey felsic gneiss (quartz-feldspar-biotite). Weathered basement.

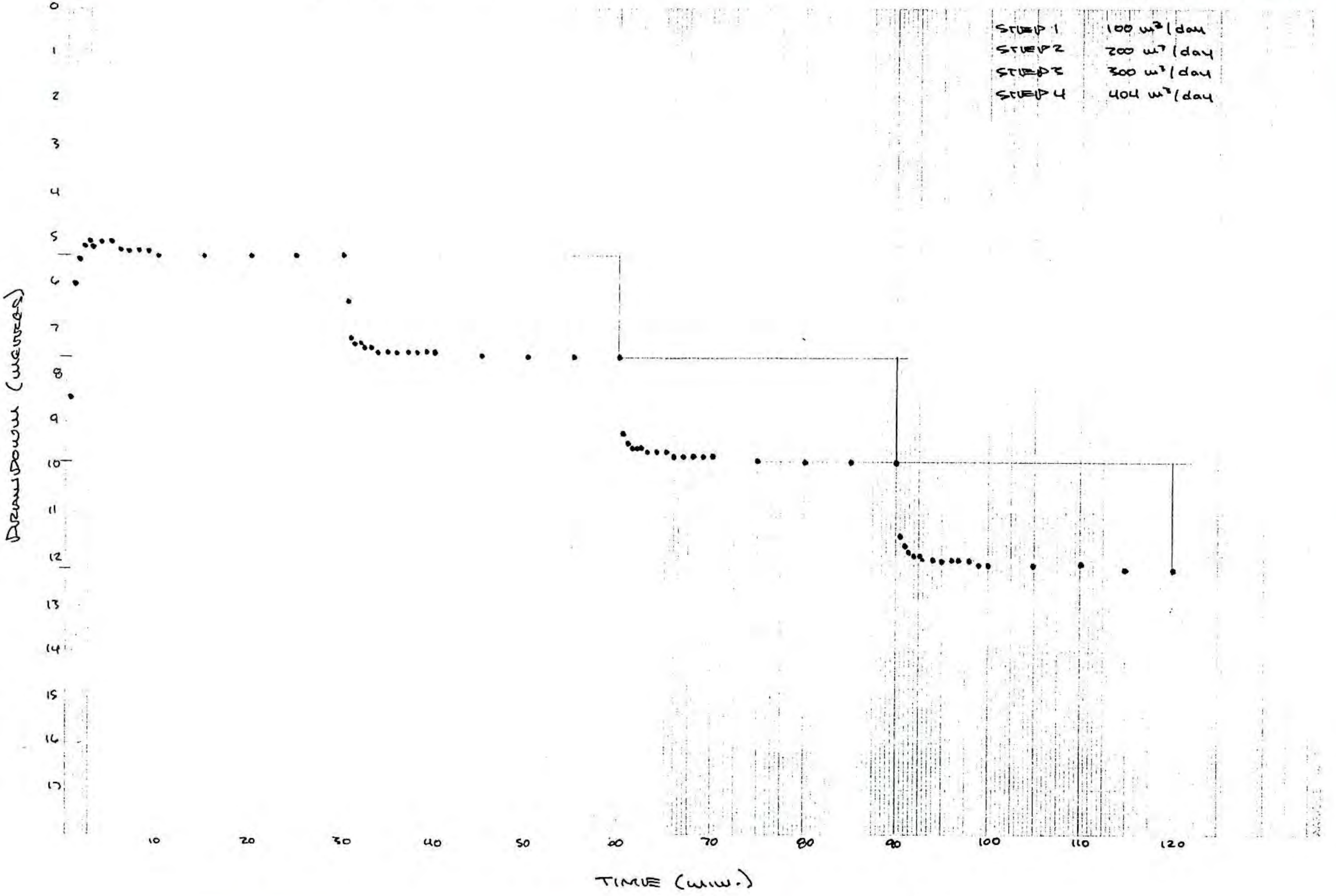
END OF HOLE.

jr lithlogi-dec.,93

APPENDIX B

PUMPING TEST DATA

DRAWDOWN Z - M

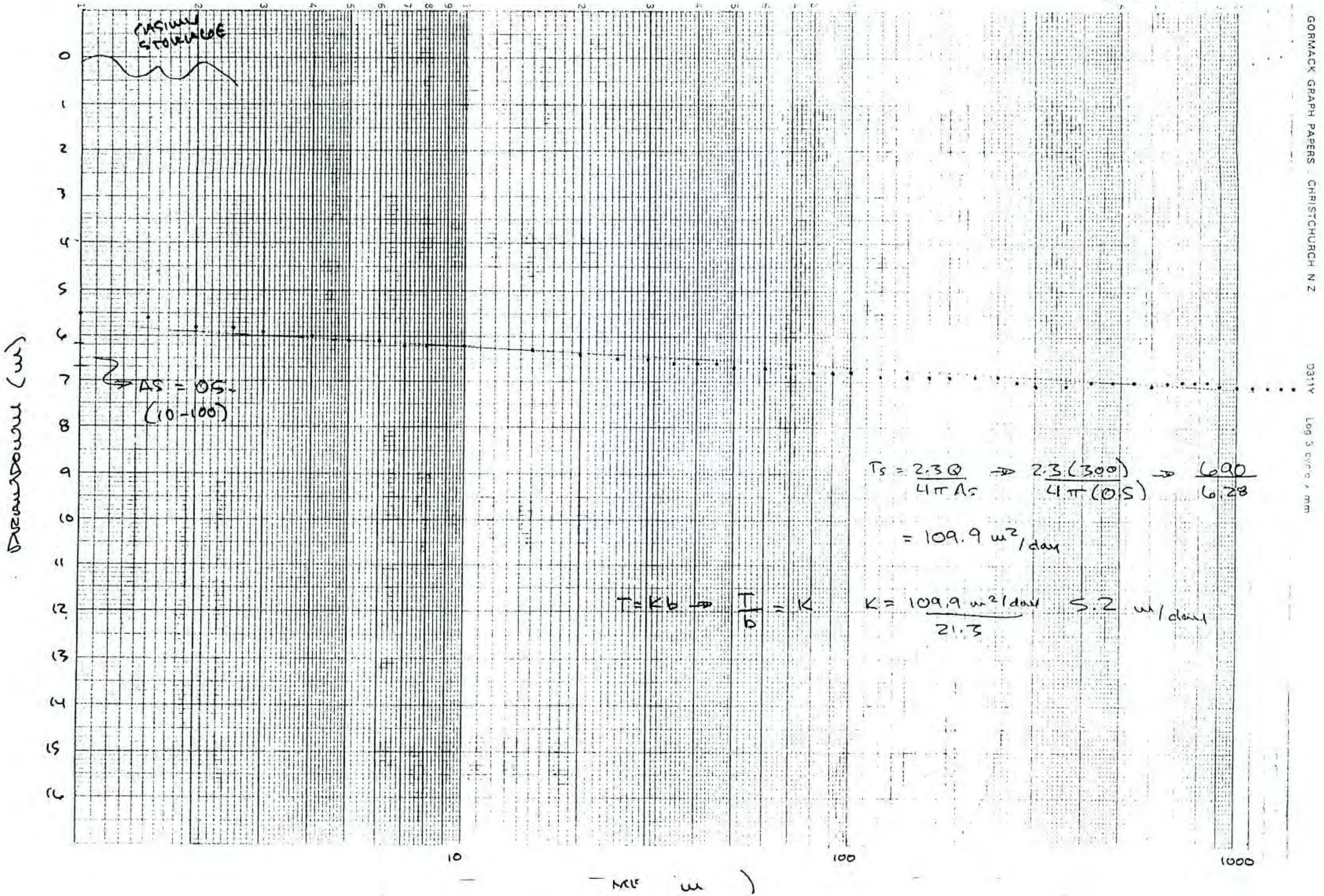

STEP 1 100 m³/day
STEP 2 200 m³/day
STEP 3 300 m³/day
STEP 4 404 m³/day
DRAWDOWN (METRES)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
10
20
30
40
50
60
70
80
90
100
110
120
TIME (min.)

MAURIKUP ABATTOIR
W9202

6-7 MAY 1995
9:46 am START

24 HOUR ~~CONSTANT~~ RATE TEST
(300 m³/day)

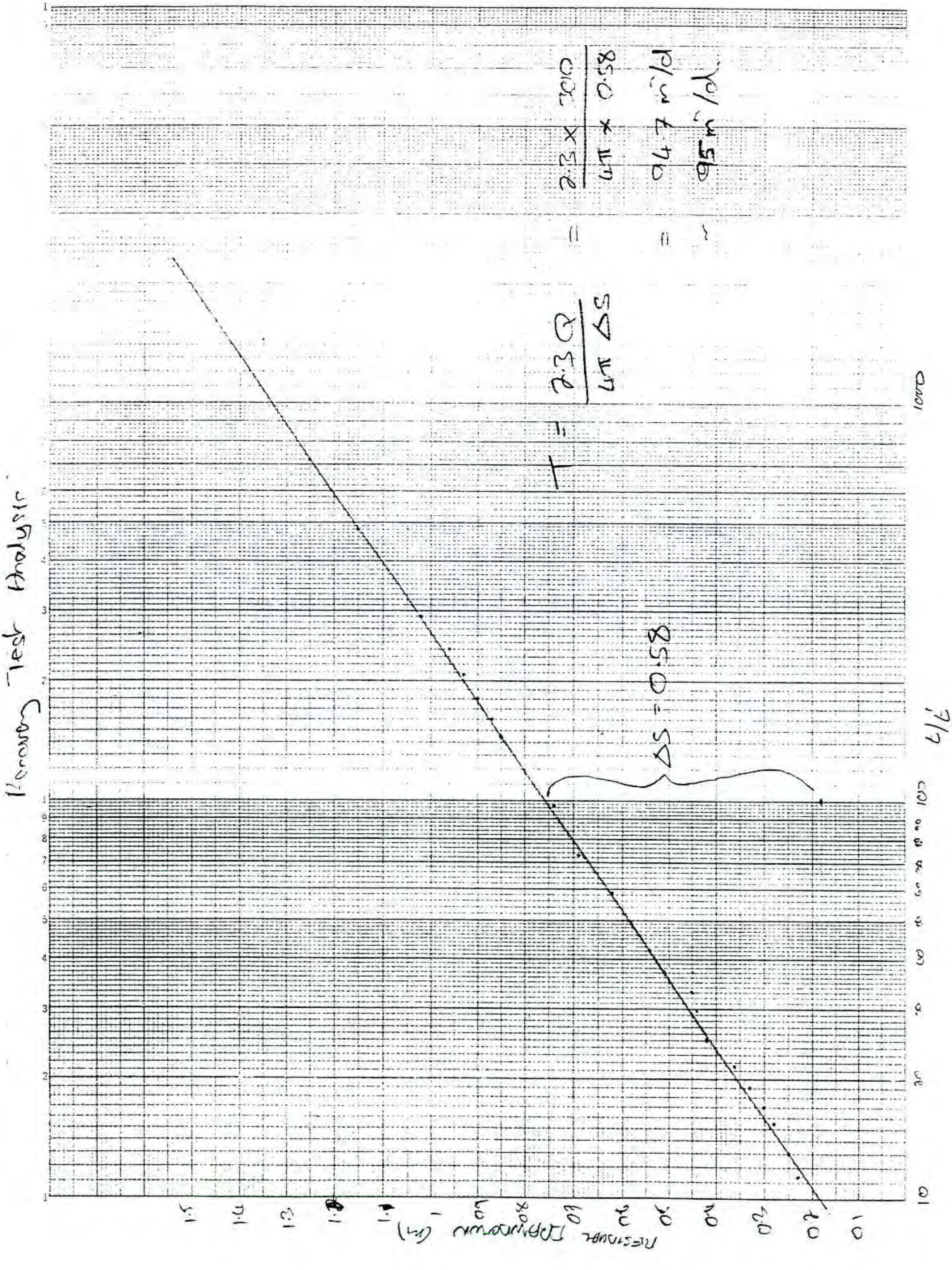
STATIC W.L. 8.80m
AVAILABLE DRAWDOWN ~19.2m



$T_s = \frac{2.3Q}{4\pi \Delta s} \Rightarrow \frac{2.3(300)}{4\pi(0.5)} \Rightarrow \frac{690}{6.28}$

$= 109.9\ m^2/day$

$T = Kb \Rightarrow \frac{T}{b} = K \qquad K = \frac{109.9\ m^2/day}{21.3}\ 5.2\ m/day$



$$T = \frac{2.3Q}{4\pi \Delta S} = \frac{2.3 \times 300}{4\pi \times 0.58} = 94.7\ m^2/d \approx 95\ m^2/d$$

APPENDIX C
MODELLING DATA

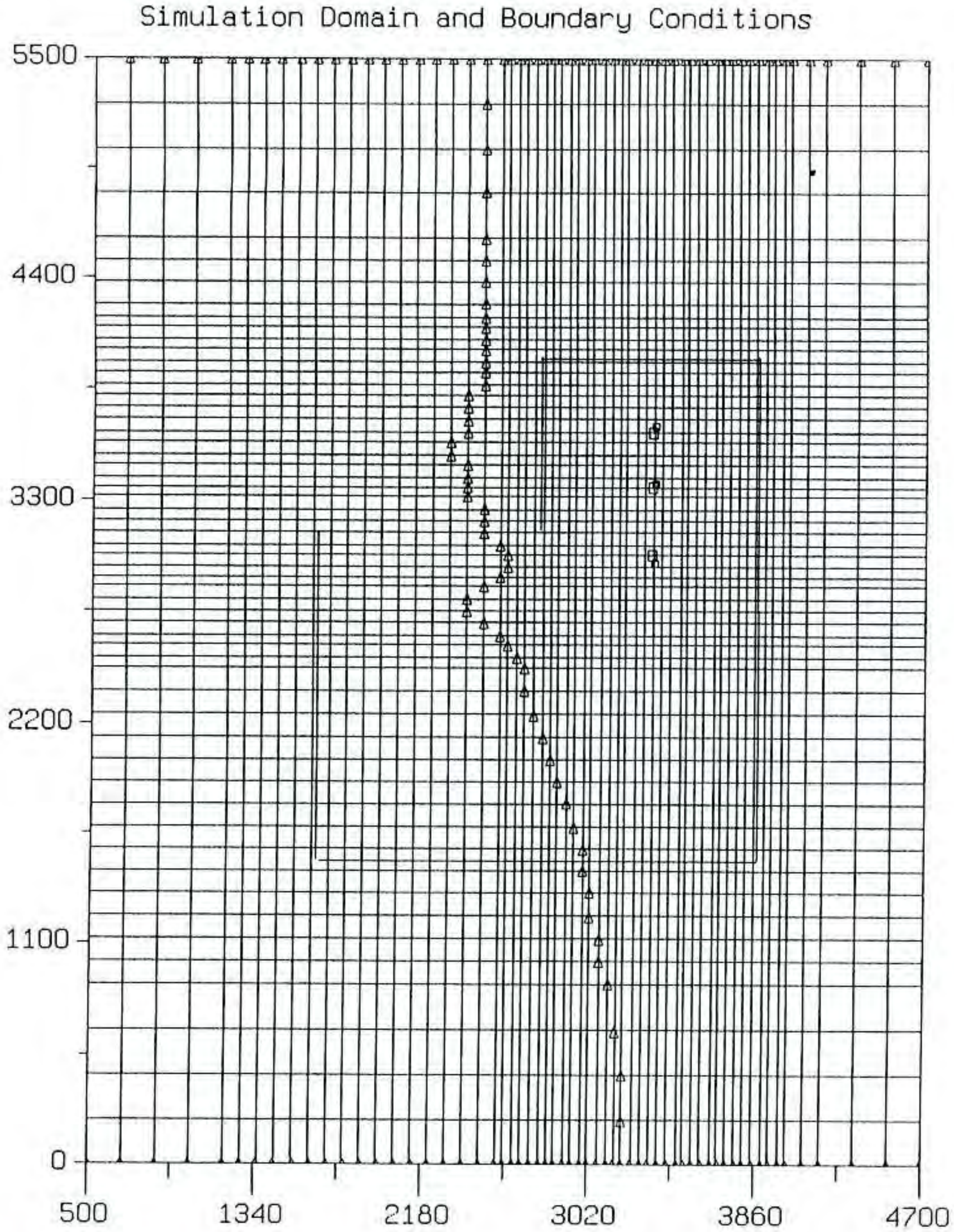
GROUNDWATER MODELLING - ASSUMPTIONS

The following basic assumptions normally apply in groundwater modelling:

- flow regions are of infinite extent in the longitudinal direction and of great extent in the lateral direction;
- the aquifer can be characterised using homogeneous and isotropic material properties;
- the groundwater flow is uniform, and continuous in direction and velocity;
- contaminant adsorption (if present) is governed by a linear and reversible equilibrium adsorption isotherm;
- the groundwater upgradient from the flow region is initially free of the contaminant;
- hydraulic properties of the aquifer do not vary with temperature or density of the groundwater;
- flow in the unsaturated (vadose) zone is steady and in the vertical direction only.

Other assumptions specific to the particular modelling task may also apply. If so, they should be detailed by the modeller.

1.



FLOWPATH

Copyright

1989-1992

by WHS

Rows :

58

Cols :

60

Wells:

3

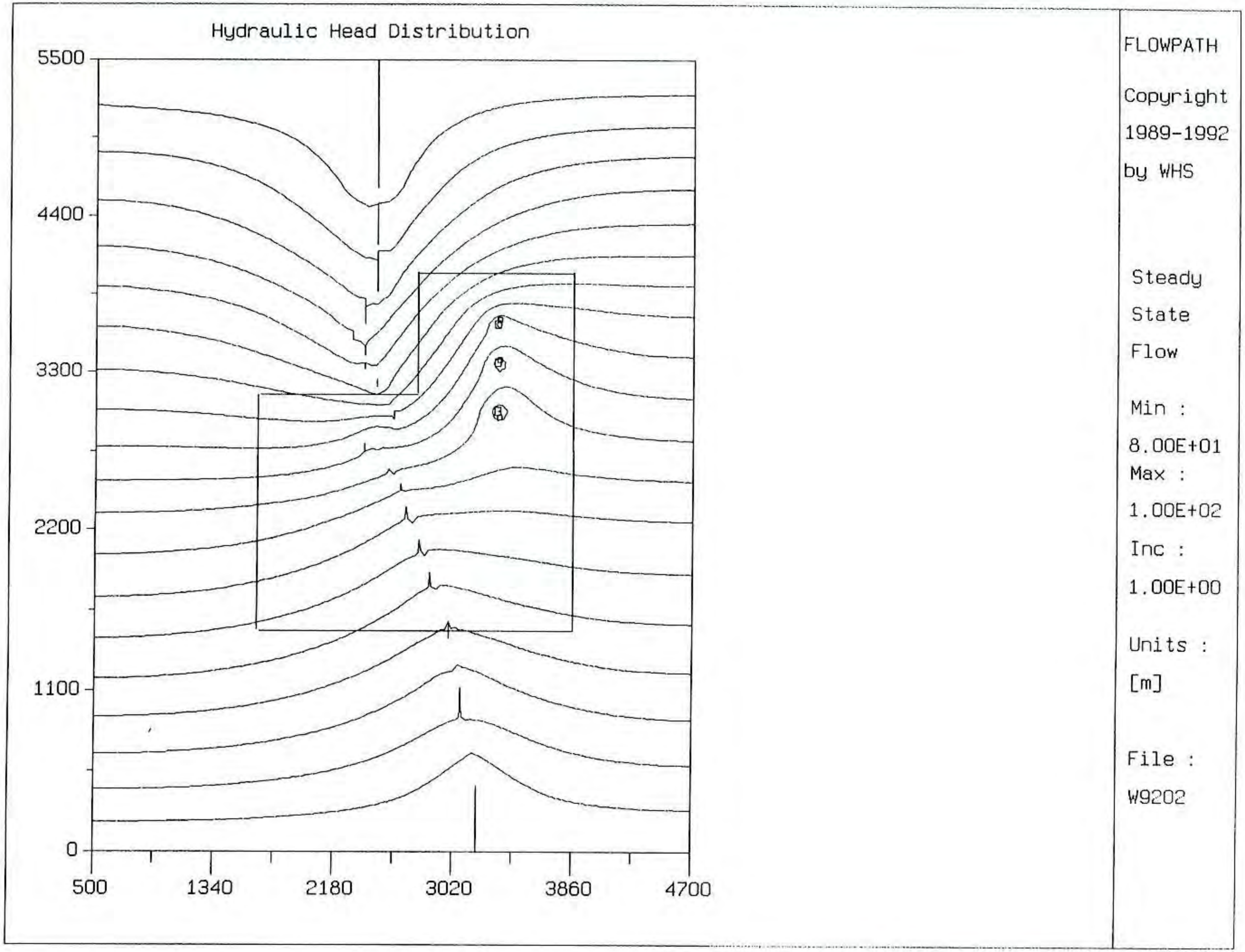
Units :

[m]

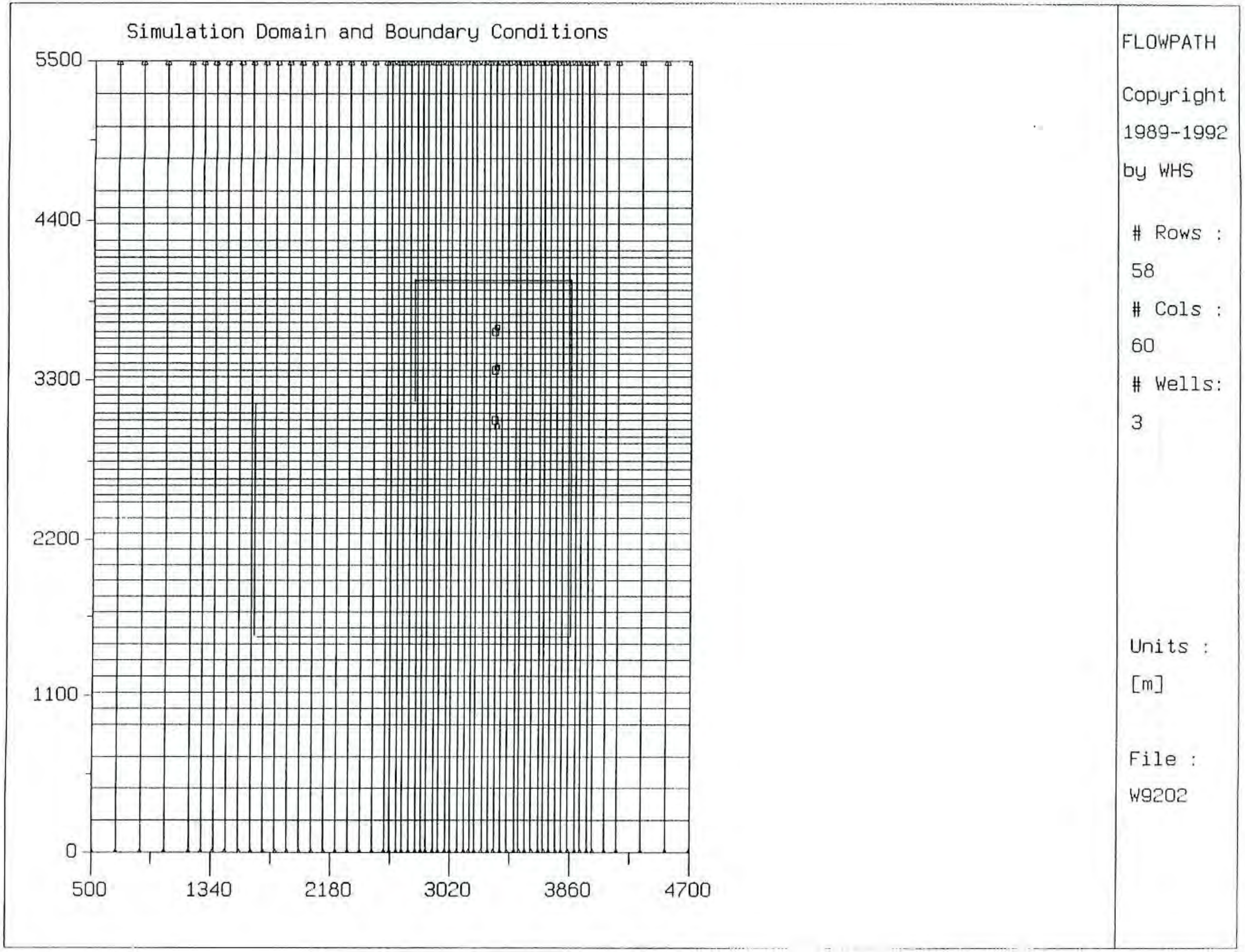
File :

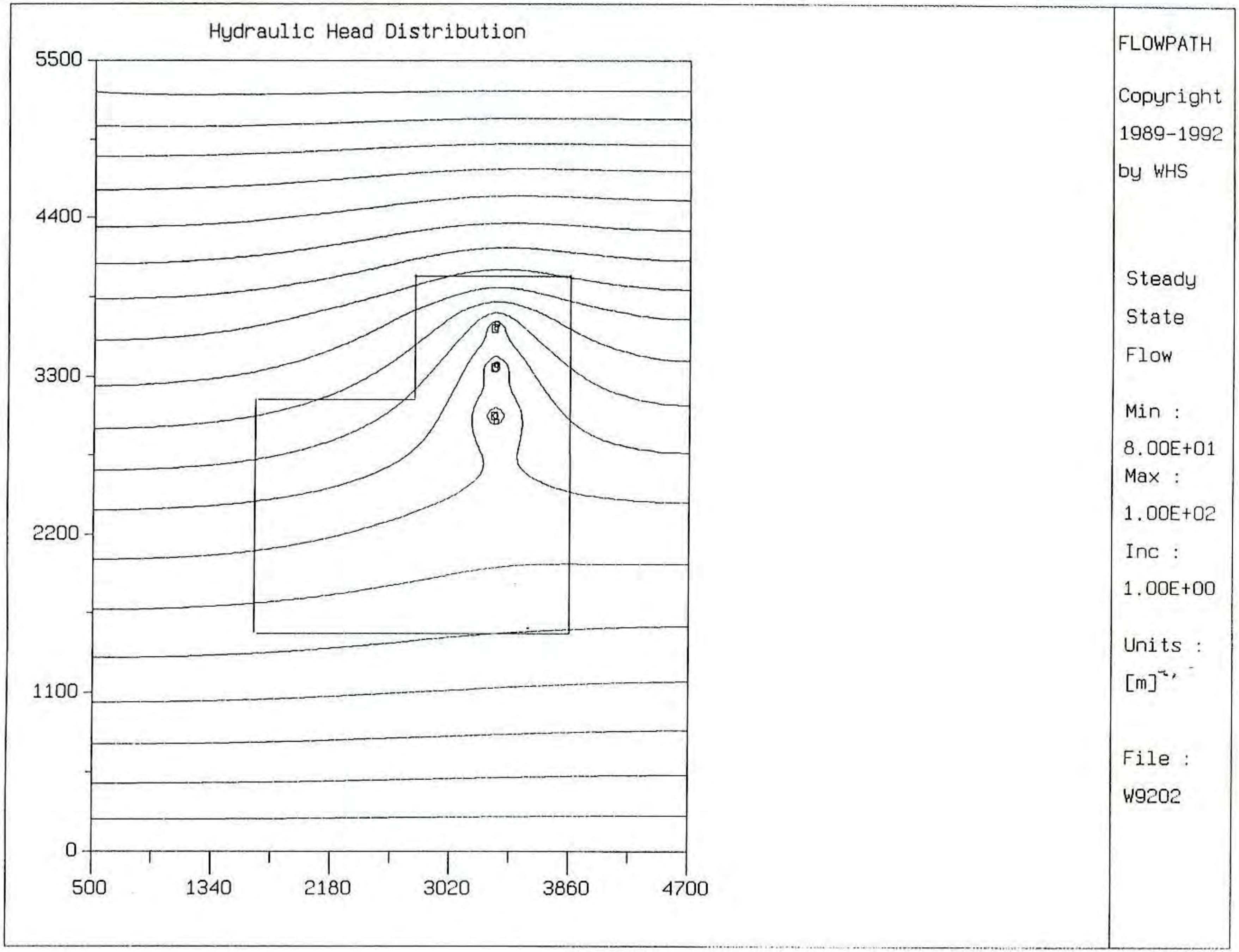
W9202

1.


Hydraulic Head Distribution
5500
4400
3300
2200
1100
0
500
1340
2180
3020
3860
4700
FLOWPATH
Copyright
1989-1992
by WHS
Steady
State
Flow
Min :
8.00E+01
Max :
1.00E+02
Inc :
1.00E+00
Units :
[m]
File :
W9202

2.


Simulation Domain and Boundary Conditions
5500
4400
3300
2200
1100
0
500
1340
2180
3020
3860
4700
FLOWPATH
Copyright
1989-1992
by WHS
Rows :
58
Cols :
60
Wells:
3
Units :
[m]
File :
W9202


Hydraulic Head Distribution
5500
4400
3300
2200
1100
0
500
1340
2180
3020
3860
4700
FLOWPATH
Copyright
1989-1992
by WHS
Steady
State
Flow
Min :
8.00E+01
Max :
1.00E+02
Inc :
1.00E+00
Units :
[m]
File :
W9202

APPENDIX D
LOADING RATE CALCULATIONS

HYDRAULIC LOADING **WOODLOTS**							
	Crop Fact	1		Hydraulic Conductivity (K)			100mm/day
				Wet/Dry Factor			0.07
	ET	Precip.	ET - Pr	Op. Days	Pw	Lw	
	mm/mth	mm/mth	mm/mth				
JAN	211	13	198	21	147	345	
FEB	148	38	110	21	147	257	
MAR	143	34	109	22	154	263	
APR	99	18	81	20	140	221	
MAY	67	117	-50	21	147	147	
JUN	51	89	-38	0	0	0	
JUL	54	102	-48	0	0	0	
AUG	56	111	-55	21	147	147	
SEP	75	81	-6	21	147	147	
OCT	114	62	52	21	147	199	
NOV	130	54	76	22	154	230	
DEC	195	11	184	20	140	324	
Total	1343	730	613	210	1470	2280	
			Annual Hydraulic Loading Rate			2.3	m/yr
			Total Percolate incl Rainfall			2.9	m/yr

HYDRAULIC LOADING **PASTURE**							
	Crop Fact	0.7		Hydraulic Conductivity (K)			100mm/day
				Wet/Dry Factor			0.07
	ET	Precip.	ET - Pr	Op. Days	Pw	Lw	
	mm/mth	mm/mth	mm/mth				
JAN	148	13	135	21	147	282	
FEB	104	38	66	21	147	213	
MAR	100	34	66	22	154	220	
APR	69	18	51	20	140	191	
MAY	47	117	-70	21	147	147	
JUN	36	89	-53	0	0	0	
JUL	38	102	-64	0	0	0	
AUG	39	111	-72	21	147	147	
SEP	53	81	-29	21	147	147	
OCT	80	62	18	21	147	165	
NOV	91	54	37	22	154	191	
DEC	137	11	126	20	140	266	
Total	940	730	210	210	1470	1968	
			Annual Hydraulic Loading Rate			2.0	m/yr
			Total Percolate incl Rainfall			2.2	m/yr

Hydraulic Loading Based on Nitogen Limits

$$L_n = U + F(L_n) + A(C_p)(P_w)$$

where L_n = mass Loading of N (kg/h

U = Crop Uptake (kg/Ha.yr)

F = Fraction of N lost to soil storage, denitrification etc

A = conversion Factor

C_p = Percolate N concentration (mg/

P_w = Percolate Flow cm/yr

$$L_n = 0.1(C_n)(L_{wn})$$

where C_n = N concentration in applied waste water (mg/L)

L_{wn} = Hydraulic Loading Rate controled by N

$$\therefore \quad L_{wn} = \frac{C_p(P_r - ET) + 10(U)}{(1-F)(C_n) - C_p.}$$

where $U = 90$ kg/Ha/yr (woodlots)

$= 240$ kg/Ha/yr (pasture)

$P_r - ET = -61.3$ cm/yr (woodlots)

$= -210$ cm/yr (pasture)

$C_p = 1$

$F = 0.15$

$C_n = 60$ mg/L

$\therefore$ L_{wn} (woodlots) = 17cm/year

L_{wn} (pasture) = 43cm/year.

From Reed et al (1995)

APPENDIX 3

ACOUSTIC STUDY

NARRIKUP EXPORT ABATTOIR

ACOUSTIC STUDY

HERRING STORER ACOUSTICS
JULY 1995

1.0 INTRODUCTION

Herring Storer Acoustics were requested by Alan Tingay & Associates on behalf of Benale Pty Ltd to assess and give opinions of the likely impact to surrounding residences of a proposed Abattoir at Narrikup, Mount Barker WA.

The two main areas of consideration are the general noise emission from the abattoir complex, specifically mechanical plant and associated traffic noise along Settlement Road.

The above two situations have been considered and emissions to the nearest affected residences assessed in accordance with the Environmental Protection Act 1986.

2.0 REGULATORY CRITERIA

Noise emissions from the Abattoir complex would be regulated under the Environmental Protection Act 1986 and specific Regulations of the Noise Abatement (Neighbourhood Annoyance) Regulations 1979. These Regulations define acceptable noise levels based on the definition of the area surrounding the place of receipt of noise.

The area in question is zoned rural with special use allowable. This tends to put it in a category where commercial operations are allowable such as B2 of the Regulations. Category B2 allows a worst case level (night time) of 45 dB(A), however, this will likely be unacceptable to residences that are predominantly surrounded by rural countryside at present. It is therefore considered that Category A2 would be more appropriate for this area which assigns the following levels:

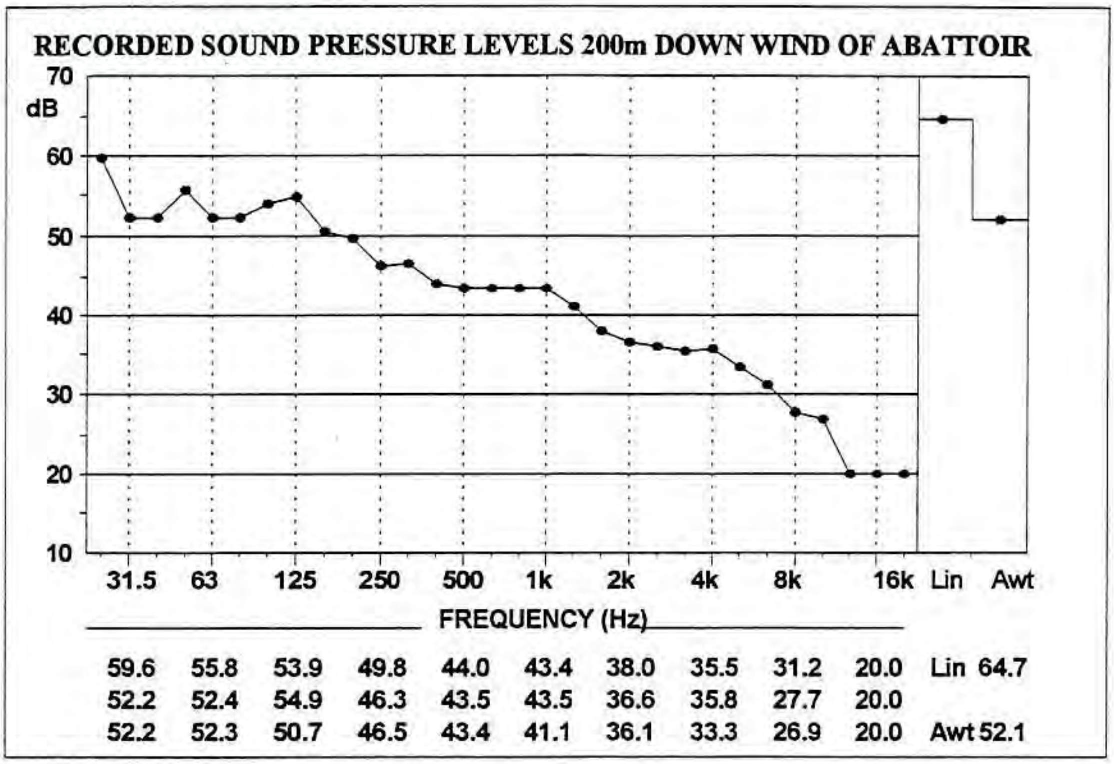
Monday to Friday	0700-1900 hrs	45 dB(A)
Monday to Friday	1900-2200 hrs	40 dB(A)
Weekends and public Holidays	0700-2200 hrs	40 dB(A)
Always	2200 - 0700 hrs	35 dB(A)

Revisions to the current Regulations are proposed and are presently being circulated for public comment. Under these Regulations, which are based on the actual land use within a 450m radius, the assigned levels would be as per Category A2 above except the values would be L_{10} percentile levels as measured over a representative period.

There are currently no regulations that govern road traffic noise. Main Roads have a policy to restrict traffic noise at residential locations to an L_{10} 18hr of 63 dB(A) wherever practicable. The Department of Environmental Protection are of the opinion that this level should be closer to 58 dB(A) wherever practicable.

Also the Department of Environmental Protection are of the opinion that instantaneous (maximum) levels should not exceed 80 dB(A) but preferably be closer to 65 dB(A).

Predicted noise emissions from the Abattoir complex has been based on file data of measured levels of an existing abattoir. Primarily, the levels used were those measured at a distance of 200m from the acoustic centre under down wind conditions. These levels are shown in Figure 1 and were recorded at an overall level of 52 dB(A). From the spectrum shown, it is deduced that there could be tonal components in the noise, particularly at 125 Hz and 50Hz.



59.6	55.8	53.9	49.8	44.0	43.4	38.0	35.5	31.2	20.0	Lin 64.7
52.2	52.4	54.9	46.3	43.5	43.5	36.6	35.8	27.7	20.0	
52.2	52.3	50.7	46.5	43.4	41.1	36.1	33.3	26.9	20.0	Awt 52.1

JUNE 1995

FIGURE 1

These measured levels relate to a sound power level of the complex of approximately 105 dB(A) when considered as a point source.

Based on the determined sound power level, the sound pressure level at various distances under down wind conditions would be as follows:

200m	52 dB(A)
400m	46 dB(A)
800m	40 dB(A)
1600m	34 dB(A)
3200m	28 dB(A)

The nearest residence is at a distance of 1200m the next closest is 1800m resulting in levels of 36 and 33 dB(A) respectively. These levels are under down wind conditions which is a worst case scenario. For calm conditions the levels would be 30 and 27 dB(A) respectively.

For the worst case conditions at the nearest residence, the level is likely to be tonal, therefore, in accordance with the Regulations, an adjustment of +5 dB(A) is made to reflect the annoyance potential. This results in an adjusted level of 41 dB(A) which is within the stated day time 'acceptable' criteria of 45 dB(A).

3.0 ROAD TRAFFIC EMISSION

Assessment of road traffic noise along Settlement Road is based on the following scenarios:

I)	From the west	30 truck movements per day between 0700 hrs and 1600 hrs
ii)	From the east	26 truck movements per day between 0700 hrs and 1600 hrs
iii)	From the west	300 light vehicles between 0630 & 0700 hrs and between 1600 hrs and 1630 hrs.
iv)	From the west (occasionally)	120 trucks movements per day between 0700 & 1900 hrs.

Based on the prediction method of CRTN (Calculation of Road Traffic Noise) which is endorsed by the Department of Environmental Protection and Main Roads, resultant noise levels at a distance of 50 metres for the above scenarios would be as follows:

SCENARIO	**SOUND LEVEL dB(A)**	
	L_{10} 1 hour	**L_{10} 18 hour**
1	51	38
2	50	36
3	61	51
4	56	44

Clearly all levels are within the more critical criteria of an L_{10} 18 hour of 58 dB(A). The scenario 3 value of 61 dB(A) exceeds the daily criteria but this would only occur for two thirty minute periods per day and it is light vehicles only.

Trucks licensed for road use must comply with pass by ADR 28/01 levels of 81 to 87 dB(A) at 7.5 metres and stationary levels of 93 to 103 dB(A) at 1 metre. At a distance of 50 metres this relates to levels ranging from 65 to 71 dB(A). Such levels are well within the vehicle maximum noise level criteria providing they comply with the ADR criteria.

4.0 SUMMARY

Noise emission from the proposed abattoir complex can comply with the Regulatory criteria. Checks should be made at the design stage to ensure that the total emission does not exceed a total sound power level of 110 dB(A) and that no tonal characteristics exist.

Typically this will mean that most plant such as refrigeration units, compressors etc. will be inside enclosures. Some items, such as cooling towers and condensing units may require discharge silencers if sufficiently quiet units cannot be selected.

Management policies will need to be developed for the operating abattoir with respect to vehicle noise. These policies should ensure that all trucks delivering and collecting goods from the complex are in good working order and comply with ADR 28/01 noise emission levels. Also that workers practice "good neighbourly" driving when proceeding to and leaving the complex to ensure excessive vehicle noise is not created.

With the engineering design and management policies listed above, the Abattoir complex and infrastructure can operate with minimal noise impact to surround residences.

Lynton Storer
30 July 1995

APPENDIX 4

WASTEWATER TREATMENT CALCULATIONS

EVANGELISTI
& ASSOCIATES

CER. – NARRI WVP	JOB No. C95016	
WASTEWATER TREATMENT	BY MRE	SHEET No. 1
BENIAUE P/L	CHECKED	DATE 6/95

STABILISATION PONDS (BOD_5 REDUCTION)

(1) Anaerobic Ponds

BOD_5 loading = 0.2 kg/m³/day

HRT = 12 days

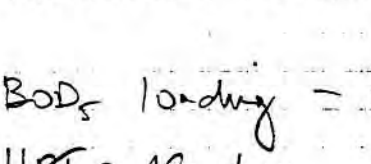
Depth = 5.0 m

BOD_5 influent concentration = 1500 mg/l

Influent volume = 1000 m³/day / 2 (parallel) = 500 m³/day

Minimum Storage Requirements = 12 days × 500 m³/day = 6000 m³

Based on batter slope of 1(V) : 1(H) and using a pond area = 60 m x 60 m actual volume ≈ 15000 m³



∴ Actual HRT = $\frac{15000}{500}$ = 30 days.

∴ Actual BOD_5 loading = $\frac{1500 \text{ mg/l} \times 500 \text{ m}^3/\text{day}}{15000 \text{ m}^3}$ =

= 0.05 kg/m³/day

(2) Low Rate Aerobic Pond

- Plug Flow Model (Eq. 4.6, Reed et al)

C_e = BOD_5 effluent concentration = 38 mg/l

C_o = BOD_5 influent concentration = 375 mg/l

K_p = 0.129 d^{-1} (based on organic loading 112 kg/ha/day, Table 4.2)
at 20°C

T_{winter} = 10°C

HRT = ?

EVANGELISTI & ASSOCIATES

CER – NARRIWUP | JOB No. C95016
WASTEWATER TREATMENT | BY MRE | SHEET No. 2
BENALE P/L | CHECKED | DATE 6/95

$K_{pT} = K_{p_{20°C}} (1.09)^{T-20}$ (Eq 4.6, Reed et al)

$K_{p_{10°C}} = 0.129 (1.09)^{-10} = 0.072$

$\Delta_{BOD_5} = \frac{C_e}{C_o} = 0.1 = e^{(-K_{p_{10°C}} \cdot HRT)}$ ∴ HRT = 32 days

- Wehner – Wilhelm / Thirumurthi Model (Eq. 10.30 & Table 10.44 Metcalf & Eddy)

$\Delta BOD_5 = 90\%$

$K = 0.129 d^{-1}$ (Typical)

$\theta = 1.09$ @ 20°C

$T_{winter} = 10°C$

$d_{max} = 1.0$

D = 0.8 (Pond Dispersion factor)

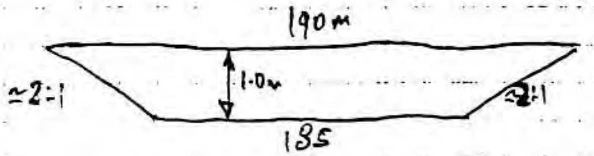
Dispersion number varies from D=0 (Plug flow) to D=∞ (complete mixed), most values less than 1.0.

$K.t = 3$ (Table 10.44)

$K_{10°C} = K_{20°C} \cdot \theta^{T-20} = 0.129 (1.09)^{-10} = 0.072$

$\therefore$ HRT = t = $3/0.072$ = 42 days.

Based on the two models above, HRT ≈ 40 days



Pond Area = 190 × 190

actual volume ≈ 35 000 m³/each

∴ Actual HRT = $\frac{70000 \text{ m}^3}{1000 \text{ m}^3/\text{day}}$ = 70 days

∴ Actual BOD_5 loading = $\frac{375 \text{ mg/l} \times 1000 \text{ m}^3/\text{day}}{70000 \text{ m}^3}$ ≈ 54 kg/Ha/day

(3) Aerobic - Maturation / Holding Pond.

Calculation as per Low Rate Aerobic Pond.

- Plug Flow Model

C_e = BOD_5 effluent concentration = 11 mg/l

C_o = BOD_5 influent concentration = 38 mg/l

$K_p \approx 0.04 d^{-1}$ at 20°C (Table 4.2, Reed et al extrapolation)

T_{winter} = 10°C

HRT = ?

$K_{10°C} = K_{20°C} (1.09)^{T-20°C} = 0.04 (1.09)^{-10} \Rightarrow K_{10°C} \approx 0.017$

$\Delta_{BOD_5} = \frac{C_e}{C_o} = 0.3 = e^{(-K_{10°C} \cdot HRT)}$ ∴ HRT ≈ 71 days

- Wehner - Wilhelm / Thirumurthi Model

ΔBOD_5 = 70%

d_{ave} = 1.5 m

D = 2.0 (Pond Dispersion Factor)

K.t = 2

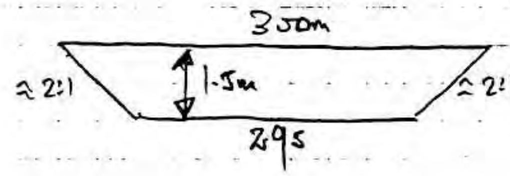
$K_{10°C} = K_{20°C}\, \theta^{T-20} = 0.04 (1.09)^{-10} \Rightarrow K_{10°C} = 0.017$

EVANGELISTI & ASSOCIATES

CER – NARRIKUP	JOB No. C95016	
WASTEWATER TREATMENT	BY MRE	SHEET No. 4
BENALE P/L	CHECKED	DATE 6/95

$\therefore$ HRT = t = $\frac{2}{0.017}$ = 118 days.

Based on the two models above, HRT ≈ 90 days.



Pond Area = 300 x 300

Actual Volume ≈ 135000 m^3

$\therefore$ Actual HRT = $\frac{135\,000\ m^3}{1000\ m^3/day}$ = 135 days.

$\therefore$ Actual BOD$_5$ loading = $\frac{38\ mg/\ell \times 1000\ m^3/day}{135\,000\ m^3}$ ≈ 3 kg/Ha/day

STABILISATION PONDS (TN REDUCTION)

(1) Anaerobic Ponds.

No TN reduction, potential to increase nutrient load if solids separation is inefficient or blood makes its way into waste stream.

Assume $\Delta_{TN} = 0$.

(2) Low Rate Aerobic Ponds

- Model 1 $N_e = N_o \cdot e^{\{-K_t\,[HRT+60.6(pH-6.6)]\}}$

(Eq 4.7, Reed et al)

EVANGELISTI & ASSOCIATES

CER - NARRIKUP
WASTEWATER TREATMENT
BENALE P/L

JOB No. C95016
BY MRE
SHEET No. 5
CHECKED
DATE 6/95

N_e = effluent total nitrogen = ?

N_o = influent total nitrogen = 150 mg/l (pH ≈ 7.0)

$T_{winter} = 10°C$

$\theta = 1.039$

$K_{20t} = 0.0064 \quad \therefore \quad K_{10} = K_{20}\theta^{T-20} = 0.0064(1.039)^{-10} = 0.0044.$

HRT = 70 (∴ Possible) / 2 (short circuiting) = 35 days (Probable)

$\therefore N_e = N_o e^{\{0.0044[35 + 60.6[7.0 - 6.6]]} = 116$ mg/l

(ΔTN = 23%)

- Model 2 (Eq. 4.18, Reed et al)

$$N_e = N_o \cdot \left[\frac{1}{1 + HRT(0.000576T - 0.00028)e^{[(1.08 - 0.042T)(pH - 6.6)]}}\right]$$

$$\therefore N_e = 150\left[\frac{1}{1 + 35(0.000576 \times 10 - 0.00028)e^{[(1.08 - 0.042 \times 10)0.4]}}\right]$$

= 120 mg/l (ΔTN = 20%)

Therefore based on Models 1 & 2, $\Delta BOD_5 \approx 20\%$.

(3) Aerobic Maturation Pond

As per Low Rate Aerobic Ponds.

N_e = effluent total nitrogen = ?
N_o = influent total nitrogen = 120 mg/l (pH = 7.0)
$T_{winter} = 20°C$
$K_{20°C} = 0.0064$
HRT = 135 (Possible) / 2 (Short circuiting) ≈ 70 days. (Probable)

- Model 1

$$N_e = 120 . e^{\{-0.0044[70 + 60.6(0.4)]\}}$$

$$= 79 \text{ mg/l} \quad (\Delta TN = 34\%)$$

- Model 2

$$N_e = 120 . \frac{1}{1 + 70(0.000576 \times 10 - 0.0028)\, e^{[(1.08 - 0.042 \times 10)(7 - 6.6)}}$$

$$= 120 \frac{1}{1 + 70(0.0055)\, e^{1.302}} = 54 \text{ mg/l}$$

$$(\Delta TN = 45\%)$$

Therefore based on Models 1 & 2, ΔTN ≈ 30%.

EVANGELISTI & ASSOCIATES	CER - NARRIKUP	JOB No. C95016	
	WASTEWATER TREATMENT	BY MRE	SHEET No. 7
	BENALE P/L	CHECKED	DATE 6/95

LAND TREATMENT (TN REDUCTION)

Total Load = $\frac{85 \text{ mg/l}}{1000}$ × 210 days × 1000 m³/day

= 17850 kg (TN)/annum.

- Slow Rate Irrigation (Forage/Pasture)

Nitrogen / White Clover - 480 kg/ha/yr (irrigated)

- 175 kg/ha/yr (dryland)

Due to short term grazing reduce, irrigated crop uptake by 50% & rotate half area between irrigation & dryland.

- 20 ha × 480 kg/ha/yr / 2 = 4800 kg (TN)
- 20 ha × 175 kg/ha/yr = 8500 kg (TN)

8300 kg

Nitrogen limited hydraulic loading rate (Lwn)
(Eq. 13.2, Metcalf & Eddy)

$$L_{wn} = \frac{C_p (P - ET) + 10'(U)}{(1-f)C_n - C_p}$$

C_p - Total nitrogen concentration in percolating water

ET - Design Evapotranspiration

P - Precipitation

U - nitrogen uptake by crop
C_n - total nitrogen concentration in applied wastewater
f - fraction of applied total nitrogen removed by denitrification and vollatilisation

$$L_{wn} = \frac{0(86-65)+10(480/2)}{(1-0.15)(85)-0} = 33\text{ cm/yr}$$

(3.3 m/yr)

$L_{wn} < L_W$ (Groundwater Technology calculations)

∴ nitrogen application limited. (Kikuyu - irrigated)

$$L_{wn} = \frac{0(86-65)+10(175)}{(1-0.15)(85)-0} = 24\text{ cm/yr}$$

(2.4 m/yr)

$L_{wn} < L_w$ ∴ Nitrogen appl. limited (Kikuyu - dryland)

- Slow Rate Irrigation - (Woodlots)

Eucalyptus Species - 90 kg/ha/yr (irrigated)

100 ha × 90 kg/ha/yr = 9000 kg (TN)

$$L_{wn} = \frac{0(86-65)+10(90)}{(1-0.15)(85)} = 12\text{ cm/yr}$$

(1.2 m/yr)

EVANGELISTI & ASSOCIATES

CER-NARRIKUP
WASTEWATER TREATMENT
BENALE P/L

JOB No. C9501b
BY MRE
SHEET No. 9
CHECKED
DATE 6/95

$L_{wn} < L_w$ ∴ nitrogen application limited (Eucalyptus.

Total Nitrogen Uptake = 8300 (pasture) + 9000 (woodlots)
= 17200 kg ≃ Total load
(17850 kg) O.K.

LAND TREATMENT (TP REDUCTION)

Total load = $\frac{30 \text{ mg/l}}{1000}$ × 210 days × 1000 m³/day
= 6300 kg (TP) / annum

- Slow Rate Irrigation (Forage / Pasture)

Kikuyu / White Clover
20 ha × 56 kg/ha/yr (irrigated) = 1120 kg
20 ha × 20 kg/ha/yr (dryland) = 400 kg
1520 kg / annum

- Slow Rate Irrigation (Woodlots)

Eucalypt Species
100 ha × 2 kg/ha/yr (irrigated) = 200 kg/annum

Total Phosphorus Uptake 1720 kg/annum
Total Phosphorus load 6300 kg/annum
4580 kg/annum
Shortfall.

EVANGELISTI & ASSOCIATES

CER – NARRIKUP
WASTEWATER TREATMENT
BENALE P/L

JOB No. C95016
BY MRE
SHEET No. 10
CHECKED
DATE 6/95

- Soil Amendment (RMG)

TP loading rate – 4580 kg/annum

Soil Storage Capacity – 100 kg/ha (TP)
RMG Storage Capacity – 0.0005 kg (TP)/kg (RMG)
(No leaching)

Total Soil Storage (TP) = Soil Depth × Storage Capacity × Area
≈ 8.0 × 100 kg/ha/m × 140 ha
≈ 112000 kg

Total RMG Storage (TP) = Amendment Depth × % Amendment × Storage Cap. × Area
= 0.4 m × 25% × 0.0005 × 1500 kg/m³ × 140 ha
= 105000 kg

∴ Total Phosphorus Storage ≈ 220 000 kg

$$\text{Life Span} = \frac{220000\ \text{kg}}{4580\ \text{kg/annum}} \approx 50\ \text{years.}$$