SHIRE OF SERPENTINE-JARRAHDALE

TOWN PLANNING SCHEME NO. 2
AMENDMENT NO. 77
PT LOTS 521 AND 523 SOUTH WESTERN HIGHWAY, BYFORD

ENVIRONMENTAL REVIEW

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REPORT NO: 97/50

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AN INVITATION TO COMMENT ON THIS ENVIRONMENTAL REVIEW

The Shire of Serpentine-Jarrahdale invites people to make a submission on this Environmental Review (ER).

The Environmental Review (ER) was prepared for Amendment 77 to the Shire of Serpentine-Jarrahdale Town Planning Scheme No.2 for Part Lots 521 and 523 South Western Highway, Byford for rezoning from 'Rural to Residential, Commercial, Public Open Reserve, Community Purpose Reserve and Mixed Use'.

In accordance with the Environmental Protection Act, 1986 as amended this ER has been prepared to describe the proposed Amendment and its likely impact on the environment.

The ER will be available for public review in accordance with the advertising period which has been determined by the Minister for Planning to be 17 March, 1998 to 28 April, 1998.

After receipt of comments from Government agencies and from the public the Shire of Serpentine-Jarrahdale will forward submissions to the EPA. 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 responsible authority.

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 ER 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 ER.

- If you discuss different sections of the ER, 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:

28 April, 1998

Submissions should be addressed to:

Attention: The Shire Clerk
Shire of Serpentine-Jarrahdale
6 Paterson Street
MUNDIJONG WA 6202

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SUMMARY

This Environmental Review has been prepared for a proposed Amendment to the Shire of Serpentine-Jarrahdale's Town Planning Scheme No. 2 (Amendment No.77). Amendment 77 proposes the rezoning of Part Lots 521 and 523 South Western Highway, Byford from "Rural" to "Residential", "Commercial", "Public Open Space Reserve," "Public and Community Purpose Reserve" and "Mixed Use".

The Amendment is being proposed by the Shire of Serpentine-Jarrahdale in response to a development proposal by Bredwell Pty Ltd (Smith Corporation Pty Ltd).

Amendment 77 to the Shire of Serpentine-Jarrahdale Town Planing Scheme No. 2 was referred to the Environmental Protection Authority (EPA) in accordance with recent legislative changes to the Environmental Protection Act, 1986. The EPA determined that the proposed rezoning may have significant environmental impact and decided that the Amendment should be assessed. The EPA identified the relevant environmental issues (key factors) for the proposed rezoning in the instructions issued for the preparation of this Environmental Review.

Issues relevant to the proposed rezoning of the site principally involve the potential for nutrient pollution and the quality of waters leaving the site. The key factors and associated management initiatives proposed to minimise potential impacts are listed in Table A1.

The proposed Amendment area has areas of remnant vegetation within and adjacent to it. Vegetation within the Amendment area is in poor condition while vegetation along Cardup Brook and adjacent to the eastern margin of Amendment area is in relatively better condition. Vegetation along the southern boundary (Cardup Brook) and adjacent to the eastern edge of the Amendment Area is identified in the draft Perth Bush Plan as being regionally significant and representative of the Guildford, Forrestfield and Darling Scarp vegetation complexes. Changes to the zoning may potentially lead to impacts on the remnant vegetation as a result of changes in land use. The Amendment will therefore include provisions to ensure the quality and long term viability of the regionally significant vegetation. These include retaining the vegetation and managing access to it using defined walk trails as part of the development plan.

Increases or a decrease in the amount and quality of water entering Cardup Brook as a result of the Amendment may adversely affect the long term health and viability of the brook. Prior to any development and as a condition of the Amendment, drainage management provisions which will maintain the amount and quality of water entering Cardup Brook at pre-development levels, including the preparation of a Nutrient and Drainage Management Plan, will therefore be required. Retention of a vegetated buffer along the edge of Cardup Brook will also be a condition of any development approval.

The quality and quantity of surface water leaving the Amendment area may potentially change due to the proposed development. Stormwater following

development may cause erosion and nutrients originating from the site may be transported through the drainage system and ultimately impact on the Serpentine River and Peel-Harvey Estuary. Therefore, as a condition of the Amendment any developer will prepare a drainage management system to ensure stormwater flow from the site following development does not exceed that prior to development. Stormwater from a 1 in 10 year storm event of 72 hours duration will be held on site for 3 to 7 days and nutrient discharge levels from the site will meet required levels.

Areas of potential soil contamination are present at the site. These areas may contribute to ground water and surface water contamination in the area and potentially pose a health risk. Investigations into the nature and extent of any contamination will be undertaken and a remediation plan developed and implemented. Remediation of any identified area of soil contamination will be undertaken prior to any development as a condition of the Amendment. This will remove any associated potential health risks.

Gaseous emissions from the brickworks adjacent to the southern boundary of the Amendment area may potentially impact on future land uses following development. Therefore as a condition of the Amendment undeveloped buffers will be incorporated into any design plan to ensure future land users of the Amendment area are not affected by gaseous emissions.

Land uses (a shale pit, brickworks, flour mill, and wreckers yard) surrounding the Amendment area may potentially impact on future land users as a result of particulate and dust emitting activities. Modelling of the dust emissions from the brickworks stacks show that they have no impact on the Amendment area. Thorough investigations into the potential impacts of the other industries on the Amendment area will be undertaken. The study will be timed to allow for worst case scenarios, eg. summer. If necessary, as part of the Amendment, provisions to protect the health and amenity of future land users in the Amendment area will be incorporated into any development plan.

Noise emissions from land uses (shale pit, brickwork, light industrial zone, dog kennels, flour mill, wreckers yard) surrounding the Amendment area may potentially impact on future land users. Provisions in the Amendment to protect the health and amenity of future land users will be incorporated into the design of any development plan.

Archaeological sites identified on the assessment area may be adversely impacted upon by the Amendment. Provisions in the Amendment, to the satisfaction of the Aboriginal Affairs Department, will be incorporated in the design of any development plan for protection of the sites.

The potential presence of ordnance and explosive wastes in the Amendment area may pose a risk to health and safety of future land users. Therefore, a comprehensive survey to identify the presence of any ordnance and explosive wastes and a remediation program to remove any material uncovered will be undertaken. As a condition of the Amendment this will be implemented prior to any other implementation activity on the Amendment area occurring to ensure the risk to public health and safety has been reduced to acceptable levels.

Environmental management provisions to be implemented by the proponent for each of the key environmental factors identified by the EPA as relevant to the rezoning are listed in Table A2.

TABLE A1

SHIRE OF SERPENTINE-JARRAHDALE TPS NO. 2 AMENDMENT 77 SUMMARY OF ENVIRONMENTAL FACTORS

Environmental Factor	Present State of the Environment	Proposed Change Resulting from Scheme	Proposed Management	Predicted Outcome
Vegetation	Areas of vegetation adjacent to and within the proposed area identified in the draft Perth Bushplan as regionally significant	Design of the proposed development will ensure the long term viability of the remnant vegetation identified in the draft Perth Bush Plan and present along the southern boundaries of the amendment area.	Implementation of appropriate remnant vegetation management provisions will be effected through a schedule to TPS Amendment 77 as a condition of subdivisional approval.	Minimal impact on the remnant vegetation
Wetlands	Water courses (Cardup Brook)	Using the principles of water sensitive urban design and a vegetated buffer the expected change in site drainage as a result of the proposed development will be fully compensated on site to ensure the amount and quality of discharge from the site into Cardup Brook is kept at pre-development levels.	Implementation of the drainage management provisions will be effected through a schedule to TPS Amendment 77 as a condition of subdivisional approval	Minimal impact on the quality of Cardup Brook
Surface Water Quality	Part of Peel-Harvey catchment. Main issues are nutrients and erosion. Subsurface water movement from the ridge down slope onto heavier clay soils results in seasonal waterlogging.	Drainage design for the site will include provision for nutrient and pollutant stripping, integrated catchment management and water sensitive urban design techniques such as dead storage and maximisation of retention time and the installation of interceptor traps to ensure minimal nutrients are transported off site.	Implementation of the drainage management provisions will be effected through a schedule to TPS Amendment 77 as a condition of subdivisional approval	Minimal impact on the Peel-Harvey estuary

Soil Contamination	Evidence of chemicals leaking from unexploded munitions causing local soil contamination. Soil contamination from underground fuel storage tank. Asbestos fibre contamination.	Thorough investigation for soil and ground water contaminants at the site to identify the nature and extent of contamination and development and implementation of a remediation strategy appropriate for individual areas	Development and implementation of a remediation and management program for any identified contaminants will be effected through a schedule to TPS Amendment 77 as a condition of subdivisional approval. The remediation and management program will be developed prior to approval of any subdivision proposal	Removal of contaminant sources and management of ground-water contamination, if required
Gaseous Emissions	Brickworks on southern boundary	Development design will include provision for appropriate buffers to ensure that future land users are not affected by fluoride emissions from the brickworks	Implementation of appropriate provisions in the development design to protect future land users will be effected through a schedule to TPS Amendment 77 as a condition of subdivisional approval	Minimal impact on future land users
Particulates/ Dust	Shale Pit on southeastern boundary, Brickworks on southern boundary, Flour mill, Wreckers yard	Thorough investigation of impact of particulates/dust from surrounding land uses on the Amendment area and , if necessary, incorporation of provisions in the development design to protect future land users	Investigation into and, if necessary, implementation of appropriate provisions in the development design to protect future land users will be effected through a schedule to TPS Amendment 77 as a condition of subdivisional approval	Minimal impact on future land users
Noise	Shale Pit on Southeastern boundary, Brickworks on southern boundary, Urban Industrial area to northwest, Dog Kennels (AQS) adjacent to northeast corner, Sawmill, Flour mill, Wreckers Yard.	Development design will include provision for appropriate buffers to ensure that future land users are not affected by noise emissions from surrounding land uses	Implementation of appropriate provisions in the development design to protect future land users will be effected through a schedule to TPS Amendment 77 as a condition of subdivisional approval	Minimal impact on future land users

Aboriginal Heritage	Archaeological sites identified within the site	Development design will include provision for the management of archaeological sites on the property in accordance with the provisions of the Aboriginal Heritage Act (1972)	Compliance with the requirements of the Aborigonal Hertiage Act (1972) will be effected through a schedule to TPS Amendment 77 as a condition of subdivisional approval	Compliance with Aboriginal Heritage Act
Public health and Safety (risk and hazard)	Presence of degraded unexploded munitions on the site.	Comprehensive survey to identify the presence of any ordnance and explosive wastes that may be a risk to public health and safety, and development of a remediation strategy for their removal	Development and implementation of a survey and remediation program for any identified ordnance and explosive wastes will be effected through a schedule to TPS Amendment 77 as a condition of subdivisional approval. The program will be developed and undertaken prior to any other implementation activity occurring	Minimised risk to public health and safety

TABLE A2

SUMMARY OF PROVISIONS FORMING PART OF SHIRE OF SERPENTINE-JARRAHDALE TPS NO. 2 AMENDMENT 77

Issue	Objective/s	Provision	Timing (Phase)	Whose Requirements	Specification (Performance Indicator)
Protection of remnant vegetation within and adjacent to the Amendment area	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	i) Retain remnant vegetation within and adjacent to the amendment area, and implement management strategies to ensure its long term viability and minimal human impact	Prior to subdivisional approval	DEP in consultation with CALM and the Shire of Serpentine - Jarrahdale	Submission of Development Plan to DEP
Protection of long term health and viability of Cardup Brook	Maintain the integrity, functions and environmental values of watercourses.	i) Incorporate in the subdivision application a vegetated buffer around Cardup Brook ii) implement drainage measures which will ensure flows in Cardup Brook are maintained at pre-development levels	Prior to subdivisional approval	i & ii) DEP in consultation with Waters & Rivers Commission	i & ii) Submission of Drainage Management and Development Plans to DEP and Waters and Rivers Commision
Surface water quality from the site may impact on Peel-Harvey Estuary	Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993)(and the NHMRC/ARMCANZ Australian Drinking Water Guidelines-National Water Quality Management Strategy).	i) Implement drainage measures which will ensure the on-site disposal of stormwater from a 1 in 10 year event of 72 hour duration for 3 to 7 days ii) Implement drainage measures which will ensure that phosphorous discharge levels into the Serpentine River are less than 0.225kg/P/ha/a iii) Implement drainage measures which will ensure the discharge level of nitrogen leaving the site is maintained at levels equal to or less than predevelopment concentrations	Prior to subdivisional application	i, ii & iii) DEP in consultation with Waters & Rivers Commission and Shire of Serpentine -Jarrahdale	i, ii, iii) Submission of Nutrient and Drainage Management Plan to DEP, Shire of Serpentine - Jarrahdale, and Waters and Rivers Commision

Evidence of soil contamination	Ensure the rehabilitation of the site to an acceptable standard that is compatible with the intended land use, consistent with appropriate criteria.	i) Conduct an appropriate investigation on the site to determine the nature and extent of any soil and groundwater contamination ii) Development of a remediation program, if necessary a management program, for any identified contaminants that is to be implemented prior to implementation of the scheme	Prior to subdivisional approval	i, ii) DEP	i) Submission and implementation of remediation and, if necessary, management program to the DEP and prior to implementation of the scheme
Impact of gaseous emissions from brickworks on Amendment area	Ensure that gaseous emissions do not adversely affect that environment or health, welfare and amenity of nearby land users by meeting the statutory requirements (including Section 51 of the Environmental Protection Act 1986) and acceptable standards.	i) Conduct modelling exercise to examine gaseous emissions over the Amendment area ii) Incorporate in the subdivision application a buffer encompassing the Amendment areas in which gaseous emissions from the brickworks exceed relevant criteria	Prior to subdivisional approval	i) & ii) DEP	I & ii) Submission of Development Plan to DEP, including details of modelling and justification of any buffer area
Impact of particulates/dust from land uses adjacent to Amendment area	Ensure that the dust levels generated by the proposal do not adversely impact upon the welfare and amenity or cause health problems by meeting statutory requirements and acceptable standards.	i) undertake investigations during summer to examine the effect of particulates/dust on the Amendment area ii) incorporate in the subdivision application buffer/s encompassing the Amendment areas in which the impacts of particulates/dust exceed the guidelines; as defined by studies (modelling)	Prior to subdivisional approval	I & ii) DEP	I & ii) Submission of Development Plan to DEP, including details of modelling and justification of any buffer area
Impact of noise emissions from land uses adjacent to the Amendment area	Protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring that noise levels meet statutory requirements and acceptable standards.	i) Incorporate in the subdivision application a buffer encompassing the Amendment areas in which noise guidelines are exceeded	Prior to subdivisional approval	i) DEP	i) Submission of Development Plan to DEP, including details of modelling and justification of any buffer area

Protection of archaeological sites on assessment area	Ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972; and ensure that changes to the biological and physical environment resulting from the project do not affect cultural associations with the area.	i) incorporate in the subdivision application management strategies to ensure that significant archaeological sites are protected	Prior to subdivisional approval	i) Aboriginal Affairs Dept.	i) Submission of Development Plan to Aboriginal Affairs Dept.
Risk to public health and safety from ordnance and unexploded wastes	Ensure that risk is managed to meet the EPA's criteria for individual fatality risk off-site and DOME's requirements in respect of public safety.	i) Conduct an appropriate investigation on the site to determine the presence of any ordnance and explosive wastes. Develop and implement a remediation program as necessary	Prior to subdivisional approval and the implementation of any ground activity occurring	i) DEP in consultation with UXO Branch, WA Police Service and DOME	i) Submission of investigation and remediation program, and results to DEP

1. INTRODUCTION

1.1 Background

Amendment 77 to the Shire of Serpentine-Jarrahdale Town Planning Scheme No. 2 proposes the rezoning of Part Lots 521 and 523 South Western Highway Byford from "Rural" to "Residential", "Commercial", "Public Open Space Reserve", "Public and Community Purpose Reserve" and "Mixed Use". The Amendment is being proposed by the Shire of Serpentine-Jarrahdale in response to a proposal for redevelopment of the area by Smith Corporation Pty Ltd. The area is currently zoned "Urban" and "Urban Deferred" under the Metropolitan Region Scheme.

1.2 Need for Amendment

The Shire of Serpentine-Jarrahdale Town Planning Scheme Amendment 77, Byford, has been prepared in response to a development proposal submitted on behalf of the Smith Corporation Pty Ltd.

At the same time, the Shire of Serpentine-Jarrahdale's rural development strategy has sought to focus future development into 'urban villages' in the Byford and Mundijong areas. An urban development framework study commissioned by Shire of Serpentine-Jarrahdale in early 1994 culminated in the "Green Towns Local Structure Plan". The report illustrated and described a development approach which attempted to reconcile and balance the many diverse aspects of major development, such as economic viability, community development, energy efficiency, environmental sensitivity and urban design. The plan defined the limits of urban development around Byford and suggested the form and nature that development should take (Mitchell Goff and Associates, 1996).

The Shire of Serpentine-Jarrahdale's development strategy is, in broad terms, closely aligned to the proposal by Smith Corporation and is in accordance with the future development of the Byford area as envisaged by the Shire of Serpentine-Jarrahdale.

1.3 Purpose and Scope

1.3.1 Environmental Assessment Process

Recent legislative changes have linked the planning and environmental assessment processes. The Planning Legislation Amendment Act, 1996 enables the Environmental Protection Authority (EPA) to assess all Town Planning Schemes, Redevelopment Schemes, Regional Planning Schemes, and all subsequent Amendments.

Under the new legislation the proponent is no longer the private individual but a Government instrumentality termed the "responsible authority". The responsible

authority for the proposed rezoning for Part Lots 521 and 523, Byford is the Shire of Serpentine-Jarrahdale.

The Shire of Serpentine-Jarrahdale referred Amendment 77 to the EPA pursuant to the Planning Legislation Amendment Act, 1996. The EPA decided to formally assess the proposal and required the preparation of this Environmental Review. The purpose of the Environmental Review is to provide information to the EPA to enable it to assess the potential impact of the proposed amendment on the environment and provide independent advice to the Government. Instructions are issued by the EPA which identify key factors that should be addressed and assist the preparation of the Environmental Review document.

The Environmental Review will be made publicly available during the advertising period for the Town Planning Scheme Amendment. Environmental submissions on this Environmental Review will be forwarded by the Shire of Serpentine-Jarrahdale to the Environmental Protection Authority (EPA) for independent evaluation and assessment under the provisions of the Environmental Protection Act, 1986.

Following the advertising period all submissions will be considered and the EPA will evaluate the potential environmental impact of the proposed rezoning and prepare an assessment report to the Minister for the Environment. The Minister may apply environmental conditions to the Amendment in order to minimise the impact on the environment before granting approval for the proposed rezoning.

Advice on how to prepare a submission on this Environmental Review is provided at the beginning of this report.

The general process for consideration and determination of Local Authority Amendments together with the process for determination of submissions on this Environmental Review is shown in Figure 1.

1.3.2 Scope of this document

Following appeals the Environmental Protection Authority (EPA) issued final instructions for the preparation of this Environmental Review on 22 October 1997. The instructions outline the environmental issues or key factors which the EPA has identified as relevant to Shire of Serpentine-Jarrahdale TPS No. 2 Amendment 77. These include vegetation, wetlands, surface water quality, soil contamination, gaseous emissions, particulates/dust, noise, aboriginal heritage and public health and safety (risk and hazard). This report specifically provides additional information regarding these factors so that the potential impact of the proposed rezoning can be assessed.

The format of this report is based on that recommended by the EPA in its instructions for this Environmental Review. A copy of these instructions is contained in Appendix 1.

1.4 Location

The location of the assessment area, is shown in Figure 2. It occupies approximately 200ha and is situated within the Shire of Serpentine-Jarrahdale approximately 1km south of Byford and 33km southwest of Perth city centre.

The assessment area as defined by the EPA, encompasses Lots 1, 521 and 523 Byford (Figure 3). The Amendment area as defined by the Shire of Serpentine-Jarrahdale TPS Amendment 77 however, comprises part Lots 521 and 523, excluding Lot 1 as shown in Figure 4. The Amendment area occupies 95ha of land. Lot 1 is owned and used by the Commonwealth Government and is not part of this current Amendment proposal. Following recent modifications to the development plan to reflect the Environmental Review, minor changes to the zoning and residential planning codes as stipulated in the amendment will be required (Figure 4).

A proposed development (subdivision) plan for the Amendment area is provided in Figure 5. This plan has been provided for information purposes only, to indicate how the development/subdivision might occur in the future. Changes to the plan may occur following approval for the subdivision from all the relevant authorities. Provisions have been made in the subdivision plan to allow possible extension into Urban Deferred zoned land. Alternatively, the design maintains the integrity of the development in the event there are no extensions to the development area.

1.5 Previous, Current and Surrounding Landuse

The assessment area was previously owned by the Commonwealth Government and much of it was cleared to house a Royal Australian Navy Ammunition Depot (RANAD). The primary purpose of the depot was the storage and assembly of naval munitions. The munitions were stored in a network of widely spaced and bunkered buildings that were interconnected by roadways and railway lines. Areas of the site not developed for RANAD infrastructure remains mostly as remnant vegetation.

Since the closure of the RANAD facility in 1979 and up until 1996, the site caretaker has intermittently used the cleared areas as pasture for cattle. A quarantine station has also been established by the Federal Government on Lot 1 to the north-east. The entire quarantine area is fenced and access is via Nettleton Road.

Land surrounding the Amendment area includes lots with rural, industrial, residential and quarrying activities. Figure 6 illustrates the surrounding land use activities. Rural land occupies the southern, western and north-eastern boundaries of the site. Residential land lies on the northern side of Nettleton Road, while Cardup Quarry is located to the east. The quarry is owned by Metro Brick which uses it mainly for the storage and mixing of clay. The Armadale Shale is also intermittently quarried at this location.

Industrial operations occur on land located to the north, at the intersection of Nettleton Road and South Western Highway, and land abutting the south-eastern margin of the redevelopment site. The Nettleton Road industrial area is separated from the north-western portion of the redevelopment site by an unoccupied lense-shaped portion of Lot 523 that has a maximum width of approximately 230m. Industries present in this gazetted light industrial zone include a flour mill, salvage yard, wreckers yard, petrol station and light engineering firm. The industrial area on the southern margin of the property comprises the Cardup brickworks and associated infrastructure.

1.6 Topography

The assessment area is located on the western edge of the Darling Scarp. It comprises a broad, gently sloping dune that overlies the colluvial slope. The dune and colluvial slope are bisected to the north and south by valleys of the Beenyup and Cardup Brooks, respectively.

There is an overall slope on the site to the west. Exceptions to this however, occur where the Beenyup and Cardup Brooks intersect the dune. The slope direction at these points rotates to the north for the Beenyup Brook and to the south for Cardup Brook. Figure 3 provides topographic contours for the site.

The dune itself forms a gently sloping prominence that has a maximum height of approximately 102m above sea level and on average rises about 30-40m above the rest of the site. Gradients on the dune (3°-4°) tend to be relatively greater than those on the lower colluvial slope (1°-2.5°). The steepest gradients on the site are associated with the banks of Cardup Brook. These are often around 16°, but can be as high as 21°.

1.7 Geology

The Byford site lies on unconsolidated Quaternary age strata (1.8 million to 100,000 years before present). These strata drape over and rest unconformably on sediments of the Perth Basin.

The Armadale 1:50,000 Environment Geology Series Map indicates that the near surface geology of the site comprises the Yoganup Formation underlain by colluvial and piedmont deposits of an unnamed geological unit. These surface units are unconformably underlain by the Armadale Shale and most probably the Cattamarra Coal Measures Member of the Cockleshell Gully Formation. The contact between the Armadale Shale and Cattamarra Coal Measures Member is delineated by the Darling Fault.

The Yoganup Formation is described by the Geological Survey of Western Australia on the Armadale 1:50,000 Environmental Geology Series Map as a unit of Early Pleistocene age (approximately 1.8 to 1.0 million years before present) that was deposited in a beach or strand line environment. It consists of structureless yellow, fine to coarse grained quartz sand with minor silt and clay of colluvial origin.

The colluvial and piedmont deposits are mapped by the Geological Survey of Western Australia in their Armadale 1:50,000 Environmental Geology Map Series as the unnamed map unit 'Csg'. The unit is described as gravelly sandy clay with lenses of silt, gravel and quartz sand that is of Pleistocene age (approximately 1.8 million to 10,000 years before present).

The Catamarra Coal Measures Member of the Cockle Shell Gully Formation is described by Playford *et al.* (1976) as a unit of Early Jurassic age (approximately 195 to 176 million years before present) that is of fluviatile origin. It consists of very fine to very coarse grained sandstone with interbedded claystone and siltstone, which are in part carbonaceous, and seams of coal.

The Armadale Shale is described by Playford *et al.* (1976) as a unit of Late Proterozoic age (approximately 1600 to 650 million years before present) that is of shallow marine origin. It consists of black and white shale with minor sandstone and orthoquartzite. The type section for the Armadale Shale is in Cardup Quarry where a stratigraphic section of 483m was measured.

The presence of the Yoganup Formation and the unnamed gravelly sandy clay unit "Csg" on the redevelopment site was confirmed by field observations. The Yoganup Formation crops out in the form of a broad dune covering the eastern half of the site. Higher areas of this dune contain common pisolitic nodules that are mixed through the yellow to light grey quartz sand. The gravelly sandy clay "Csg" unit occupies the remaining western portion of the site. This unit is composed of a clay rich gravelly sand. The sand is often poorly sorted and is composed of angular fragments of quartz and minor feldspar.

No outcrop of the underlying Armadale Shale and Cattamarra Coal Measures Member was noted on the Assessment area.

2. KEY ENVIRONMENTAL FACTORS

2.1 Introduction

The EPA, in its instructions for this Environmental Review, has defined a series of relevant factors which it considers are particularly important for its assessment of the proposed Amendment. Relevant environmental factors are defined as those which have the potential to have significant environmental impacts, and which the EPA therefore may be required to report on to the Minister for the Environment.

The discussion of the environmental implications of the Amendment which is given in this section of the Environmental Review addresses the relevant factors. For each factor, the EPA objective and a description and analysis of the environmental implications associated with the Amendment is provided. This is followed by a description of how the Amendment will incorporate provisions for environmental management where appropriate, and in some instances a description of programs which will be required during the scheme amendment. The provisions form part of the Amendment and cannot be altered without going through an additional amendment.

A summary of the relevant environmental factors and draft provisions forming part of the Amendment are provided in Appendices 1 and 2, respectively.

2.2 Vegetation

2.2.1 EPA Instructions

Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.

2.2.2 Description

The vegetation associations on the assessment area are shown in Figure 7. A large proportion of the site has been cleared of native vegetation for use by the former ammunition depot. Much of the cleared area is covered with introduced weeds and grasses and is very degraded.

Scattered trees of *Eucalyptus calophylla* (Marri), *Eucalyptus marginata* (Jarrah) and *Nuytsia floribunda* (West Australian Christmas Tree) occur throughout the cleared site and many are of an exceptional size and age. Banksia trees *(Banksia attenuata* and *Banksia menziesii)* are also common. There are also a number of established trees, including *Eucalyptus* species, that do not naturally occur in the area. These were probably planted during the time the Navy occupied the site.

Seasonal waterlogged depressions are present on the site and are recognisable by patches of *Juncus* sedgeland (Figure 7). A permanent underground spring is located in the south-west of the site. This provides a constant flow of fresh water which feeds a small wetland area containing *Agonis linearifolia* shrubs.

Brickwood Reserve, a seasonal wetland, is located close to the site on the western side of South-western Highway and it is possible that during the wet season water drains from the site towards this reserve.

Flooded Gums *(Eucalyptus rudis)* occur on the banks of Cardup Creek which flows along the southern boundary of the site. *Agonis linerarifolia* is the dominant understorey shrub, growing in and around the creek where water is permanent.

The eastern portion of the site which has not been cleared contains Jarrah, Marri and Banksia woodland with a dense, diverse understorey. The dominant trees are *Banksia attenuata, Banksia menziesii, Eucalyptus calophylla* (Marri) and *Eucalyptus marginata* (Jarrah). *Xylomelum occidentale* (Woody Pear), a small tree around 4m high and *Nuytsia floribunda* (Christmas tree) are also common in the area. Understorey species include *Allocasuarina humilis, Baeckea camphorosmae, Hibbertia hypericoides, Mesomelaena tetragona* and *Xanthorrhoea preissii.* A list of the plant species recorded on the site is provided in Appendix 3.

No Declared Rare or Priority flora were recorded during the vegetation surveys (February, 1996 and September, 1997). A total of eight native orchids were found on the property during the September 1997 survey for ephemeral species. None of these are listed as Declared Rare or Priority species.

Vegetation Condition

A map showing the quality of vegetation on the site condition is given in Figure 8. A large proportion of the vegetation on the site was cleared for the Navy ammunitions depot and more recently the location has been used as pasture for grazing stock. As a result, vegetation in the area is badly degraded. The remnants of buildings and many old roads lie derelict on the site and have been overrun by introduced weeds and grasses. Very few native shrubs and herbs remain in the area used by the Navy. However, there are many large healthy trees including Marri, Jarrah and West Australian Christmas Trees that have some visual appeal.

The permanent freshwater spring that is located in the south-west of the cleared region is also badly degraded, mainly due to the grazing of stock. However, it does have some significance as a source of freshwater throughout the year for birds and other animals. White-faced Herons (*Egretta novaehollandiae*) and Western Grey kangaroos (*Macropus fulinginosus*) were seen at the spring during the survey.

The natural vegetation around Cardup Creek is also in poor condition due mainly to disturbances by stock and the invasion of weeds and introduced grasses.

The Jarrah, Marri, Banksia woodland on the eastern part of the Assessment Area is in relatively good condition, despite some disturbance with tracks and fire breaks, and dust related to the clay stockpile in the quarry. Clay silt is being washed downhill from the quarry and fine dust covers the vegetation during quarrying operations.

There is no evidence of dieback disease in the area.

2.2.3 Environmental Management

The vegetation of the assessment area has been subjected to various disturbances including clearing for use by the Navy, development as pasture, and weed invasion. As a result, much of the site is in relatively poor condition and has low biological value.

Remnant vegetation on the eastern portion of the assessment area however, is in relatively good condition and represents Jarrah, Marri and Banksia woodland vegetation typical of the region. The bushland also provides habitat for a variety of native animals. Red-tail Black Cockatoos (*Calyptorhynchus banksii*) were observed feeding on Marri nuts in this area.

Vegetation occupying the eastern parts of the assessment area and surrounding Cardup Brook has been identified under the Perth Environment Project as regionally significant with a Vegetation Ecological Index within the top 6-10%. The vegetation in the eastern sector and around Cardup Brook is included in the Draft Perth Bush Plan and identified as being representative of the Darling Scarp, Forrestfield, and Guildford vegetation complexes, respectively.

Part of this woodland could provide a useful natural barrier between activities to the east and the residential development to the west and would help reduce noise and dust created during activities conducted in the quarry.

The Amendment area does not include the Jarrah, Marri, and Banksia woodland vegetation, but does include vegetation along Cardup Brook. The Scheme Amendment will prevent impact on the regionally significant vegetation contained within the Assessment area.

2.2.4 Management Implementation

The Shire of Serpentine-Jarrahdale Scheme will require in the provisions forming part of TPS No. 2 Amendment 77 the incorporation of management strategies in any subdivision plan to ensure the protection and long term viability of the regionally significant vegetation within and adjacent to the Amendment area. The management strategy will include the following:

- Retention of vegetated areas on eastern part of the assessment area and along Cardup Creek and definition of a walking trail to reduce disturbances, and

- Clear delineation of vegetated areas through the use of dual use paths, roads and the like.

2.3 Watercourses

2.3.1 EPA Objectives

Maintain the integrity, functions and environmental values of watercourses.

2.3.2 Description

Evidence from aerial photograph interpretation and field observations suggest that a large proportion of the property is poorly drained and subject to seasonal waterlogging. Water drainage from the site appears to be mostly via seepage and overland flow rather than through well defined water courses. The South West Highway act as a retention basin and compensates flow via culverts.

The southern edge of the Amendment area is defined by Cardup Brook. There is little evidence of coordinated drainage into this water course, but there is a series of small seeps on its northern banks. Cardup Brook is an intermittent stream that generally flows during periods of extended rainfall and the winter months.

Hill et al., (1996) identified the presence of an extensive palusplain (seasonally waterlogged) in the south western corner of the Amendment area. The palusplain encompasses part of Cardup Brook which was described by Hill et al., (1996) as a 'vegetated section of wetland'. They assigned a management category of 'conservation' to this part of the brook. The objective of this category is to preserve wetland attributes and functions through reservation in national parks, crown reserves, state owned land, and protection under environmental protection policies.

2.3.3 Environmental Management

The proposed Amendment may potentially affect the quantity and quality of water entering Cardup Brook and the vegetation surrounding it. Consequently, to protect the brook ecosystem, provisions (e.g. a buffer) will need to be incorporated into any proposed subdivision development plans. The boundaries of the proposed buffer incorporating Cardup Brook are shown in Figure 9.

2.3.4 Management Implementation

The Shire of Serpentine-Jarrahdale Scheme will require in the provisions forming part of TPS No. 2 Amendment 77 the property owner to ensure the long term viability of Cardup Brook and minimise impacts upon it from the adjacent development by implementing the following management strategies:

- Provision of a vegetated buffer, including native trees and shrubs, 50m wide extending from the centre line of the water course to protect the brook ecosystem. This buffer area will incorporate existing wetland vegetation along Cardup Brook and is in accordance with advice from the Waters and Rivers Commission.

- Preparation of a site drainage plan incorporating best practice in Water Sensitive Urban Design (see Section 2.4) which will:

a) maximise on site water infiltration

b) maintain the existing water quality within Cardup Brook by ensuring no drainage emanating from the proposed development will enter Cardup Brook.

c) ensure that the pattern of flow from the property will remain largely unchanged.

The drainage program will be monitored after development to ensure the pattern of flow is unchanged from predevelopment.

2.4 Surface Water Management

2.4.1 EPA Objective

Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993)(and the NHMRC/ARMCANZ Australian Drinking Water Guidelines-National Water Quality Management Strategy).

2.4.2 Description

General

The proposed development of the Amendment area has the potential to impact on the quantity and quality of water leaving the site. Potential impacts include an increase in run off during storm events and an increase in concentrations of nutrients, in particular nitrogen and phosphorus, in the water run off.

Using water sensitive design concepts consulting engineers Gilbert Rose Consulting Pty Ltd have developed a Conceptual Drainage Management Plan for the proposed Amendment to ensure the quality and quantity of water leaving the site meets the required objectives.

Modelling, Methodology and Drainage Design

Drainage design to ensure surface water parameters (i.e. rate of discharge and nutrient concentration) on the Amendment area do not exceed those when the property is under rural land use requires an assessment of the site's catchment hydrology pre- and post development.

Pre and post development catchment hydrology and the derivation of flows for a range of flood events for the site was assessed using RAFTS modelling software. RAFTS has been designed specifically to assess the impact of drainage from rural catchments in transition to urban use. Local data was used to recalibrate the RAFTS model. Modelling results were used for the assessment of detention basin location and design of retaining flows. The modelling took into account water

sensitive urban design concepts and the utilisation of upstream retention by combining some open space and roadway design with a detention function.

Table 1 outlines the parameters of the drainage catchments identified on the Assessment area. The catchment areas for each detention basin include only those areas to be developed. Both pre-development and post development flows exclude the quarantine station and the bushland to the east. Figure 10 shows the catchment boundaries and detention basin locations on the Assessment area.

TABLE 1

AMENDMENT AREA CATCHMENT PARAMETERS*

Parameter	Detention Basin 1	Detention Basin 2	Detention Basin 3
Area	64.33ha	42.57ha	29.34ha
Clearing	50%	50%	50%
Length	1.2km	1.2km	1.26km
Rainfall	1000-1200mm	1000-1200mm	1000-1200mm
Slope	40m/km	44m/km	44m/km
Runoff Q50	0.854m^3/s	0.661m^3/s	0.52m^3/s

* using the rationale of AR&R (1987) for south west region-low jarrah with sandy soils.

The calculated runoff flows were then adopted to calibrate the RAFTS-XP rural, ie. undeveloped, flow conditions. Tables 2 and 3 provide the calibrated rural flow conditions for 50 year and 100 year events.

TABLE 2

CALIBRATED RURAL FLOWS (50 year event)

Parameter	Detention Basin 1	Detention Basin 2	Detention Basin 3
Q50 Flow	0.85m^3/s	0.68m^3/s	0.53m^3/s
Peak after	125 mins	125 mins	125 mins
Storm length	6 hrs	6 hrs	6 hrs

TABLE 3

CALIBRATED RURAL FLOWS (100 year event)

Parameter	Detention Basin 1	Detention Basin 2	Detention Basin 3
Q100 Flow	1.3 m^3/s	1.06 m^3/s	0.76 m^3/s
Peak after	135 mins	135 mins	135 mins
Storm length	6 hrs	6 hrs	6 hrs

The flow values determined in Table 3 were adopted as being representative of maximum basin outflow during a 100 year storm event of any duration.

To determine the peak flows under developed conditions the RAFTS-XP model was adjusted using parameters derived from the proposed development plan. Table 4 outlines the calculated flows within each drainage catchment following development, but without detention basins.

TABLE 4

CALIBRATED DEVELOPED FLOWS
(100 year event; no detention basins)

Parameter	Catchment 1	Catchment 2	Catchment 3
Developed area	22.92 ha	36.25 ha	19.34 ha
Q100 Flow	2.73 m^3/s	3.42 m^3/s	1.98 m^3/s
Peak after	90 mins	90 mins	90 mins
Storm length	9 hrs	9 hrs	9 hrs

The calibrated developed flows were then used to derive flows which include the provision of detention basins in the development. Tables 5 and 6 outline the general design parameters of each basin in the three drainage catchments on the property and developed flows following the provision of detention basins, respectively. Table 7 summarises the flow rates during a 1 in 100 year storm event.

TABLE 5

GENERAL DETENTION BASIN DESIGN PARAMETERS

Parameter	Detention Basin 1	Detention Basin 2	Detention Basin 3
Base RL	58m	58m	58m
Spillway RL	60	60	60
Batters	6:1	6:1	6:1
Base Area	2500 m^2	1600 m^2	625 m^2
Top Batter	5476 m^2	4096 m^2	2600 m^2
100 year outlet	900 RCP	725 RCP	600 RCP

TABLE 6

CALIBRATED DEVELOPED FLOWS
(100 year event; with detention basins)

Parameter	Detention Basin 1	Detention Basin 2	Detention Basin 3
Max. Inflow	2.73 m^3/s	3.42 m^3/s	1.97 m^3/s
Max. Outflow	0.93 m^3/s	0.93 m^3/s	0.67 m^3/s
Storage	3147 m^3	3637 m^3	1995 m^3
Top Water Level	58.9 m	59.37 m	59.4 m
Developed flows including basins	1.44 m^3/s	0.97 m^3/s	0.64 m^3/s

TABLE 7

SUMMARY OF FLOWS
(100 year event)

Parameter	Detention Basin 1	Detention Basin 2	Detention Basin 3
Pre-development flow	1.3 m^3/s	1.06 m^3/s	0.76 m^3/s
Developed flows	2.73 m^3/s	3.42 m^3/s	1.98 m^3/s
Developed flows including basins	1.44 m^3/s	0.97 m^3/s	0.64 m^3/s

It can be seen in Table 7 that the proposed system of detention basins will effectively reduce post-development flow rates to pre-development regimes for the worst conditions, ie. 1 in 100 year storm event. A series of outlets will accommodate lower flow rates.

Analysis of the peak flows for the 100yr ARI event enables determination of the compensation area and outlet required for the worst case. More frequent return intervals will result in the storage required above the permanent water being less than the height predicted in the 100yr event. The outlet will be controlled using a vee-notch weir so that the discharge at that more frequent event is reduced to that which would flow pre-development.

2.4.3 Environmental Management

The Conceptual Drainage Management Plan developed to manage stormwater originating on site is based on Water Sensitive Urban Design (WSUD) principles incorporating the following Best Management Practices (BMPs):

- vegetated swales
- wet detention basins
- gross pollutant traps

These BMP's are the tools to meet WSUD objectives, and range from BMP's utilised on the lot through to practices at the street and neighbourhood scale.

The pollutant removal and flow attenuating ability of neighbourhood scale BMP's is complemented by the use of lower order water management practices like on-lot infiltration retention wells, street swales/table drains and check drains. The principal pollution removal mechanisms employed by swales/table drains is infiltration and sedimentation. The use of these lower order BMP's contribute to further significant reduction in flow rates.

The lower order BMP's attenuate the flow rates of minor storms and reduce velocities sufficiently to prevent scouring and ensure lower peak flow rates and pollution loads.

Three detention basins have been incorporated within the proposed subdivision layout with the primary purpose to attenuate the quantity of water flowing from the development site so the post-development discharge equals the pre-

development flows over a range of storm events including, but not limited to the EPA nominated 1 in 10 year 72 hour storm being retained for 3 to 7 days. The basins will be designed to retain permanent water as a landscape feature (Figure 10).

Water quality improvement or pollution control will be accomplished by the use of WSUD BMP's and to a degree the detention basins in the drainage design. Waters and Rivers Commission guidelines place a limit of 40% of pollution reduction to be undertaken in detention basins. The remaining improvement in water quality will be via the construction and use of Water Sensitive Urban Design concepts upstream of the wet basins. The WSUD BMP's will include swale collectors, sheet flow through vegetation and landscape recycling featuring swamp land above the permanent lake. Construction of the swales will comprise a chain of macrophyte ponds with all the runoff from the subdivision directed along them. The major swales are shown on Figure 11.

Surface Water Quality

The guidelines set by the EPA for this project refer to nutrient targets exported in drainage waters flowing from the site. These targets, particularly that relating to phosphorus, are derived from the Peel/Harvey Environmental Protection Policy (EPP) even though the Amendment Area is outside the EPP area. The EPA determined the objective of maintaining or improving the quality of surface water leaving the site and set nutrient load targets of 0.225 Kg P/ha/a and 0.075mg/L for phosphorous in waters discharged from the site. Following an appeal, it was determined that where the responsible authority believed the 0.225Kg P/ha/a target was inappropriate alternative target values or management techniques could be proposed. The overriding discharge target of not more than 0.225 Kg P/ha/a however, was retained.

The Shire of Serpentine-Jarrahdale subsequently determined that stormwater quality control objectives are to be met by ponds and other water sensitive urban design features within the redevelopment area. The conceptual drainage management plan for the subdivision has been developed to meet this target.

Monitoring, undertaken by the former Water Authority of WA, of phosphorous discharges from a range of urban projects in the Perth metropolitan region during 1990/1 provided results in the range of 0.095 to 0.538 kg P/ha/a, depending on soil type and season. Further monitoring performed by the WRC on sites with soils similar to those found in Byford gave results of 0.4 kg P/ha/a (Westfield) and 0.6 kg P/ha/a (Armadale).

The exact level of nutrients in discharges to the final detention and nutrient removal basins in this proposal cannot be determined until the design of the water sensitive design features incorporated at lot and street level within the subdivision is finalised, but recent experience suggests levels would be well below the 0.4 kg P/ha/a figure obtained at Westfield and therefore this figure has been adopted as a basis for design.

The Conceptual Drainage Management Plan proposes to primarily use the three on-site detention basins and include three swale collectors in each of the three stages of subdivision. The swales will be built as each stage of the subdivision is developed. This will include a swale located adjacent to most of the developments' South West Highway frontage. Figure 11 shows the location of the swales in Stage 1 of the proposed development.

Discharge from roads above the central open space will be fed into surrounding flat swales and the water allowed to sheet over the park with nutrients being taken up by the vegetation and part of the flow recharging groundwater. The POS is situated at the western edge of the sand dune on the property which discharges at the proposed permanent lake/detention basin. The discharge of surface runoff from the POS will be into a landscape feature with provision to recycle by pumping from the lake.

The three onsite basins would be interlinked with outlets to the west. Two points of discharge from the on site detention basins are proposed, with each one carrying flow from the existing land via culverts under the South Western Highway (Figure 11). A fourth pollution control pond could be situated adjacent to the existing drains on Hopkinson Road. Following release from this pollution control pond, the water will ultimately be discharged to the Oaklands drain.

As a result of urban development peak storm water flows tend to increase and water accumulates more quickly in detention basins due to the presence of paved surfaces and pipes used to convey water downstream. Attenuation of peak water flow is achieved by the storage within detention basins which also have an outlet that restricts the water flow leaving the basins.

Pollution control basins are usually shallower than detention basins and proportionately have much larger areas of 'shallows'. The 'shallows' are used as macrophyte zones and often have substantial plantings of reeds which extract pollutants from the water that flow through the reed banks.

These artificial wetlands will improve water quality prior to its detention by creating a shallow matrix of sediment, plants, water and detritus that collectively removes pollutants through a series of complementary physical, chemical and biological processes. The primary removal processes that will occur in the wetland are as follows:

- Sedimentation
- Adsorption to sediment/emergent plants and detritus
- Physical filtration by plants
- Microbial activity
- Uptake by wetland plants
- Uptake by algae.

Current guidelines recommended by the WRC suggest a total basin volume of 450m^3/ha of developed urban land for pollution control. The required volume for the proposed development therefore, is 35100m^3. The same guidelines also allow up to 40% of that storage volume to be within the detention basins themselves. None of the three on-site basins reach the 40% limit due to the

configuration of the proposed development and the outlet flows for pre-development. The three detention basins designed to service the proposed development have been sized following the WRC guideline and are 3417m^3, 3637m^3 and 1995m^3 in size, for a total volume of 8779m^3. Table 5 provides details of pond design for the proposed development.

Allowing for the volumes within the detention basins to be deducted from the volume required for pollution control, the additional swales need to have a volume of 26321m^3 to accommodate pollution control for this development. Current practice provides for 30% of this volume to be at depths of up to 0.5m to provide macrophyte zones with the balance up to 2m depth. This results in a water quality or pollution control area of 2.9ha being required to accommodate the indicative subdivision plan. The required 2.9ha is satisfied by the proposed linear swales (1.5ha) and other vegetated beds (1.4ha) within the development.

Monitoring shows that "state of the art" artificial wetlands are capable of reducing phosphorous content by 50% - 70%. On this basis, the loading of phosphorous in waters discharged off-site from the subdivision will be reduced from around 0.4 kg P/ha/a to 0.12 - 0.2 kg P/ha/a which is well within the targets set by the EPA for the project. Should the fourth pollution control pond mentioned previously be constructed then a further reduction could be achieved before the water is discharged to the environment. Figure 12 demonstrates the way such a reduction would be achieved.

In the event that monitoring showed that target nutrient loads were being exceeded, a number of actions could be taken to improve the efficiency of the nutrient removal systems. These actions include,

- the installation of more macrophyte beds;
- the catchment boundaries between detention basins can be amended to flow regimes; and/or
- the size of the basins could be increased.

This Conceptual Drainage Management Plan will be augmented by the preparation of a Nutrient and Drainage Management Plan to be submitted at the time of subdivision application. It will be based on output from the RAFTS computer model and the AQUAM program (a water quality model) and data from the WRC to estimate phosphorus and nitrogen loadings for a range of flows to ensure peak discharge complies with EPA objectives.

The total volume of the pollution control devices will be determined in the preparation of the Nutrient and Drainage Management Plan. It will be prepared in consultation with the DEP, WRC and Shire of Serpentine-Jarrahdale and its performance checked by appropriate monitoring as the subdivision matures.

In addition to the proposed pollution control measures, should monitoring demonstrate that performance of these measures does not achieve the required targets then the following measures can be applied: a) more macrophyte beds can be installed; b) the catchment boundary between

detention basins 1 and 2 amended to divert more flow to the former and; c) the sizes of the basins increased.

Measures to provide long term protection of the water quality in the drains downstream of the development need to include both non-structural and structural measures. Structural measures include the detention basins and pollution control measures described above.

Non-structural controls for reducing urban stormwater and groundwater pollutants are practices that are intended to improve run off quality by reducing generation and accumulation of potential stormwater run off and groundwater contaminants at or near their sources. Non-structural controls are therefore modifications to catchment practices that will require the long term cooperation of residents within the catchment, Council, DEP and WRC to be effective.

The following non-structural controls are proposed for implementation at the development:-

- Minimisation of fertiliser application
- Pesticide use control
- Control of pollution from construction sites
- Resident education.

This will be addressed in more detail in the Nutrient and Drainage Management Plan.

2.4.4 Management Implementation

The Shire of Serpentine-Jarrahdale Scheme will require in the provisions forming part of TPS No. 2 Amendment 77 the subdivider to:

Prepare a Nutrient and Drainage Management Plan to maintain the quantity and quality of surface water leaving the property at predevelopment levels to the satisfaction of the DEP, Waters and Rivers Commission and Shire of Serpentine-Jarrahdale;

Monitor water quality parameters and water quantities until such time as the DEP, Waters and Rivers Commission and Shire of Serpentine-Jarrahdale are satisfied that the objectives of the Nutrient and Drainage Management Plan have been achieved.

The Plan will incorporate best practice in Water Sensitive Design which will:

- maximise on-site water infiltration,
- ensure the quantity of surface water leaving the site will be largely unchanged,
- ensure the quality of water leaving the site meets DEP requirements, and
- provide for contingency plans.

2.5 Soil Contamination

2.5.1 EPA Objective

Ensure the rehabilitation of the site to an acceptable standard that is compatible with the intended land use, consistent with appropriate criteria.

2.5.2 Description

Initial investigations have identified some areas on the property where soils may be contaminated. The locations of potentially contaminated soil are shown in Figure 13.

Three relatively small areas of potential soil contamination have been identified, which are believed to be associated with the disposal of munitions. The presence of ammunition in these localities has caused them to be informally described as 'Red Alert" areas. Bullets, shells and shell casings of various calibres have been dumped and sometimes burnt in these areas. Soil at the north-eastern 'Red Alert' locality No. 1 is stained green, has a greasy texture, and lacks vegetation. No sub surface examination of the soil in these Red Alert locations has been undertaken due to the potential presence of ordnance and unexploded wastes (OEW). However, it is considered likely that chemicals leaking from various types of ammunition has caused local soil contamination.

Other potentially contaminated areas include the underground fuel storage tanks at the entrance to the former site, a small vehicle servicing pit adjacent to RANAD building number 77, and a small concrete pad which is stained with hydrocarbons. In addition, it is possible that some soils around former and existing buildings where smashed and weathered asbestos has been scattered may contain asbestos fibres.

2.5.3 Environmental Management

The identification of potentially contaminated soils on the Amendment area indicates that further investigations are required to identify the nature and extent of any contamination in the soils and groundwater.

2.5.4 Management Implementation

The Shire of Serpentine-Jarrahdale Scheme will require in the provisions forming part of TPS No. 2 Amendment 77 the developer to undertake further investigations to determine the nature and extent of groundwater or soil contamination. A remediation strategy will be developed to the satisfaction of the DEP and implemented prior to any subdivision approval. No soil or groundwater investigations will be undertaken until the Amendment area has been checked and cleared of any unexploded ordnance.

2.6 Gaseous Emissions

2.6.1 EPA Objective

Ensure that gaseous emissions do not adversely affect the environment or health, welfare and amenity of nearby land users by meeting the statutory requirements (including Section 51 of the Environmental Protection Act 1986) and acceptable standards.

2.6.2 Description

General

The Cardup brickworks (owned by Metro Brick) located at the south-east corner of the property has the potential to impact on the Amendment area. Emissions from brickworks generally comprise a gaseous component and a dust/particulates component. The gases emitted comprise mostly hydrogen fluoride (HF) and hydrogen chloride (HCl). Stack emission data from the brick works indicates the presence of these compounds.

Modelling of the gaseous emissions from the brickworks (incorporating meteorological data applicable to the site) and their impact on the Amendment area was undertaken by Sinclair Knight Merz (Sinclair Knight Merz, 1997).

Modelling Methodology

The air dispersion model AUSPLUME was used to predict ground level concentrations of airborne contaminants around the brickworks. AUSPLUME is a plume dispersion model that has been used extensively throughout Australia for this purpose. It is designed to model gaseous and dust emissions from point, area and volume sources and from surface releases, and is applicable to a range of source types.

AUSPLUME utilises a time series of hourly meteorological data, optional formulations for plume dispersion, plume rise and inversion penetration to estimate the ground level concentrations. In this study, modelling results were based on:

- A cartesian grid of 0.15km spacing;
- Assumption of no terrain;
- Pasquil Gifford dispersion curves, with adjustments for roughness length and buoyancy;
- Partial plume penetration, with an assumed inversion strength of 0.004km; and
- Roughness length of 0.25m for the area surrounding the site consisting of open fields and forested areas.

The assumption of no terrain was made because AUSPLUME's treatment of the terrain is simplistic and incorrect for two dimensional terrain, especially where the terrain slopes in one direction as in the case in the Amendment area (i.e. east to west).

The model results, using the no terrain assumption, should lead to realistic results for terrain lower than the stack base, that is for terrain lower than approximately 80m above sea level. This area is approximately in a line west of the brickworks, (ie. west of the easting 407,200m), which corresponds approximately to the area of interest. Concentrations predicted to the east of this line however, should be treated with caution. To accurately predict concentrations to the east of the brickworks, a model such as the Complex Terrain Dispersion Model (CTDMPLUS) which requires statistics on turbulence in both the vertical and horizontal dimensions from near stack or plume height is needed. These data are not available for this area.

The meteorological data used for the modelling was obtained from the DEP's Middle Swan Meteorological station (Figure 14). These data were used because the station is a similar distance from the Darling escarpment and therefore will be subject to the same foothill wind patterns. Other sites which may be closer to Cardup, such as Kenwick, are further from the foothills and will be less subject to the high summer and winter winds from the nearby escarpment that occur at the site.

The data were processed into an AUSPLUME file with mixing heights derived from the DEP analysis, and stabilities from surface head fluxes using the USEPA program AERMET (Sinclair Knight Merz, 1997).

Emissions Characteristics

Emission data for the modelling as obtained from Metro Brick based on stack testing undertaken in 1993 are presented in Table 8.

TABLE 8

METRO BRICK (CARDUP) STACK EMISSION CHARACTERISTICS

Parameter	Units	East Stack	West Stack
Stack Height	m	27.5	29.6
Stack Tip Diameter	m	1.7	1.1
Exit Volume	m^3/s	24.3	15.9
Exit Velocity	m/s	10.7	16.7
Exit Temperature	°C	162	145
Mass Flux HF	g/s	1.57	0.92
Mass Flux HCl	g/s	1.49	1.16
Mass Flux Particulate	g/s	0.2	0.9

Notes:

1. Emission volumes, temperatures and mass fluxes derived from 2 samples on each stack on the 22 and 23 June 1993 (Stack Air, 1993).
2. The east stack vents the gasses from kilns 1, 2, and 3, whilst kiln 4 is through the west stack.
3. Stack heights and diameters from Metro Brick (1997a).

An average emission rate was estimated using annual clay throughput and average fluorine content of the clay, and information from two stack test samples taken on 22 and 23 June 1993. The Cardup Brickworks has an annual throughput of 210,000tpa, with an average weighted fluorine content of 370ppm from all clay types (minimum 190ppm, maximum 500ppm) (Metro Brick, 1997b). Using an assumed fluoride retention in the fired bricks of 12% (EPA, 1987), the estimated annual quantity of hydrogen fluoride emissions is 68.4tpa. This is equivalent to an average emission of 2.17g/s, which is slightly lower than the total emission of 2.49g/s in Table 8. It would appear therefore, that the stack testing is reasonably representative of average conditions.

Air Quality Objectives and Modelling Results

Fluoride

The waste gas of most interest from brick works in WA is fluoride. This is a naturally occurring mineral in all clays and is released as a gas in the firing process. Fluoride emissions are of concern due to the effects on vegetation and grazing animals. The levels that affect sensitive vegetation are one thousand times less than the level of concern for human health (EPA, 1993).

The DEP in Western Australian has set objectives (EPA, 1993) for ambient fluoride (as hydrogen fluoride; HF) levels which follow the ANZECC guidelines (ANZECC, 1990). These guidelines are for a range of averaging periods from 12 hours to 90 days and for two types of land use, general use and specialised use. Table 9 lists the fluoride objectives for the Swan Valley. Objectives for general land uses are designed to protect the majority of the sensitive species in the natural environment, while objectives for specialised land uses apply when commercially valuable plants, which are very sensitive to fluoride, are being considered.

TABLE 9

FLUORIDE (AS HYDROGEN FLUORIDE) OBJECTIVES FOR THE SWAN VALLEY

Averaging Time	General Land Use ($\mu g/m^3$)	Specialised Land Use ($\mu g/m^3$)
12 hours	3.7	1.8
1 day	2.9	1.5
7 days	1.7	0.8
30 days	0.84	0.4
90 days	0.5	0.25

No commercially sensitive plant species are found or intended to be grown in the Amendment area and therefore it is considered that the general land use values are appropriate for determining the implications of the brickworks for the Amendment area.

The maximum predicted 12 hour and 90 day ground level concentrations of HF from the Cardup brickworks in the assessment area are presented in Figures 15

and 16, respectively. This choice of averaging periods follows the EPA assessment of fluoride in the Swan Valley (EPA, 1993).

The locations in the assessment area where the maximum allowable concentrations of HF for the 12 hours and 90 day averaging periods are exceeded are relatively restricted. Predicted maximum 12 hour concentrations are confined to the extreme south-west corner while the maximum 90 day concentrations are exceeded in the extreme southwest and south east corners of the Amendment area only. These areas are shown in Figures 15 and 16.

Hydrogen Chloride

No air quality objectives for hydrogen chloride (HCl) have been set by the Western Australian EPA. Consequently, for this assessment, the Victorian EPA design guideline of 0.2ppm or 200 ($\mu g/m^3$), expressed at 25°C and 101.3kPa is used (EPAV, 1985).

The maximum 3 minute concentration predicted anywhere within the Amendment area is $16\mu g/m^3$. This is 8% of the adopted objective of $200\mu g/m^3$ and indicates that hydrogen chloride emissions from the brick works are not likely to have any environmental or public health implications.

2.6.3 Environmental Management

The modelling results illustrate that the gaseous emissions from the Cardup Brickworks are well below the EPA criteria within the majority of the Amendment area. Locations within the Amendment area where predicted HF emissions are above the recommended guidelines are confined to the extreme south west and south east corners of the property. HCl emissions from the brickworks are well below the recommended guidelines throughout the Amendment area.

Management strategies will be incorporated into the proposed Amendment to ensure future land users are not adversely affected in those parts of the Amendment area where HF emissions exceed the guidelines.

2.6.4 Management Implementation

To ensure the long term health and amenity of future land users the Shire of Serpentine-Jarrahdale Scheme will require in the provisions forming part of TPS No. 2 Amendment 77 to employ the following management strategy, to the satisfaction of the DEP:

- Provision of a buffer/s incorporating those parts of the Amendment area in which HF emission guidelines are likely to be exceeded.

2.7 Particulates/Dust

2.7.1 EPA Objective

Ensure that the dust levels generated by the proposal do not adversely impact upon the welfare and amenity or cause health problems by meeting statutory requirements and acceptable standards.

2.7.2 Description

Initial site investigations by Alan Tingay & Associates (1996) identified land uses surrounding the Amendment area that involve potential dust generating activities. The EPA subsequently recognised this issue and included particulates and dust as a key environmental factor for further investigation. In particular, particulates and dust may be generated by the nearby shale pit, brickworks, flour mill and wreckers yard.

The summer months are the times of least rainfall and the dry conditions present the greatest potential for dust generation. In consideration of this, detailed studies of the dust and particulate emissions from the nominated nearby industries and their effect on the Amendment area should be undertaken during the summer period to provide meaningful 'worst case' data. This is yet to be done.

As part of the study undertaken by Sinclair Knight Merz (1997) however, particulate emissions from the stacks of the Cardup Brickworks were modelled. The Kwinana Environmental Protection Policy residential standard of 90 $\mu g/m^3$ (EPA, 1992) for a 24 hour average was used in order to assess the significance of the predicted dust emissions from the brickworks stacks. The policy states that it is "desirable" that this concentration not be exceeded.

Modelling of the dust emissions from the brickworks stacks indicate that the maximum 24 hour concentrations of particulate matter predicted anywhere within the Amendment area is 2.3$\mu g/m^3$. This is 3% of the objective and indicates that dust emissions from the brickwork stacks are not a concern for future land uses.

2.7.3 Environmental Management

At this stage there are no indications that specific planning measures are required to cater for dust emissions from surrounding land uses. Further site assessments however, may establish this requirement.

2.7.4 Management Implementation

The Shire of Serpentine-Jarrahdale Scheme will require in the provisions forming part of TPS No. 2 Amendment 77 any developer to undertake investigations to examine the effect of particulates/dust on the Amendment area. This will include the production of plans showing those parts, if any, of the Amendment area that may be influenced by excessive levels of dust and particulates. The study will entail site sampling and process modelling using recognised

environmental guidelines. If necessary, development constraints to minimise the influence of dust and particulates in the Amendment area will be incorporated into the final planning design following discussions with the DEP.

2.8 Noise

2.8.1 EPA Objective

Protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring that noise levels meet statutory requirements and acceptable standards.

2.8.2 Description

An assessment of the effects of noise on the Amendment area has been made by Herring Storer Acoustics (HSA) (1996). The assessment included the preparation of a noise contour plan based on site sampling and comparison of estimated noise levels with recognised environmental guidelines.

Summary of Sound and Noise Terms

Definition of Acoustical Terms

a) Sound (Noise) Level

Noise is unwanted sound. Sound can be measured, but noise cannot be measured as it is subjective judgement on the part of the recipient. Sound is measured by a Sound Level Meter with resultant sound pressure levels. Sound consists of minute fluctuations in atmospheric pressure capable of being detected by the human ear. The human ear responds to changes in sound pressure over a very wide range. The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms, and because of this the addition of decibels is logarithmic and not arithimetic. For example 41dB(A) plus 41dB(A) equals 44dB(A).

Sound Level, or Sound Pressure Level (SPL), is defined as:

$$SPL = 20 \log_{10} (P/P_{ref}) \text{ dB}$$

where P is the sound pressure fluctuation measured in Pascals (Pa) (above or below atmospheric pressure) and P_{ref} is 20 micropascals (2×10^{-5} Pa), which is approximately the threshold of hearing. "L" is used in conjunction with other letters to represent Sound Pressure Level. Sound Power level etc., "L_A" or "dB(A)" represent the A-weighted Sound Pressure Level.

Sound Power Level (SWL) is defined as:

$$SWL = 20 \log_{10} (W/W_{ref}) \text{ dB}$$

where W is the sound power in watts and W_{ref} is the accepted reference sound power of 10^{-12} watts.

Sound power is an inherent and invariable property of a sound source, whereas sound pressure is that which can be detected by the ear or by a sound level meter, and is dependent on distance, shielding and other effects associated with the environment.

b) dBL_A (A-Weighting)

The overall level of a sound is usually expressed in terms of dB(A), which is measured using the "A-weighting" filter incorporated in sound level meters. This is an electronic filter having a frequency response corresponding approximately to that of human hearing.

People's hearing is most sensitive to sounds at mid frequencies (500Hz to 4000Hz), and less sensitive at lower and higher frequencies. Thus, the level of a sound in dB(A) is often a good measure of the loudness of that sound. Different sounds having the same dB(A) level generally sound about equally as loud, although the perceived loudness can also be affected by the character of the sound (e.g. the loudness of human speech and a distant truck will most likely be perceived differently, although they might have the same dB(A) level).

A change of 1dB(A) or 2dB(A) in the level of a sound is difficult for most people to detect, whilst a 3dB(A) to 5dB(A) change corresponds to a small but noticeable change in loudness. A 10dB(A) change corresponds to an approximate doubling or halving in loudness. Table 10 shows examples of typical noise levels.

TABLE 10

TYPICAL NOISE LEVELS

Sound Pressure Level (dB(A))	Typical Source	Subjective Evaluation
130 120 110	Threshold of pain Heavy rock concert Grinding	Extremely noisy/ intolerable
100 90	Loud car horn at 3m Construction site with pneumatic drilling	Very noisy
80 70	Curb side of busy street Loud radio or television	Loud
60 50	Department Store General Office	Moderate to quiet
40 30	Inside private office Inside bedroom	Quiet to very quiet
20	Unoccupied recording studio	Almost silent

c) Statistical Sound (Noise) Levels

Sounds that vary in level over time, like road traffic noise and most community noise, are commonly described in terms of the statistical exceedance levels "LAN", where LAN is the A-weighted sound pressure level exceeded for N% of a given measurement period, and/or "L_{Aeq}", the A-weighted equivalent continuous noise level.

For example "L_{A1}" is the noise level exceeded for 1% of the time, "L_{A10}" the noise exceeded for 10% of the time, and so on. The L_{A90} noise level is described as the background sound level (in the absence of the source under consideration), or simply the background level.

The equivalent continuous noise level (L_{Aeq}) is essentially the average sound level. It is defined as the steady sound level that contains the same amount of acoustical energy as a given time-varying sound. L_{Aeq} (24 hour) is the equivalent continuous noise level over a complete 24-hour period. L_{Aeq} (9 hour) is the night time (10:00pm to 7:00am) equivalent continuous noise level.

L_{Amax} is the maximum noise level, and is often used to quantify the noise from single events (such as heavy vehicle passes and train movements).

For assessment purposes, results from the study were compared to the Environmental Protection Act, 1986 Regulations, specifically Table 1, extracted from the Noise Abatement (Neighbourhood Noise) Regulations, 1979.

2.8.3 Environmental Management

The results of the noise assessment and the locations of data collection points are provided in Figure 9. A copy of the report by HSA, including monitoring data, is provided in Appendix 5.

Analysis of the monitored data by HSA (1996) demonstrated that there is minimal impact of noise in the Amendment area, except for within short distances of the quarantine station dog kennels, quarry, brickworks, and Nettleton Road industrial area. Noise contours were not developed elsewhere within the boundaries of the Amendment area as the data indicated that there was no noise impact.

The distances around existing land uses in which noise levels exceed those stipulated in the noise regulations (Noise Abatement (Neighbourhood Noise) Regulations, 1979) are given in Table 11.

TABLE 11

EXTENT OF NON-RESIDENTIAL NOISE LEVELS AROUND EXISTING LAND USES

LOCATION	BUFFER DISTANCE
Nettleton Road Industrial Area	250m
Quarantine Station	200m
Cardup Quarry	200m
Brickworks	200m

HSA (1996) recommended a 250m buffer around the Nettleton Road industrial area in recognition of the possibility of new industries establishing themselves within it.

However, the zoning of this industrial area also needs to be considered. The land is zoned "light industry" within which neither Extractive, General, Hazardous or Noxious industries are permitted and only uses of a light, service or rural nature are allowed. In particular, Appendix 1 of the Shire of Serpentine-Jarrahdale Town Planning Scheme (TPS) No. 2 specifically stipulates that light industries "will not adversely affect the amenity of the locality by reason of the emission of light, noise, vibration, smell, fumes, smoke, vapour, steam, soot, ash, dust, wastewater or other waste products."

This means therefore that any existing industry within the zone which generates noise emissions which exceed the relevant noise regulations in an adjacent residential area, would be a non-conforming use. Similarly, the establishment of a new industry which may create a noise nuisance within the zone is not permitted. It is important to note that TPS No. 2 does not define "the locality" and therefore it may be interpreted to include any land beyond the boundaries of the light industrial zone. In this case, a noise buffer beyond these boundaries should not be required.

Noise monitoring results obtained by HSA demonstrated there was no impact on the Amendment area by current quarry operations. However, in keeping with the conservative design of this project and the possibility of Metro Brick's future quarry operations moving closer to their lot boundary (Lot 6) and creating nuisance noise that affects future land users on the Amendment area a 200m buffer from the Lot 6 boundary will be incorporated into the subdivision plan as a worst case scenario (Figure 9). Should written evidence be obtained from Metro Brick showing that their present operations are representative of a worst-case scenario then the developer retains the right to adopt the buffer recommended by HSA (1996).

2.8.4 Management Implementation

The Shire of Serpentine-Jarrahdale Scheme will require in the provisions forming part of TPS No. 2 Amendment 77 the property owner to incorporate noise buffers into the Amendment area, to the satisfaction of the DEP, ensuring the future land users amenity. These buffers include:

- a 200m buffer for the dog kennels at the quarantine station;
- a 200m buffer for the quarry and;
- a 200m buffer for the brickworks.

2.9 Aboriginal Heritage

2.9.1 EPA Objectives

Ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972; and ensure that changes to the biological and physical environment resulting from the project do not affect cultural associations with the area.

2.9.2 Description

An Aboriginal heritage survey of the Amendment area which included archaeological and ethnographic assessments was undertaken by McDonald, Hales & Associates (1996).

The survey identified 29 archaeological sites on the Assessment area. The material discovered comprised both isolated finds and surface artefacts. These sites were considered by McDonald Hales & Associates (1996) to vary between low and medium to high significance.

Interviews were undertaken with aboriginal consultants and no ethnographic sites were reported.

2.9.3 Environmental Management

The presence of archaeological sites in the Amendment area will require management of these localities under the Aboriginal Heritage Act, 1972 to the satisfaction of the relevant regulatory bodies.

2.9.4 Management Implementation

The Shire of Serpentine-Jarrahdale Scheme will require in the provisions forming part of TPS No. 2 Amendment 77 management strategies to be developed to protect the identified archaeological sites in the Amendment area under the provisions of the Aboriginal Heritage Act, 1972, to the satisfaction of the Aboriginal Affairs Department and prior to subdivision approval.

2.10 Public Health and Safety (Risk and Hazard)

2.10.1 EPA Objective

Ensure that risk is managed to meet the EPA's criteria for individual fatality risk off-site and DOME's requirements in respect of public safety.

2.10.2 Description

Initial site investigations by Alan Tingay & Associates (1996) identified the potential presence of OEW on the property (see Section 2.5). A total of three 'red alert areas' were identified where munitions in varying states of degradation

were present. The locations of the 'red alert' areas in the Assessment area are shown in Figure 13.

2.10.3 Analysis

As a large of portion of the Amendment area was used formerly as a Royal Australian Navy ammunition depot (RANAD), there is potential for contamination by ordnance and explosive wastes. The presence or potential presence of these materials on the Amendment area is not compatible with the proposed future land uses. Consequently, there is a need to undertake a detailed assessment of the property to identify the existence of any OEW and have it removed before any other activities take place.

2.10.4 Management Implementation

The Shire of Serpentine-Jarrahdale Scheme will require in the provisions forming part of TPS No. 2 Amendment 77, prior to any other implementation activity occurring, a comprehensive survey to be conducted to determine the presence of any OEW that may be a risk to public health and safety, and to remove any material found and dispose of it in a manner satisfactory to the relevant regulatory authorities.
The survey and any remediation will be required to include the following:

- A historical review;
- Development of sub-surface investigation strategies and plans;
- Site investigations;
- Development of remedial strategy (if necessary);
- Remedial operations (if required); and
- Validation and certification of remedial activities.

The UXO (Unexploded Ordnance) Unit of the West Australian Police Service is the only agency currently authorised by the State Government to conduct studies or operations of this nature in Western Australia.

3. CONCLUSIONS

The Shire of Serpentine-Jarrahdale Town Planning Scheme No. 2 Amendment 77 proposes the rezoning of Part Lots 521 and 523, South Western Highway Byford from "Rural" to "Residential", "Commercial", "Public Open Space Reserve", "Public and Community Purpose Reserve" and "Mixed Use". The development proposal is designed to embrace contemporary environmental concerns and emerging technologies being pioneered in urban development and conform with the Shire of Serpentine-Jarrahdale's Rural Development Strategy and "Green Towns Local Structure Plan".

Examination of the key environmental factors identified by the EPA indicates that the environmental impacts on the area surrounding, and future land users within, the proposed amendment will be minimal. The key factors examined include vegetation, wetlands, pollution management issues (surface water quality, soil contamination, gaseous emissions, particulates/dust, and noise), aboriginal heritage, and public health and safety.

Where impacts on the surrounding environment or future land users have been assessed to exist or potentially exist, the Shire will require the landowner to incorporate protection measures into any development plan. Protection measures for vegetation and water courses comprise using buffers for the protection of remnant vegetation and water courses and the development of a drainage management plan to ensure the long term health and viability of Cardup Brook.

Pollution management in the proposed Amendment area includes measures to protect the surrounding natural environment and future land users. Surface water quality will be protected by the development of a nutrient and drainage management plan designed to ensure off site transport of nutrients is kept to required levels and erosion due to storm events does not occur. The amenity of future land users will be protected from impacts of gaseous emissions, and noise emitted by surrounding land uses through buffers in which incompatible development will not be permitted.

The land within the proposed Amendment area that may be developed given the constraints identified, is illustrated in Figure 17.

Management strategies will be incorporated into the development plan for protection of the archaeological sites on the assessment area to the satisfaction of the Aboriginal Affairs Department.

In cases where key factors identified by the EPA require further investigations, ie. soil contamination, particulates/dust, and public health and safety, the Shire will require the landowner to undertake these studies to the satisfaction of the DEP prior to subdivision approval.

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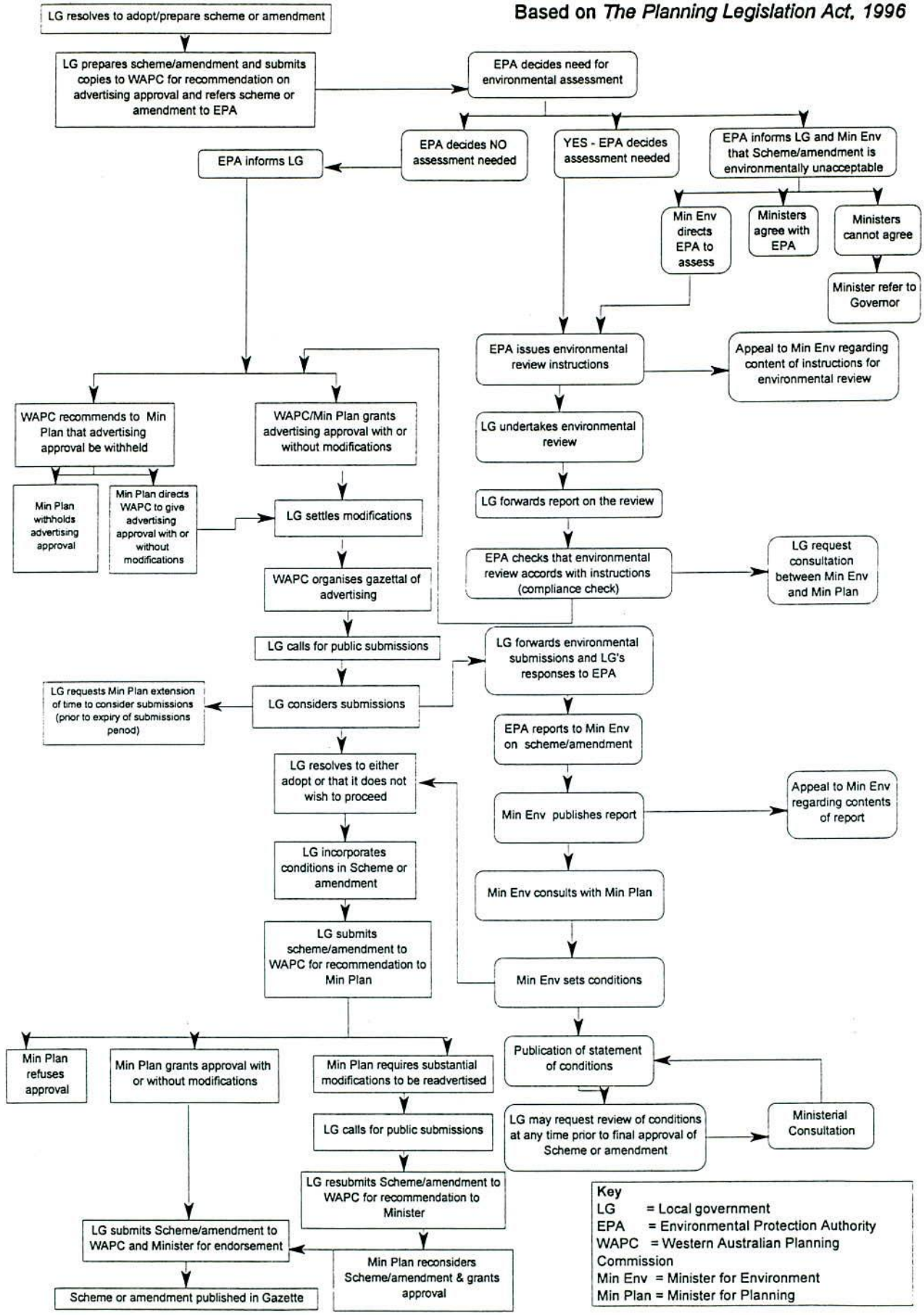
Project Number:	97057
Draft:	Final
Checked:	M. Scheltema
Approved:	N. Davies
Date:	6/04/98

FIGURES

Preparation & Environmental Assessment of Local Schemes & Amendments

Based on *The Planning Legislation Act, 1996*



SOURCE: WA PLANNING COMMISSION, 1996

DRAWN BY: ST 18/7/97 CHECKED BY: GJM 2/10/97

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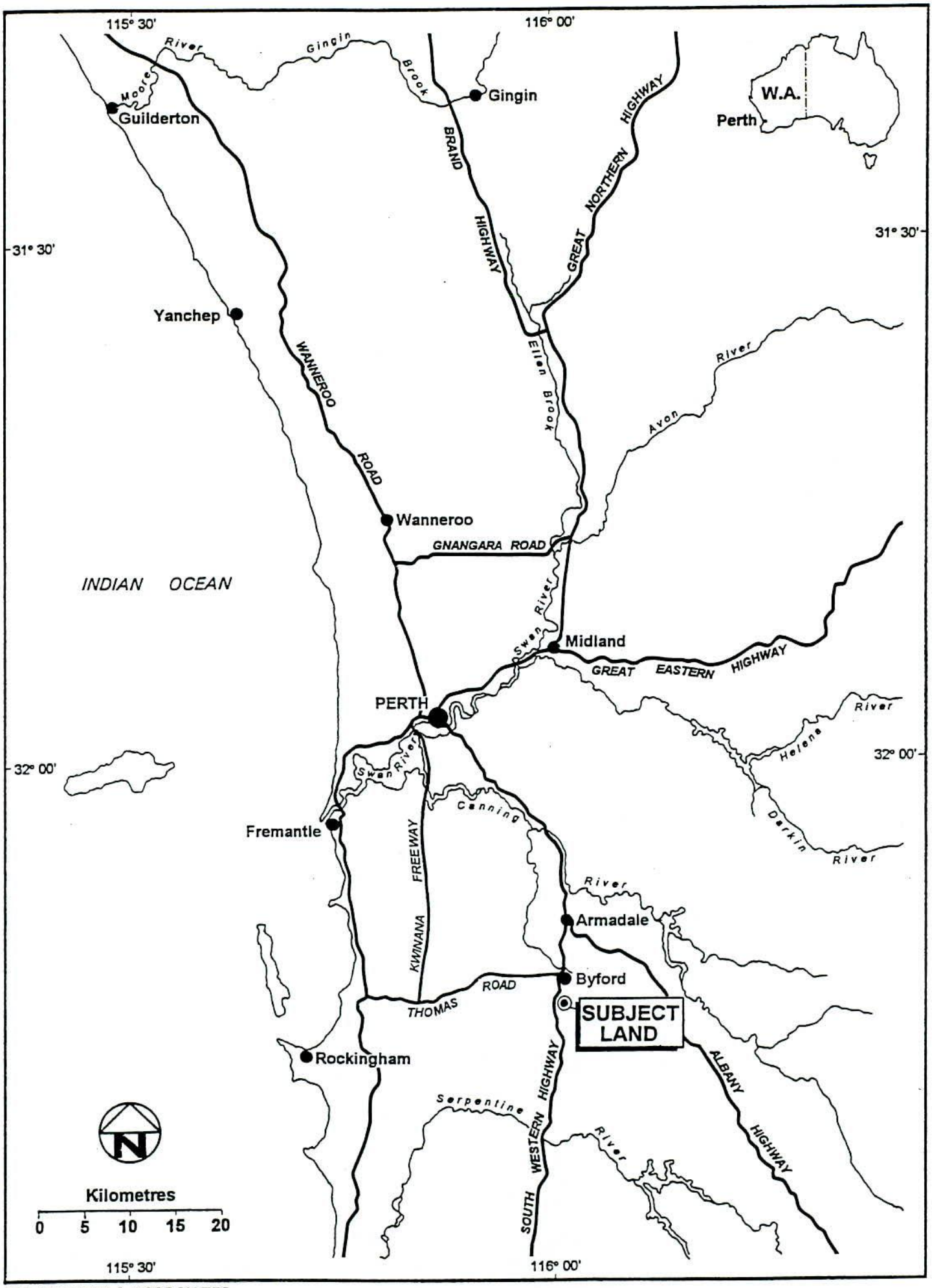
PT LOTS 521 & 523 SOUTH WESTERN HIGHWAY, BYFORD
ENVIRONMENTAL REVIEW PROCESS
FIGURE 1



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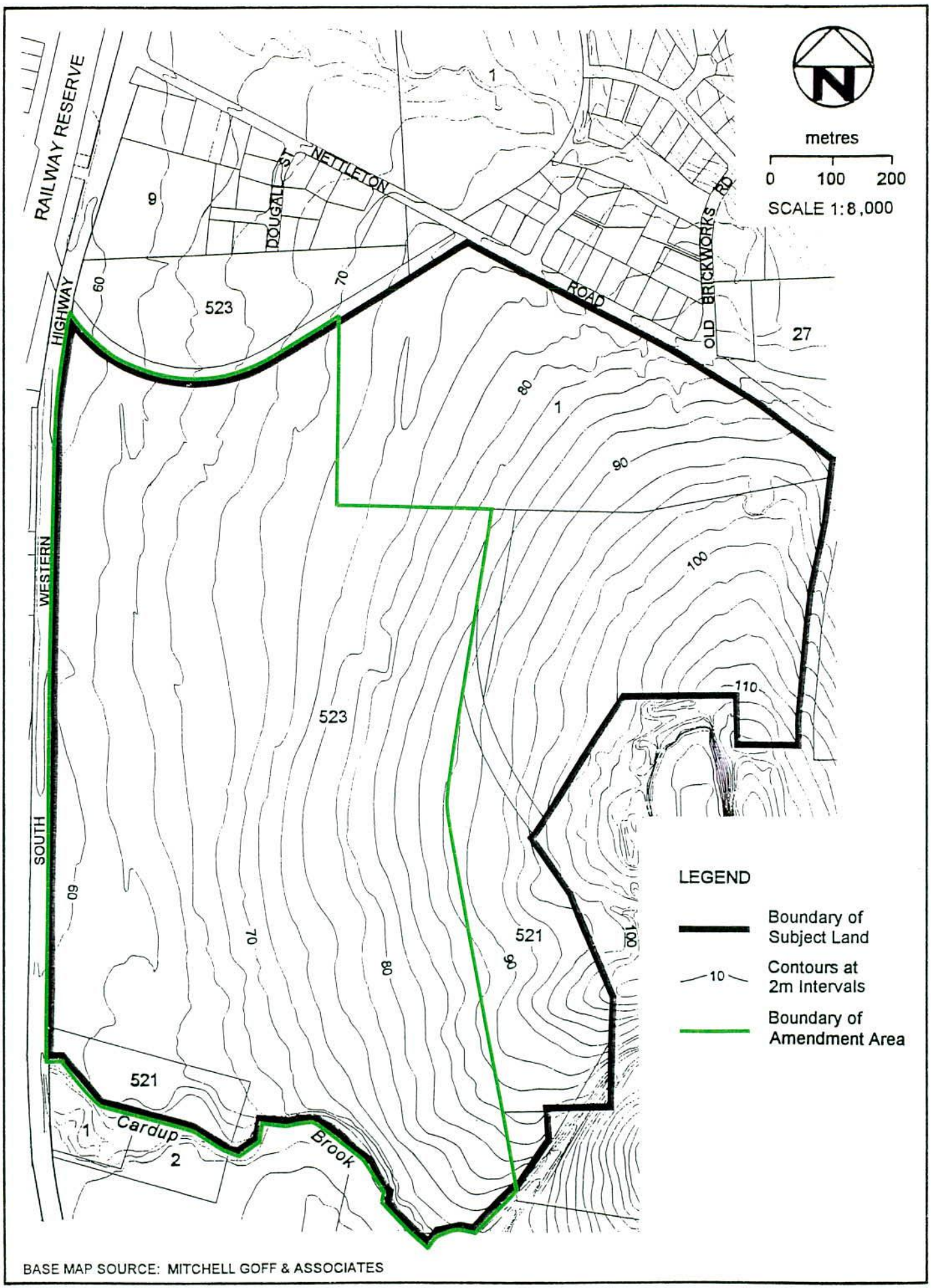
PT LOTS 521 & 523 SOUTH WESTERN HIGHWAY, BYFORD
REGIONAL LOCATION
FIGURE 2



BASE MAP SOURCE: MITCHELL GOFF & ASSOCIATES

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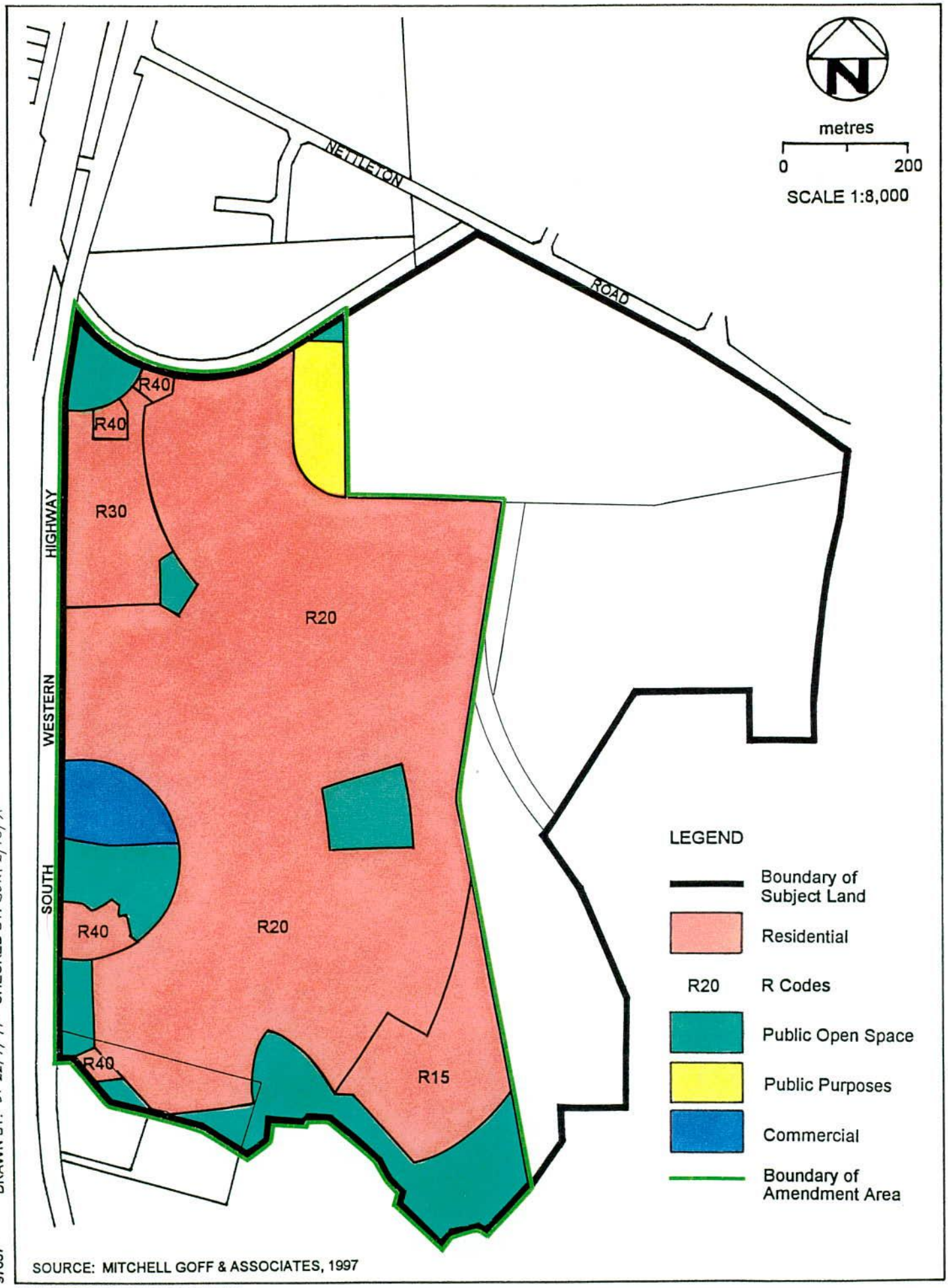
PT LOTS 521 & 523 SOUTH WESTERN HIGHWAY, BYFORD
SUBJECT LAND & TOPOGRAPHY
FIGURE 3



SOURCE: MITCHELL GOFF & ASSOCIATES, 1997

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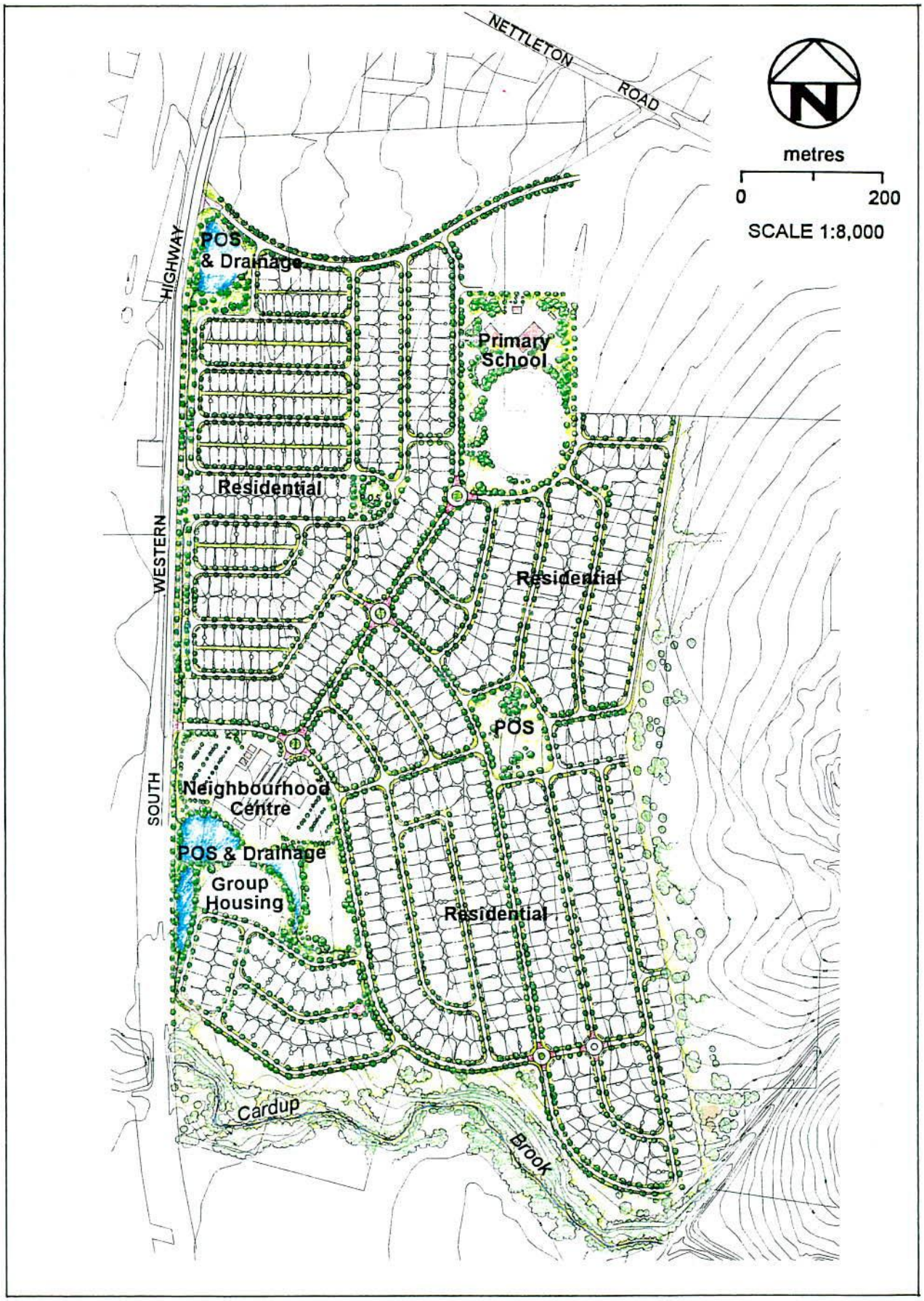
PT LOTS 521 & 523 SOUTH WESTERN HIGHWAY, BYFORD
PROPOSED SCHEME AMENDMENT
FIGURE 4



SOURCE: MITCHELL GOFF & ASSOCIATES, 1997

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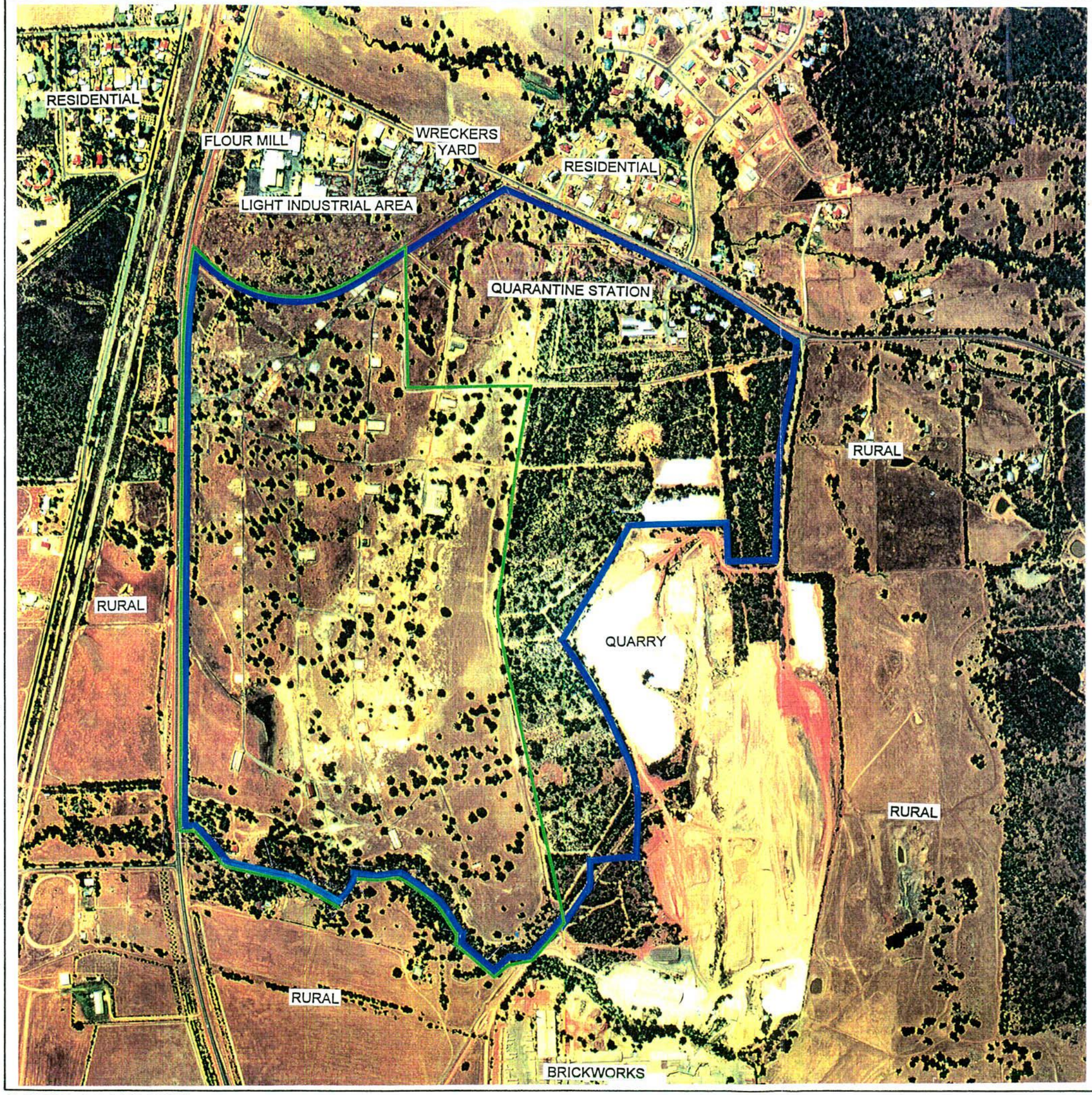
PT LOTS 521 & 523 SOUTH WESTERN HIGHWAY, BYFORD
PROPOSED STRUCTURE PLAN
FIGURE 5



metres

0 200 400

SCALE 1:8,000

LEGEND

Boundary of Subject Land

Boundary of Amendment Area

PT LOTS 521 & 523
SOUTH WESTERN HIGHWAY, BYFORD
SURROUNDING LAND USE
FIGURE 6

DRAWN BY: ST 24/7/97 CHECKED BY: GJM 2/10/97

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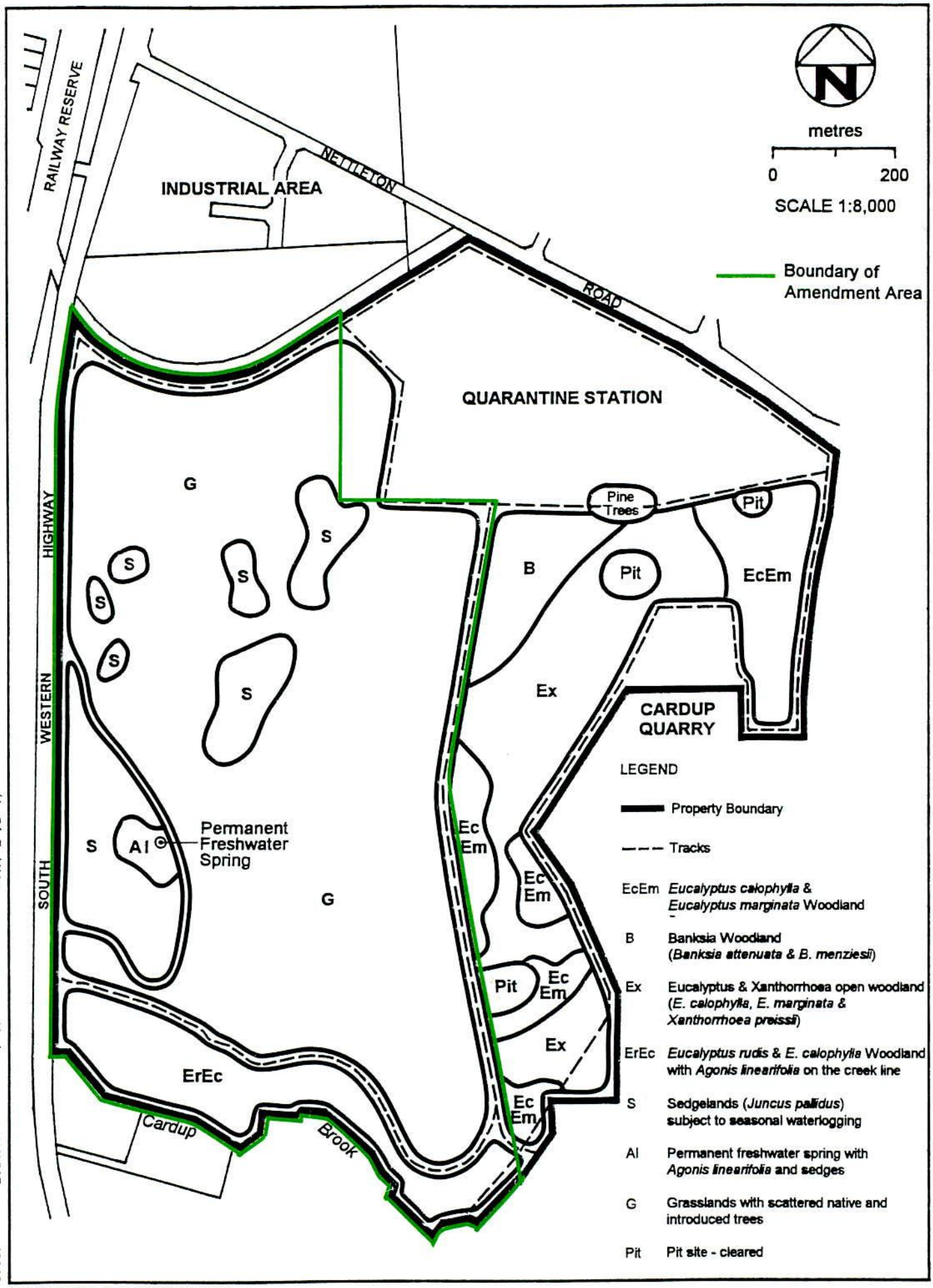

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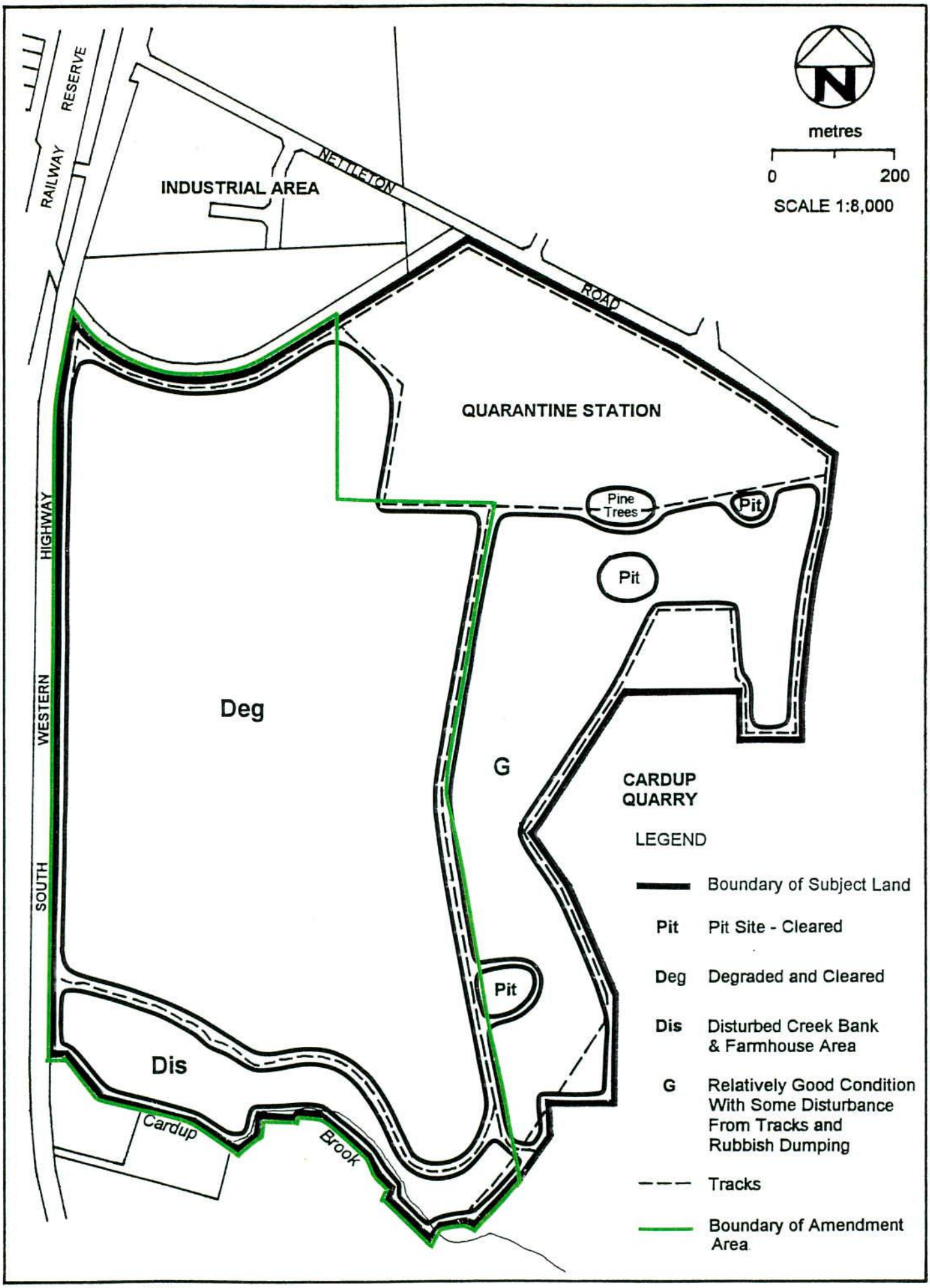
PT LOTS 521 & 523 SOUTH WESTERN HIGHWAY, BYFORD
VEGETATION ASSOCIATIONS
FIGURE 7



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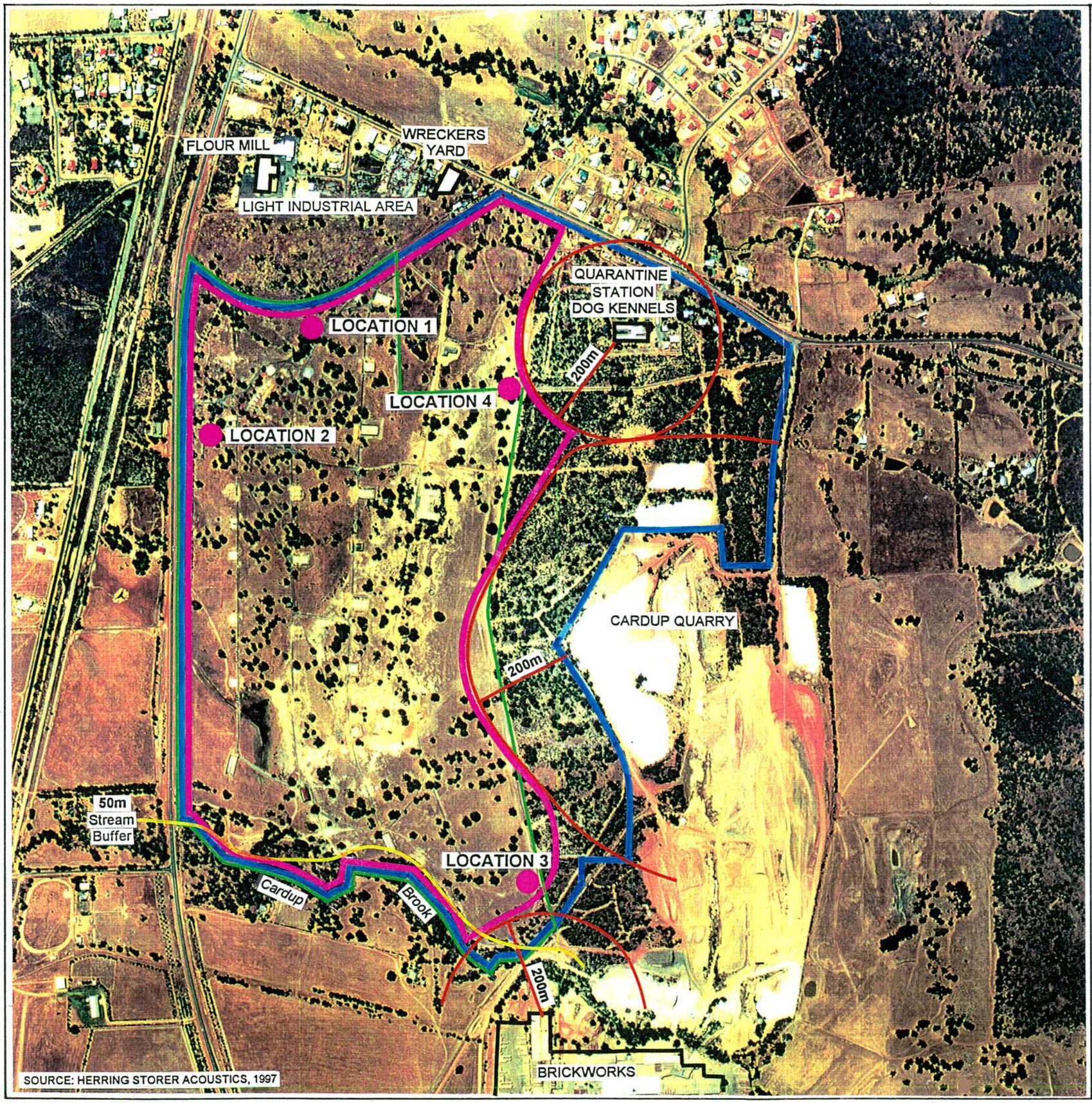
PT LOTS 521 & 523 SOUTH WESTERN HIGHWAY, BYFORD
VEGETATION CONDITION
FIGURE 8



N

metres

0 200 400

SCALE 1:8,000

LEGEND

- Boundary of Subject Land
- Noise Buffer Zones
- Noise Level Monitoring Site
- Noise Limit Boundary
- 50m Cardup Brook Buffer
- Boundary of Amendment Area

PT LOTS 521 & 523
SOUTH WESTERN HIGHWAY, BYFORD
CARDUP BROOK BUFFER
NOISE BUFFERS &
NOISE MONITORING LOCATIONS
FIGURE 9

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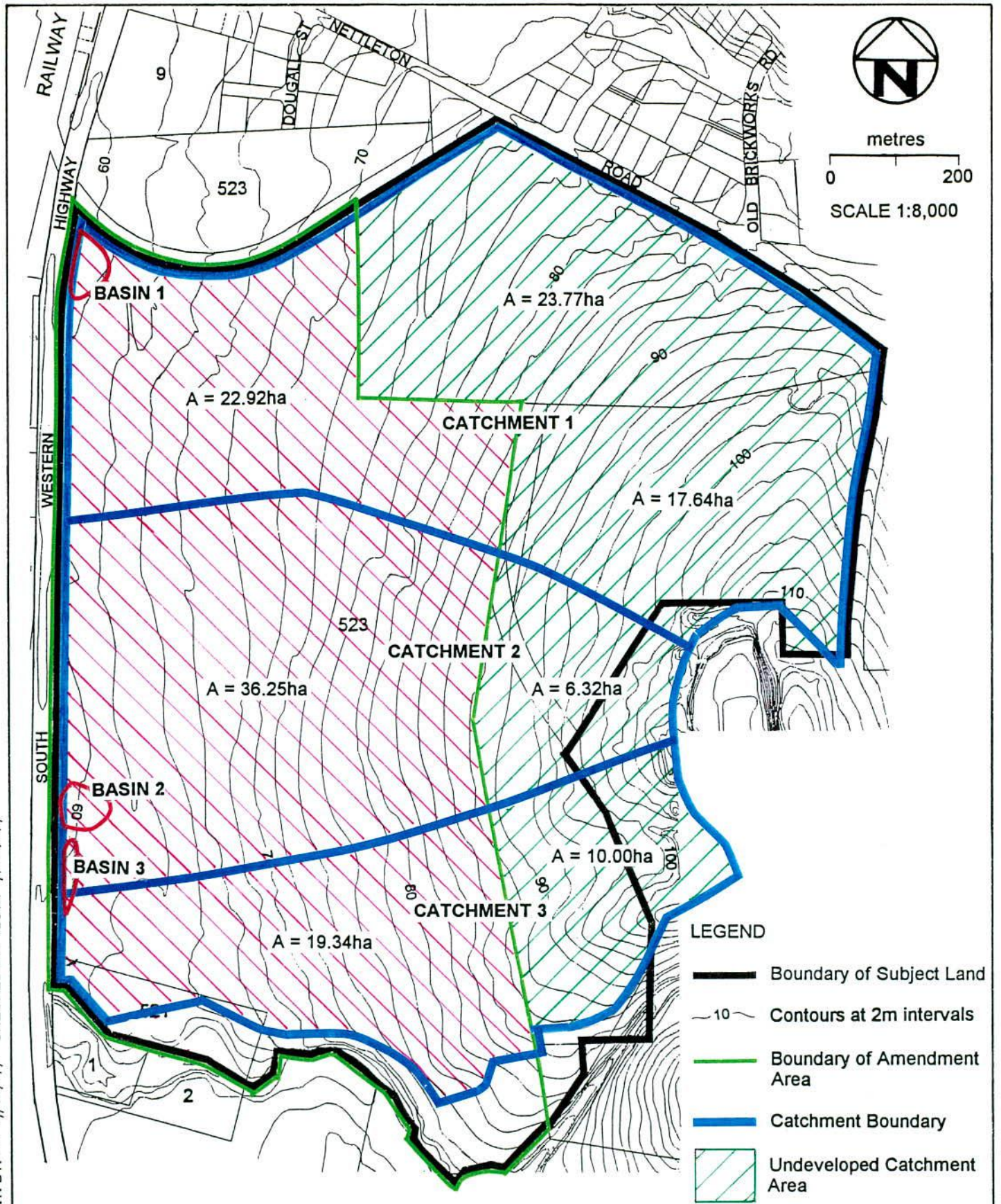

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97057

SOURCE: GILBERT ROSE CONSULTING PTY LTD ,1997

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PT LOTS 521 & 523 SOUTH WESTERN HIGHWAY, BYFORD
CATCHMENT DRAINAGE BOUNDARIES & BASIN LOCATIONS
FIGURE 10

metres

0 SCALE 1:4,000 200

CATCHMENT 1

STORMWATER FLOWS CATCHMENT 1

Existing Rural Flow: (Worst case 1:100 year ARI 6hr storm)	= 1.3m3/s
Developed flow with min basin size: (Worst case 1:100 year ARI 9hr storm)	= 1.44m3/s

STORMWATER QUALITY CATCHMENT 1

	Required	Proposed
Developed Catchment:	22.94ha	
Pollution Control Volume (Reqd 450m2/1ha):	10,325m3	14,500m3
Volume in Retention Basin (40%max):	4,130m3	6,500m3
Volume in Swales (depth<0.5m 30%max):	3,100m3	3,500m3
Volume in Swales (depth>0.5m):	3,095m3	4,500m3

CATCHMENT 2

STORMWATER FLOWS CATCHMENT 2

Existing Rural Flow: (Worst case 1:100 year ARI 6hr storm)	= 1.06m3/s
Developed flow with min basin size: (Worst case 1:100 year ARI 9hr storm)	= 0.97m3/s

STORMWATER QUALITY CATCHMENT 2

	Required	Proposed
Developed Catchment:	36.25ha	
Pollution Control Volume (Reqd 450m2/1ha):	16,315m3	18,040m3
Volume in Retention Basin (40%max):	6,525m3	7,500m3
Volume in Swales (depth<0.5m 30%max):	4,895m3	4,960m3
Volume in Swales (depth>0.5m):	4,895m3	5,580m3

CATCHMENT 3

STORMWATER FLOWS CATCHMENT 3

Existing Rural Flow: (Worst case 1:100 year ARI 6hr storm)	= 0.76m3/s
Developed flow with min basin size: (Worst case 1:100 year ARI 9hr storm)	= 0.64m3/s

STORMWATER QUALITY CATCHMENT 3

	Required	Proposed
Developed Catchment:	19.34ha	
Pollution Control Volume (Reqd 450m2/1ha):	8,705m3	9,385m3
Volume in Retention Basin (40%max):	3,480m3	3,500m3
Volume in Swales (depth<0.5m 30%max):	2,610m3	2,675m3
Volume in Swales (depth>0.5m):	2,610m3	3,210m3

DRAINAGE BASIN 1
DRAINAGE BASIN 2
DRAINAGE BASIN 3
OUTLET
OUTLET
SOUTH WESTERN HIGHWAY
HERITAGE SITE
POS
RESERVE
EXISTING WETLAND
COMMERCIAL
GROUP HOUSING
FORESHORE
VCL

LEGEND

CATCHMENT BOUNDARY

SWALE TYPE 1 — 7.0 / 6.0 / 7.0 — 0.5 / 1.0

SWALE TYPE 2 — 8.0 / 6.0 / 8.0 — 0.5 / 1.0

SWALE TYPE 3 — 2.5 / 2.0 / 2.5 — 0.5 / 1.0

Direction of Flow

PT LOTS 521 & 523 SOUTH WESTERN HIGHWAY, BYFORD
CONCEPTUAL DRAINAGE MANAGEMENT PLAN
FIGURE 11

SOURCE : GILBERT ROSE CONSULTING PTY LTD, AUGUST 1997

97057 DRAWN BY: ST 9/12/97 CHECKED BY: GJM 9/12/97

ALAN TINGAY & ASSOCIATES

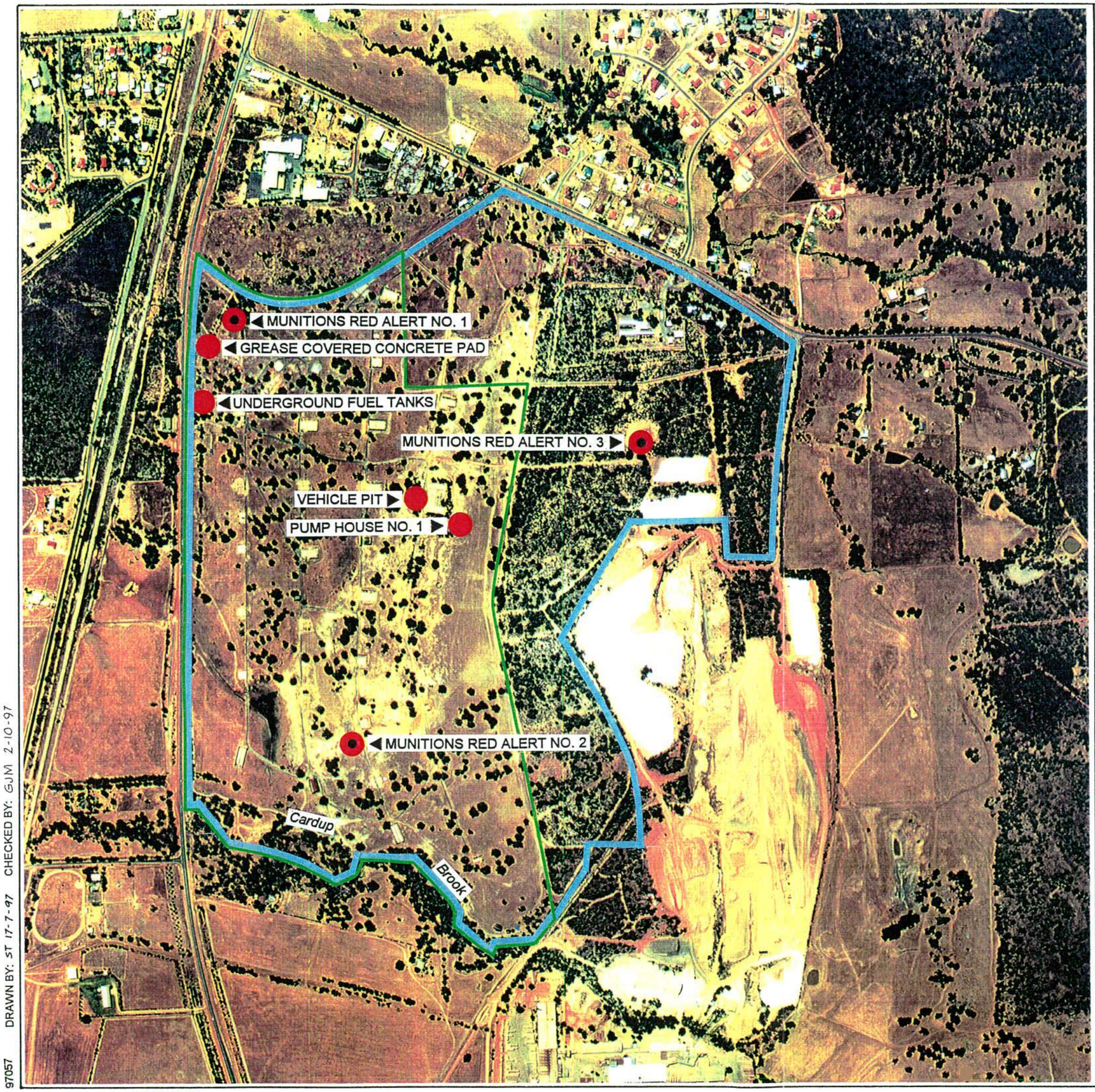
97057 DRAWN BY: DB 27/1/98 CHECKED BY: G.J.M. 27/1/98

ALAN TINGAY & ASSOCIATES

PT LOTS 521 AND 523 SOUTH WESTERN HIGHWAY BYFORD

PHOSPHORUS LEVELS IN DISCHARGE WATER

FIGURE 12



N

metres

0 200 400

SCALE 1:8,000

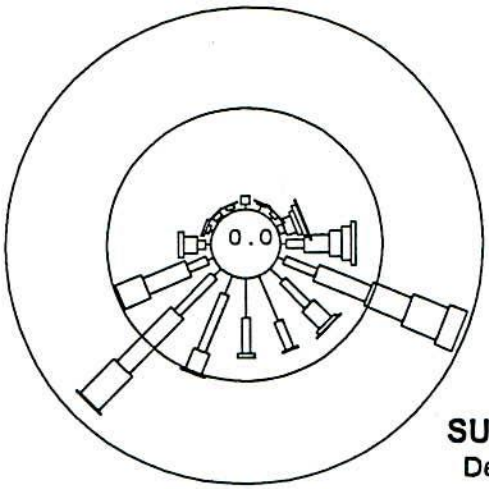
LEGEND

- Boundary of Subject Land
- Points of Potential Soil Contamination
- Munitions Red Alert Areas
- Boundary of Amendment Area

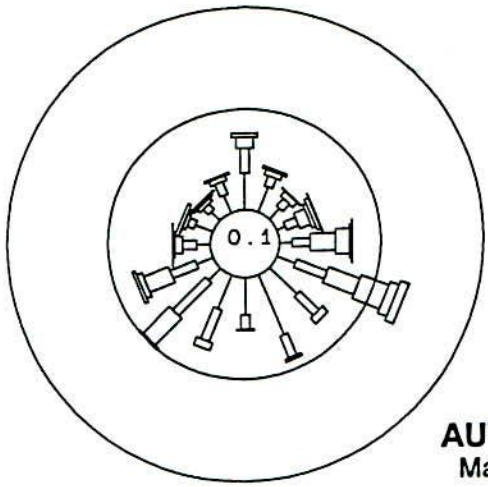
PT LOTS 521 & 523
SOUTH WESTERN HIGHWAY, BYFORD
POTENTIAL SOIL CONTAMINATION
& MUNITIONS RED ALERT AREAS
FIGURE 13

97057 DRAWN BY: ST 17-7-97 CHECKED BY: GJM 2-10-97

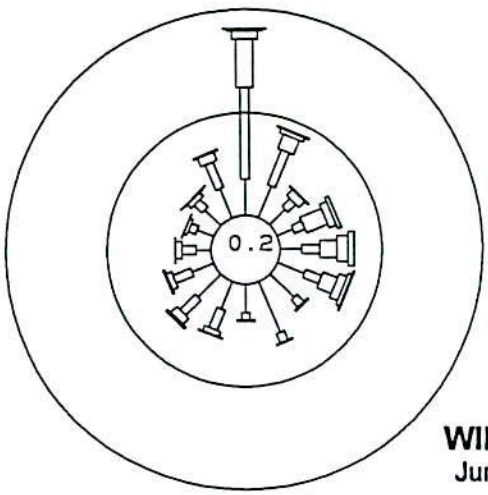
ALAN TINGAY & ASSOCIATES



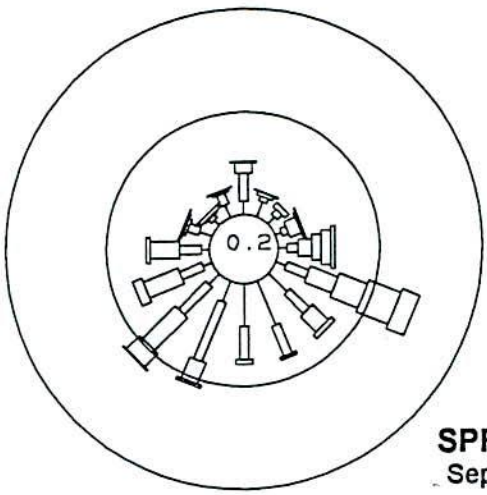
SUMMER
Dec-Feb



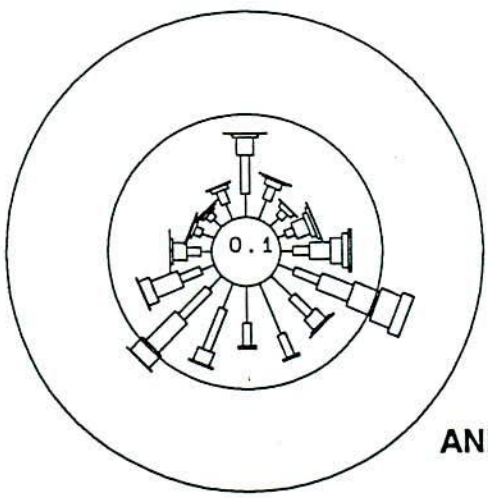
AUTUMN
Mar-May



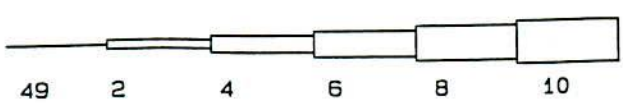
WINTER
Jun-Aug



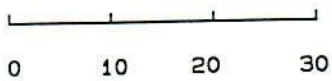
SPRING
Sep-Nov



ANNUAL



WIND SPEED m/s



PERCENTAGE OCCURRENCE

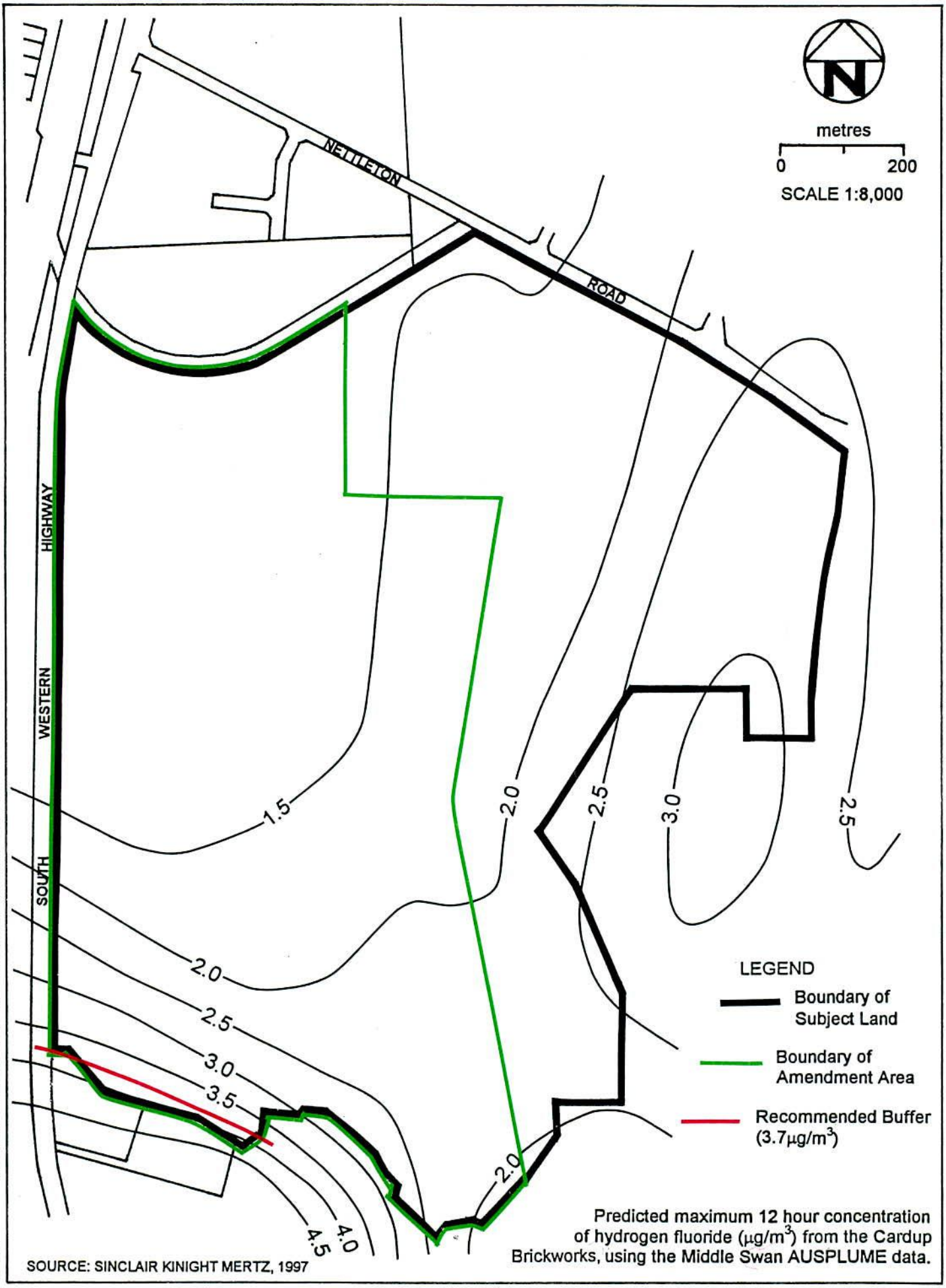
SOURCE: SINCLAIR KNIGHT MERTZ, 1997

DRAWN BY: ST 18/7/97 CHECKED BY: GJM 2-10-97

97057

ALAN TINGAY & ASSOCIATES

PT LOTS 521 & 523 SOUTH WESTERN HIGHWAY, BYFORD
ANNUAL & SEASONAL WIND ROSES
FOR MIDDLE SWAN
FIGURE 14

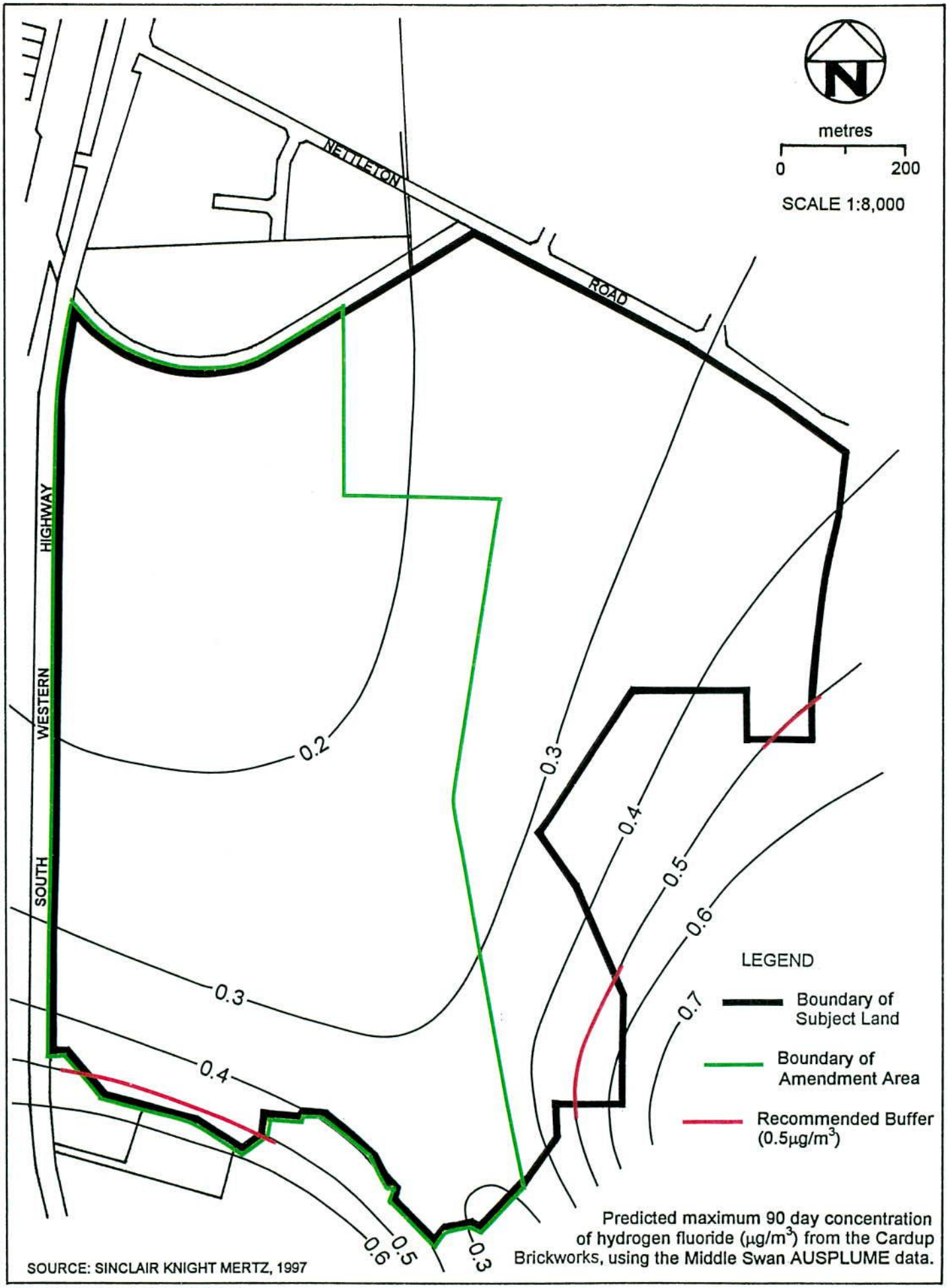


DRAWN BY: GLM 14-8-97 CHECKED BY: GJM 2-10-97

97057

ALAN TINGAY & ASSOCIATES

PT LOTS 521 & 523 SOUTH WESTERN HIGHWAY, BYFORD
PREDICTED 12 HOUR HYDROGEN FLUORIDE CONCENTRATIONS (µg/m³)
FIGURE 15

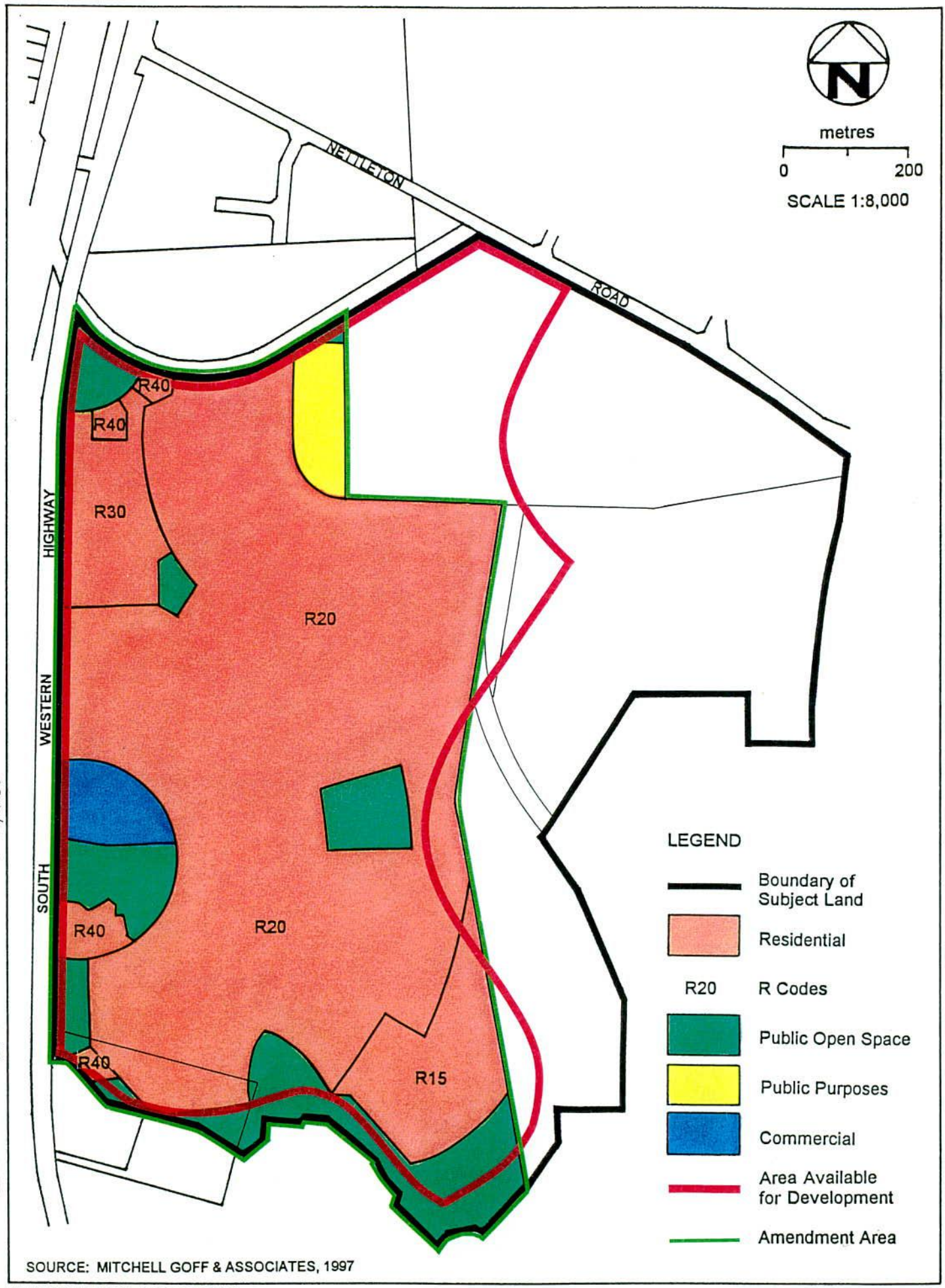


DRAWN BY: GLM 14-8-97 CHECKED BY: GJM 2-10-97

97057

ALAN TINGAY & ASSOCIATES

PT LOTS 521 & 523 SOUTH WESTERN HIGHWAY, BYFORD
PREDICTED 90 DAY HYDROGEN FLUORIDE CONCENTRATIONS (µg/m³)
FIGURE 16



SOURCE: MITCHELL GOFF & ASSOCIATES, 1997

DRAWN BY: ST 24/7/97 CHECKED BY: GJM 27/1/98

97057

ALAN TINGAY & ASSOCIATES

PT LOTS 521 & 523 SOUTH WESTERN HIGHWAY, BYFORD
AMENDMENT AREA AVAILABLE FOR DEVELOPMENT
FIGURE 17

APPENDICES

APPENDIX 1

EPA INSTRUCTIONS

Department of Environmental Protection

Head Office:
Westralia Square
141 St Georges Terrace
Perth, Western Australia 6000
Tel (08) 9222 7000 Fax (08) 9322 1598
http://www.environ.wa.gov.au

Postal Address:
PO Box K822
Perth, Western Australia 6842

Alan Tingay and Associates
21 Howard Street
PERTH WA 6000

Your Ref
Our Ref TP112/3
Enquiries Wes Horwood

Attention: Alan Tingay

Dear Sir

SCHEME/AMD TITLE.: **Town PLanning Scheme 2 Amendment 77. Rezone from "Rural" to "Residential", "Commercial", "Public Open Space Reserve", "Public & Community Purpose Reserve" & "Mixed Use" Zones**

SCHEME/AMD LOCATION: **Pt Lots 521 & 523 South Western Highway**

LOCALITY: **Byford**

RESPONSIBLE AUTHORITY: **Shire of Serpentine-Jarrahdale**

Instructions for the above scheme/amendment were issued to the responsible authority and a copy provided to you on 9 May 1997. As you are aware, a number of appeals were received regarding the content of the instructions and the Minister has now determined those appeals. The appeals that were upheld effect the scope and content of the instructions and consequently, please find attached the revised instructions which have been prepared in accordance with the decisions made by the Minister for the Environment. The revised instructions now also include a list of the environmental objectives relating to each of the relevant environmental factors previously identified.

The Environmental Review should focus on the relevant environmental factors and explain how the scheme/amendment meets the EPA objectives, as one of the key elements of the environmental impact assessment process is determining whether the scheme/amendment meets EPA objectives. In the event that EPA objectives cannot be met, alternative objectives should be proposed and the Environmental Review should discuss why the new objective is more appropriate.

It is expected that the responsible authority will prepare their environmental review in accordance with the attached, final instructions.

Yours sincerely

K J Taylor
DIRECTOR
EVALUATION DIVISION.

22 October 1997

Environmental factors relevant to the scheme

CONTENT			SCOPE OF WORK	
Prelim Env'tal Factors	**Site specific factor**	**Objective**	**Work required for the environmental review**	**Additional comments**
Biophysical				
Vegetation	Areas of vegetation adjacent to and within the proposed area are identified in the draft Perth Bushplan as regionally significant.	Maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities.	Identify the potential impacts direct and indirect of the implementation of the Amendment on the long the term viability of regionally significant vegetation within and adjacent to the proposal. Prepare and incorporate appropriate measures into the Amendment to ensure long term viability of regionally significant vegetation within and adjacent to the proposal.	Regionally significant vegetation includes the Guildford and Forrestfield complexes. Particular reference to fragmentation of vegetation blocks and long term viability. To adequately address the issues a Spring survey of the bushland is likely to be necessary.
Wetlands	Watercourses	Maintain the integrity, functions and environmental values of watercourses.	Incorporate adequate buffers to ensure the long term health and viability of watercourses within and adjacent to the proposed Amendment	Water course adjacent/within the Southern boundary of the proposed Amendment.

CONTENT			SCOPE OF WORK	
Prelim Env'tal Factors	**Site specific factor**	**Objective**	**Work required for the environmental review**	**Additional comments**
Pollution Management				
Surface Water Quality	Part of the Peel Harvey Catchment. Main issues are nutrients and erosion. Subsurface water movement from the ridge downslope onto heavier clay soils results in the seasonal waterlogging.	Maintain or improve the quality of surface water to ensure that existing and potential uses, including ecosystem maintenance are protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993) [and the NHMRC / ARMCANZ Australian Drinking Water Guidelines - National Water Quality Management Strategy].	Investigate potential impacts of the implementation of the Amendment on downstream surface water management. Dispose of stormwater on-site to the extent that a one in ten year storm event of 72 hour duration is detained for three to seven days. The Environmental review should demonstrated that P discharge into the Peel-Harvey Estuary from this development is acceptable. As an interim, the target of less than 0.225 kg P/ha/a should be used. Where the Responsible Authority believes that this target is not appropriate, the Environmental Review should either: propose an alternative target; or propose alternative management techniques including off-site management, so that the 0.225 kg P/ha/a target can be met. In each case the Environmental Review should provide adequate technical information to show what the P export rates for the site will be. Ensure future discharge concentrations and loads of Total Nitrogen are equal to or less than the current levels from the Amendment area.	Part of the Peel Harvey Catchment. Take particular note of nutrient movement from the proposal in surface or ground water with potential to influence nutrient concentrations or loads in downstream or adjacent water courses. Target nutrient loads and concentrations are in line with requirements for the Amerillo development and the Peel Harvey EPP. In the Amerillo situation the flow weighted annual average Total Phosphorous concentration requirement for discharging waters is less than 0.075mg/L. The acceptable phosphorus concentration value may vary slightly for this proposal.

CONTENT			SCOPE OF WORK	
Prelim Env'tal Factors	**Site specific factor**	**Objective**	**Work required for the environmental review**	**Additional comments**
Soil Contaminati on	Evidence of chemicals leaking from unexploded munitions causing local soil contamination. Soil contamination from underground fuel storage tanks. Asbestos fibre contamination	Ensure the rehabilitation of the site to an acceptable standard that is compatible with the intended land use, consistent with appropriate criteria. Contaminated material should be treated on-site or disposed of off-site at an appropriate land fill facility. Where this is not feasible, contaminated material should be managed on-site to prevent <further> groundwater contamination or risk to public health.	Prepare an appropriate investigation of the site to identify the nature and extent of soil contamination. Develop a remediation strategy to be implemented prior to the implementation of the Scheme.	Leaching of soil contaminants by ground water moving through the site. Likely to be high contamination at "Burning grounds" sites.
Gaseous Emissions	Brickworks on Southern boundary	Ensure that gaseous emissions do not adversely affect the environment or health, welfare and amenity of nearby land users by meeting the statutory requirements (including Section 51 of the Environmental Protection Act 1986) and acceptable standards.	Identify elements in the gaseous emissions which are of environmental and social significance. Conduct investigations to identify constraints on development within the Amendment area based on site sampling, process modelling, and recognised environmental criteria, conditions or guidelines for each element.	Main area of concern appears to be the emissions from the Brickworks stack and the elements it contains (eg: F2)
Particulates/ Dust	Shale Pit on Southeastern boundary including the access roads Brickworks on Southern boundary including the access roads Flour mill Wreckers Yard	Ensure that the dust levels generated by the proposal do not adversely impact upon welfare and amenity or cause health problems by meeting statutory requirements and acceptable standards.	Investigate the operations and local environmental features associated with adjacent dust generating activities. Prepare plans showing the area of influence and associated planning constraints based on site sampling, process modelling, and recognised environmental guidelines.	

CONTENT			SCOPE OF WORK	
Prelim Env'tal Factors	**Site specific factor**	**Objective**	**Work required for the environmental review**	**Additional comments**
Noise	Shale Pit on Southeastern boundary including the access roads Brickworks on Southern boundary including the access roads Urban industrial area to Northwest Dog kennels (AQS) adjacent to Northeast corner Sawmill including the access roads Flour mill Wreckers Yard	Protect the amenity of nearby residents from noise impacts resulting from activities associated with the proposal by ensuring that noise levels meet statutory requirements and acceptable standards.	Investigate the impact of activities adjacent to the proposed Amendment to prepare a plan of noise contours across the site identifying planning constraints and impacts on the proposal based on site sampling, process modelling, and recognised environmental guidelines.	
Social Surroundings				
Aboriginal Heritage	Archaeological sites identified within the site.	Ensure that the proposal complies with the requirements of the Aboriginal Heritage Act 1972; and Ensure that changes to the biological and physical environment resulting from the project do not adversely affect cultural associations with the area.	Investigate whether the site is of cultural or historical significance to indigenous people. If it is found to be of significance, identify how this will be addressed in liaison with the relevant aboriginal groups.	
Public health and safety (risk and hazard)	Presence of degraded unexploded munitions on the site.	Ensure that risk is managed to meet the EPA's criteria for individual fatality risk off-site and the DME's requirements in respect of public safety.	Prepare a program to locate and remove all unexploded munitions from the site prior to any other implementation activity occurring.	

APPENDIX 2

SCHEDULE TO SHIRE OF SERPENTINE-JARRAHDALE TOWN PLANNING SCHEME No. 2 AMENDMENT 77

APPENDIX 2

PROPOSED SCHEME PROVISIONS FOR TPS No. 2 AMENDMENT 77

The following provisions will form part of Shire of Serpentine - Jarrahdale TPS Amendment 77:

1. VEGETATION

Any subdivision application will retain remnant native vegetation within and adjacent to the Amendment area, ensuring its long term viability and minimal human impact.

Accordingly, the Western Australian Planning Commission shall not issue an approval to subdivide the subject land until it has received written confirmation from the Department of Environmental Protection that is satisfied the remnant vegetation will be managed appropriately. A development plan will be submitted to the DEP.

Management will include retention of vegetated areas on eastern part of assessment area and along Cardup Brook and retention of a walking trail to reduce disturbances and; clear delineation of vegetated areas through use of dual use paths, roads and the like.

2. WETLANDS

Any subdivision application will incorporate a vegetated buffer around Cardup Brook and implement drainage measures which will ensure flows in Cardup Brook are maintained at predevelopment levels and protect the long term health and viability of the book.

Accordingly, the Western Australian Planning Commission shall not issue an approval to subdivide the subject land until such time it has received written confirmation from the Department of Environmental Protection it is satisfied the long term health and viability of Cardup brook will be protected.

Implementation of protection measures will include:

- Provision of a vegetated buffer, including native trees and shrubs, 50m wide extending from the centre line of the water course to protect the brook ecosystem. This buffer area will incorporate existing wetland vegetation along Cardup Brook and is in accordance with advice from the Waters and Rivers Commission.

- Preparation of a site drainage plan incorporating best practice in Water Sensitive Urban Design which will maximise on site water infiltration, maintain the existing water quality within Cardup Brook by ensuring drainage emanating from the proposed development does not enter the Brook and ensure the pattern of flow from the property remains largely unchanged.

The drainage program will be monitored after development to ensure the pattern of flow is unchanged from predevelopment.

3. SURFACE WATER QUALITY

Any subdivision application will prepare a nutrient and drainage management plan to ensure rate of storm water leaving the site is maintained at no greater than predevelopment levels and provide measures to facilitate the removal of pollutants and nutrients. The strategy will be prepared and lodged prior to issue of subdivision approval.

The nutrient and drainage management plan will incorporate best practice in Water Sensitive Design which will:

- maximise on-site water infiltration,
- ensure the quantity of surface water leaving the site will be largely unchanged, and
- ensure the quality of water leaving the site meets DEP requirements
- provide for contingency plans

Monitor water quality parameters and water quantities until such time as the DEP, Waters and Rivers Commission and Shire of Serpentine-Jarrahdale are satisfied that the objectives of the Nutrient and Drainage Management Plan have been achieved.

Accordingly, the Western Australian Planning Commission shall not issue an approval to subdivide the subject land until it has received written confirmation from the Department of Environmental Protection it is satisfied with the nutrient and drainage management plan.

4. SOIL CONTAMINATION

Any subdivision application will undertake an appropriate investigation on the Amendment area to determine the nature and extent of any soil and groundwater contamination. If contamination is identified then a remediation program, and if necessary management program, will be developed and be implemented prior to the implementation of the scheme.

Accordingly, the Western Australian Planning Commission shall not issue an approval to subdivide the subject land until such time it has received written confirmation from the Department of Environmental Protection is satisfied any contaminants identified on the subject land have been remediated or will be managed in manner that is compatible with the intended landuse and consistent with DEP approved criteria.

5. GASEOUS EMISSIONS

Any subdivision application will undertake a modelling exercise to determine the impact of gaseous emissions emanating from the brickworks located a the southern boundary on the Amendment area. A buffer encompassing the Amendment areas in which gaseous emissions exceed relevant criteria will be incorporated into the subdivision plan.

Accordingly, the Shire of Serpentine - Jarrahdale shall not issue an approval to subdivide the subject land until such time it has received written confirmation from the Department of Environmental Protection it is satisfied modelling of gaseous emissions from the brickworks has been undertaken and if required a buffer incorporated into the development plan to ensure future land users are not affected by those emissions.

6. PARTICULATES/DUST

Any subdivision application will incorporate buffer/s encompassing the Amendment areas where the impacts of particulates/dust exceed the guidelines (as defined by modelling) to ensure the welfare, amenity and health of future land users is not adversely impacted by the development.

Accordingly, the Western Australian Planning Commission shall not issue an approval to subdivide the subject land until such time it has received written confirmation from the Department of Environmental Protection is satisfied buffer/s have been incorporated into the subdivision plan as appropriate.

7. NOISE

Any subdivision application will incorporate buffer/s encompassing the Amendment areas in which noise guidelines are exceeded to protect the amenity of future landusers from noise impacts by ensuring that noise levels meet statutory requirements and acceptable standards.

Accordingly, the Western Australian Planning Commission shall not issue an approval to subdivide the subject land until such time it has received written confirmation from the Department of Environmental Protection it is satisfied buffer/s have been incorporated into the subdivision plan as appropriate.

8. ABORIGINAL HERITAGE

Any subdivision application will incorporate management strategies to comply with the requirements of the Aboriginal Heritage Act, 1972 and ensure that changes to the biological and physical environment resulting from the project do not affect cultural associations with the area.

Accordingly, the Western Australian Planning Commission shall not issue an approval to subdivide the subject land until such time it has received written confirmation from the Aboriginal Affairs Department it is satisfied that management strategies have been implemented as appropriate.

9. PUBLIC HEALTH AND SAFETY (RISK AND HAZARD)

Any subdivision application will conduct an appropriate investigation on the site to determine the presence of any unexploded ordnance (UXO) and/or explosive wastes; and develop and implement a remediation program as necessary. Implementation of the UXO survey and, if necessary, remediation programs will occur prior to the implementation of any other ground disturbing activity occurring within the Amendment area.

Accordingly, the Western Australian Planning Commission shall not issue an approval to subdivide the subject land until such time it has received written confirmation from the West Australian Police Service (UXO Unit) that appropriate unexploded ordnance hazard reduction standards have been achieved; the Department of Environmental Protection that risk is managed to meet the Environmental Protection Authority's criteria for individual fatality risk offsite, and the Department of Minerals and Energy's requirements in respect to public safety are met.

APPENDIX 3

PLANT SPECIES LIST

APPENDIX 3

LIST OF FLORA OCCURRING AT BYFORD REDEVELOPMENT SITE

Flora Survey Conducted on February 9 and 10, 1996 and September 6, 1997
Introduced Trees are not Included
(* Denotes Introduced Weeds)

Acacia lateriticola
Acacia pulchella
Adenanthos meisneri
Adinatum sp. (fern)
Agonis linearifolia
Allocasuarina humilis
Anigozanthos humilis
Anigozanthos manglesii
Arthropodium capillipes
Astroloma ciliatum
Astroloma pallidum
*Avena fatua**
Baeckea camphorosmae
Banksia attenuata
Banksia grandis
Banksia menziesii
Borya sphaerocephala
Bossiaea aquifolium
Bossiaea eriocarpa
Bossiaea ornata
*Briza maxima **
*Briza minor **
Burchardia umbellata
Caesia parviflora
Calectasia cyanea
Calytrix angulata
Chamaescilla corymbosa
Cheilanthes austrotenuifolia
Conostephium pendulum
Conostylis aculeata
Conostylis juncea
Conostylis setigera
Conostylis setosa
Corynotheca micrantha
Cryptandra arbutiflora
Dampiera alata
Dampiera linearis
Dampiera sp.
Daviesia decurrens
Daviesia divaricata
Daviesia preissii
Daviesia sp.
Dianella divaricata
Drosera erythrorhiza
Drosera glanduligera
Drosera menziesii
Drosera pallida
Drosera stolonifera
Dryandra bipinnatifida
Dryandra nivea
Dryandra sessilis
Dsaypogon bromelliifolius
*Eragrostis curvula **
Eremaea pauciflora
Eriostemon spicatus
Eucalyptus calophylla
Eucalyptus marginata
Eucalyptus rudis
Gahnia trifida
Gompholobium marginatum
Gompholobium tomentosum
Grevillea pilulifera
Haemodorum laxum
Hakea lissocarpha
Hakea ruscifolia
Hakea stenocarpa
Hakea trifurcata
Hardenbergia comptoniana
Hemigenia incana
Hemigenia sp.
Hibbertia huegelii
Hibbertia hypericoides
Hibbertia pachyrriza
Hibbertia vaginata
Hovea chroizemifolia
Hovea trisperma
Hyalosperma cotula
Hypocalymma angustifolium
Hypocalymma robustum
Hypolaena exsulca
Isopogon asper
Jacksonia sternbergiana
Juncus articulatus
Juncus caespiticius
Juncus pallidus
Kennedia coccinea

Kennedia prostrata
Kunzea micrantha
Labichea punctata
Lagenifera huegelii
Lechenaultia biloba
Lepidobulus preissianus
Lepidosperma angustatum
Lepidosperma tenue
Lepidosperma tetraquetrum
Leucopogon capitellatus
Lomandra caespitosa
Lomandra odora
Lomandra preissii
Lomandra sp. 1
Lomandra sp. 2
Lovelia alata
Loxocarya fasciculata
Loxocarya flexuosa
Lyginia barbata
Macrozamia riedlei
Meeboldina cana
Melaleuca scabra
Mesomelaena pseudostygia
Mesomelaena tetragona
Nemcia capitatum
Neurachne alopecuroidea
Nuytsia floribunda
Opercularia vaginata
Patersonia occidentalis
Patersonia pygmaea
Patersonia rudis
Pentapeltis peltigera
Petrophile linearis
Petrophile striata
Phyllanthus calycinus
Pimelea argentea
Pimelea ciliata
Pimelea suaveolens
Pronaya fraseri
Ptilotus manglesii
Restio sinosus
Rubus sp. (blackberry) *
Sowerbaea laxiflora
Stachystemon vermicularis
Stirlingia latifolia
Stylidium piliferum
Stypandra glauca
Synaphea petiolaris
Tetraria octandra
Tetratheaca hirsuta
Thomasia foliosa
Thysanotus manglesianus
Thysanotus sparteus
Ursinia anthemoides *
Waitzia sp.
Xanthorrhoea preissii
Xanthosia huegelii
Xylomelum occidentale
Zantedeschia aethiopica *

ORCHIDS:
Burnettia nigricans
Caladenia flava
Cyrtostylis huegelii
Diuris corymbosa
Pterostylis recurva
Pterostylis vittata
Thelymitra sp.
Microtis sp.

APPENDIX 4

GILBERT & ROSE
ENGINEERING REPORT

GILBERT ROSE

CONSULTING PTY LTD A.C.N. 076 000 989

22 Mayfair Street
WEST PERTH WA 6005
Phone: (08) 9322 2955
Fax: (08) 9486 9180
Email: gilbrose@p085.aone.net.au.

Mr Greg Milner
Alan Tingay & Associates
21 Howard Street
PERTH WA 6000

4th December 1997

Dear Greg,

RE: BYFORD ENVIRONMENTAL REVIEW

The following is a calculation of stormwater flows both before development and after urban development in accord with the subdivisional layout prepared by Mitchell Goff & Associates. It sizes the areas needed for the three detention basins. It has been revised from our advice dated 18/9/97 to exclude the Quarantine Station and limit urbanisation up to the re-zoning limit with bushland retained to the east.

	1.	2.	3.
	Basin Catchment	Basin Catchment	Basin Catchment
Area =	64.33	42.57	29.34
Clearing =	50% cleared	50%	50%
Length =	1.2 km	1.2 km	1.26 km
Rainfall =	1000 - 1200 mm	1000 - 1200 mm	1000 - 1200 mm
Slope Runoff =	40 m/km	44 m/km	44 m/km
Q50 =	0.854 m 3/s	0.661 m 3/s	0.52 m 3/s

These flows were then adopted to calibrate the RAFTS-XP rural flow conditions.

The model when calibrated gave the following output:-

	Basin 1.	Basin 2.	Basin 3.
Q50 flow	0.85 m 3/s	0.68 m 3/s	0.53 m 3/s
Peak after	125 mins	125 mins	125 mins
Storm length	6 hrs	6 hrs	6 hrs

Once the 50 year model was calibrated the 100 year rural condition analysis was carried out. Results showed expected flows of:-

Q100	1.3 m 3/s	1.06 m 3/s	0.76 m 3/s
Peak after	135 mins	135 mins	135 mins
Storm length	6 hrs	6 hrs	6 hrs

The above values were adopted as the maximum basin outflow during a 100 year ARI storm event of any duration.

DEVELOPED FLOWS

The model was then adjusted to represent developed conditions:-

The peak flows achieved were:-

	Basin 1	Basin 2	Basin 3
Developed Area	22.92 ha	36.25 ha	19.34 ha
Q100 in	2.73 m 3/s	3.42 m 3/s	1.98 m 3/s
Peak after	90 mins	85 mins	90 mins
Storm duration	9 hrs	9 hrs	9 hrs

DEVELOPED WITH BASINS

Basins were provided at locations shown on catchment plan, generally of the following criteria:-

	Basin 1	Basin 2	Basin 3
Base RL	58	58	58
Spillway RL	60	60	60
Batters	6:1	6:1	6:1
Base Area	2500 m 2	1600 m 2	625 m 2
Top Batter	5476 m 2	4096 m 2	2600 m 2
100yr outlet	900 RCP	725 RCP	600 RCP

RESULTS

Max Inflow	2.73 m 3/s	3.42 m 3/s	1.97 m 3/s
Max Outflow	0.93 m 3/s	0.93 m 3/s	0.67 m 3/s
Storage	3147 m 3	3637 m 3	1995 m 3
Top Water Level	58.90	59.37	59.40

SUMMARY OF FLOWS

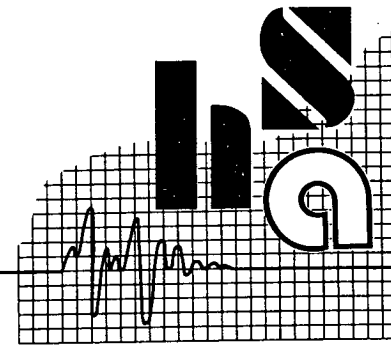
1:100 year	Basin 1	Basin 2	Basin 3
Pre development flow	1.3 m 3/s	1.06 m 3/s	0.76 m 3/s
Developed flows	2.73 m 3/s	3.42 m 3/s	1.98 m 3/s
Developed with Basin	1.44 m 3/s	0.97 m 3/s	0.64 m 3/s

The proposed detention system will effectively reduce post development flow conditions to pre-development for the worst condition. A series of outlets will accommodate lower flows.

APPENDIX 5

HERRING STORER ACOUSTICS
NOISE ASSESSMENT REPORT

Rochdale Holdings Pty Ltd A.C.N. 009 049 067 trading as:
HERRING STORER ACOUSTICS
P.O. Box 219
Suite 34, 11 Preston Street
Como, W.A. 6152
Telephone: (09) 367 6200
Facsimile: (09) 474 2579
Email: hsa@icenet.com.au



ALLAN HERRING M.I.E. AUST. M.A.A.S.
LYNTON STORER M.A.I.E.A., M.A.A.S.

ENVIRONMENTAL NOISE ASSESSMENT

R.A.N.A.D SITE

BYFORD

JUNE 1996

Our Ref: 4377-2-96083

CONTENTS

APPENDIX

1.0 INTRODUCTION

This report sets out the results and findings of a study of the acoustic environment of the former Royal Australian Navy Ammunition Depot (RANAD) located on the South West Highway Byford.

The purpose of this study is to assess the suitability of the site for residential use based on the acceptable criteria as set out in the Environmental Protection Act 1986 Regulations and other generally accepted criteria.

2.0 METHOD

Noise data loggers were established at four locations around the site in order to assess the noise contribution from surrounding industry and road traffic.

The four locations chosen are shown on the attached sketch and described as follows:

Location 1	North	Nearest source - Defiance Flour Mill
Location 2	West	Nearest source - South Western Hwy
Location 3	South East	Nearest source - quarry and brick works
Location 4	North East	Nearest source- Quarantine Road

Observations were made during the monitoring period to help establish contributing sources.

3.0 CRITERIA

The main criteria, for assessment purposes, is taken from the Environmental Protection Act 1986 Regulations specifically Table 1, extracted for the Noise Abatement (Neighbourhood Noise) Regulations 1979. These criteria would apply to all areas except those influenced by road traffic noise.

As the north, east and southern areas are primarily bounded by industrial or commercial sites, locations within 200 metres would fall under Category B2 of Table 1 of the Regulations. This category assigns the following levels.

Monday to Friday	*0700 - 1900 hours*	*55 dB(A)*
Monday to Friday	*1900 - 2200 hours*	*50 dB(A)*
Weekends & Public Holidays	*0700 - 2200 hours*	*50 dB(A)*
Always	*2200 - 0700 hours*	*45 dB(A)*

The Department of Environmental Protection does not set down criteria for road noise impact. Guidance can be taken from Main Roads policy which considers the percentile levels L_{10} over an 18 hour period from 0600 to 2400 hours.

Where new roads are proposed through relatively quiet areas, the L_{10} value of 63 dB(A) is sought. Where the road is existing, then 68 dB(A) is considered as a desirable maximum limit. In the study area, as residents would be moving into an existing and apparent traffic noise environment then an L_{10} 18 hours value of 68 dB(A) would be an appropriate maximum.

4.0 RESULTS

The results of the monitoring at four locations are shown in graphical form attached. The graphs show the recorded levels at hourly intervals as percentile values L_0, L_{10} and L_{100}. Percentile levels are the levels in dB(A) that are exceeded for the percentage of time nominated. That is the L_{10} value is the level of noise exceeded for 10% of the time. Similarly, the L_0 value is the level of noise exceeded for 0% of the time or in other words, the maximum level. Similarly, the L_{100} level is the minimum level.

The L_{10} values are considered to the best parameter for assessing intrusive noise.

5.0 DISCUSSION

NORTHERN SITES

This area has significant influence from traffic noise accosiated with the South Western Highway. Other major influences are from the Defiance Flour Milling operations directly to the north at approximately 250m. There is a steady tonal noise from the flour mill, probably due to a dust collector fan. This noise was measured at 47 dB(A) and Defiance will need to consider reduction of this source as it will not comply with the Regulations to existing residential locations.

The print-out of monitored data shows relatively consistent data throughout for the L_{10} values. The minimum level can be seen to reduce over 26 and 27 May, which was a public holiday and a Saturday. The typical day time levels range from 46 to 55 dB(A) (L_{10}) and night time around 43 dB(A). The exception being the 24 to 25 May which was subject to wind noise. The L_{10} 18 hour values ranged from 44 to 51 dB(A). In terms of the criteria previously set out, the area falls within the assigned levels and is therefore deemed to be acceptable for residential use under Category B2.

It should be noted that the timber mill appeared to be non-operational. As other industry in this area could develop, it is recommended that a distance of 250 metres be maintained, as a buffer, to allow for the additive increase in level.

WESTERN SITES

This area is dominated by traffic noise from South Western Highway. The typical day night pattern of the L_{10} values can be seen on the monitored data graph.

The monitor location was 50 metres from the road edge and the L_{10} 18 hour values ranged from 61 to 64 dB(A) . In terms of the stated acceptable criteria of 68 dB(A) (L_{10} 18 hour) residences could be located as close as 20m from the road. However, it is recommended that the 63 dB(A) criteria be considered for existing conditions which would limit residences to the 50m distance. Alternatively, a wall constructed along the verge would allow distances of 20m. Basing selection on the existing 63 dB(A) criteria will allow for future increases in level due to natural flow rate increases.

SOUTH EAST SITES

There is some influence on this area from noise associated with the brick works and quarry operations.

Specific levels recorded included quarry loader operations at 52 to 61 dB(A), brickworks noises (brick rumble) at 54 dB(A) and truck movement at up to 58 dB(A). Most of this activity seems to be in the early morning. The graphed monitored data shows the levels to be very consistent with minimum values from 39 to 43 dB(A). The L_{10} values ranged from 43 to 52 dB(A) with one exception where it reached 56 dB(A). These levels are consistent with the B2 category as being acceptable for residential use. It is therefore recommended that distances to proposed residences be maintained at 200m from the northern boundary of the brickworks and operational areas of the quarry.

NORTH EAST SITES

This area has some influence from dog barking noise associated with the Quarantine Station but is mainly influenced by traffic noise. The flour mill operations are also detectable.

Typical measured levels include:

Traffic	45 dB(A)
Dogs	42 to 49 dB(A) (Short term L_{10} was 44 dB(A))
Flour mill	38 to 42 dB(A)
Wind noise	40 dB(A)

From the measured data, the day time L_{10} values ranged for 42 to 47 dB(A) and the night time 35 to 41 dB(A).

This area is therefore acceptable for use as residential under Category B2 of the Regulations. It is recommended that residences be located a minimum of 200 metres from the Quarantine Station dog kennels.

6.0 SUMMARY AND RECOMMENDATIONS

It is considered that all areas of the proposed Ranad site are acceptable for residential use with the following 'buffer zones' being recommended between certain areas.

LOCATION	BUFFER DISTANCE
North west industrial area	250m
North east Quarantine Station	200m
Eastern quarries	200m
Southern brick works	200m
Western - South Western Hwy	50m or 20m with wall

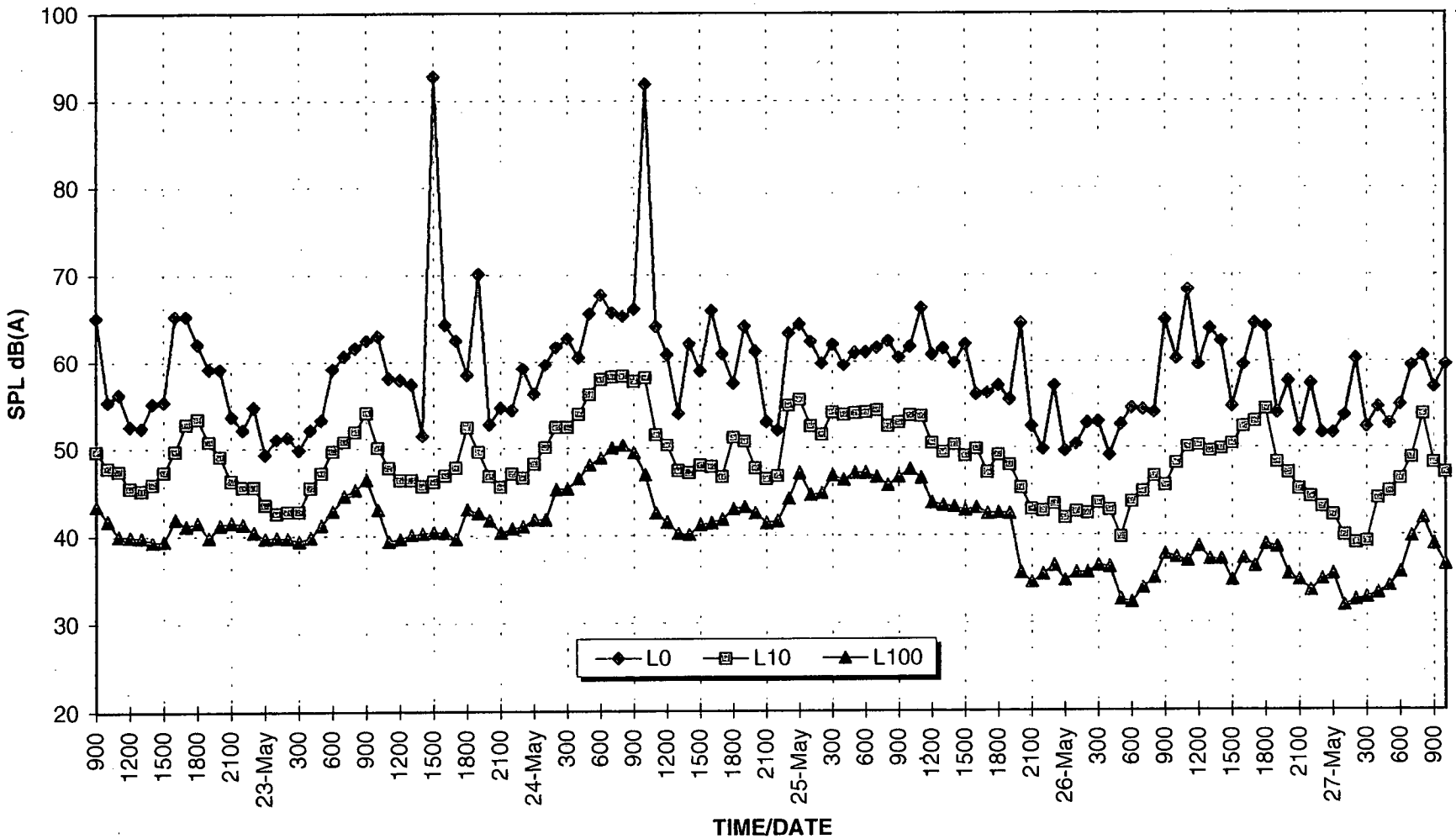
Refer attached sketches for boundaries.

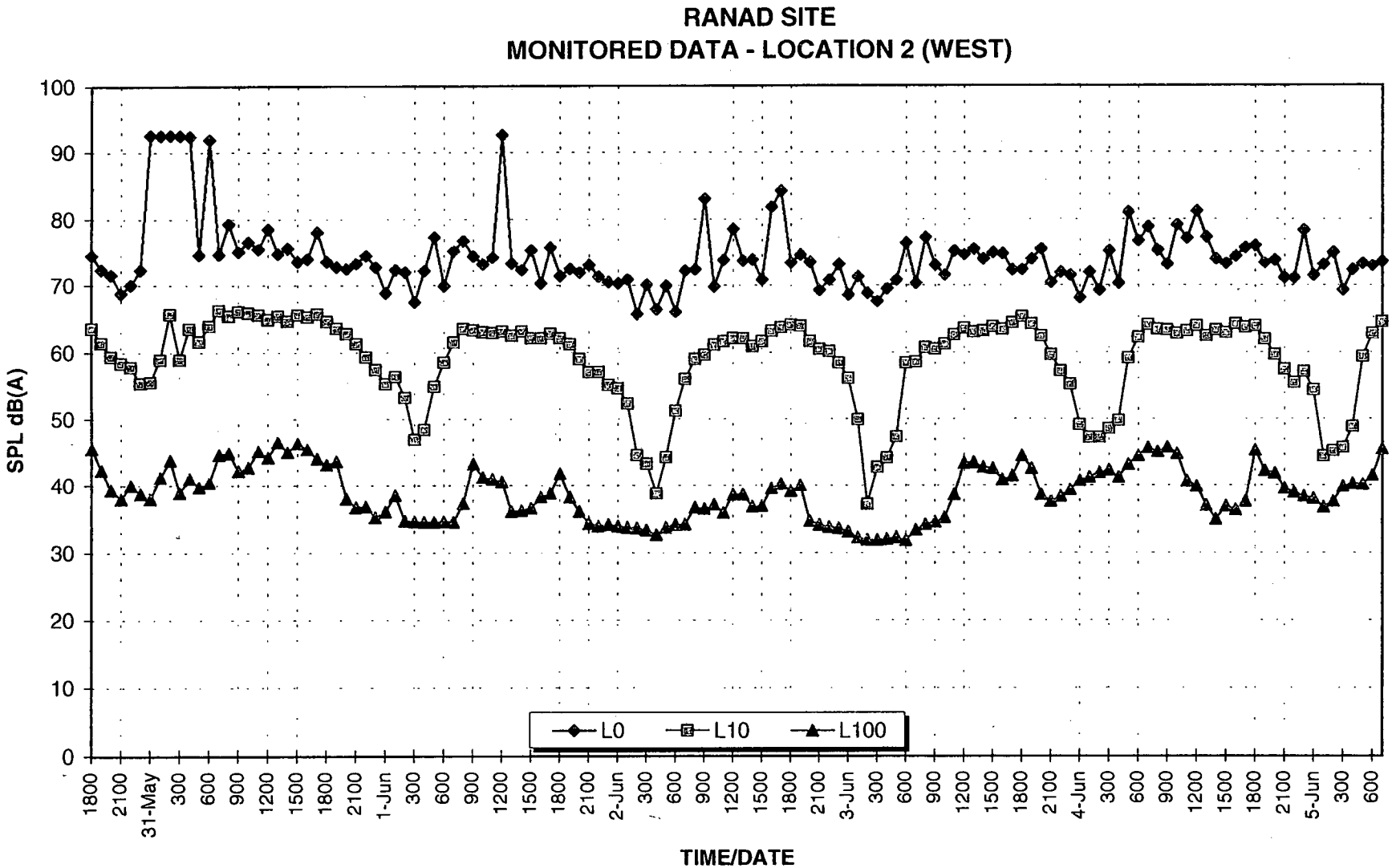
for HERRING STORER ACOUSTICS

LYNTON STORER

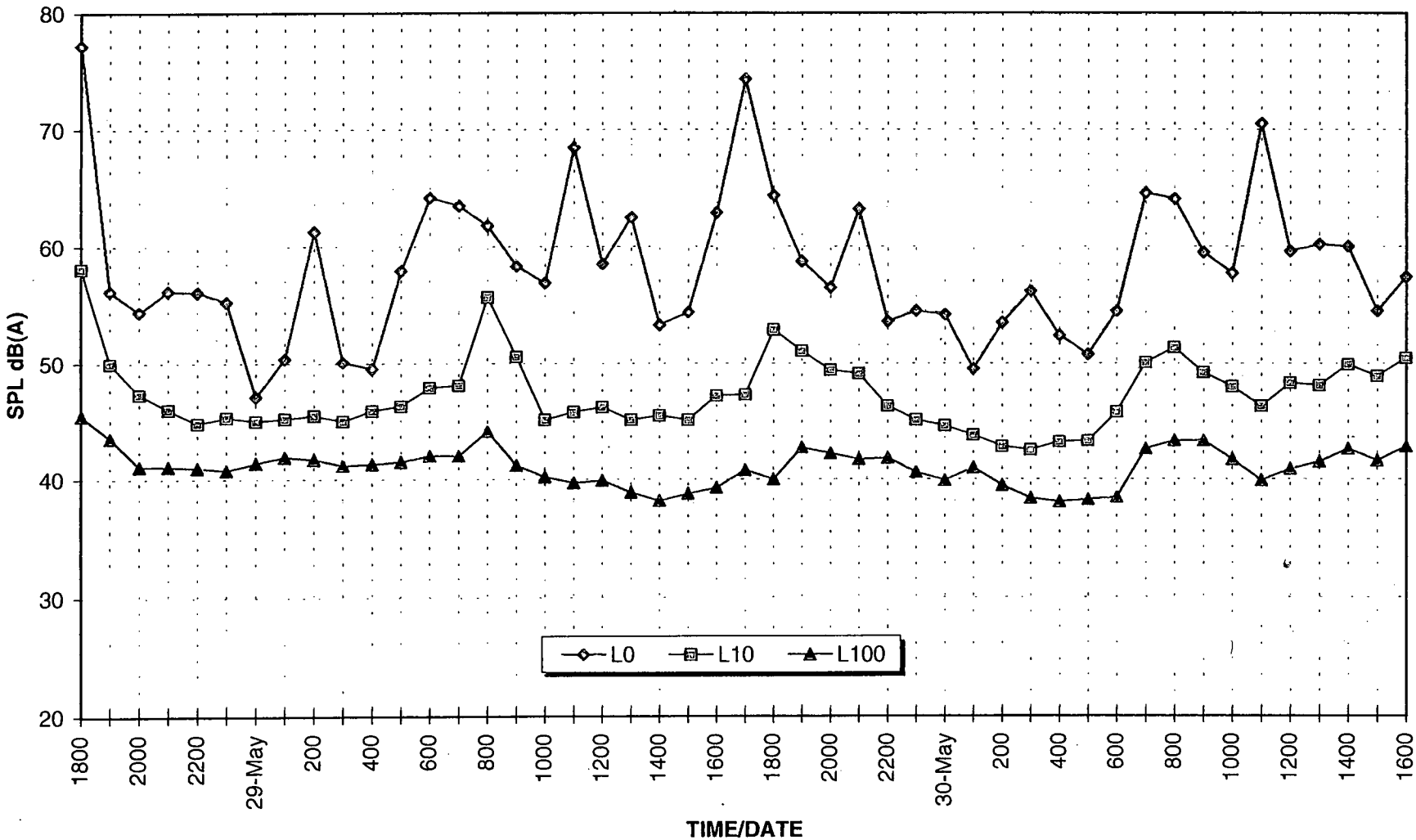
APPENDIX 1

RANAD SITE
MONITORED DATA - LOCATION 1 (NORTH)

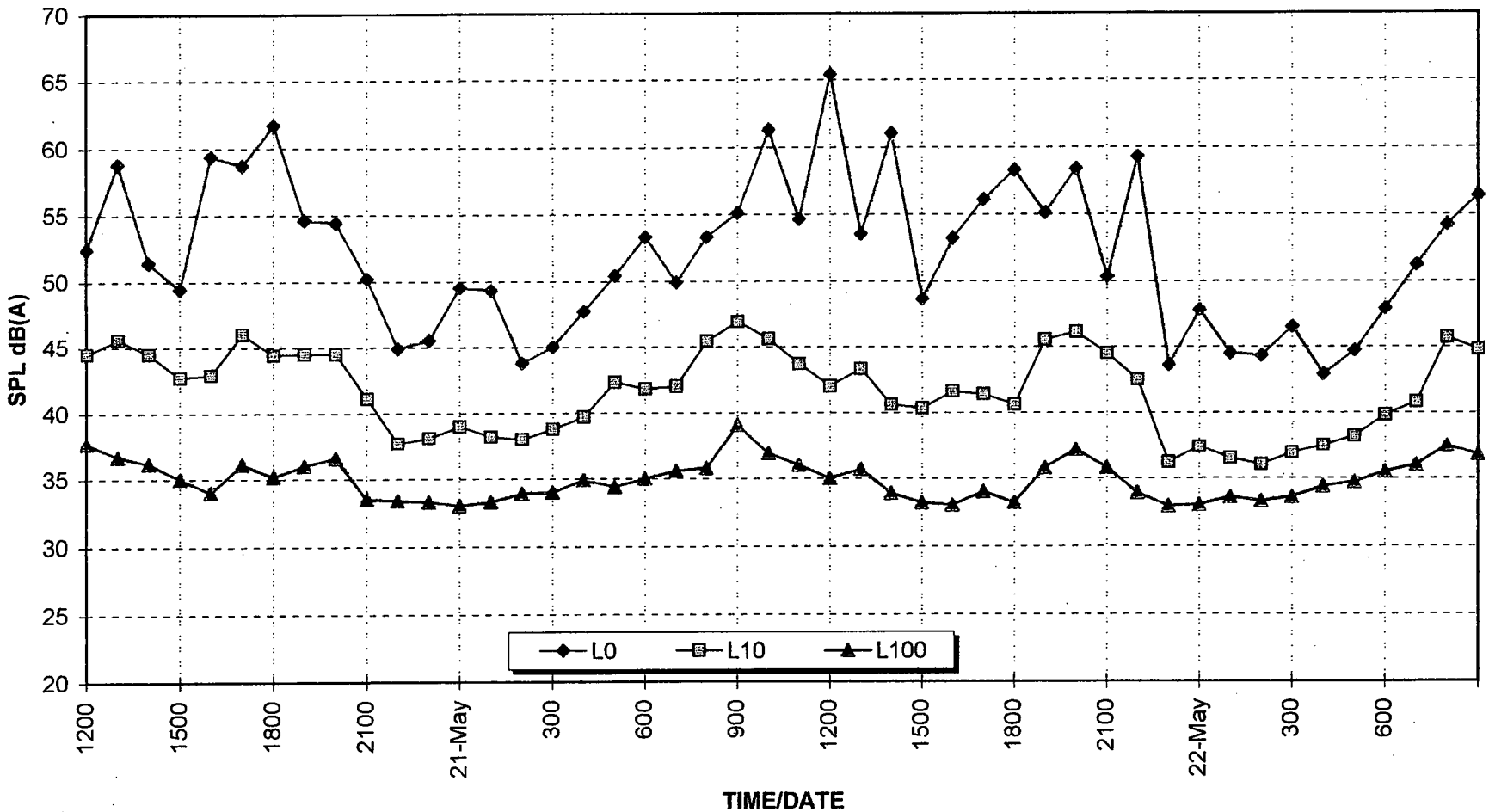



RANAD SITE
MONITORED DATA - LOCATION 2 (WEST)
SPL dB(A)
100
90
80
70
60
50
40
30
20
10
0
L0
L10
L100
1800
2100
31-May
300
600
900
1200
1500
1800
2100
1-Jun
300
600
900
1200
1500
1800
2100
2-Jun
300
600
900
1200
1500
1800
2100
3-Jun
300
600
900
1200
1500
1800
2100
4-Jun
300
600
900
1200
1500
1800
2100
5-Jun
300
600
TIME/DATE

RANAD SITE
MONITORED DATA - LOCATION 3 (SOUTH EAST)



RANAD SITE
MONITORED DATA - LOCATION 4 (NORTH EAST)



APPENDIX 2

location 4
location 3
location 2
location 1