Consultative Environmental Review

CONSULTATIVE ENVIRONMENTAL REVIEW
GLENHAVEN ESTATE
LOT 48 AND PART LOT 35 BRIXTON STREET, KENWICK
CITY OF GOSNELLS

St. Joseph's Properties Pty Ltd

Dudley and Dwyer Ltd

Hames Sharley Australia

December, 1991
9021

Comment News 7.1.92

St. Joseph's Properties Pty Ltd
and
Dudley and Dwyer Ltd

Glenhaven: Proposed Residential Estate Brixton Street, Kenwick

Consultative Environmental Review (CER)

Public Comments invited

St. Joseph's Properties Pty Ltd and Dudley and Dwyer Ltd propose to develop 238 single residential lots and 135 units, on Lot 48 and Part Lot 35 Brixton Street, Kenwick in the City of Gosnells.

In accordance with the requirements of the Environmental Protection act 1986, a Consultative Environmental Review has been prepared by Hames Sharley Australia to examine the potential environmental effects associated with the proposed residential development. The CER describes the proposal, examines the potential environmental impacts and proposed environmental management procedures.

Copies of the CER will be available between 7 January, 1992 and 4 February, 1992 at:

ENVIRONMENTAL PROTECTION AUTHORITY
1 Mount Street, Perth WA 6000

THE BATTYE LIBRARY
Alexander Library Building
Perth Cultural Centre

CITY of GOSNELLS
2120 Albany Highway, Gosnells, and its Public Libraries:

GOSNELLS
2240 Albany Highway

THORNLIE
Connemara Drive

LANGFORD
Brookman Road

BECKENHAM
Streatham Street

The document will be available for public comment for a four week period from 7 January, 1992 to 4 February, 1992.

Interested persons and organisations are invited to make a written submission by 4 February, 1992 to:

ENVIRONMENTAL PROTECTION AUTHORITY
1 Mount Street,
PERTH WA 6000

EPA Project Officer: Barry Cugley
Telephone: (09) 222 7080

CONSULTATIVE ENVIRONMENTAL REVIEW

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

The Consultative Environment Review (CER) for the proposed Urban Development and Wetland Conservation on Lot 48 and Part Lot 35 Brixton Street, Kenwick has been prepared in accordance with Western Australian Government procedures. The report will be available for comment for 4 weeks beginning Tuesday 7 January, 1992.

Comments from government agencies and from the public will assist the EPA to prepare an Assessment Report in which it will make recommendations to Government.

Following receipt of comments from Government agencies and the public, the EPA will discuss the issues raised with the proponent and may ask for further information. The EPA will then prepare its assessment report with recommendations to Government, taking into account issues raised in the public submissions.

The proposal deals with an intention by St. Joseph's Properties Pty Ltd and Dudley & Dwyer Ltd to develop mixed density housing on land in proximity to existing urban employment centres, facilities and services.

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 will be acknowledged.

DEVELOPING A SUBMISSION

You may agree or disagree, or comment on, the general issues discussed in the CER or with 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 proposals in the CER:

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

POINTS TO KEEP IN MIND

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

Attempt to list points so that the issues raised are clear. A summary of your submission is helpful. Refer each point to the appropriate section, chapter or recommendation in the CER. If you discuss sections of the CER, keep them distinct and separate, so there is no confusion as to which section you are considering.

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

Please indicate whether your submission can be quoted in part or full, by the EPA in its Assessment Report.

REMEMBER TO INCLUDE:

YOUR NAME/ADDRESS/DATE

THE CLOSING DATE FOR SUBMISSIONS IS:

4 February, 1992.

SUBMISSIONS SHOULD BE ADDRESSED TO:

The Chairman
Environmental Protection Authority
1 Mount Street
PERTH WA 6000

Attention: Mr Barry Cugley

PREFACE

This document has been produced further to a direction of the Environmental Protection Authority (EPA) for an environmental assessment of proposed residential development on Part Lot 35 and Lot 48 Brixton Street, Kenwick, pursuant to Section 38 of the Environmental Protection Act, 1986.

The assessment is in response to the concern regarding the potential environmental impact of the proposed development on the existing biological environment.

It is believed that this concern is consequential to the recent decision by the EPA to recommend against the development of Lots 37 and 47 Brixton Street (Homeswest) directly opposite the subject site.

The recommendations of that decision (Bulletin 577, September, 1991) were:

- ***Recommendation 1***

The Environmental Protection Authority has concluded that the proposed urban development on Lots 37 and 47 Brixton Street Kenwick is environmentally unacceptable and should not proceed.

In reaching this conclusion, the Environmental Protection Authority identified the main environmental factors requiring detailed consideration as:

- *the significance and scarcity of the ecosystem types; and,*
- *the floral diversity on the site.*

Given the site's high ecological value, the Environmental Protection Authority believes that it should be preserved in its entirety and protected from future development proposals, and thus the following recommendation is made:

- ***Recommendation 2***

The Environmental Protection Authority recommends that the Department of Conservation and land Management and the National Parks and Nature Conservation Authority investigate the merits of acquiring the land for reservation as part of the conservation estate.

Whilst making these recommendations, it should be recognised that the Authority is <u>not</u> setting a precedent in terms of development on non-System 6 areas around the Brixton Street site, and any other proposals will be judged on their merits.

EXECUTIVE SUMMARY

The proposed residential development of Lot 48 and Part Lot 35 Brixton Street Kenwick, has been referred to the EPA, by the City of Gosnells, and the EPA has determined the need for assessment as a Consultative Environmental Review, consequent to the EPA recommendation against development of the Homeswest site opposite.

The subject site is a classic example of an urban land use conflict resulting in a dichotomy of opposing land use scenarios.

Development Scenario

- *On the one hand the land has strategic urban value.*
- *The site has been classified under the Metropolitan Region Scheme as Urban Zone for 23 years.*
- *It offers an opportunity for a range in affordable housing types relatively close (14 kilometres) to the CBD (compared to urban land alternatives in the North West Corridor (Joondalup 25 kilometres) and South East Corridor) and in reach of comprehensive commercial, industrial, cultural and recreational land uses and transport facilities.*
- *The consequence of the development option is full impact on the biological environment. The hydrological regime of the surrounding areas would remain unaffected.*

Conservation Scenario

- *On the other hand the subject land has some inherent environmental value.*
- *It has similarities to the adjacent Yule Brook Botany Reserve (University of Western Australia) and the Homeswest site (proposed for vesting in the National Parks and Nature Conservation Authority) in that it is floristically diverse and occupies an intermediate position in the continuum of vegetation types.*
- *The topographic gradient of the site offers a unique set of niches for plant growth different to the adjacent conservation sites.*
- *The presence of 2 Priority List species increases the value of the site floristically.*
- *It represents a significant patch of remnant bushland (albiet degraded) providing resources for a wide range of fauna species.*
- *Although the Bandicoot's distribution encompasses larger areas of the State, the site may provide a movement corridor for the Gazetted rare species.*
- *Conservation of the site is considered desirable by biologists, mainly because it helps maintain the integrity of the adjacent conservation sites and, to a lesser extent, its value as a representative wetland habitat.*
- *Acceptance of the conservation alternative requires consideration of land acquisition or land exchange solutions.*
- *There is the inherent implication that the adjacent Lot 106 Wanaping Road also warrants reservation to assist in protecting the subject site and the importance of the vegetation continuum.*

- *The earth embankment for the proposed Brixton Street flyover would sever the continuum of the conservation areas.*

- *The proposed flyover would obliterate with its earthwork footprint, a measurable part of the Gazetted rare flora habitat for which the Homeswest site was preserved.*

- *The implied consequences of accepting the principle of maintaining the vegetation continuum is that there shall be no development of Lot 48, Part Lot 35, Lot 106 and the Brixton Street flyover. The latter implies that eventually Brixton Street should be closed when the Roe Freeway is built and an alternative route found for the projected 10,000 vehicles per day volume.*

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1. INTRODUCTION

1.1 Location and Ownership

The subject land is located one kilometre north of Albany Highway, in the vicinity of the Kenwick passenger rail station, and 14 kilometres from Perth Central Business District (refer Figure 1.1). This compares to alternatives, for example in the North West Corridor at Joondalup, 25 kilometres from the CBD.

Lot 48 comprises 14.5383 Ha and is described in Certificate of Title Volume 1342 Folio 067 as being owned by St. Joseph's Properties Pty Ltd.

Part Lot 35 comprises 15.7550 Ha and is described in Certificate of Title Volume 471 Folio 56A as being owned by Dudley & Dwyer Ltd.

1.2 Land Use

The tracks are used by local horse owners for exercise, and in summer may also be used by trailbike riders. Large parts of the eastern third of the site along Wanaping Road (including Lot 106) are badly invaded by exotic species. These areas may have been partially cleared or have been grazed in the past. Dumping of garden refuse continues to introduce weedy plants to the area. As is the case with most remnants in the metropolitan area, the site has been frequently burnt. Part of the central-northern quarter was burnt earlier in 1991.

Surrounding land use includes rural subdivisions on the east and north, a recreation complex west of the railway line, and residential development to the south. To the north-east is the Yule Brook Botany Reserve which belongs to the University of Western Australia. South of Brixton Street are Lots 37 and 47, in Homeswest ownership, which have been proposed for vesting in the National Parks and Nature Conservation Authority as a reserve for the protection of flora and fauna (Environmental Protection Authority, 1991). These two areas of remnant bush are both considered to be biologically important, specifically their native flora (refer to Speck and Baird (1984) and Keighery and Keighery (1991)).

Figure 1.2 shows the generalised land use of the Kenwick area and, when read in conjunction with Figure 1.3, emphasises the presence of the urban development front.

1.3 Existing Zoning

The Metropolitan Region Scheme has classified Lot 48 and Part Lot 35 as "Urban Zone" land since 8 November, 1968 (refer Figure 1.3).

The subject land is zoned "Rural" under the City of Gosnells Town Planning Scheme No. 1 (refer Figure 1.4). The Local Authority zoning is therefore not consistent with the Metropolitan Region Scheme and may be regarded as a breach of the Town Planning and Development Act 1928 (as amended).

The request to rezone the lots for "Residential A" (Residential Coding R17.5) and "Residential B" (Residential Coding R30) purposes, under the Gosnells City Council Town Planning Scheme No. 1, has been before the City Council.

At its meeting of 25 September, 1990 Council resolved to withhold the rezoning request until a number of subdivisional standards or infrastructure matters had been resolved. Response to these requests occurred and the Chief Planner (under delegated power) authorised advertising of the rezoning. On completion of the 42 day advertising, the rezoning documentation went before the full Gosnells City Council on 25 June, 1991. At that meeting the Council resolved to defer final approval of the rezoning Amendment subject to compliance with certain conditions including liaison with the Environmental Protection Authority to determine whether any environmental impacts will be generated by the development.

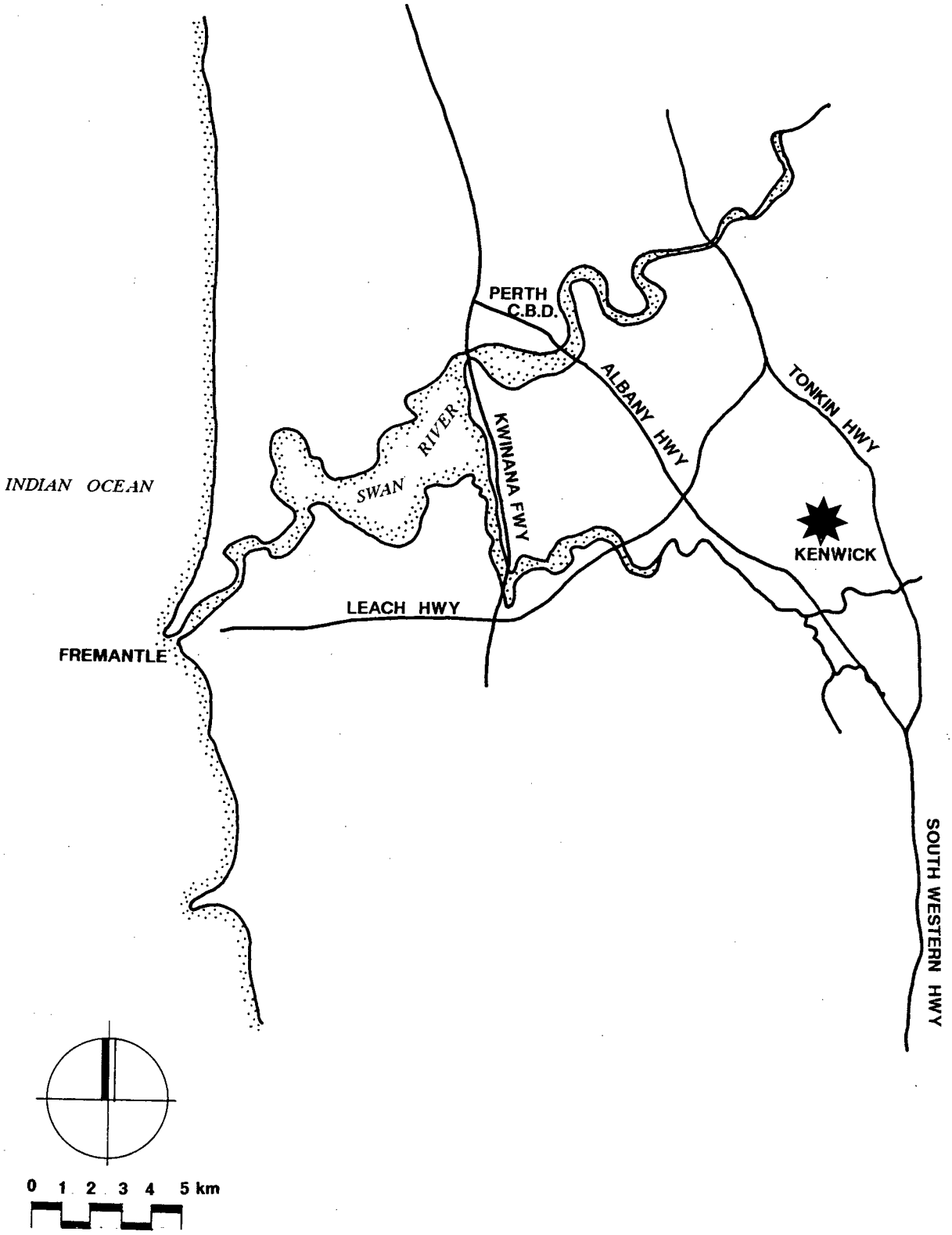


FIGURE 1.1
LOCALITY

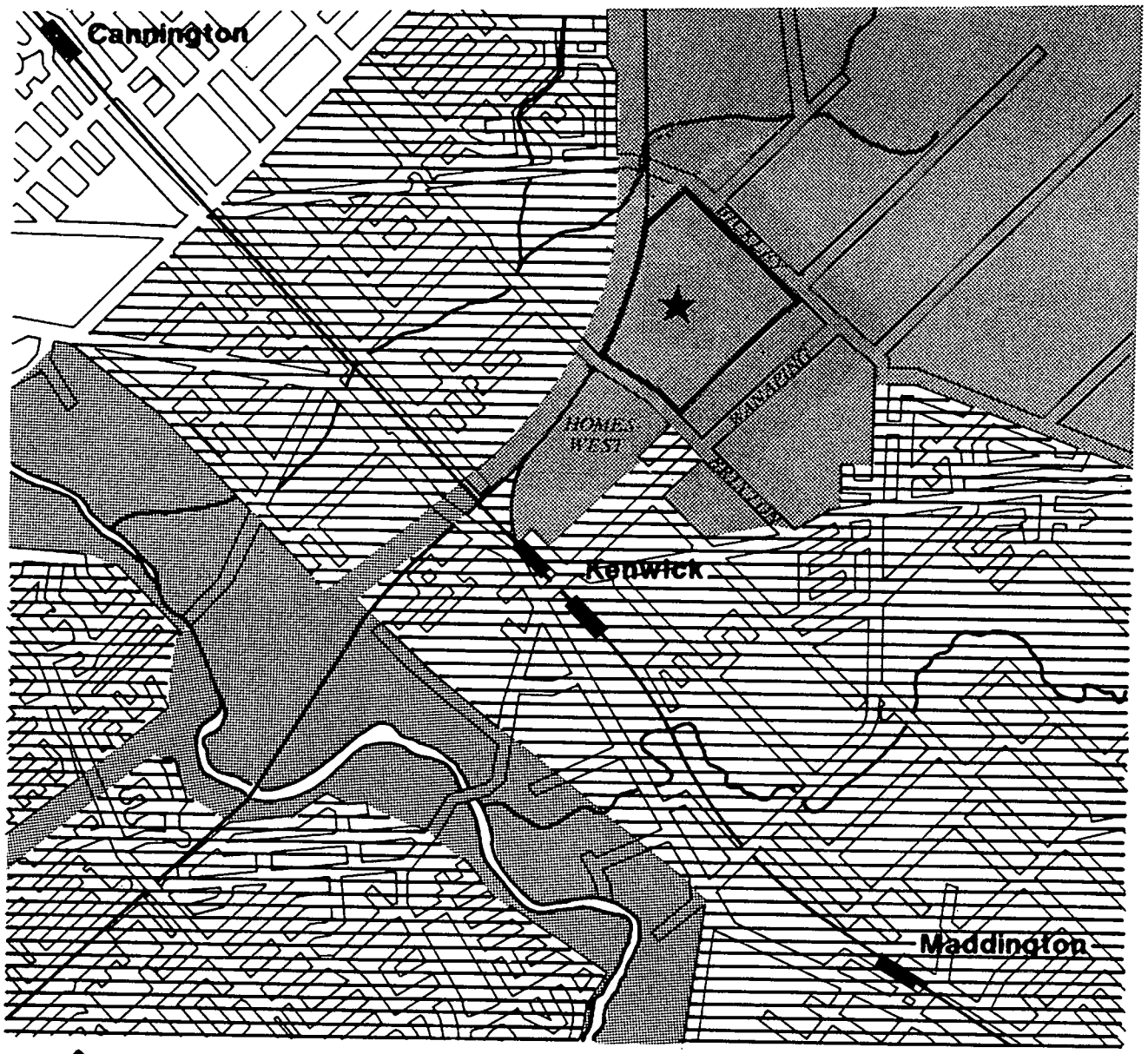


FIGURE 1.2

GENERALISED LAND USE IN THE KENWICK AREA

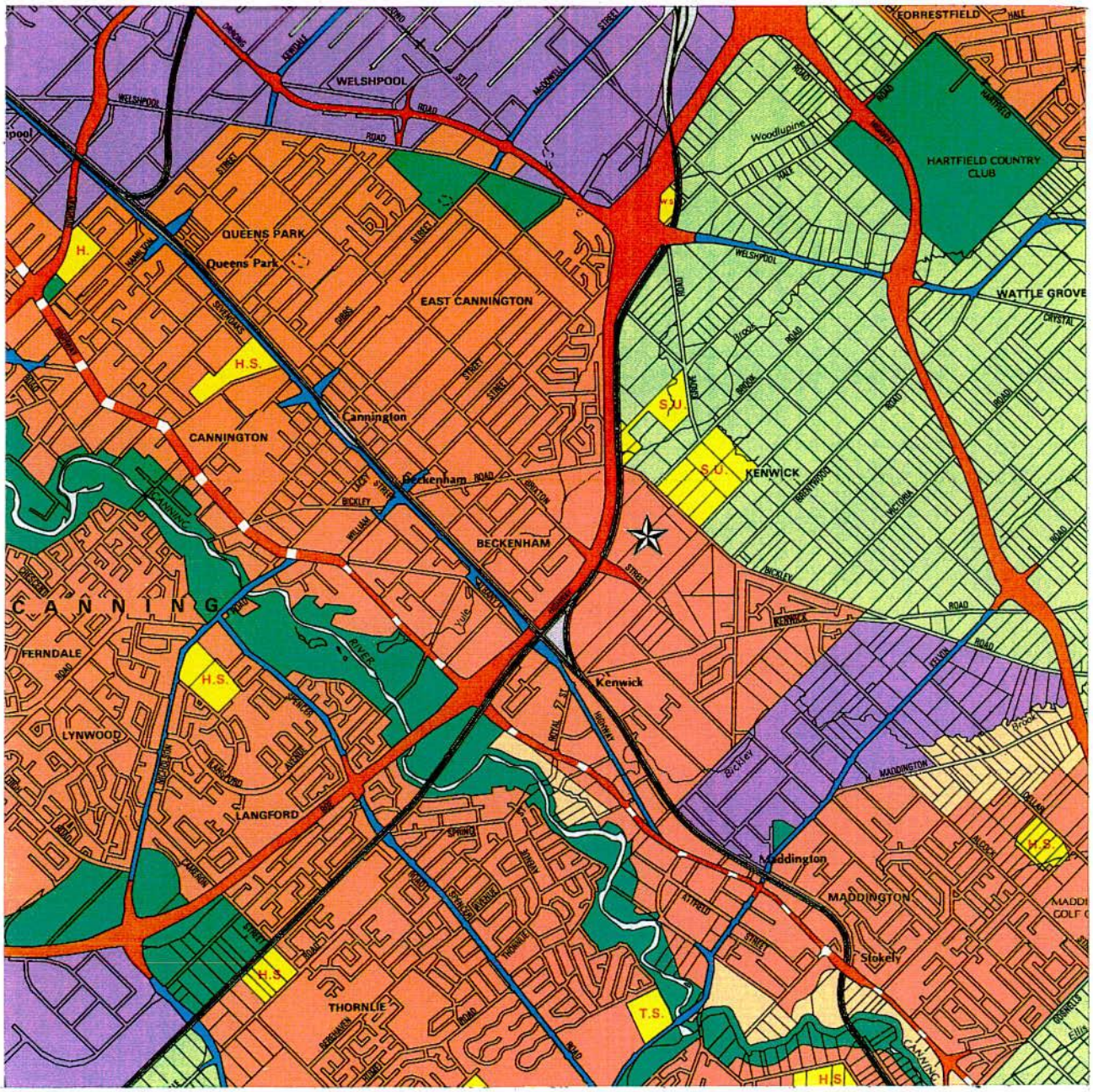
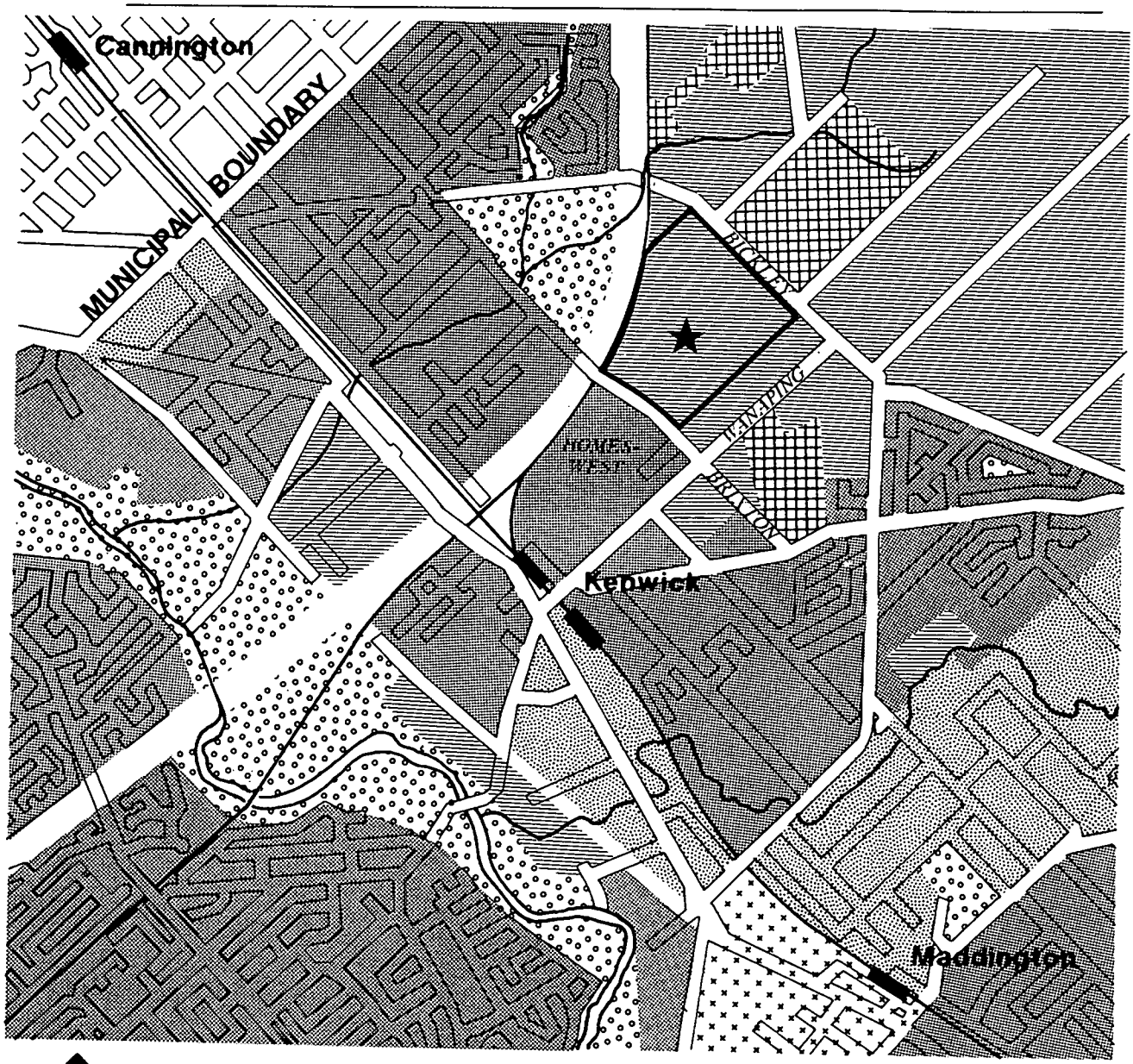


FIGURE 1.3
MRS ZONING



SOURCE: CITY OF GOSNELLS
TOWN PLANNING SCHEME No. 1 ZONE PLAN

PARKS AND RECREATION

RESIDENTIAL

RURAL

PUBLIC USE

COMMERCIAL

INDUSTRIAL

FIGURE 1.4

LOCAL SCHEME ZONING IN THE KENWICK AREA

1.4 Development Rationale

The intention of the proposal is to create a mixed density residential development with property sizes ranging from individual group housing lots of 335m^2 to single residential lots of 750m^2. This is in response to demand for affordable residential housing accessible to a range of facilities including the Central Business District.

Public Open Space is proposed to be developed covering an area of 2.75 hectares. A small neighbourhood shop is also proposed to cater for local convenience goods shopping.

1.5 Statutory Processes

To assist the reader, Figure 1.5 represents the stages of the planning and environment process requiring compliance before any form of development can proceed.

PLANNING AND ENVIRONMENTAL PROCESS.

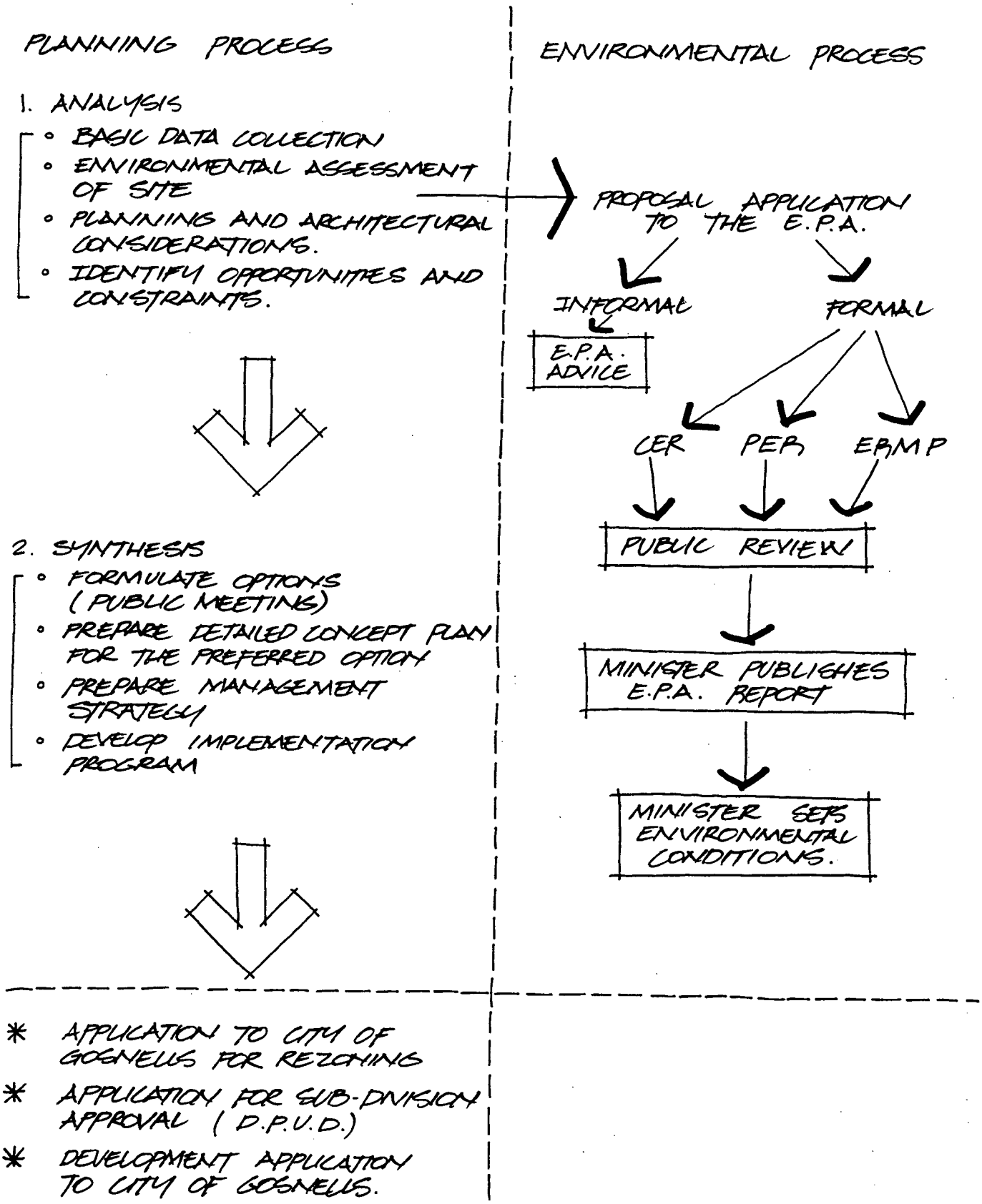


FIGURE 1.5
PLANNING AND ENVIRONMENTAL PROCESS

2. PUBLIC CONSULTATION

At the local level the public consultation process commenced with the advertising of the proposed rezoning of the land from "Rural Zone" to "Residential A" and Residential B Zones".

On the completion of advertising on 30 May, 1991 (for a 42 day period), the City of Gosnells Council resolved on 25 June, 1991 to refer the proposal to the EPA. This resolution then commenced a further public consultation process under the jurisdiction of the Environmental Protection Authority Act.

This report constitutes the requirements for a Consultative Environmental Review to which the public may make further comment. Upon review of this document and any public submissions, the EPA will make a recommendation to the Minister for Environment.

3. BENEFITS OF THE PROPOSAL

The development proposal has several benefits both to the local community and the broader metropolitan community.

3.1 Urban Consolidation

This land lies in the centre of one of the Perth Metropolitan Region's urban development corridors. It lies immediately to the east of the Perth-Armadale railway line and is prime land for urban development. This proposal is in keeping with the recommendations of the report, "Planning for the Future of the Perth Metropolitan Region" (1987). The report states:

> *"One of the most important themes of the preferred strategy is the emphasis on urban containment. This finds expression in a more compact urban form, an emphasis given to consolidation and infill in the existing urban area and replacing corridor growth in the more peripheral parts of the region with areas of land closer to employment opportunities and urban facilities in the existing built-up area".*

3.2 Improve the Level of Use of the Perth-Armadale Rail Line

This proposal reflects the objectives of the Department of Planning and Urban Development's Policy DC 1.6 "Development Near Metropolitan Railway Stations".

A new electric suburban rail system is presently being implemented. This will shorten travel times and improve passenger comfort. Land in proximity to rail stations is highly accessible and should be planned to permit as many people as possible to benefit from the rail service and to maximise the patronage of the system.

The policy goes on to encourage medium to high density residential development as well as commercial, intensive recreation and employment generating development. The policy calls for a minimum residential density of R40, which is higher than this proposal.

3.3 Energy Conservation

The proposal will encourage the utilisation of the rail system to commuters rather than use of the private motor vehicle.

Recent research by Professor Peter Newman and Dr Jeff Kenworthy of Murdoch University indicate the Metropolitan Perth is a higher consumer of fuel than most other cities in the world. Perth has the highest ratio of cars per 1,000 population of Australian cities (475) and the highest number of car kilometres driven per car (13,891). Conversely, it has the lowest transit ridership of 1.3 trips per kilometre of service of any Australian city.

Research indicates that Perth's outer suburbs use an average of 40,379 MJ per person of petrol per annum.

A specific study of the Perth-Armadale rail line indicated that the Kenwick station had the highest potential number of dwellings in its precinct.

3.4 The Provision of Affordable Housing

The cost of housing is increasing at a greater rate than salaries. Over the past few years the Commonwealth and State Governments have undertaken research into providing more affordable housing under the auspices of the "Joint Venture for More Affordable Housing".The research has shown that medium density housing utilising reduced lot sizes, verges and street widths is able to reduce the cost to buyers - especially to younger people, who are less able to afford housing. It is intended to use these principles in this development and to produce more affordable housing (Stokes, J., 1987).

3.5 Assist in the Reduction of Greenhouse Gases

Perth presently generates 2.25 tonnes of carbon dioxide from gasoline (petrol) and 0.48 tonnes of carbon dioxide from diesel per head of population per annum. This is higher than all other Australian, European and Asian cities studied and is only surpassed by a number of American cities (Newman, P., 1990).

It is generally accepted the community needs to reduce the level of "greenhouse gases". The proposal, which is proximate to a rail station, supports this objective.

3.6 Summary

Upon implementation the proposed subdivision will provide benefits to the community including:

- *a wider range of residential property to meet the changing needs of the population throughout the region;*
- *an adequate supply of affordable housing, particularly for first home buyers;*
- *a more contained urban area, that is, to increase the number of houses in existing urban areas and make better use of existing facilities and services;*
- *provision of a housing mix and density, as suggested by the Department of Planning and Urban Development, which is:*
  - *close to significant areas of employment, including industrial areas such as Welshpool, Canning Vale and Davison, and shopping centres (Carousel), major educational institutions, the Perth Central Business District and regional centres;*
  - *close to public transport routes (Albany Highway less than 1,000 metres) and interchanges, including bus services and the upgraded rail system (Kenwick Rail Station approximately 1,000 metres); and,*
  - *close to major recreational leisure facilities including regional open space and district sporting complexes (Mills Park).*

3.7 Alternative Options

The request for a CER raises some community concern as to the environmental suitability of the site for development purposes.

Partial development of the site in any form whatsoever would render the undeveloped portion of the site unsustainable as a viable ecosystem in the long term (refer Section 5.0 and 6.0). This was evidenced in the recent consideration on the analogous Homeswest site, as reported by the EPA, in Bulletin 577, September, 1991.

Depending on the outcome of the description of the existing environment, particularly the biological environment, and the environmental impacts of developing the site for its preferred (residential) option, the site may be found to have greater utility for the wider community in an undeveloped form. For instance, the physical and biological qualities of the site may be regarded by the Authorities as worthy of protection and therefore recommend declaration of the site as a conservation reserve.

Such an undertaking would provide the following benefits to the community:

- *conservation of physical and biological elements considered worthy; and,*
- *an expansion of open space Reserves in the vicinity.*

4. DESCRIPTION OF EXISTING ENVIRONMENT

4.1 Physical Environment

4.1.1 Site

The site slopes from the north-east to the south-west, with a 1.5 metre variation in contour over 700 metres. It is low lying and, with the exception of the north-eastern corner, is subject to waterlogging. Tracks/firebreaks surround and cross the site, and drainage channels run along the Brixton Street boundary and between Bickley Road and Brixton Street on the eastern boundary.

4.1.2 Landform and Soils

The subject land is situated on the eastern side of the Swan Coastal Plain on a fairly wide development of the Geomorphic Unit known as the Pinjarra Plain (McArthur and Bettenay, 1960). The soils are fluvial in origin and belong to the Guildford Association (Bettenay et al, 1960). The Armadale map sheet of the Perth Metropolitan Region 1:50,000 Environmental Geology Series (Jordan, 1986) shows the greater part of the site to have clayey sand at the surface. Surface material in the southern corner has a higher proportion of fine material and is mapped as sandy clay, whilst in the north-eastern corner the Guildford Formation is overlain by a thin layer of Bassendean Sand (refer Figure 4.1).

4.1.3 Subsurface Conditions

The subsurface conditions at the site were investigated using a combination of boreholes, to a depth of 3.0m at various locations, and test pits to depths ranging from 1.2 to 2.6m.

The test pits and boreholes drilled across the site encountered a variable profile consisting of clays, sands, clayey sands and sandy clays. In the northern sections of Lot 48, the soils had been partially laterized giving bands or pockets of ironstone gravel or ferruginous sandstone (Coffey, 1988 : P173/1).

At the time of the investigation most of the soils encountered were dry and hard. Some difficulty was encountered in the excavating backhoe pits on the northern sections of Lot 48. The soils underlying much of Part Lot 35 were generally moist. Some pockets of calcareous material were encountered in this area. This may correspond to a small pocket of lacustrine limestone known as Muchea limestone. This material was generally of a low density.

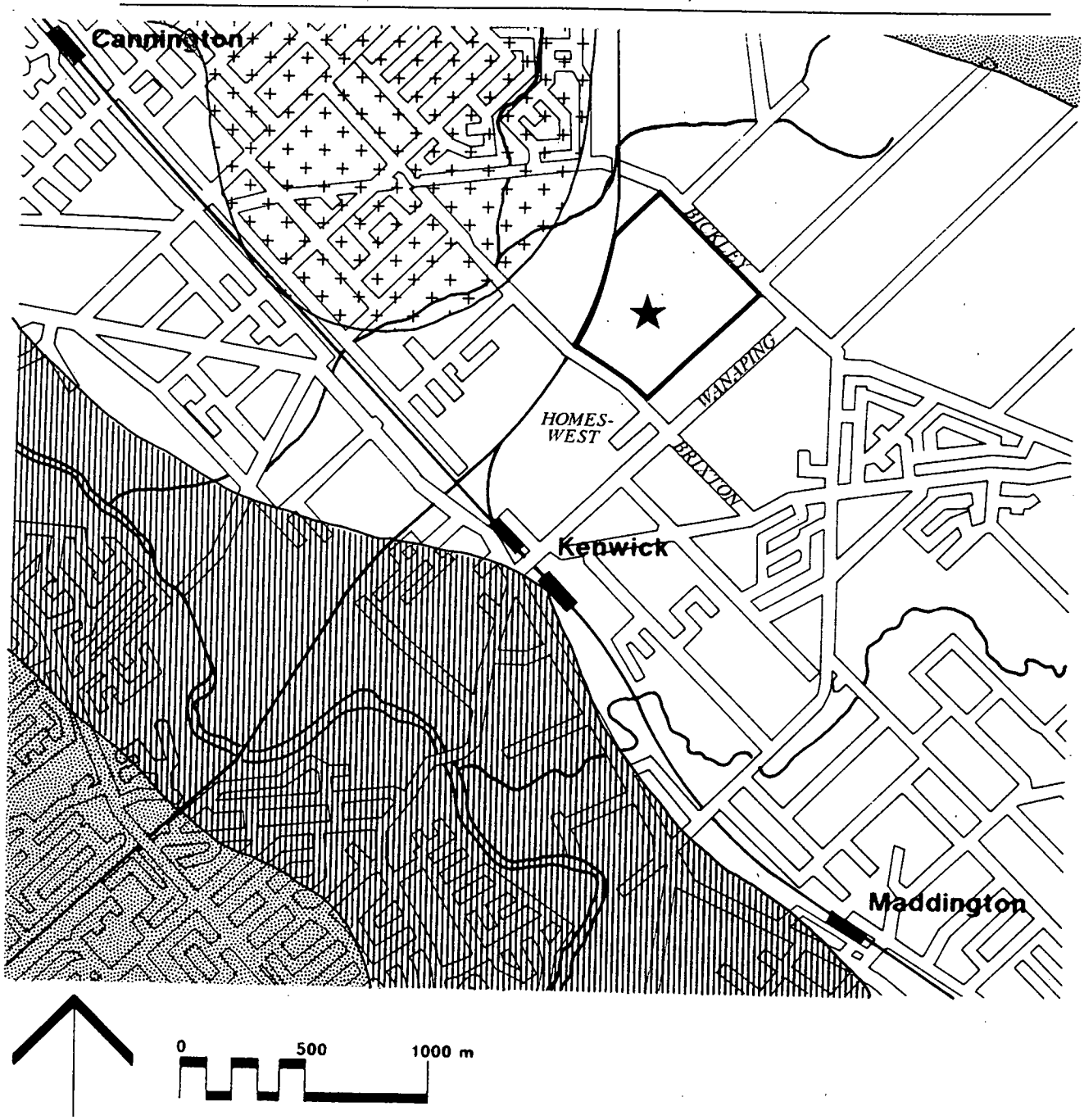
4.1.4 Hydrology

The landform and soil characteristics described are typical of the Guildford Formation resulting in a similar hydrological regime to that found on adjacent Lots 37 and 47 Brixton Street (CALM, 1989: 2284/1).

Historically, hydrology of the region has been influenced by drainage works to permit access to and development of the area. Regional drainage is westward across low lying, flat land towards Yule Brook. Surface drainage is intercepted by formalised open unlined drains directing water beneath the rail to Yule Brook.

CALM indicate that, historically, drainage construction in the area has not significantly altered groundwater levels. Inspection of drains indicated groundwater levels vary from 1.1 metre to 0.9 metre. During subsurface investigations, Coffey and Partners encountered no groundwater in any of the test pits or bore holes. Depressions are occasionally inundated.

As reported by CALM the development of Lot 48 and Part Lot 35 requires the maintenance of drainage channels and the filling of the site with a sand pad. Such development does not require the lowering of the groundwater levels. This is evidenced by the lack of interrelation between the groundwater and surface water.



LEGEND

SOUTHERN RIVER: Sandplain with low dunes and many intervening swamps; iron and humus podzols, peats, and clays.

CANNINGTON: Poorly drained plains with calcareous substrate; yellow duplex soils with minor areas of red and black clays over limestone.

GUILDFORD: Flat plain with medium textured deposits; yellow duplex soils.

SWAN: Alluvial terraces with red earths and duplex soils.

FIGURE 4.1

LANDFORMS & SOILS OF THE KENWICK AREA

No groundwater was encountered in any of the test pits or the boreholes.

During winter much of the surface of the site is covered with retained water (the primary source being rainfall) presumably the result of surface drainage that has not been able to infiltrate because of high clay content soils.

4.1.5 Noise Levels

The site has a standard gauge railway line along its western boundary and the Perth-Armadale railway line to the South. The standard gauge does not currently carry heavy traffic but trains do sound their sirens when approaching the Brixton Street level-crossing. The future Roe Freeway will be built to the west of the site. A bridge is proposed on Brixton Street to straddle the rail and proposed freeway.

The present noise levels were considered to be acceptable. Future noise levels are difficult to estimate but it was considered that building design along the western edge of the development could be used to reduce noise from the general area.

This approach has been used in Rochester Avenue, north of the railway, and Stirling adjacent to the freeway. In the former case noise abatement methods comprise insulated ceilings and blank rear walls. In the Stirling case, double storey buildings are situated backing into the noise source. A rear boundary wall reduces noise at ground level and small windows on the upper storey prevent noise penetration. Such buildings create a noise shadow effect for other buildings on the site.

Judicious design of the proposed bridge may also reduce projected noise levels of traffic.

It is anticipated that a system such as described above will be incorporated into the development to reduce noise affect.

4.2 Biological Environment

4.2.1 Flora and Vegetation

The general floristics of the area are known from the work done by the Botany Department of the University of Western Australia, the Department of Conservation and Land Management and interested members of the public. The winter wet areas are particularly diverse, and the flora includes a suite of specialised winter short-lived plants. The local flora is also known to contain elements normally associated with Darling Scarp habitats (refer Attachment 4.2).

Since 1987, the proponent's have had various written and informal advice that the site does not attract the same level of interest as adjoining conservation sites.

Of the 10 species from the Metropolitan Region currently on the Schedule of Declared Rare Flora, Aponogeton hexatepalus, Calytrix breviseta ssp. breviseta, Diuris purdiei and Hydrocotyle lemnoides have been previously identified in the vicinity, but not on the subject land.

On a regional scale the vegetation of the Pinjarra Plain has been described by Beard (1979), mapped the vegetation of the area as Marri (Eucalyptus calophylla) Woodland, though he described the Pinjarra Plain vegetation on clay soils as Paperbark swamp with a range of Melaleuca species, and patches of Banksia low woodland. Heddle et al (1980) show the native vegetation potential as being in the Southern River Complex.

This is Marri/Jarrah woodland with Melaleuca thickets along water courses and in lower, wetter areas. This description applies more to the southern distribution of the Pinjarra Plain.

In the Kenwick area the Melaleuca and associated wetland communities are more prevalent. However, much of the Pinjarra Plain has been cleared for agriculture and in some areas the original vegetative cover can only be extrapolated from small remnants.

4.2.2 Flora

A total of 211 taxa of vascular plants were identified during the survey of which 163 were native taxa, and 48 naturalised exotics (Appendices 1 and 2). The flora compares with that of the two adjacent sites with almost half of the native species identified (72), common to all three areas. A further 48 taxa are shared with the Yule Brook Reserve, and there are 21 others which also occur on the proposed reserve on Lots 37 and 47 Brixton Street.

There are 109 genera from 46 families of native vascular plants represented in the checklist. The families best represented are the Myrtaceae (19 taxa), the Proteaceae (16 taxa), the Papilionaceae (14 taxa), the Restionaceae (11 taxa), and the Cyperaceae and Haemodoraceae (9 taxa each). Surveying over a longer period of time would undoubtedly add to the checklist, especially for less conspicuous herbaceous species.

The most heavily inundated areas of the site where Robin Redbreast Bush (Melaleuca laterita) occurs and where the two aquatic species (Aponogeton hexatepalus and Hydrocotyle lemnoides) might be expected, are now choked with weedy perennial grasses. The pools on the flats on the western side are either not deep enough, or are not inundated for long enough to support these species.

A small area of Perlcalymma eliptica dominated vegetation which is the typical habitat of Purdie's Donkey Orchid (Diuris purdiei), does occur on the site, but as this plant is only visible after a summer fire it was not found. Calytrix breviseta spp. breviseta is known to occur in association with various Feather Flower (Verticordia species) in low heath similar to that found on the site, but was not encountered in the survey.

Three taxa on the Priority Flora lists were encountered during the survey. Two are Priority 1 taxa:

- ***Eryngium pinnatifida ssp. "palustris":*** *This is an as yet not formally described taxon which is only known from the adjacent proposed reserve site on Brixton Street and from the Serpentine area.*
- ***Grevillea thelemanniana ssp. "thelemanniana":*** *This subspecies appears to be confined to moist sites on the eastern side of the Swan Coastal Plan in the metropolitan area. It also occurs on the Yule Brook Botany Reserve.*

The third Priority taxon is listed as Priority 3:

- ***Gonocarpus pithyoides:*** *This species occurs on the Swan Coastal Plan between Perth and Gingin, and is possibly poorly collected rather than rare. It has been recorded on both the Yule Brook Reserve and the proposed reserve on Brixton Street.*

A species of Calectasia was provisionally identified on the site as Calctasia grandiflora. The plants were in bud, and it is possible that this might be C. cyanea, or that both species occur on the site as they do on the adjacent proposed reserve area. Confirmation of the presence of C. grandiflora would mean that the following comments made by the Department of Conservation and Land Management concerning the adjacent site also apply:

- *The site is the sole known co-occurence of the Star of Bethlehem Lilies, Calectasia cynaea and C. grandiflora. It is also the only known extant population of Calectasia grandiflora on the Swan Coastal Plain, ... this population is thus of importance in assessing taxonomic status of these species.*

4.2.3 Vegetation

The vegetation may be described in general terms as a mosaic of wetland communities. Community boundaries are rarely distinct but integrate in the form of a continuum. The distribution of species assemblages is determined by the topography and substrate conditions, and thus the hydrological regime. The degree and temporal extent of winter inundation are probably the primary limiting factors on the lower lying areas, whilst the depth of sand above the clay and soil fertility factors play a major role on better drained areas. The fire history (frequency and timing) and the degree of historical and current human use also influence the current boundaries.

Structurally the vegetation ranges from a low (1m), open community of samphires (Halosarcia halocnemoides) and sedges (Leptocarpus species), to dense thickets of Melaleuca species to 3m in height. The majority of the site however, supports various dense shrublands which rarely exceed 1.5m.

The following vegetation/community types were used as mapping units. The numbers correspond to the numbers appearing on Figure 4.2, with types ordered roughly in descending order of wetness of the habitat:

(1) *Melaleuca Shrubland (Swamp Paperbark, Robin Redbreast Bush, Rottnest Tea Tree, Orange Wattle);*

(2) *Leptocarpus species Flats (Coast Saw-sedge, White Myrtle);*

(3) *Hypocalymma angustifolium and Verticordia species Low Shrubland;*

(4) *Viminaria Tall Shrubland (Semaphore Sedge, White Myrtle, Dwarf Sheoak);*

(5) *Mixed Low Shrubland (Swamp Cypres, Swish Bush);*

(6) *Pericalymma ellipticum Low Shrubland (Semaphore Sedge, Quivery Cord Rush, Swish Bush); and,*

(7) *Eremaea Low Shrubland (Pineapple Bush, Semaphore Sedge).*

4.2.4 Fauna

A total of 19 species of bird, 1 native and 1 introduced mammal, 2 amphibians and 2 reptiles were recorded during the site inspection. Numerous diggings, footprints and "tunnels" through dense vegetation of the gazetted Southern Brown Bandicoot (Isooden obesulus) were recorded during the site inspection. Based on an assessment of the habitat available a further 44 birds, 10 native and 3 introduced mammals, 5 amphibians and 26 reptiles are likely to occur there. These additional species represent those that would be present during different seasons (ie. migrants and nomadic species) or cryptic species.

Protected Jewel Beetles of the Family Buprestidae were observed feeding on Hypocalymma and Hakea flowers during the site inspection.

The Importance of the Proposed Development Site for Bandicoots

At present there is a viable population of Bandicoots using the proposed development site. This is evident from their persistence at the site despite disturbance from land clearing and a high weed invasion in the south-eastern section, the presence of introduced predators and adjacent roads and the occurrence of fire. The population estimate of 0.05-0.37 animals/ha (a possible total population of between 1 and 11 individuals) for the proposed 30 ha development site, although reasonable, is somewhat lower than for other study areas.

The adjacent sites, Yule Brook Botany Reserve (M69) and the former Homeswest site (Lots 37 and 47), contain a high percentage of suitable Bandicoot habitat and their presence was confirmed by sightings of large numbers of diggings, footprints and "tunnels" throughout the two areas during the site assessments. An evaluation of the available habitat and the presence of diggings at the two adjacent sites indicated that at the time of the assessment the population of Bandicoots at these sites was possibly higher than in the proposed development site.

Even though the population at Lot 48 and Part Lot 35 may at present be lower than adjacent areas, not enough is known about seasonal fluctuations or movements of the species to draw definite conclusions as to the importance of the site vis a vis the adjoining areas. Lot 48 and Part Lot 35 could well be an integral part of the Bandicoot habitat of the whole area and if development went ahead dispersion of young animals and movement of adult animals might be restricted.

In summary, the Bandicoot population of the area as a whole would certainly decrease both as a direct result of clearing Lot 48 and Part Lot 35, and/or indirectly due to aggressive competition between animals displaced to adjacent areas.

Vegetation Types

1. MELALEUCA SHRUBLAND
2. LEPTOCARPUS FLATS
3. HYPOCALYMNA/VERTICORDIA LOW SHRUBLAND
4. VIMINARIA TALL SHRUBLAND
5. MIXED LOW SHRUBLAND
6. PERICALYMNA LOW SHRUBLAND
7. EREMAEA LOW SHRUBLAND

FIGURE 4.2

AERIAL PHOTOGRAPH VEGETATION OVERLAY

Peregrine Falcon (Falco peregrinus)

This special protection species of bird was not sighted during the site inspection but is known to occur in the metropolitan area.

4.2.5 Discussion

The site has floristic similarities with both of the adjacent remnant sites of native vegetation, and similarly occupies an intermediate position in the continuum of vegetation types across the area as a whole. The topographic gradient presents a unique set of niches for plant growth, and it is with respect to the different associations in the turnover of species along that gradient that the site differs from the adjacent ones. The site must thus be considered to occupy a special position in the landscape, as would any area situated midway along a gradient in the physical environment.

Notwithstanding the disturbed nature of part of the site, the area is still floristically diverse. The presence of Priority List species (two of very limited distributions and another which is poorly known) increase the value of the site floristically.

The area supports a small but apparently viable population of the Southern Brown Bandicoot, which is gazetted as a rare fauna species.

No vertebrate species are thought to be restricted to this location and all have distributions encompassing larger areas of the state (including the Southern Brown Bandicoot) although some species are uncommon on the Swan Coastal Plain.

In a local context, the site occupies a distinctive position in the landscape and may provide a function with respect to the movement of the rare fauna species. It represents a significant patch of remnant bushland providing resources for a wide range of fauna. In addition to the Southern Brown Bandicoot many other vertebrates inhabit the area.

Urbanisation of the site would also increase the pressures on the adjacent reserve areas. Management of these areas in the form of fence maintenance, removal of dumped garden refuse, and fire control would probably have to be increased. In addition, any new drainage scheme on the development site would have to be planned so as not to affect the hydrology of the reserve areas.

Reclamation of degraded bushland such as that which occurs on the survey area is possible, but only with a large expenditure of funds and/or intensive community effort. With respect to the long term integrity of the adjacent reserve areas, and also with respect to the intrinsic value of the site as a representative of wetland habitat for both flora and fauna, reclamation would be a desirable action.

In a regional context, the habitats typical of the Pinjarra Plain geomorphic unit are becoming increasingly scarce, and this is particularly so for the ephemeral wetland communities.

4.3 Biophysical Associations

The ecosystems formed by the biophysical association of soil, hydrology and vegetation facet are in evidence on the site.

The high clay content soils are characteristic of imperfect drainage. As evidenced by investigations, the landform and soils have created perched wet areas. Rainfall cannot drain from the virtually flat site nor can it permeate the clay soil. Consequently the gently inclined site creates a gradient of vegetation and habitat.

4.4 Social Environment

4.4.1 Current Human Use of the Site

The broad land use of the Kenwick area is shown on Figure 6.1. The development site falls into the south-west corner of a wedge of undeveloped land. It is anticipated that much of this undeveloped land will be developed in the near future as the land has been zoned Urban under the Metropolitan Region Scheme for some years.

The site is currently unused for any permanent human uses. Apart from a network of tracks which are presumably part of a firebreak system there is no development on the site.

There are signs that the site is used on a temporary basis, ie:

- *dumping of garden refuse;*
- *trail bike riding;*
- *cycling or playing by children; and,*
- *horse agistment.*

4.4.2 Aboriginal Significance

The Department of Aboriginal Sites of the Western Australian Museum was contacted in relation to determining whether there are any Aboriginal sites on the land. A search of their records revealed no known sites on the land.

The only spiritual Aboriginal site in the City of Gosnells is in the vicinity of the Gosnells Golf Club, several kilometres to the south of Kenwick. This site, a swamp, is fed by a perennial spring which is maintained, according to Aboriginal lore, by the Waugul.

Prior to European settlement the land in the vicinity of the Canning River was inhabited by groups of Aboriginal people who hunted and gathered on a seasonal basis. The men concentrated on hunting or capturing the larger animals and the women dug for roots, collected fruits, seeds, birds eggs, larvae and trapped small animals (City of Gosnells, 1988).

The Aboriginal people led a nomadic way of life based on food availability in various places. The wetlands and river flats of the Canning River were productive (Figure 4.3). They contained waterfowl, tortoises, gilgies and frogs. The surrounding sands yielded macrozamia nuts and blood roots. The Canning River itself was a source of fresh water, rich in fish and crustaceans and on the banks yam patches occurred and kangaroos favoured the open grassy plains as pasture. These plains were carefully managed by the Aboriginal people, burning out the understorey to encourage new growth.

4.4.3 European Settlement

Europeans settled in the area in the 1830s. Crown grants were made on either side of the Canning River in a series of ribbon lots to equitably allocate fertile red soil on the flood plain as well as large tracts of less fertile clayey or sandy soils further away (Figure 4.4).

European settlement led to immediate conflict with the local Aboriginal people - neither of whom understood the culture of the other. The fixed settlement of the Europeans and introduction of stock and sheep drove off the kangaroos. The Aboriginals responded by spearing sheep and cattle. Retaliation by the settlers resulted in most of the Aboriginal people leaving the area within a decade.

By the mid 1800s Kenwick had become the centre of settlement in the Canning Region. A church, school and post office were built, social activity and sport thrived. By 1890 additional growth had focused activities on Armadale and Kenwick declined as a prominent centre.

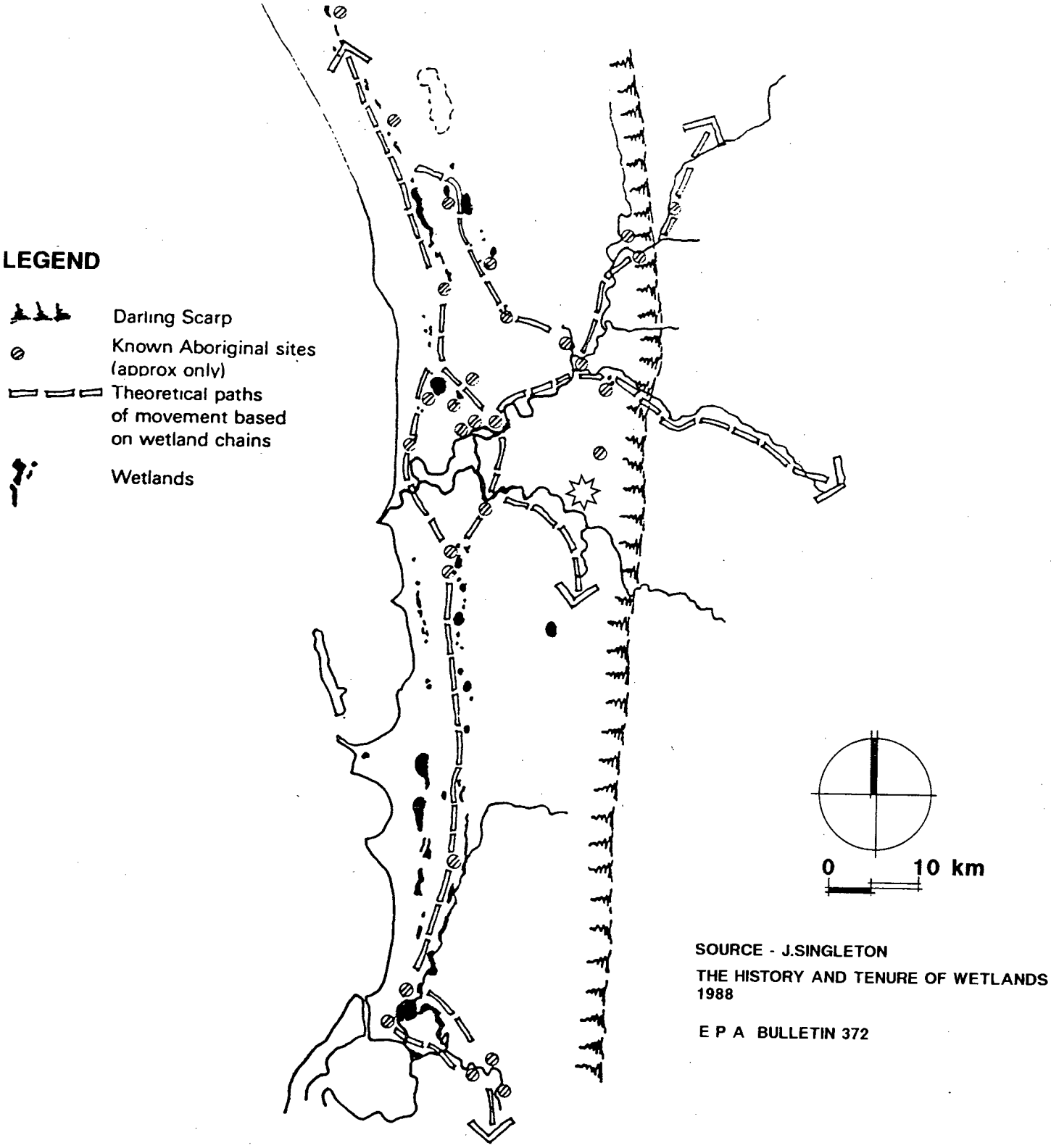


FIGURE 4.3

WETLANDS AND THEORETICAL ABORIGINAL MOVEMENT

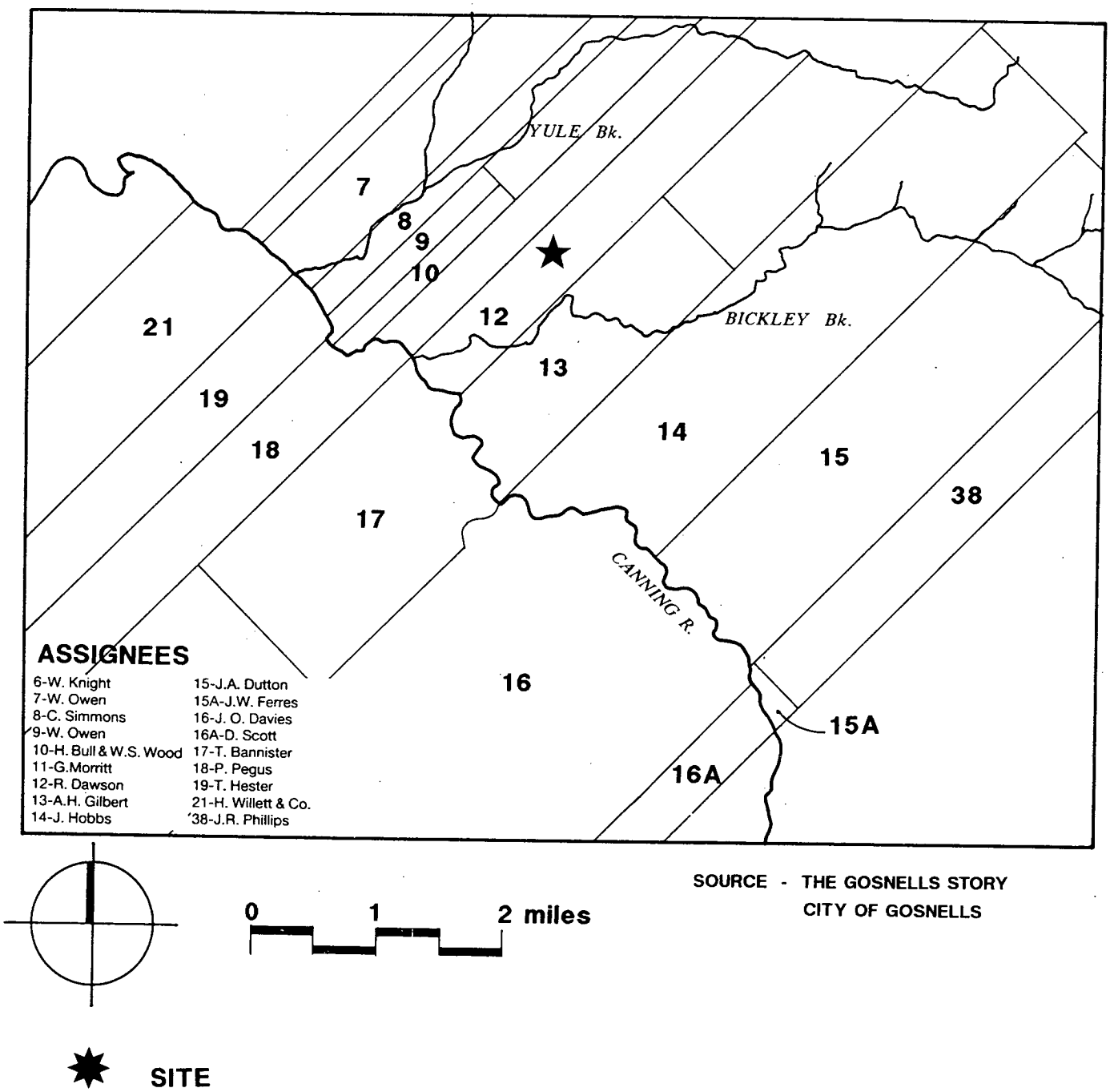


FIGURE 4.4

PATTERN OF EUROPEAN SETTLEMENT IN THE KENWICK AREA

As far as it is possible to determine, Lot 48 and Part Lot 35 have always been on the periphery of both Aboriginal use and European settlement. Being on the less fertile clayey soil the European settlers would not have found it of much use. It was probably used for grazing by the settlers and as a kangaroo hunting area by the Aboriginal people.

4.5 Summary

The foregoing description of the physical environment can be summarised as follows:

- *the site is almost flat, the entire site lying between the 5 and 7 metre contour;*
- *the site consists of unconsolidated clays of the Guildford Formation which are too malleable for roads and building construction in their present form and require fill;*
- *the complex soil structure and impervious nature of the clays is responsible for the poorly drained soils;*
- *the site has been drained in previous years by constructed stormwater drains;*
- *the constructed drainage has not affected the wet areas which are surface features relying entirely on winter rainfall for their continued survival;*
- *if appropriate drainage is installed the development will have negligible effect on the hydrological status of neighbouring wetlands;*
- *the vegetation on the site falls into E. calophylla openforest, Viminaria, Melaleuca woodland, Pericalymma sedgeland and Mel. laterita;*
- *the subject site will assist the maintenance of the integrity of the adjacent conservation sites and has value as a representative of a wetland habitat;*
- *two species of Priority List Flora occurs on the site;*
- *one species of declared fauna occurs on the site;*
- *the design of the urban development on the site can be used to reduce potential noise levels affecting the subdivision; and,*
- *the site is not known to have any cultural significance of Aboriginal or European cultures.*

5. PROJECT DESCRIPTION

It is intended to subdivide the land into 238 single residential lots, 4 duplex lots and 10 group housing sites comprising approximately 135 units.

5.1 Brixton Street Access

Access to the site is from Brixton Street and Bickley Road. The Brixton Street access has been positioned at the eastern extreme of the site to create the greatest separation possible between the proposed Brixton Street flyover.

The location, and height extent of the Brixton Street flyover embankment is shown at Figures 5.1 (a) and 5.1 (b). The embankment has significance to the subject site in relation to the vegetation continuum described in Section 4.2.5.

It is apparent that a break in the vegetation continuum will occur as a result of either the proposed residential development or the proposed Brixton Street flyover. Acceptance of the importance of the vegetation continuum's maintenance implies that no development of the site or the flyover is to occur. On the other hand, approval of either development implies acceptance of the other.

5.2 Road Layout

In response to the City of Gosnells' request the road pattern for the proposed subdivision has been modified considerably from the original proposal to have a broken road configuration from Brixton Street to Bickley Road. Council was concerned that the single road would attract excessive extraneous through traffic.

In accordance with the Residential Road Policy the roads with the most direct link from Bickley Road and Brixton Street have 18 metre reserves. Other sections which will carry no through traffic have 16 metre reserves. Culs-de-sac have 16 metre reserves except where fewer than 10 lots are proposed in which case 14 metres reserves are provided.

The road design, as shown on the subdivision plan at Figure 5.2, is the best means of providing relatively easy access to the residential lots and group housing sites, and a safe and pleasant living environment whilst discouraging any extraneous through traffic. At the instruction of Gosnells City Council a road connection is to be made with proposed development on abutting Lot 106.

5.3 Local Shopping Centre

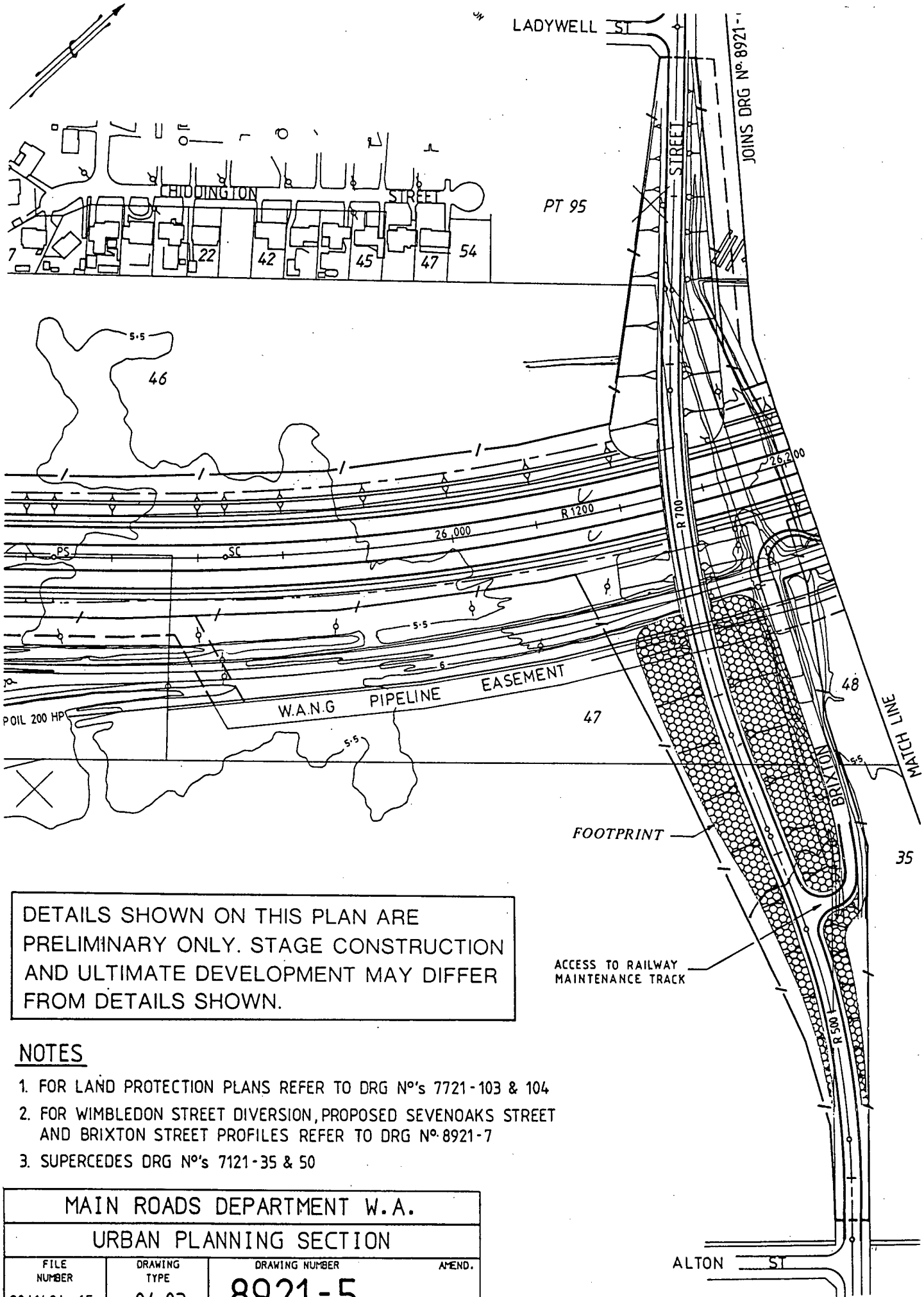
The Local Shopping Centre as shown on the Development Concept Plan is in accordance, in terms of size and location, with the City of Gosnells retail structure plan.

The centre will comprise approximately 500m^2 of floorspace providing for the essential convenience goods needs of the local community, for example, super deli/newsagent type services.

5.4 Single Residential Lots

The Development Concept Plan shows single residential lots not less than 600m^2 in area with an the average around 630m^2. Larger lots have been incorporated at the heads of culs-de-sac and fronting the local distributor road where smaller lots would be less suitable for development purposes.

Residential lots have a minimum actual frontage of 14 metres with an effective frontage (ie. at the building line) of no less than 15 metres. The exception is at culs-de-sac heads where actual frontage is 12 metres or more.



DETAILS SHOWN ON THIS PLAN ARE PRELIMINARY ONLY. STAGE CONSTRUCTION AND ULTIMATE DEVELOPMENT MAY DIFFER FROM DETAILS SHOWN.

NOTES

1. FOR LAND PROTECTION PLANS REFER TO DRG Nº's 7721-103 & 104
2. FOR WIMBLEDON STREET DIVERSION, PROPOSED SEVENOAKS STREET AND BRIXTON STREET PROFILES REFER TO DRG Nº 8921-7
3. SUPERCEDES DRG Nº's 7121-35 & 50

MAIN ROADS DEPARTMENT W.A.			
URBAN PLANNING SECTION			
FILE NUMBER	DRAWING TYPE	DRAWING NUMBER	AMEND.
90/1484-65	04·03	8921-5	

FIGURE 5.1 (A)

BRIXTON ST EMBANKMENT FOOTPRINT

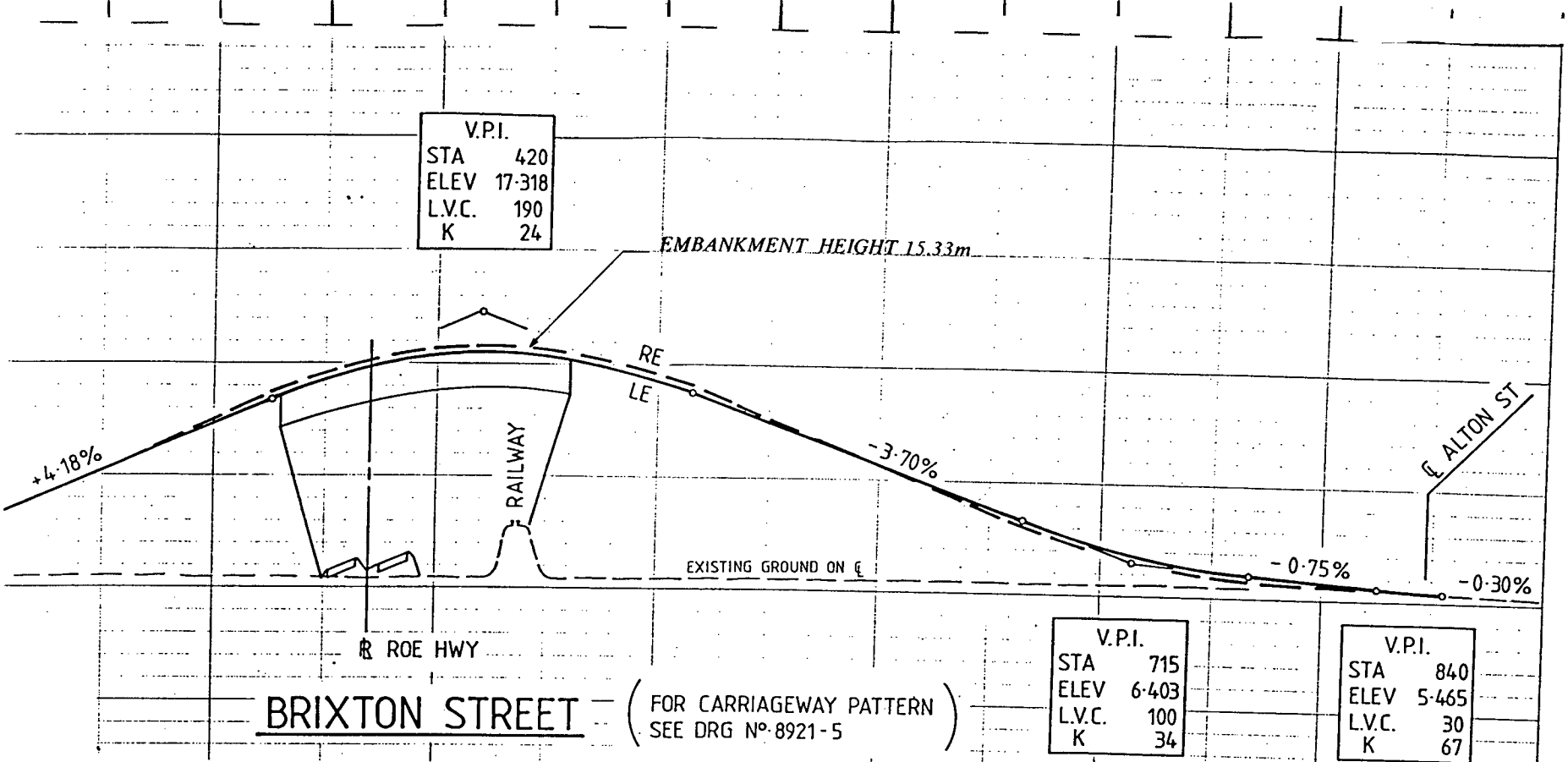


FIGURE 5.1 (B)

BRIXTON ST EMBANKMENT HEIGHT

ROE HIGHWAY H18

SIDE STREET PROFILES

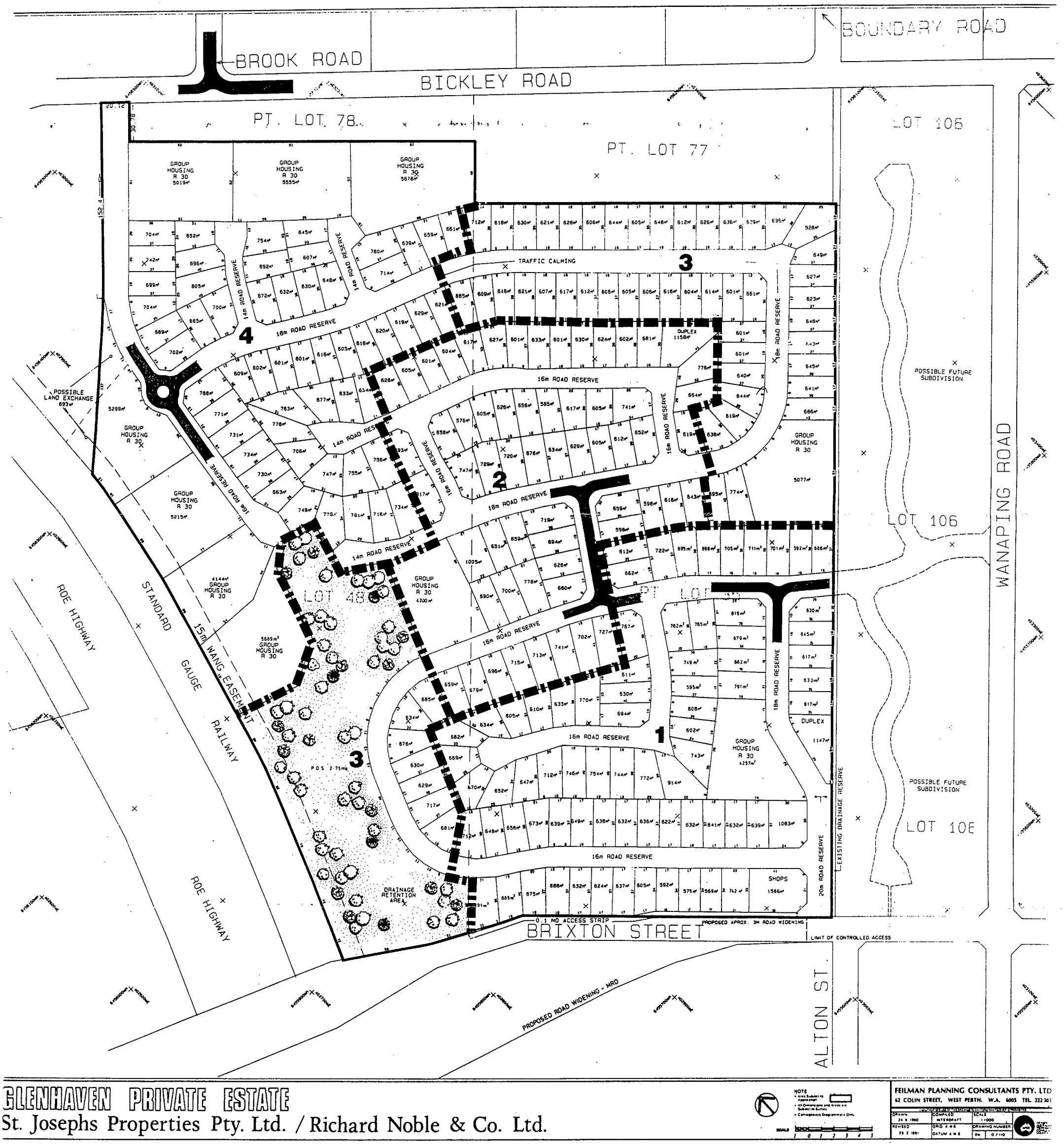
WILLERI DVE, NICHOLSON RD, SPENCER RD, PROPOSED SEVENOAKS ST, WIMBLEDON ST DIVERSION & BRIXTON ST

LOCAL AUTHORITY CITY OF CANNING (114) & CITY OF GOSNELLS (104)

MAIN ROADS DEPARTMENT W.A.

URBAN PLANNING SECTION

FILE No.	DRG. TYPE	DRAWING NUMBER	AMDT.
90/1484-65	05·00	8921-7	



GLENHAVEN PRIVATE ESTATE

St. Josephs Properties Pty. Ltd. / Richard Noble & Co. Ltd.

FEILMAN PLANNING CONSULTANTS PTY. LTD
62 COLIN STREET, WEST PERTH. W.A. 6005 TEL. 322 301

FIGURE 5.2

DEVELOPMENT CONCEPT PLAN AND STAGING

The size of the single residential lots reflects the demand for affordable residential land within easy access of the Perth Central Business District and other major facilities. Many home builders are now marketing standard project homes specifically designed to be developed on small, narrower lots.

5.5 Group Housing Sites

The subdivision plan proposes 10 group housing sites capable of accommodating a total of 135 dwelling units. The sites have been designed such that one dwelling unit per 335m^2 of site area can easily be accommodated within the Residential R-Coding R30.

The quantity of group housing is a response to the State Government's appeal for greater urban development densities particularly within close proximity to the Perth/Armadale railway.

The developer intends developing the group housing sites to a good standard with full sized homes (rather than units) situated closer together by virtue of the small yard areas afforded by group housing design criteria.

The sites will be suitable for development under the proposed Villa Titles as well as under the existing Strata Titles Act.

5.6 Service Provision

The proposed subdivision will be provided with full urban services including underground power, water, sewer, telephone, and stormwater drainage.

Of particular importance to this site is the provision of drainage (refer to Section 6.1.1). Drainage of the subdivision will consist of a piped system discharging into a compensation basin in the south-west corner of the site. Initially, the existing soil will be reshaped to conform to the proposed road pattern. Stormwater will be directed to the compensation basin, enabling controlled discharge from the site, before being directed into the regional drainage system.

5.7 Timing of Development

The proposed sequence of development is shown on the conceptual subdivision plan at Figure 5.2. It indicates in broad terms the logical development areas, staging size and staging pattern. The staging sequence was determined as discussed below:

- *The size of each area was based on commercial aspects of the development. These typically relate to expected number of stages over time together with the cost and peak debt of each stage.*
- *Road access to Brixton Street dictates that the first stage is adjacent to this road. Brixton Street will be used as the major thoroughfare by commuters to other areas.*
- *Sewer and drainage connections for the whole of the area are made in Brixton Street or adjacent to it. Therefore it is necessary to make these connections first and then develop immediately adjacently.*
- *The rest of the stages link logically in terms of development of the road system and the extension of the sewerage and drainage systems.*
- *The site falls from Bickley Road towards Brixton Street.*
- *Gravity service systems such as sewerage and drainage tend to follow the fall of the land. The staging reflects this requirement of construction from downstream to upstream.*

6. ENVIRONMENTAL IMPACTS AND MANAGEMENT

This section details the environmental impacts which will result from the proposed development. These matters are discussed in two parts: first in terms of the preferred development option - a residential subdivision; and secondly, in terms of the alternative option - an area for conservation.

6.1 Preferred Option

6.1.1 Hydrological Impacts

The effect of the proposed development on the hydrology will be insignificant. From the hydrological studies it was determined that the wetlands depend on rainfall for their continued existence. Some overland water movement into the wetland will occur when the rainfall is heavy but the survival of the wetland does not depend on this. If extremely heavy rain falls, the wetland area will experience localised flooding perhaps up to approximately 300 centimetres before the water runs off into the drains.

Drainage Works

Prior to the commencement of road and drainage earthworks on the site it will be necessary to strip the vegetation and root mat to spoil. It is understood that the slope of the individual housing lots will be adjusted so that any water on the surface of the lots will drain towards the street drainage system. Any clayey fill placed during this operation should be placed in 300mm maximum loose thickness layers and compacted. Sand fill is proposed to be placed and completed to a final minimum thickness of 600mm.

The Water Authority of Western Australia wish to drain the area east of the railway (inclusive of the subject site) directly to Binley Brook. To this end the Water Authority of Western Australia propose to extend their main drain along the eastern boundary of Part Lot 35 to Alton Street and Brixton Street. When this occurs, flow from the proposed subdivision and areas to the north and east will be redirected into this main drain. This will mean that potential flows through the railway culvert will be dramatically reduced to such levels that it would only act as an emergency flow path. In the meantime, compensated flows from the subject site are to be discharged toward Yule Brook.

In order to avoid site drainage conditions that may affect the proposed development or the existing drainage regime of adjacent land used by the University of Western Australia, the following site works will be undertaken:

- *Subdivisional works for Lots 48 and 35 will include the shaping of clay such that runoff is directed to the site drainage system and/or the roads;*
- *on top of the shaped clay, 600mm of sand is placed to facilitate site drainage and building;*
- *at approximately the sand/clay interface subsoil drainage is provided; and,*
- *Part Lot 35 and Lot 48 are downstream of Lots Pt 77 and 78, that is, runoff is away from the University's land, not towards the land.*

The effect of the proposed drainage system together with the natural topography of the land ensures that:

- *no ponding will occur at the boundary as this will be picked up by the subsoil system; and,*

- *on site drainage and hence phosphoric fertilisers due to the natural fall of the ground will drain away from Lot 77 and 78 and find their way into the piped drainage system. This system ensures that site runoff will not affect the Yule Brook Botany Reserve.*

It has therefore been established the site can be drained without adversely affecting the hydrologic situation of the adjacent site in the control of the University of Western Australia.

6.1.2 Impact on Flora, Species and Habitat

The impact on the flora in general, particular species and habitats is most serious:

- *two species of Priority Listed flora will be lost from the site; these are Erynguim pinnatifida ssp. and Grevillea thelemanniana ssp. thelemanniana. These are known to exist on other reserved sites in the vicinity;*
- *one species poorly known, named Gonocarpus pithyoides, is also of concern. This is also found elsewhere; and,*
- *the vegetation continuum will be severed thereby affecting the integrity of the adjacent conservation reserves.*

During construction of engineering services these species and habitat will be lost from the site and no techniques or programs are known to minimise or negate the impact of development.

6.1.3 Impact on Fauna, Species and Habitat

The impact on general fauna, the gazetted species of Southern Brown Bandicoot and various habitats is of concern.

- *Two species of waterbird, the black duck (Anas supercidiosus) and white faced Heron (Ardea noveahollandise) were observed. The existing habitat would be lost to these and other species.*
- *The Bandicoot population of the area as a whole would decrease as a result of the development. These are known to exist on adjacent conservation sites.*
- *With regards to habitat, the site, considered to be a significant patch of remnant bushland providing resources for a wide range of fauna, will be lost.*

No techniques or programs are known which might minimise or negate the impact of development.

6.1.4 Noise Impacts

Railway noise and potential vehicular noise from main roads on this site is not as great as many parts of the metropolitan area.

Discussions with the relevant officer at the Environmental Protection Authority indicate that noise can be reduced by development design which will result in noise being screened from most of the site.

Furthermore judicious design of the proposed MRD bridge across the rail and freeway may baffle the noise produced by traffic moving across the structure.

6.1.5 Ethnographic and Archeological Values and Impacts

There are no known Aboriginal sites on this land. The area, being to the north of the Canning River and situated on clay would not have been prime food producing land in pre-settler times.

Areas such as this would have been on periphery of European settlement in the 1800s. The settlers and Aboriginal people preferred the fertile alluvial soils along the Canning River.

It is therefore believed that there are no ethnographic or archaeological values to be impacted in this area. A comprehensive survey may be undertaken, if necessary, before development takes place.

6.1.6 Impact of the Development on Existing Adjacent Residences

The proposed development will obviously result in changes in the area which will have positive and negative implications.

Negative aspects are:

- *increased traffic on local roads;*
- *greater numbers of people; and,*
- *creation of dust and noise during site works.*

Positive aspects are:

- *improved local shopping in the immediate area;*
- *increased opportunity for affordable housing in close proximity to the CBD; and,*
- *creation of 2.7 hectares of Public Open Space with play equipment.*

It is assumed that the social impacts will be handled by the local government through their planning and development approvals system and the Department of Planning and Urban Development.

The creation of dust and noise nuisance during site works is not likely to be of an inordinate magnitude. However, if these aspects prove troublesome during the time of site works, the EPA may offer guidance as to the reduction of any ill effects.

6.1.7 Summary

The main points to emerge from the examination of impacts are as follows:

- *there is insignificant impact on the hydrology of the area;*
- *the greatest impact will be the loss of the vegetation continuum and the flora and fauna;*
- *noise related problems can be managed by building design and layout and bridge construction; and,*
- *the social impact on the existing residents will have advantages and disadvantages - it is believed that the community advantages outweigh the perceived local disadvantages.*

6.2 Alternative Option

6.2.1 Conservation and Impacts

As an alternative option to development the site may be considered worthy of conservation. At the local level the site occupies a distinctive position in the landscape. Regionally the site provides habitats typical of the Pinjarra Plain which are becoming increasingly scarce - particularly the ephemeral wetlands.

If considered for conservation use then environmental impacts are negligible. From a hydrological viewpoint seasonal rainfall on the clayey soils will continue to maintain the ephemeral wetlands. This regime is the basis to many of the species and habitat that occupy the site.

6.2.2 Management

It will be necessary, however, to introduce management programs to assist in the protection of the ecosystem. These include:

- *declaration of the site's conservation significance;*
- *acquisition of the site;*
- *appropriate rezoning of the site at MRD and Local Scheme levels;*
- *fencing of the site;*
- *control of exotic species;*
- *removal of dumped refuse;*
- *fire control; and,*
- *maintenance of existing drainage of the site.*

With these management methods reclamation of the site is considered possible, however, would require funding from the appropriate Authorities and conscientious community effort.

With respect to the long term integrity of the adjacent reserve areas and the intrinsic value of the site as a representative of the wetland habitat for both flora and fauna, biologists consider reclamation a desirable action.

Furthermore, in view of the MRD's proposed bridge across the adjacent rail and freeway Reserves, consideration may need to be given to the extent of the reserved land acquired for the construction of the bridge. Some of the endangered species discovered on the Homeswest site lie within the land set aside to contain the bridge construction. In view of the potentially reduced urban development east of the rail and the biological qualities of the vicinity, it may be necessary to reconsider the proposed bridge for the consequences of its construction amount to the demise of the vegetation continuum, and therefore the integrity of the adjacent conservation sites, and the loss of some endangered species on the former Homeswest site.

There is the inherent implication that adjacent Lot 106 Wanaping Road warrants reservation to assist in protecting the subject site and the importance of the vegetation continuum.

In the event that the site is considered unsuitable for development and that the environmental characteristics are appropriate for conservation, declaration of the significance of the site requires consideration of a rezoning Amendment under the Metropolitan Region Scheme from "Urban Zone" to reservation of the land as "Public Purposes : Special Uses". Furthermore, an Amendment would also be required of the City of Gosnells Town Planning Scheme No. 1 from "Rural Zone" to "Public Use Reserve".

In respect to land tenure arrangements, consideration of compensation in the form of a land exchange or direct acquisition of the site is necessary.

7. CONCLUSION

This proposal is a typical urban land use conflict. The land has inherent environmental value and therefore may be regarded by environmentalists to have attributes worthy of conservation. The land also has strategic urban value being in proximity to the railway station and is seen by urban planners and energy conservationists as being valuable land suitable for development.

On the one hand, the analysis has shown that the greatest environmental value lies in the biology of the site. Conservation of the site is considered desirable by biologists mainly because it helps maintain the integrity of the adjacent conservation sites and, to a lesser extent, its value as a representative wetland habitat. The site also offers habitat for the Gazetted rare species of Bandicoot.

Acceptance of the conservation alternative requires consideration of land, acquisition or land exchange solutions in addition to an environmental management plan for the site. The implied consequences of accepting the principle of maintaining the vegetation continuum is that there shall be no development of Lot 48, Part Lot 35, Lot 106 and the Brixton Street flyover.

On the other hand, the land in question is in the centre of an urban development corridor and has a high value for residential use. Development of the site will incur insignificant impact on the hydrology of the area and any noise related problems can be managed.

Most developments on land which has not previously been developed incur a loss to the environment. In this instance, the major impact of the proposal is that vegetation and flora will be lost due to clearing of the site and filling with approximately 600mm of sand.

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9. *Singleton, J., 1989: The History and Tenure of Wetlands, in* ***Wetlands in Crisis - What Can Local Government Do?,*** *Bulletin 372, Environmental Protection Authority, Perth, Western Australia.*

10. *State Planning Commission, 1987:* ***Plannning for the Future of the Perth Metropolitan Region,*** *WA Government Printer.*

11. *Stokes, J., 1987: Innovation in Residential Development - the Joint Venture for More Affordable Housing,* ***Australian Planner,*** *Vol. 25 No. 2.*

Attachment 1.1
EPA GUIDELINES

GUIDELINES FOR THE PREPARATION OF A CONSULTATIVE ENVIRONMENTAL REVIEW (CER) - PROPOSED URBAN DEVELOPMENT ON LOTS 35 AND 48 BRIXTON STREET, KENWICK

The following is a guide to the type of information required for the preparation of a CER to enable environmental assessment of the above proposal to be undertaken.

1. Introduction

The introduction should be a brief preview of the proposal and should include identification of the proponent and the rationale behind the development. In this case the suitability of the site for low and medium density development due to its location close to the railway could be discussed Identification of the site location should also be undertaken at this stage.

A discussion of the relevant statutory processes involved including environmental impact assessment and approvals needed through the planning process is also helpful to the reader of the final document.

2. Public Participation and Consultation

A description should be provided of any public participation and consultation activities which may be undertaken. This should include the methods used, the people involved (such as local authorities and conservation groups), the timetable of the activities and the objectives A summary of concerns raised by these people should be included along with measures proposed by the proponent to address them.

3. Benefits of the Proposal

This section provides the proponent with the opportunity to discuss the rationale for the proposal in more detail including benefits to the community if the proposal were to proceed. A discussion of alternatives to the preferred development option (including no development) should also be undertaken.

4. Description of Existing Environment

This section should include a thorough description of the existing physical biological and social environment in the area. This should included a description of:

Physical Environment

- *topography;*
- *soil types and their distribution over the site;*
- *hydrological information (surface and groundwater); and,*
- *noise levels on the site, particularly with regard to the railway line.*

Biological Environment

- *indigenous and exotic flora on the site and their conservation value on a local and regional scale; and,*
- *indigenous and exotic fauna on the site and their conservation value on a local and regional scale.*

Associations formed between these facets of the physical environment and the biological environment to form the ecosystem as a whole should also be investigated. For example, this could include such techniques as mapping vegetation against soil types and the hydrological system.

Social Environment

- *historical/anthropological significance of the area; and,*
- *current human use of the site.*

5. Project Description

This section should contain a thorough description of the proposal including facets such as proposed development design, the provision of services and timing of the development. This should also include a brief discussion of potential environmental impacts and their management as an integral facet of the proposal.

6. Environmental Impacts and Management

The environmental impacts section should be a thorough discussion of environmental impacts and proposed techniques for their management. The environmental impacts should be discussed in relation to the construction (physical impact of equipment etc) and operation (for example the long term management of remnant bushland) phases of the development. Some potential environmental impacts likely on this site are listed below but it should be noted that this list is a guide only and is not necessarily comprehensive:

- *hydrological impacts including the impact of development on the existing wetlands/and stormwater disposal;*
- *impacts on the flora and fauna on the site in terms of indivdual plant and animal losses and loss of habitat;*
- *noise impacts on future residents of the site, particularly from the railway;*
- *ethnographical archeological values; and,*
- *impacts of the development on existing adjacent residences and landuses.*

After the environmental impacts have been identified, integrated management programmes and techniques need to be developed to minimise or negate these. To be effective, the management if impacts should be an integral, well planned partof the project as a whole.

7. Conclusion

This should be a synthesis of the overall environmental impact of the proposal and how it has been addressed to make the project environmentally acceptable.

8. Environmental Commitments

When a potential environmental impacts is identified, the proponent should provide an undertaking (Environmental Commitment) to address this potential impact to prevent its occurrence. A commitment should contain the following information:

- *who will do the work?;*
- *what is the nature of the work?;*
- *to whose satisfaction will the work be carried out?;*
- *when the work will be carried out?; and,*

- *if appropriate, where the work will be carried out?*

An example of a list of commitments from a recent EPA assessment report is attached for your information.

Commitments should be individually numbered in their own section to improve the ease of implementation.

9. Diagrams/Plans

Detailed plans of the site should be included showing:

- *existing land uses including vegetation areas and types;*
- *adjacent land uses;*
- *residential development layout; and,*
- *roads and services.*

A copy of the finalised guidelines should be incorporated in the CER.

Attachment 4.1
CALM/A.G. Consulting Hydrology Report

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

2284/1

NOVEMBER 1989

HYDROLOGICAL INVESTIGATIONS
HOMESWEST SITE BRIXTON STREET
KENWICK

INDEX

APPENDICES

FIGURES

2 SITE INVESTIGATION

2.1 Location

The total Homeswest site includes Lot 37, Lot 47, Pt 34 and Pt 36, zoned Urban in the Metropolitan Region Scheme, and Residential A under Council's Scheme. Lots 37 and 47 have a 350 m frontage to Brixton Road, as indicated on the accompanying plans. The Midland-Fremantle railway forms the north-western boundary of the project site, while the Midland-Armadale railway and unimproved Staplehurst Street form its south-western boundary.

The approximate area of the total site is 24 hectares.

The wetland areas containing the rare and endangered vegetation are entirely within Lot 37, although their localised catchment extends into the adjoining Lot 47. Lot 37 comprises 19 ha of the total site area.

2.2 Soils

Within the Homeswest site, the substrate is a thin veneer of silty to clayey sand (between 0.01 m to 0.4 m thickness) overlying Guildford Formation clay and sandy clay. Soils of the Guildford Formation occur to a depth of about 12 m below ground level. The Guildford Formation in turn overlies Osborne Formation sands and silts. Logs of two auger holes dug on Lot 37 are presented in Appendix II of this report.

Occasional lenses (or possibly layers) of clayey sand and sand are present within the Guildford Formation, intersection occurring at depths between 7 and 12 m below ground level in sewerage line trenches on the adjacent Lot 46 and some nearby water bores.

Soils of the Guildford Formation also underlie much of Lots 106, Pt 35 and Pt 48 to the north of the Homeswest site.

1 INTRODUCTION

Homeswest proposes to develop a site in Brixton Street, Kenwick for residential purposes. The site includes wetland areas which contain rare and endangered species of vegetation. The development concept proposed by Homeswest provides for retention of the wetland areas, although there is still concern about maintaining the hydrological integrity of the wetlands following development. To assist decision-making on the development proposal, the Department of Conservation and Land Management (CALM) has requested Australian Groundwater Consultants Pty Limited to conduct a brief hydrological examination of the Homeswest site and surrounding area. The study brief is included as Appendix I.

Site inspection was undertaken to map drainage and inspect water bores. A discussion was also held with the engineering consultant Wood and Grieve which has undertaken some recent development related work in the area. Reference was also made to the following reports provided by CALM. These reports relate to the development of land adjacent to the Homeswest site.

> Feilman Planning Consultants (September 1989) 'Proposed Subdivision Lot 48 and Pt Lot 35 Brixton Street, Kenwick. Planning Report for St Josephs Properties Pty Ltd and Dudley and Dwyer Limited'.
>
> Wood and Grieve Engineers (September 1989) 'Servicing Lots 48 and Pt Lot 35 Brixton Street, Kenwick, for St Josephs Properties Pty Ltd and Dudley and Dwyer Ltd'.

2.3 Groundwater Levels

A site inspection was conducted on 7 November 1989 during dry weather. Unfortunately water bores could not be inspected as landholders were absent. However, some indication of groundwater level may be determined from Water Authority records, auger holes, and inspection of drains.

Groundwater static water levels are about 1.3 m below ground level under the Homeswest site, deepening to approximately 1.5 m in and adjacent to the deeper drains.

To the northwest, in Lots 106, Pt 35 and 48 (between Bickley Road and Brixton Street), groundwater levels are a little more shallow. From inspection of drains, groundwater levels vary from 1.1 m to 0.9 m below ground level, with water table swamps occurring in Lots 106, Pt 35 and Kenwick Swamp near Boundary Road.

3 DISCUSSION

The brief provided poses a number of specific questions and these are addressed hereunder.

What are the drainage patterns, into, and out of the whole area?

Drainage patterns have been identified at the regional scale (Figure 1).

The site is part of low lying flat land between Yule and Bickley Brooks. Water table swamps, and depressions seasonally filled with water are evident.

Drainage is westward as illustrated on Figure 1, towards Yule Brook, a Water Authority drain and stream collecting runoff from an extensive foothills catchment. Runoff from the foothills between Yule and Bickley Brooks (Figure 1) is probably redirected south or north by Tonkin Highway and other roads.

Surface runoff from the eastern part of the catchment is towards Kenwick Swamp (Figure 2), the low ground between Brixton Street and Bickley Road, and Lot 37. As it moves west and southwest, runoff is intercepted by a drain (clogged with vegetation and debris) on the north-eastern side of the levee formed by Brixton Street (Figure 2). This drain directs runoff towards Yule Brook.

A clogged, shallow drain dug sub parallel to Brixton Street, between Wanaping and Kenwick Roads, may allow flow also towards Yule Brook.

Whilst most runoff is directed by the Brixton Street levee to Yule Brook, a culvert under Brixton Street may allow some runoff into a very shallow clogged drain along side Alton Street. Thus, some runoff from the land to the north east of Lot 37 may find its way into Lot 37, via this culvert.

Surface runoff from Wanaping Road and Brixton Street is intercepted by a deep drain on the south-east boundary of Lot 37 (Figure 2). This drain also intercepts surface runoff from Lot 37, and discharges via culverts into the Binley Brook Branch Drain, and thence into Yule Brook to the south of Albany Highway (see Figure 2). Surface runoff within Lot 37 is via an ill defined intermittent 'stream' with associated depressions (ie the wetland areas of interest).

An approximate catchment and drainage area is sketched on Figure 1 at 1:50 000 scale with the more detailed drain and stream pattern on Figure 2 (1:5 000 scale). Lots 37 and those lots between Bickley Road and Brixton Street (Lots 106, Pt 35, Pt 48, Pt 243) have a catchment area of approximately 2.5 km^2. The catchment area for Lot 37 appears to be largely internal, due to the presence of the Brixton Street levee. Just how much 'outside' water finds its way into Lot 37 via the culvert under Brixton Street is unknown, although the size and elevation of the culvert pipe suggest that such contribution is not large.

What are the sources of water to the damp flats and the seasonal wetland; especially, is groundwater involved?

Kenwick Swamp, situated adjacent to Bickley and Boundary Roads, is a water table swamp. Swampy ground in Lots 106 and Pt 35 between Bickley Road and Brixton Street contains bullrushes (Typha) and may also be a water table swamp.

The damp flats and depressions within Lot 37 do not intersect the water table. They either lie within pre-existing natural drainage (Figure 2) or in natural hollows over a clayey substrate. The wetlands receive water via surface runoff from the northern portions of Lots 37 and 47, and possibly from the culvert under Brixton Street. Exactly if and how water from the culvert under Brixton Street drains to the depressions is unclear as the land is very flat.

Refer to Figure 2 for the approximate catchment area of these wetlands.

What changes to water levels, drainage patterns, or water quality, might result from -

i) development on parts of the 19 ha block itself?

ii) proposed developments to the north east and north west of the block?

The development concept proposed by Homeswest is illustrated on Figure 3, which also shows present drains. It is evident that there will be a change to local surface runoff patterns within Lot 37 in the event of development as proposed by Homeswest.

As previously indicated, the wetlands within the Homeswest site are sustained by surface runoff from the northern portions of Lots 37 and 47. Under the development concept proposed by Homeswest, about 15% of the catchment area of the wetlands within Lot 37 would be developed. This is a very approximate figure only, as the actual extent of the catchment is difficult to determine because of the flatness of the site. Clearly, this would result in some reduction of water input to the wetlands. However, without undertaking a full water balance for the wetlands, quantification of this reduction is not possible. Nevertheless, because of the characteristics of the catchment, the amount of water being lost to the wetlands would be less than the actual proportion of the catchment to be removed through development.

Water quality changes may occur, although such changes cannot be quantified at this stage. Typically, however, there would be some deterioration in the quality of runoff water from Lot 37 following development, potential pollutants including petroleum products from vehicles, detergents, herbicides and pesticides used by residents. It is assumed that the proposed development would be sewered, thereby obviating sewage as a source of potential pollutants.

It is expected that groundwater levels will be little affected by development in Lot 37 alone. Historically, drainage construction in this area has not significantly altered groundwater levels. Accordingly, the establishment of drains within and at the perimeter of the site should have minimal impact on groundwater levels, although the magnitude of any changes cannot be quantified at this stage.

Proposals for adjoining lands include development of a low lying wetland area. This area will need to be filled to approximately RL 6.5 AHD, with a drain constructed along the boundary between Pt Lot 35 and Lot 106 (Figure 3). This drain would discharge to the drain on the north-east side of Brixton Street and thence to Yule Brook. Under these arrangements, there appears little need to lower groundwater levels in this area.

Development proposals for the adjoining area also include a scheme whereby drainage from the Brentwood-Bickley Road area would be routed along the south-east boundary of Lot 37 (Alton Street), and thence to the Binley Brook Branch Drain. Such a scheme would require extension of the present drain along Alton Road. There would be no impact from this drain on runoff within Lot 37, as it is merely carrying water from elsewhere and unless topographic gradients within the south-eastern part of Lot 37 were modified, would not be collecting drainage from Lot 37. However, the scheme includes a compensation basin in the south-western extremity of the site (see Figure 3) in an area that Homeswest proposes for open space. This and other basins are intended as compensating areas for runoff from more intense storm events (ie greater than 5 year recurrence intervals).

It is concluded that runoff and site drainage from adjacent development will have little impact on Lot 37. Provided drains and compensation basins conducting runoff from the Brentwood-Bickley Road area are properly designed and constructed, the drain along Alton Street should not overtop, thereby threatening the wetlands or development within the Homeswest site.

Any possible lowering of groundwater levels in surrounding areas (for example by dewatering or pumping), even if affecting groundwater levels under Lot 37, will have no effect on the surface fed depressions. Deep rooted trees may be affected, although most would be removed as a direct consequence of the proposed development.

Although detailed design work has not been completed, indications are that approximately 30% of the catchment area of the wetlands within the Homeswest site will be required to accommodate embankments associated with the bridging of Brixton Street over the railway line and Roe Highway. The potential loss of water to the wetlands as a result of embankment construction would be of far greater significance than that associated with residential development proposed by Homeswest. Obviously, a full water balance would be needed to determine what the effects of embankment construction would be.

Is it feasible to minimise or eliminate the hydrological impacts affecting the portions of the site containing the rare plant species which could result from residential development over the balance of the site and nearby land?

What options are there for controlling the hydrology of the land containing the rare plant species so as to minimise or eliminate the impact of nearby residential development upon that land?

As indicated, the wetlands within the Homeswest site are localised surface water features. Any threat to the hydrological integrity of the wetlands will, therefore, arise from development within the Homeswest site rather than beyond the site.

Under the development concept proposed by Homeswest, some of the wetlands' catchment area would be lost and there would obviously be a consequent reduction (albeit small) in water input to the wetlands.

To determine the actual volume of make up water that would be needed to compensate for the loss of catchment area, a full water balance would need to be undertaken. However, it is clear that surface runoff from the proposed development would considerably exceed the volume of water currently reaching the wetlands from that part of the catchment affected by the development proposal. The opportunity to supplement the wetlands with runoff water from the development therefore exists.

If this option was to be pursued, however, only non-polluted roof water (as distinct from general surface drainage) should be used. Roof water should be sufficient to compensate for the lost area of catchment and would not carry the range of pollutants contained in normal surface runoff from residential lands. However, it is again stressed that the volume of make up water actually needed would have to be clearly established. Also, a drainage system that would deliver this quantity of roof water, while directing excess roof water and general surface drainage elsewhere, would need to be designed and installed as part of the development. This is essential because of the sensitivity of the rare and endangered species to water level changes and the consequent need to maintain the present water regime in the wetland areas.

Other sources of make up water could also be used, although the roof water would inevitably be a less potentially polluting supply.

Another alternative for addressing the hydrological impacts from the proposed development would be to modify the actual development concept so as to maintain the wetlands' current catchment area. This would probably be the simplest way of maintaining the hydrological integrity of the wetlands. Additionally, redesign of the development concept would be desirable from the point of view of establishing a more substantial physical buffer between the wetlands and the residential area. It is necessary to acknowledge, however, that the redesign envisaged here would inevitably reduce the area available for development.

The greatest potential threat to the wetlands is from alteration of their catchment associated with the bridging of Brixton Street over the railway line and Roe Highway. This work is understood to be totally independent of the Homeswest development proposals, being required to maintain Brixton Street as an important through route following construction of Roe Highway. While it may be possible to lessen the impact of the bridgeworks on the wetlands' catchment through redesign (eg by eliminating the embankments and extending the actual bridge) costs would be considerably (perhaps prohibitively) higher.

The provision of make up water would be the only other option for addressing the effects of the bridge works on the wetlands within the Homeswest site.

Again, the actual amount of make up water required would need to be established from a full water balance. Roof water from the Homeswest development may yield sufficient make up water. If not, other sources would be available, but would be of lesser quality. Appropriate drainage systems would also be needed to ensure satisfactory distribution of the make up water within the catchment, and that any excess water would be directed elsewhere.

4 CONCLUSIONS

Based on the investigations undertaken, the conclusions reached are as follows -

- The wetland areas within the Homeswest site are purely surface water features fed mostly by a limited catchment within the total Homeswest site, and possibly some contribution from the north-east via the culvert under Brixton Street.

- Present indications are that drainage schemes associated with broader development proposals in this area should not affect the hydrology of the wetlands within the Homeswest site. To achieve this objective, the drainage systems installed as part of the broader development proposals would need to avoid dewatering the Homeswest site or discharging water onto the site.

- The development concept for the Homeswest site would remove approximately 15% of the wetlands' catchment area and, therefore, would reduce the amount of water entering the wetlands, although a full water balance would be needed to determine the proportional reduction.

- Maintaining the current water regime in the wetlands is essential because of the sensitivity of the rare and endangered vegetation to water level changes.

- Make up water will, therefore, need to be directed to the wetlands, although the specific volume of such water cannot be determined without undertaking a full water balance.

- While various sources of make up water could be used, roof water from development within the Homeswest site would be the most appropriate supply because of its low pollution potential.

- The drainage system installed as part of development at the Homeswest site would need to ensure that only the required portion of roof water was directed to the wetlands, and that excess roof water and general surface drainage was directed elsewhere.

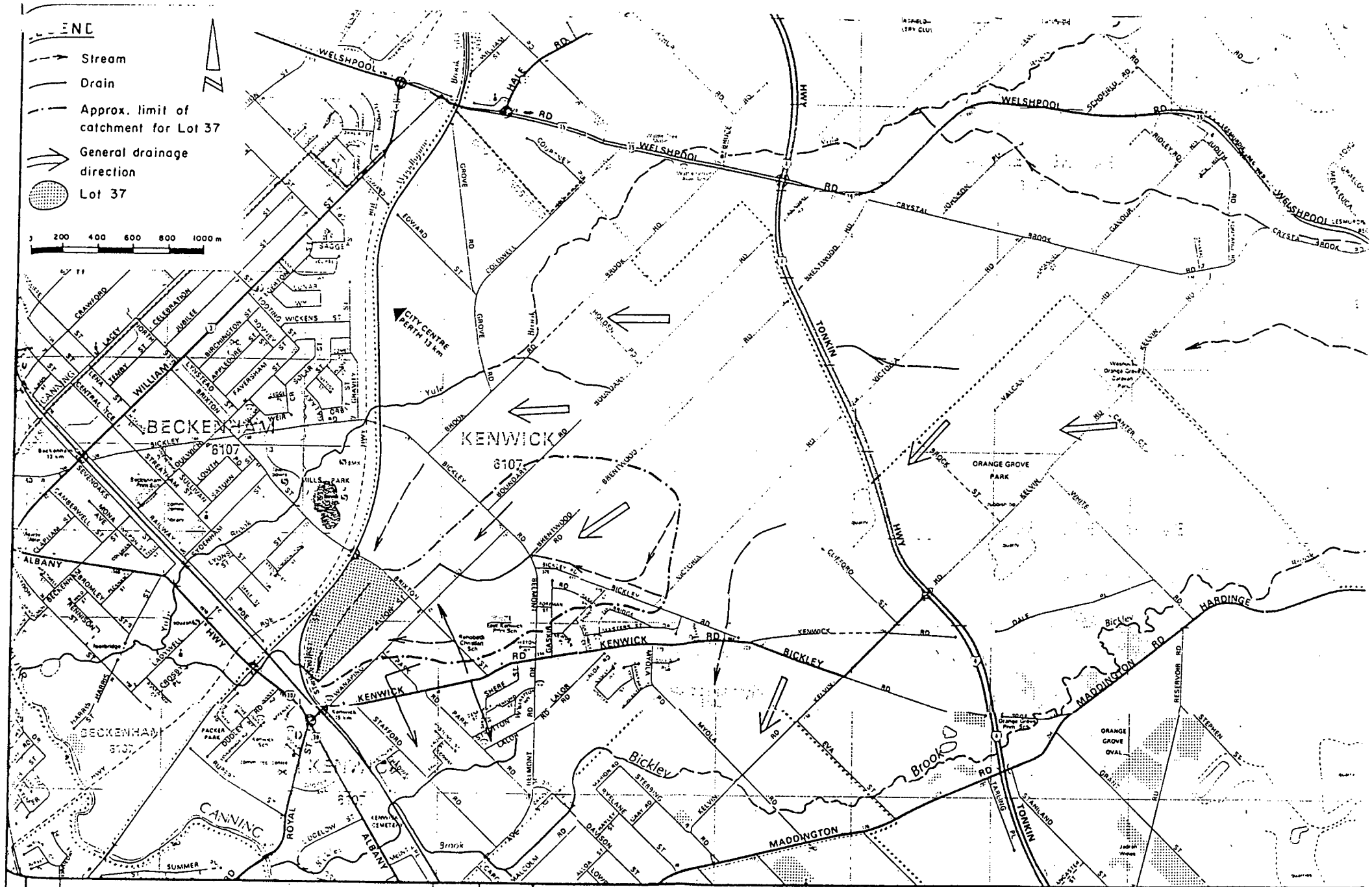
- As an alternative to manipulating drainage within the development to compensate for the loss of catchment area, the design concept could be modified to simply retain the current catchment area in its entirety.

- The greatest threat to the hydrological integrity of the wetlands within the Homeswest site is posed by proposed bridge works on Brixton Street which would lead to the loss of approximately 30% of their catchment area.

- While this threat could be lessened through redesign of the bridge works, provision of make up water to compensate for the loss of catchment appears the most realistic amelioration option.

- The volume of make up water required would need to be established from a full water balance and the sources selected accordingly (again, roof water would be the preferred source).

- Particular requirements relating to the delivery of make up water to the catchment area would need to be established, and a drainage system capable of satisfying these requirements designed and installed.

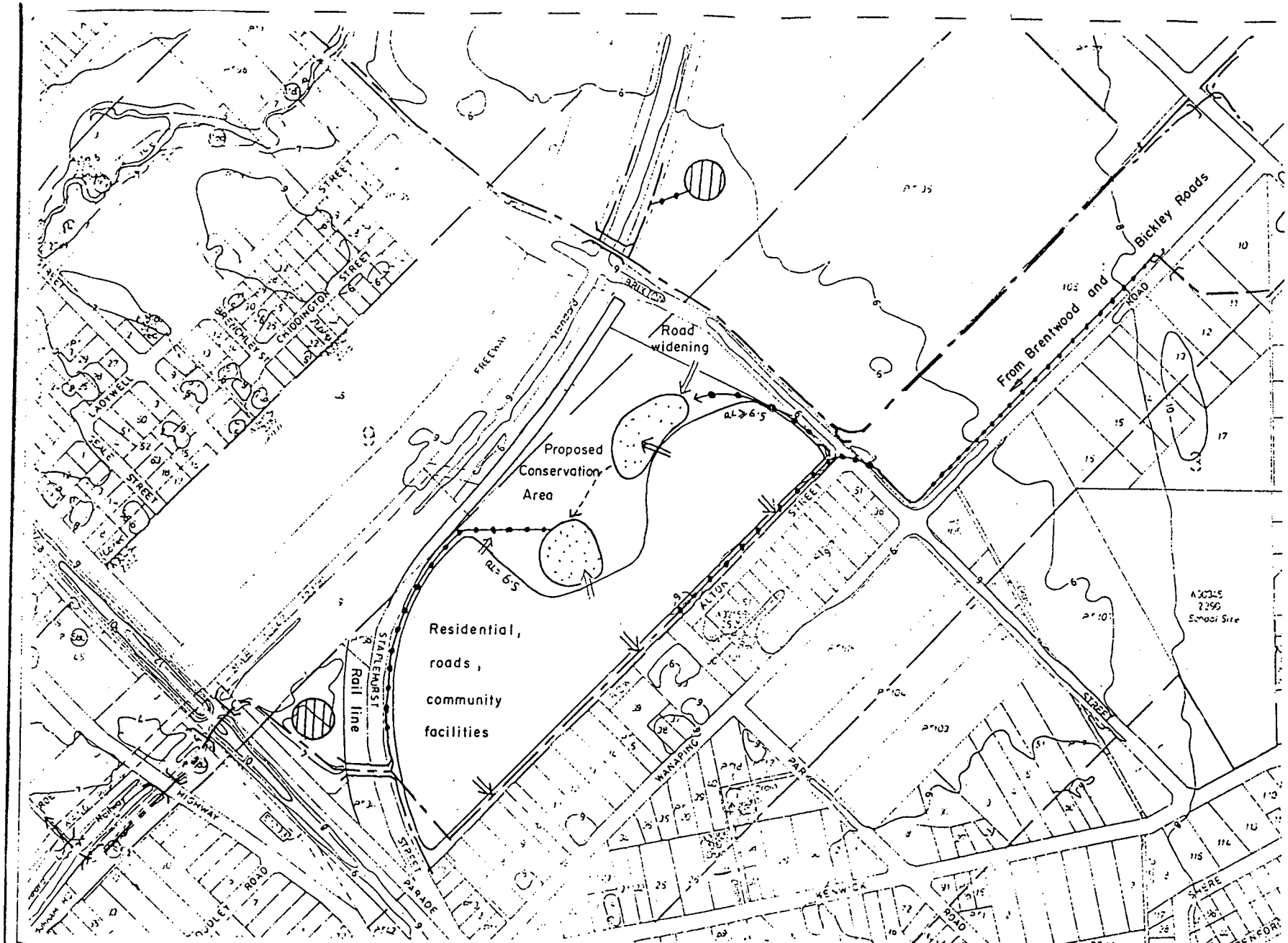


REV	DESCRIPTION	DRAWN DATE	CHECKED DATE

AUSTRALIAN GROUNDWATER CONSULTANTS PTY LIMITED

CATCHMENT AND DRAINAGE LOT 37, BRIXTON STREET

DATE November, 1989 | DWG 2284 - 1 | FIGURE 1



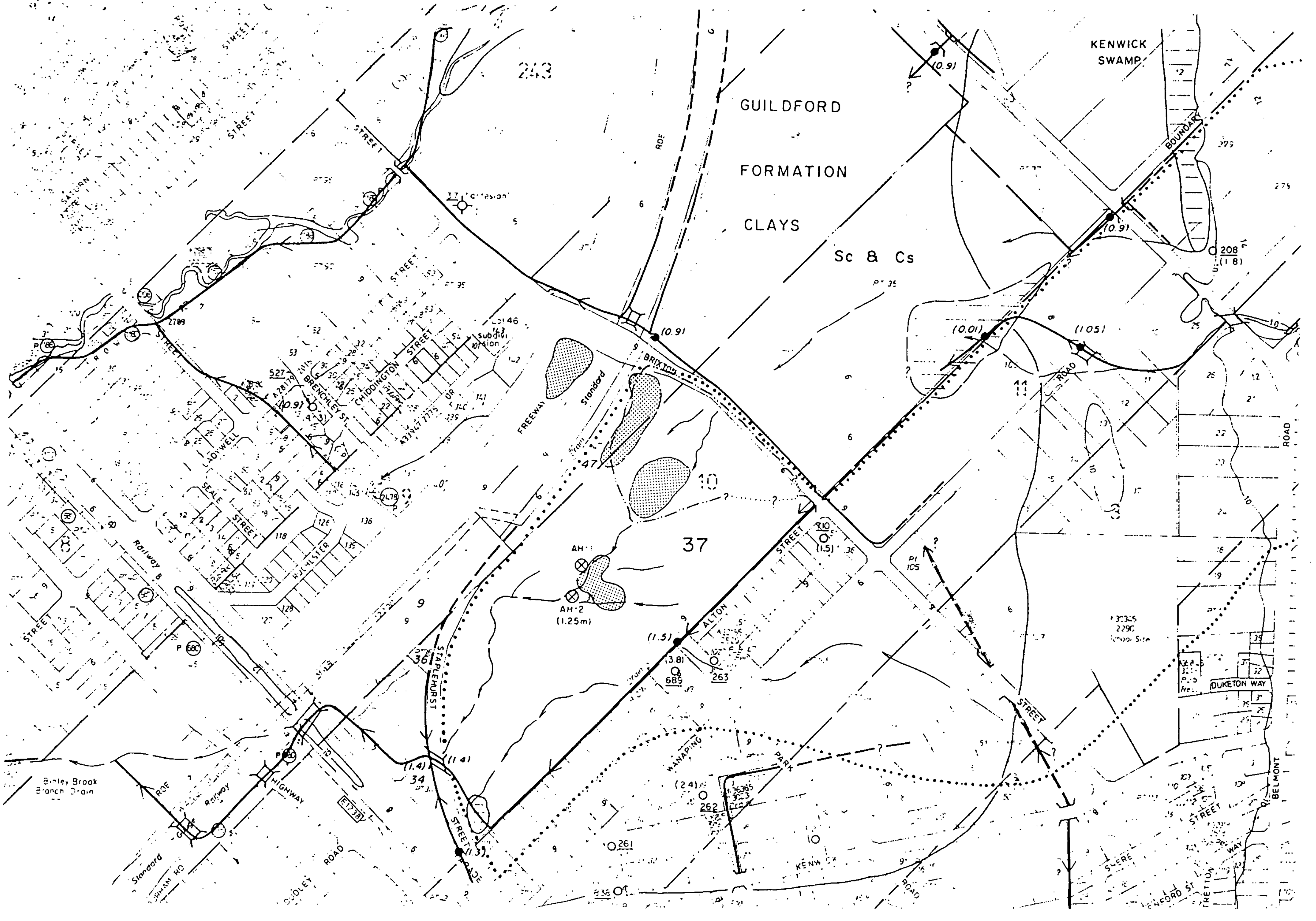
REVISION				
	DESCRIPTION	Drawn Date	Chk'd Date	

AUSTRALIAN GROUNDWATER CONSULTANTS PTY LIMITED

300 ALBANY HIGHWAY, VICTORIA PARK, W.A. 6100. (091) 362 4322

LOT 37 BRIXTON STREET
POSSIBLE DRAINAGE FROM DEVELOPMENT

Date November, 1989.	Dwg. 2284 - 3	Fig. 3



GUILDFORD
FORMATION
CLAYS
Sc & Cs
KENWICK
SWAMP
BOUNDARY
ROE
FREEWAY
Standard
BRIXTON
37
10
11
AH-1
AH-2
(1.25m)
ALTON
STREET
STAPLEHURST
HIGHWAY
Railway
ROE
Binley Brook
Branch Drain
DUDLEY
ROAD
KANAPING
PARK
KENWICK
ROAD
DUKETON WAY
BELMONT
CHIDDINGTON
BRENCHLEY ST
LADYWELL
SEALE
STREET
ROCHESTER
Subdivision
(0.9)
(0.01)
(1.05)
(1.5)
(1.4)
(3.8)
(2.4)
208
(1.8)
262
263
261
689
36
34
243

Attachment 4.2
Flora and Fauna Report

REPORT ON A BIOLOGICAL SURVEY OF LOTS 48 AND PT 35

BRIXTON STREET, KENWICK.

PREPARED FOR HAMES SHARLEY, AUSTRALIA

BY E. M. GOBLE-GARRATT AND ASSOCIATES.

October 1991.

SUMMARY.

The survey area is situated on the eastern side of the Swan Coastal Plain on a fairly wide development of the Geomorphic Unit known as the Pinjarra Plain. The soils are clayey and the site is seasonally inundated.

A total of 212 taxa of vascular plants were identified during the survey of which 163 were native taxa, and 48 naturalised exotics. The flora compares with that of the adjacent reserve areas with almost half of the native species identified (73), common to all three areas. No species of Declared Rare Flora was found on the site, however three taxa on the Priority Flora lists were encountered.

The vegetation may be described in general terms as a mosaic of wetland communities. Seven vegetation/community types were delimited and mapped. These are *Melaleuca* Shrubland, *Leptocarpus* species Flats, *Hypocalymma angustifolium* and *Verticordia* species Low Shrubland, *Viminaria* Tall Shrubland, Mixed Low Shrubland, *Pericalymma ellipticum* Low Shrubland, and *Eremaea* Low Shrubland. The site occupies an intermediate position in the continuum of vegetation types across the area as a whole.

The fauna assessment included an opportunistic site inspection, and subsequently an estimation of the Southern Brown Bandicoot population. A total of 19 species of bird, one native and one introduced mammal, two amphibians and two reptiles were recorded. Habitat assessment suggested that a further 85 native vertebrates may occur there in different seasons.

The Bandicoot population was estimated by a comparitive count of "diggings" on the survey area and on Harry Waring Reserve, Jandacot. On this basis the population on the survey area was estimated as being less than 11 individuals. At present the adjacent reserve areas appear to support denser populations of Bandicoots. Not enough is known about seasonal movements of the species, or of the effect of roads as barriers to their movement, to draw definite conclusions as to the importance of the site *vis a vis* the adjoining areas.

In a regional context, the site is an example of the ephemeral wetland habitats of the Pinjarra Plain that are becoming increasingly scarce.

TABLE OF CONTENTS.

1. GENERAL INTRODUCTION.

The following reports on a survey commissioned by Hames Sharley Australia as part of a Consultative Environmental Review (CER) for a proposed urban development on Lots 48 and Pt 35, Brixton Street, Kenwick.

The survey area is situated on the eastern side of the Swan Coastal Plain on a fairly wide development of the Geomorphic Unit known as the Pinjarra Plain (McArthur and Bettenay, 1960). The soils are fluvial in origin and belong to the Guildford Association (Bettenay *et al*, 1960). The Armadale map sheet of the Perth Metropolitan Region 1:50 000 Environmental Geology Series (Jordan, 1986) shows the greater part of the site to have clayey sand at the surface. Surface material in the southern corner has a higher proportion of fine material and is mapped as sandy clay, whilst in the north-eastern corner the Guildford Formation is overlain by a thin layer of Bassendean Sand.

The site slopes from the north-east to the south-west, but is all low lying. With the exception of the north-eastern corner the area is subject to seasonal inundation. Tracks/firebreaks surround and cross the site, and drainage canals run along the Brixton Street boundary and between Bickley Road and Brixton Street on the eastern side.

The tracks are used by local horse owners for exercising their animals, and in summer may also be used by trailbike riders. Large parts of the eastern third of the site along Wanaping Road are badly invaded by exotic species. These areas may have been partially cleared or have been grazed in the past. Dumping of garden refuse continues to introduce weedy plants to the area. As is the case with most remnants in the metropolitan area, the site has been frequently burnt. Part of the central-northern quarter was burnt earlier in 1991.

Surrounding land use includes rural subdivisions on the east and north, a recreation complex west of the railway line, and a small strip of urban development at the southern corner. To the north-east is the Yule Brook Botany Reserve which belongs to the University of Western Australia (System 6 recommendation area, M69). South of Brixton Street is another area of native vegetation which has been proposed for vesting in the National Parks and Nature Conservation Authority as a reserve for the protection of flora and fauna (Environmental Protection Authority, 1991). These two areas of remnant bush are both considered to be biologically important, especially in respect of their native flora. Species lists of the flora and descriptions of the vegetation of these areas appear in Speck and Baird (1984) and Keighery and Keighery (1991).

2. FLORA AND VEGETATION.

2.1 Introduction and Objectives.

The general floristics of the area are known from the work done over many years by the staff and students of the Botany Department of the University of Western Australia. More recent documentation of similar habitats by biologists

from the Department of Conservation and Land Management and interested members of the public have added to the information available. The winter wet areas are particularly diverse, and the flora includes a suite of specialised winter ephemerals. The local flora is also known to contain elements normally associated with Darling Scarp habitats.

Of the 10 species from the Metropolitan Region currently on the Schedule of Declared Rare Flora, *Aponogeton hexatepalus, Calytrix breviseta* ssp. *breviseta, Diuris purdiei* and *Hydrocotyle lemnoides* have been previously been identified in the vicinity.

On a regional scale the vegetation of the Pinjarra Plain has been described by Beard (1979). He mapped the vegetation of the area as Marri (*Eucalyptus calophylla*) Woodland, although he described the Pinjarra Plain vegetation on clay soils as Paperbark swamp with a range of *Melaleuca* species, and patches of Banksia low woodland. Heddle *et al* (1980) show the native vegetation potential as being of the Southern River Complex. This is Marri/Jarrah woodland with Melaleuca thickets along water courses and in lower, wetter areas. This description applies more to the southern distribution of the Pinjarra Plain. In the Kenwick area the Melaleuca- and associated wetland communities are more prevalent. However, much of the Pinjarra Plain has been cleared for agriculture or urban developments, and in some areas the original vegetative cover can only be extrapolated from small remnants.

The objectives of the current survey were:

- to provide a checklist of the vascular flora of the site,
- to describe the vegetation communities present in broad terms, and
- to comment on the importance of the site with respect to the flora and vegetation in a local and regional context.

2.2 Methods and Limitations.

The site was surveyed opportunistically over several days in late September and early October. This included walking all the tracks/firebreaks, and also traverses across the less disturbed western part. A checklist was compiled of the species encountered. Where field identification was not possible voucher specimens were pressed for later identification or verification at the WA. Herbarium. As the survey took place over a limited period, and was not systematic, the species list cannot be considered complete. Notes were taken of vegetation changes and these were used in conjunction with aerial photography to map the community types in broad terms. The vegetation types recognised were related to the published descriptions of the adjoining sites, although correspondence is not meant to be exact. The nature of the survey determined that some of the complexity in the mosaic of heath types could not be mapped. Mapped vegetation boundaries must be considered approximate as boundaries between the recognised units were rarely distinct. The fire history of the site compounded the difficulties encountered in mapping from the aerial photo.

2.3 Results.

2.3.1 Flora.

A total of 212 taxa of vascular plants were identified during the survey of which 164 were native taxa, and 48 naturalised exotics (Appendices 1 and 2). The flora compares with that of the two adjacent sites with almost half of the native species identified (73), common to all three areas. A further 48 taxa are shared with the Yule Brook Reserve, and there are 21 others which also occur on the proposed reserve on Brixton Street.

There are 109 genera from 46 families of native vascular plants represented in the checklist. The families best represented are the Myrtaceae (19 taxa), the Proteaceae (16 taxa), the Papilionaceae (14 taxa), the Restionaceae (11 taxa), and the Cyperaceae and Haemodoraceae (9 taxa each). Surveying over a longer period of time would undoubtedly add to the checklist, especially in the case of less conspicuous herbaceous species.

None of the species of Declared Rare Flora mentioned in the introduction were found on the site. The most heavily inundated areas of the site where *Melaleuca laterita* occurs and where the two aquatic species (*Aponogeton hexatepalus* and *Hydrocotyle lemnoides*) might be expected, are now choked with weedy perennial grasses. The pools on the flats on the western side are either not deep enough, or are not inundated for long enough to support these species. A small area of *Pericalymma ellipticum* dominated vegetation which is the typical habitat of *Diuris purdiei*, does occur on the site. However this plant only becomes visible after a summer fire and was not found. *Calytrix breviseta* ssp. *breviseta* is known to occur in association with various *Verticordia* species in low heath similar to that found on the site, but was not encountered in the survey.

Three taxa on the Priority Flora lists of the Department of Conservation and Land Management were encountered during the survey. Two are Priority 1 taxa, which are defined as follows:

> *These are taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat. These taxa are under consideration for declaration as "rare flora", but are in urgent need of further survey.*

These two taxa are -

- ***Eryngium pinnatifida* ssp. "*palustris*"**
  This is an as yet not formally described taxon which is only known from the adjacent proposed reserve site on Brixton Street and from the Serpentine area.

- ***Grevillea thelemanniana* ssp *thelemanniana***
  This subspecies appears to be confined to moist sites on the eastern side of the Swan Coastal Plain in the metropolitan area. It also occurs on the Yule Brook Botany Reserve.

The third Priority taxon is listed as Priority 3. These taxa are defined as follows:

> *Taxa which are known from several populations, at least some of which are not believed to be under immediate threat. These taxa are under consideration for declaration as "rare flora" but are in need of further survey.*

The species concerned is -

- ***Gonocarpus pithyoides***
  This species occurs on the Swan Coastal Plain between Perth and Gingin, and is possibly poorly collected rather than rare. It has been recorded on both the Yule Brook Reserve and the proposed reserve on Brixton Street.

2.3.2 Vegetation.

The vegetation may be described in general terms as a mosaic of wetland (seasonally inundated) communities. Community boundaries are rarely distinct but intergrade in the form of a continuum. The distribution of species assemblages is determined by the topography and substrate conditions, and thus the hydrological regime. The degree and temporal extent of winter inundation are probably the primary limiting factors on the lower lying areas, whilst the depth of sand above the clay and soil fertility factors, play a major role on better drained areas. The fire history (frequency and timing) and the degree of historical and current human use also influence the current boundaries.

Structurally the vegetation ranges from a low (<0.5m), open community of sedges (*Leptocarpus* species) and samphires (*Halosarcia halocnemoides*), to dense thickets of *Melaleuca* species to 3m in height. The majority of the site however, supports various dense shrublands which rarely exceed 1.5m.

The following vegetation/community types were used as mapping units. The numbers correspond to the numbers appearing on the map (Figure 3.1), and the types are ordered roughly in descending order of wetness of the habitat.

1. **Melaleuca Shrubland.** (Figure 3.2). This occurs on the most disturbed area of the site, and the understorey now consists primarily of exotic grasses and bulbous species. Canopy species are *Melaleuca raphiophylla, Melaleuca lateritia, Melaleuca lanceolata* and an occasional *Jacksonia sternbergiana* or *Acacia saligna* on the periphery. Native understorey species still present are *Conostylis festucacea* and *Lepyrodia muirii* (see also Speck and Baird (1984) under Fringing thickets of tall shrubs, and Keighery and Keighery (1991) under *Melaleuca laterita* shrubland).

2. **Leptocarpus species Flats.** (Figure 3.3). These clayey flats are dominated by the sedges *Leptocarpus aristatus* and *Leptocarpus canus*. The two species occur both as monospecific stands, and associated with one another. *Gahnia trifida* is also common in some areas. In spring the herbaceous geophyte flora is distinctive, with various sundews (*Drosera*

Figure 3.2. *Melaleuca* Shrubland also showing the weedy understorey.

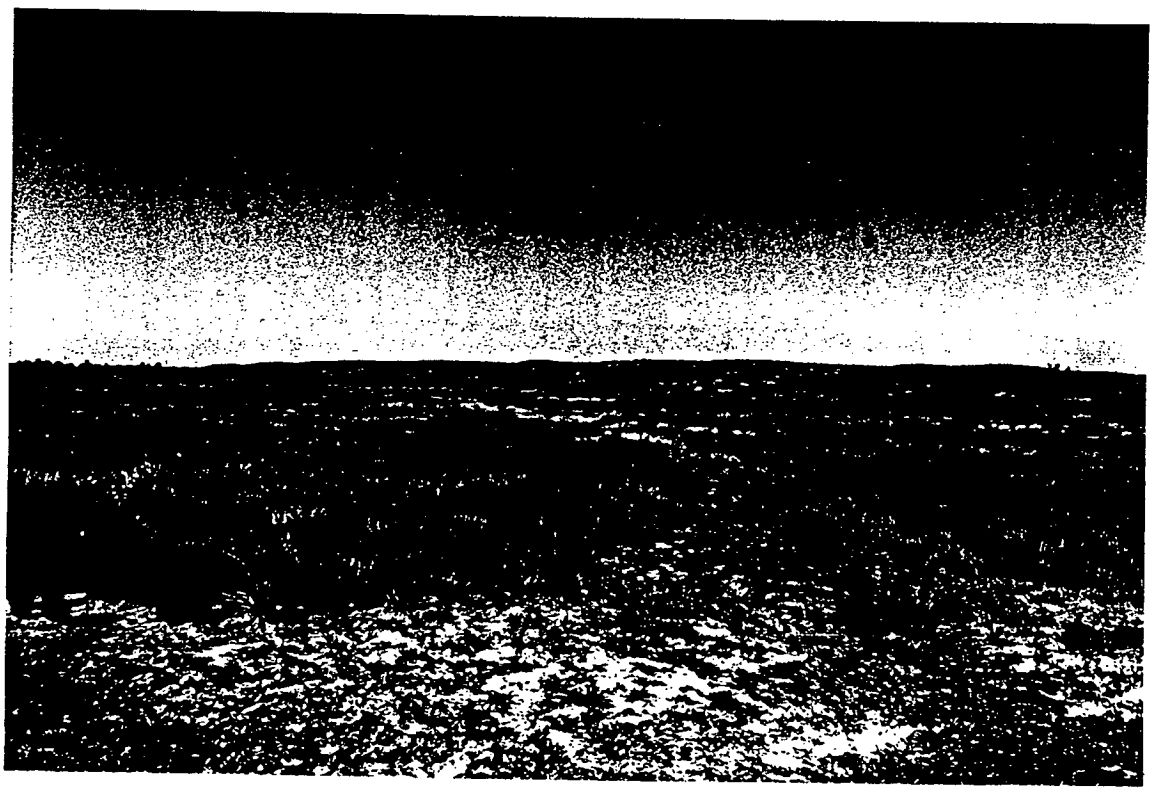


Figure 3.3. *Leptocarpus* Flats with weedy track at the south-western end of the site.

species), trigger plants (*Stylidium* species), the insectivorous genera *Utricularia* and *Polypomphylox*, and many orchids appearing.

Within the confines of these flats there are several areas which support the samphire *Halosarcia halocnemoides* and associated *Lawrencia squamatus*. These are normally found on marginally saline soils.

Also included in the *Leptocarpus* flats category are scattered mounds of shrubby species. These are reported as being initiated by the accumulation of drifting sand around low shrubs (Speck and Baird, 1984). The growth of the shrub and of the mound of sand modifies the local environment so that further shrubby species may establish. *Melaleuca lateriflora, Calothamnus hirsutus* and *Hypocalymma angustifolium* are commonly involved, with orchids and members of the family Restionaceae also present (see also Speck and Baird (1984) under *Leptocarpus aristatus* meadow).

3. ***Hypocalymma angustifolium* and *Verticordia* species Low Shrubland.** (Figure 3.4). This is a dense low shrubland (<1.0m high) which sometimes borders the sedgey flats. This vegetation type may also be inundated for various periods in winter. The dominant species is the White Myrtle (*Hypocalymma angustifolium*). Several Feather flowers (*Verticordia* species), the Wattle (*Acacia lasiocarpa*), *Eutaxia virgata* and *Kunzea* species are scattered throughout. The families Centrolepidaceae, Philydraceae and Juncaginaceae are well represented amongst the herbs present. An occasional *Melaleuca viminea*, Swish bush (*Viminaria juncea*) or Swamp Cyprus (*Actinostrobus pyrimidalis*) occur as low emergents (see also Speck and Baird (1984) under Mixed low scrub).

4. ***Viminaria* Tall Shrubland.** (Figure 3.5). This vegetation type covers much of the central part of the site. In winter the soils are saturated with the water table often at the surface. The Swish bush (*Viminaria juncea*) is the characteristic species. At maturity these shrubs may be 4m in height, but as they are killed by fire and return from seed, seldom attain this stature. The understorey of low shrubs is dense and diverse, including species also found in the surrounding low shrublands. Typical species are *Mesomelaena tetragona, Verticordia acerosa, Hypocalymma angustifolium, Pericalymma ellipticum, Acacia lasiocarpa, Scaevola lanceolata* and *Grevillea bipinnatifida*. The northernmost distribution of this vegetation type on the site also includes *Allocasurina humilis* as an important component (see also Keighery and Keighery (1991) under *Viminaria* shrubland).

5. **Mixed Low Shrubland.** (Figure 3.6). In the better drained north and north-western areas of the site is a low shrubland with *Banksia telmatiaea* as a conspicuous component. Co-occurring shrubs include *Melaleuca* species, *Acacia* species, *Verticordia acerosa* and *Acanthocarpus preissii*. On the wetter fringes of this community *Calothamnus villosus, Grevillea thelemanniana* and *Actinostrobus pyrimidalis* also occur. Several species of the family Restionaceae are common as a second stratum.

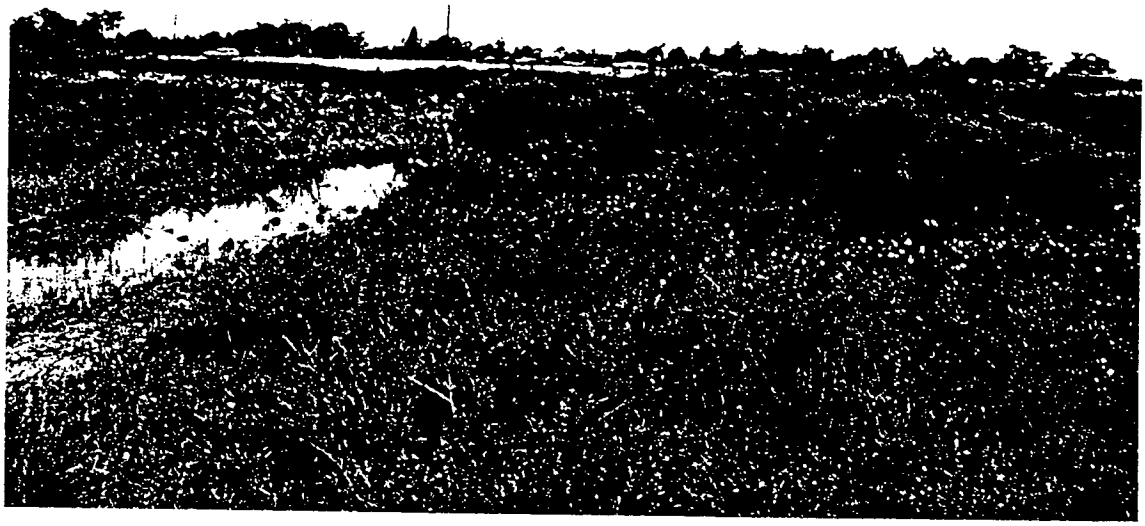


Figure 3.4. *Hypocalymma* and *Verticordia* Low Shrubland.

Figure 3.5. *Viminaria* Tall Shrubland with Mixed Low Shrubland in the foreground, near the centre of the site.

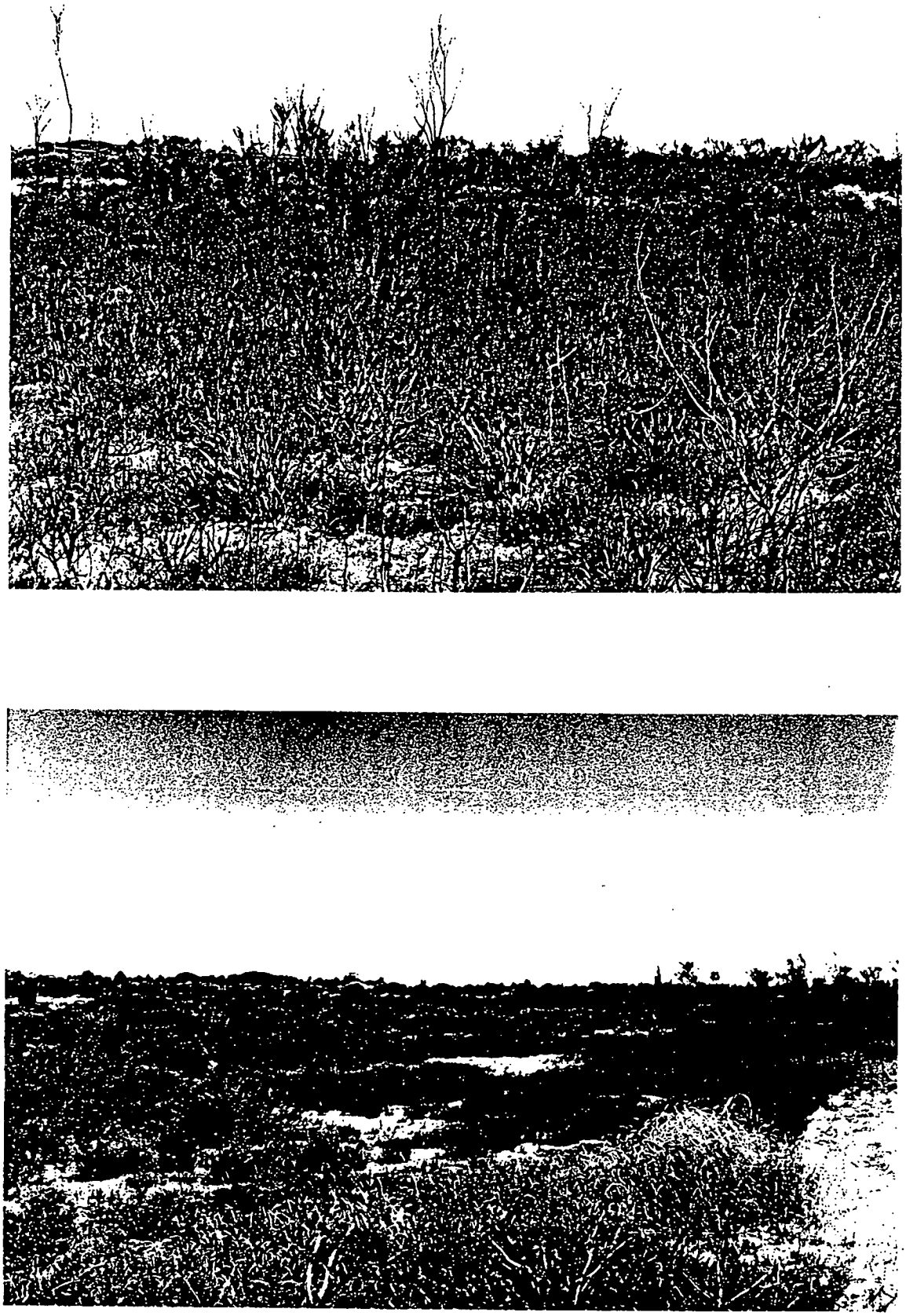


Figure 3.6. Two views of the diverse Mixed Low Shrubland. Top, near the north of the site, with adjoining *Leptocarpus* Flat. Bottom in the area burnt early in 1991.

Figure 3.7. Dense *Pericalymma ellipticum* with emergent *Viminaria juncea*.

Figure 3.8. View of the very weedy *Eremaea* Low Shrubland in the north-eastern corner of the site.

Viminaria juncea may occur as a scattered emergent tall shrub (see also Speck and Baird (1984) under Mixed low scrub).

6. ***Pericalymma ellipticum* Low Shrubland.** (Figure 3.7). A small area of this dense community occurs towards the north-eastern end of the site. At maturity the dominant species is *Pericalymma ellipticum*, though a suite of sedges and herbaceous species are also present. These include *Mesomelaena tetragona*, *Restio tremulus* and *Restio leptocarpoides*. *Viminaria juncea* occurs as an occasional emergent tall shrub (see also Speck and Baird (1984) under *Leptospermum ellipticum - Restio tremulus* low scrub and *Leptospermum ellipticum* mixed scrub and Keighery and Keighery (1991) under *Astartea fascicularis/Pericalymma elliptica* heath).

7. ***Eremaea* Low Shrubland.** (Figure 3.8). This community occurs on the driest north-eastern corner of the site. The dominant species is *Eremaea pauciflora*, though the community also includes a diverse suite of low shrubs and sedges. These include *Dasypogon bromeliifolius*, *Gompholobium tomentosum*, *Jacksonia angulata*, *Thysanotus patersonii*, *Mesomelaena tetragona* and *Lyginia barbata* (see also Speck and Baird (1984) under *Eremaea* low scrub).

2.3.3 Vegetation Condition.

Many of the tracks are now quite deeply incised and act as defacto drainage systems. This does not appear to have affected the adjacent vegetation. However all the tracks are weed infested. On the western side of the site the weeds are primarily annual grasses such as *Poa annua*, *Lolium perenne*, *Avena fatua* and *Briza* species. The drier north-eastern corner is heavily invaded by annual Veldtgrass (*Ehrharta longifolia*) and the south-eastern end is choked by a mixture of perennial grasses (*Stenotaphrum secundatum* and *Cynodon dactylon*) and the bulbous species *Ixia maculata*.

The Ixia along with Cape Tulip (*Homeria flaccida*) occur throughout the site. Rubbish dumping along Wanaping Road and in the northern corner of the site has led to the establishment of garden subjects such as Cannas, Nasturtiums and Arum Lilies.

The sedgelands and low shrublands on the western two thirds of the site are in a good condition despite the weedy tracks and occasional bulbous species. Frequent fires will, however, exacerbate the spread of the exotics, as will the indiscriminate use of the area by horse and trailbike riders.

2.4 Discussion.

As indicated in the results, the site has floristic similarities with both of the adjacent remnants of native vegetation, and similarly occupies an intermediate position in the continuum of vegetation types across the area as a whole. The topographic gradient presents a unique set of niches for plant growth, and it is

with respect to the different associations in the turnover of species along that gradient that the site differs from the adjacent ones. The site must thus be considered to occupy a special position in the landscape, as would any area situated midway along a gradient in the physical environment.

Notwithstanding the disturbed nature of part of the site, the area is still floristically diverse. The presence of the Priority List species (two of very limited distributions and another which is poorly known), increase the value of the site floristically.

The following species of interest were also identified;

- The species of *Calectasia* on the site was provisionally identified as *Calectasia grandiflora*. The plants were in bud, and it is possible that this might be *C. cyanea*, or that both species occur on the site as they do on the adjacent proposed reserve area. Confirmation of the presence of *C. grandiflora* would mean that the following comments made by the Department of Conservation and Land Management concerning the adjacent site also apply.

  > *The site is the sole known co-occurence of the Star of Bethlehem Lilies, Calectasia cyanea and C. grandiflora. It is also the only known extant population of Calectasia grandiflora on the Swan Coastal Plain, ... This population is thus of importance in assessing taxonomic status of these species.*

- One specimen of an *Anigozanthos bicolor* hybrid was found near Brixton Street.

- *Grevillea bipinnatifida* was found near Brixton Street and in the northern corner of the site. This is a species normally associated with the northern Jarrah forest.

- The green flowered form of *Eremophila glabra* found on the site is restricted to the eastern Swan Coastal Plain, and is not common.

3. FAUNA

3.1 Introduction.

The following information represents an assessment of the current status of the fauna inhabiting or likely to inhabit the proposed development area and potential impacts on the fauna should development go ahead.

The specific objectives of the fauna assessment were to:

- carry out a site inspection and record fauna observed;
- compile a list of vertebrate fauna likely to occur using published and unpublished records from the general area;
- assess the local and regional conservation value of the site with respect to fauna; and,
- provide information on potential impacts on the fauna.

During the site inspection it was found that the Southern Brown Bandicoot *Isooden obesulus* was present. This animal is gazetted on Schedule 1 of the Wildlife Conservation Act 1950 as likely to become extinct or is rare. For this reason a further study was commissioned and the specific objectives were to:

- confirm the presence of Bandicoots at the proposed development site by direct observation;
- estimate the population of Bandicoots at the site using counts of diggings; and,
- assess the importance of the site with respect to Bandicoots.

3.2 Methods.

3.2.1 Site inspection and predicted species lists.

An opportunistic site inspection of the proposed development area was carried out on September 16, 1991. Vertebrates were recorded as they were sighted and signs of their presence such as scats, tracks or diggings were also noted. The field survey did not include systematic sampling such as bird transects or pitfall trapping. However, if seasonal, systematic sampling was carried out all species listed in Appendix 3 would probably be recorded over time. The species lists included in Appendix 3 were compiled using Storr and Johnstone (1988), Strahan (1983), and unpublished records compiled by G. Harold.

3.2.2 Estimation of the Bandicoot population.

The method of estimating Bandicoot populations used during this survey was suggested by Ken Youngson, Ninox Wildlife Consulting. Bandicoot diggings were counted in 10m x 10m quadrats at the Harry Waring Marsupial Reserve, Wattleup, Thompsons Lake Reserve, Jandakot and lots 48 and pt35 Brixton Street during the period October 10-17 1991. Three quadrats were counted at each site and the average number of diggings per m^2 was calculated (Table 3.1). At each site the quadrats were placed to cover areas with the highest density of diggings, and, for ease of counting, occurred at the edges of dense vegetation. Population estimates for Harry Waring Reserve were taken from Thomas (1990) with additional figures courtesy of B. T. Clay. Estimates of the Bandicoot population of Thompsons Lake Reserve were established during 1976 and it was decided not to use these figures due to the length of time elapsed since the last population estimate. An estimate of the Bandicoot population on the survey area was calculated as follows.

The average number of diggings per m^2 was calculated for both sites. The average number of diggings per m^2 at the Brixton Street site was calculated as a percentage of those counted at Harry Waring Marsupial Reserve (i.e. the average number of diggings at Brixton Street were 37% of those counted at Harry Waring). This figure of 37% was then applied to population estimates at Harry Waring Reserve to give a population estimate for the Brixton Street site.

3.2.3 Assessment of the adjacent areas.

An assessment of the adjacent areas, lots 37 and 47, Brixton Street and the Yule Brook Botany Reserve, was carried out using the following criteria:

- the suitability of adjacent sites as Bandicoot habitat;
- the area of suitable habitat within each site;
- the importance of the survey area to Bandicoot dispersal and movement between the adjacent sites; and,
- the suitability of the adjacent sites for displaced Bandicoots should the development go ahead.

3.2.4 Literature review.

A literature review was carried out and results of published ecological studies conducted on Bandicoots are incorporated in the discussion.

3.3 Results.

3.3.1 Site inspection.

A total of 19 species of bird, 1 native and 1 introduced mammal, 2 amphibians and 2 reptiles were recorded during the site inspection. Numerous diggings, footprints and 'tunnels' through dense vegetation of the gazetted Southern Brown Bandicoot *Isooden obesulus* were recorded during the sight inspection. Based on an assessment of the habitat available a further 44 birds, 10 native and 3 introduced mammals, 5 amphibians and 26 reptiles are likely to occur there (Appendix 3). These additional species represent those that would be present during different seasons (i.e. migrants and nomadic species) or cryptic species.

Protected Jewel Beetles of the Family Buprestidae were observed feeding on *Hypocalymma* and *Hakea* flowers during the site inspection.

3.3.2 Estimate of the Bandicoot population size.

Table 3.1 *Results of counts of Bandicoot diggings and estimates of population.*

STUDY AREA	No of diggings counted in 10m x 10m quadrats						
	Q1	Q2	Q3	AVERAGE	AVE/m²	POPULATION ESTIMATE Bandicoots/ha	TOTAL
HARRY WARING (254ha)	430	420	660	503	5.03	0.14-1.00	35-254
THOMPSONS	306	417	510	411	4.11	estimates not reliable (1976)	
BRIXTON ST (30ha)	153	168	240	187	1.87	0.05-0.37	1.5-11.1

3.4 Discussion.

3.4.1 Gazetted Rare and Endangered Species.

3.4.1.1 Southern Brown Bandicoot *Isooden obesulus* - Estimating the population using counts of diggings.

The method of counting diggings to estimate the Bandicoot population on the survey area was used in preference to the more efficient and accurate mark,

release, recapture method due to the gazetted status of the Bandicoot and the site's proximity to urban areas. This is the first time, to our knowledge, that this technique has been used and therefore it is stressed that the population size derived from this method is an estimate only. For a more accurate estimate of the population size, a trapping programme would need to be carried out.

Although the method of counting diggings did not involve a rigorous scientific approach (for example, a statistical correlation between numbers of diggings and numbers of Bandicoots was not confirmed) the examination of results of other population studies shows that the results achieved here are reasonable. Population estimates of Bandicoots were carried out at the Harry Waring Marsupial Reserve between 1981 and 1986 (Thomas, 1990 and Clay, 1986). During this time population estimates varied between 0.14-1.00 animals/ha, with the majority of animals being captured in dense vegetation around Lake Banganup. Stoddart and Braithwaite (1979) studied the Brown Bandicoot in heathland in Victoria from 1974 to 1977 and estimated the average population to be 0.55 animals/ha. Strahan (1983) estimates that a large adult Bandicoot may lay claim to 7ha (0.14 animals/ha). The population estimate of 0.05-0.37 animals/ha (a possible total population of between 1 and 11 individuals) for the proposed 30 ha development site, although reasonable, is somewhat lower than those cited above for other study areas. This could be attributed to any or a combination of the following factors:

- bandicoots may be utilising different food sources in each study area therefore the use of digging varies as a method for obtaining food;
- differing predation rates by foxes, feral cats and dogs;
- higher mortality due to the presence of roads on three sides of the Brixton Street site;
- seasonal fluctuations in population; and,
- habitat at the proposed development site not as suited to Bandicoots as other study sites due to less dense cover, less food availability or limited adjacent areas for recruitment.

3.4.1.2 The importance of the proposed development site for Bandicoots.

At present there is a viable population of Bandicoots using the proposed development site. This is evident from their persistence at the site despite disturbance from land clearing and a high weed invasion in the south-eastern section, the presence of introduced predators, adjacent roads and the occurrence of fire. The adjacent sites, of the Yule Brook Botany Reserve and lots 37 and 47, also contain a high percentage of suitable Bandicoot habitat and their presence was confirmed by sightings of large numbers of diggings, footprints and 'tunnels' throughout the two areas during the site assessments. An evaluation of the available habitat and the presence of diggings at the two adjacent sites indicated that at the time of the assessment the population of

Bandicoots at these sites was possibly higher than in the proposed development site. Diggings were spread throughout the dense vegetation in lots 37 and 47 and the Botany Reserve, whereas on the survey site diggings were confined to the drier northern portion of the site. However, it is highly likely that Bandicoots would move into the grassy, wetter southern areas as the ground dries out, for they are known to occur in introduced grasses at Lake Yangebup and Lake Forrestdale.

Although the extent to which the roads act as barriers to Bandicoot movement is not known, there is a possibility that at present the three sites are functioning effectively as one habitat. Bandicoots by nature are solitary animals with a high level of social intolerance (Stoddart and Braithwaite, 1979) and their survival depends upon the possession and defence of an adequate territory (Strahan 1983; Thomas 1990). Given this fact and using the figure of 0.55 animals/ha (Stoddart and Braithwaite, 1979) the total population of the three areas (lots 37 and 47, 19ha; lots 35 and 48, 30ha; M69 35ha) could number approximately 46 individuals. Bandicoots are also known to have a high reproductive rate (Cockburn, 1990; Stoddart and Braithwaite, 1979; Thomas, 1990) and are able to colonise areas of suitable habitat in short periods of time by utilising adjacent suboptimal habitats until their optimal habitat regenerates (Cockburn, 1990; Stoddart and Braithwaite, 1979). In addition Friend (1990) remarks that '*Isooden obesulus* has proved to be extremely tolerant to the impact of white settlement'. With reference to the Kenwick site this means that as areas are burnt or disturbed Bandicoots are able to recolonise the habitat quickly as the vegetation regenerates. Even though the population at lots 35 and 48 may at present be lower than adjacent areas, not enough is known about seasonal fluctuations or movements of the species to draw definite conclusions as to the importance of the site *vis a vis* the adjoining areas. Lots 35 and 48 could well be an integral part of the Bandicoot habitat of the whole area and if development went ahead dispersion of young animals and movement of adult animals might be restricted.

As mentioned above Bandicoots are solitary animals and males are as intolerant towards females as they are towards other males (Wood-Jones 1923-1925; Stodart, 1966 cited in Stoddart and Braithwaite, 1979). If the development of lots 35 and 48 proceeds it is likely that few, if any, displaced animals would become established in the adjacent areas given that these already support populations of the species. Individuals translocated to other suitable sites would also be at risk of being killed by resident animals unless prior to their release it was ascertained that the area was free of Bandicoots.

In summary, the Bandicoot population of the area as a whole would certainly decrease both as a direct result of clearing lots 35 and 48, and/or indirectly due to aggressive competition between animals displaced to adjacent areas.

3.4.1.3 Peregrine Falcon *Falco peregrinus*.

This bird is Gazetted on Schedule 2 of the Wildlife Conservation Act 1950 as otherwise in need of special protection. This species was not sighted during the

site inspection but it is known to occur in the Perth metropolitan area and may well be present in the area from time to time. The Peregrine Falcon has a worldwide distribution and is not known to breed in the Kenwick area and therefore is unlikely to be directly affected by the development.

4. GENERAL DISCUSSION.

Though floristically similar to the adjacent sites, the proposed development area does have intrinsic biological value. The flora is diverse and includes species on the Priority Lists of the Department of Conservation and Land Management, and several other species of special interest. Habitat or vegetation types are similarly diverse and the area supports a small but apparently viable population of the Southern Brown Bandicoot, which is gazetted as a rare fauna species.

No vertebrate species are thought to be restricted to this location and all have distributions encompassing larger areas of the state (including the Southern Brown Bandicoot), although some species are uncommon on the Swan Coastal Plain (Appendix 3).

In a local context, the site occupies a distinctive position in the landscape and may provide a function with respect to the movement of the rare fauna species. It represents a significant patch of remnant bushland providing resources for a wide range of fauna. In addition to the Southern Brown Bandicoot many other vertebrates inhabit the area. Two species of waterbird, the Black Duck *Anas superciliosus*, and the White-faced Heron *Ardea novaehollandiae* were observed in the area as well as numerous honeyeaters feeding on the flowering shrubs. In the inundated areas large numbers of tadpoles and many recently metamorphosed frogs of the genus *Crinia* spp. were seen. One adult and one juvenile Bobtail Skink *Tiliqua r. rugosa* were observed basking on the edges of tracks and one Legless Lizard *Delma grayii* was found under rubbish.

Urbanisation of the site would tend to increase the pressures on the adjacent reserve areas. Management of these areas in the form of fence maintainace, removal of dumped garden refuse, and fire control would probably have to be increased. In addition, any new drainage scheme on the development site would have to be planned so as not to affect the hydrology of the reserve areas.

Reclamation of degraded bushland such as that which occurs on the survey area is possible, but only with a large expenditure of funds and/or intensive community effort. With respect to the long term integrity of the adjacent reserve areas, and also with respect to the intrinsic value of the site as a representative of wetland habitat for both flora and fauna, reclamation would be a desirable action.

In a regional context, the habitats typical of the Pinjarra Plain geomorphic unit are becoming increasingly scarce, and this is particularly so for the ephemeral wetland communities.

5. STUDY PARTICIPANTS.

Botany - E. M. Goble-Garratt.
Zoology - Moloch Fauna Consultants (A. Sanders and G. Harold).

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APPENDIX 1.

CHECKLIST OF THE NATIVE VASCULAR FLORA

LOTS 48 AND PT 35 BRIXTON STREET, KENWICK.

Note: Presence on the Yule Brook Botany Reserve and the proposed Brixton Street Reserve is also indicated.

	YULE BROOK	BRIXTON ST.
18 FAMILY CUPRESSACEAE.		
Actinostrobus pyrimidalis	+	
26 FAMILY JUNCAGINACEAE.		
Triglochin calcitrapa	+	+
Triglochin centrocarpa	+	
Triglochin mucronata	+	
Triglochin procera	+	+
31 FAMILY POACEAE.		
Neurachne alopecuroidea	+	+
32 FAMILY CYPERACEAE.		
Chorizandra enodis		
Gahnia trifida	+	+
Isolepis cernua		
Isolepis setiformis		
Mesomelaena tetragona	+	+
Schoenus humulis		
Schoenus odontocarpus		+
Schoenus subbulbosus		
Tetraria octandra		+
39 FAMILY RESTIONACEAE.		
Leptocarpus aristatus	+	
Leptocarpus canus	+	+
Leptocarpus sp.		
Lepyrodia muirii		+
Loxocarya fasciculata	+	+
Loxocarya flexuosa	+	
Loxocarya pubescens	+	
Lyginia barbata	+	
Restio leptocarpoides		
Restio tremulus	+	
Restio sp.		

	YULE BROOK	BRIXTON ST.
40 FAMILY CENTROLEPIDACEAE.		
Aphelia cyperoides	+	+
Centrolepis aristata	+	+
50 FAMILY PHILYDRACEAE.		
Philydrella pygmaea	+	+
52 FAMILY JUNCACEAE.		
Juncus sp.		
54C FAMILY DASYPOGONACEAE.		
Acanthocarpus preissii	+	
Calectasia ?grandiflora		+
Dasypogon bromeliifolius	+	
Lomandra odora		+
54D FAMILY XANTHORRHOEACEAE.		
Xanthorrhoea preissii	+	+
54F FAMILY ANTHERICACEAE.		
Borya sphaerocephala		+
Chamaescilla corymbosa	+	+
Sowerbaea laxiflora	+	+
Thysonotus patersonii	+	+
54G FAMILY ASPHODELACEAE.		
Bulbine semibarbata		
54J FAMILY COLCHICACEAE.		
Burchardia umbellata	+	+
55 FAMILY HAEMODORACEAE.		
Anigozanthos x bicolor		+
Anigozanthos humilis	+	
Anigozanthos manglesii	+	+
Anigozanthos viridus	+	+
Conostylis festucacea		+
Conostylis serrulata		
Conostylis setigera	+	+
Haemodorum spicatum	+	+
Tribonanthes australis		+

	YULE BROOK	BRIXTON ST.
60 FAMILY IRIDACEAE.		
Patersonia occidentalis	+	+
66 FAMILY ORCHIDACEAE.		
Caladenia flava	+	+
Caladenia paludosa	?	+
Diuris laxiflora	+	
Elythranthera brunonis	+	
Prasophyllum ovale var. triglichin	+	
Thelymitra crinita		+
Thelymitra flexuosa	+	+
70 FAMILY CASUARINACEAE.		
Allocasuarina humilis	+	
90 FAMILY PROTEACEAE.		
Banksia telmatiaea	+	
Conospermum huegelii	+	+
Conospermum stoechadis	+	
Dryandra nivea	+	+
Grevillea bipinnatifida		+
Grevillea thelemanniana	+	
Hakea candolleana	+	+
Hakea prostrata	+	+
Hakea sulcata	+	+
Hakea undulata		
Hakea varia	+	+
Petrophile media	+	+
Petrophile seminuda	+	+
Stirlingia latifolia	+	
Stirlingia simplex	+	+
Synaphea petiolaris	+	+
97 FAMILY LORANTHACEAE.		
Nuytsia floribunda	+	+
105 FAMILY CHENOPODIACEAE.		
Halosarcia halocnemoides	+	
111 FAMILY PORTULACACEAE.		
Calandrinia corrigiodes	+	
Calandrinia granulifera	+	
Calandrinia liniflora		

	YULE BROOK	BRIXTON ST.
131 FAMILY LAURACEAE.		
Cassytha sp.		
143 FAMILY DROSERACEAE.		
Drosera erythrorhiza	+	+
Drosera gigantea	+	+
Drosera granduligera	+	+
Drosera macrantha	+	+
Drosera menziesii	+	+
Drosera ?stolonifera	+	
149 FAMILY CRASSULACEAE.		
Crassula colorata	+	+
163 FAMILY MIMOSACEAE.		
Acacia lasiocarpa	+	+
Acacia pulchella	+	+
Acacia saligna	+	+
Acacia stenoptera	+	
165 FAMILY PAPILIONACEAE.		
Bossiaea eriocarpa	+	
Daviesia physodes		+
Eutaxia virgata	+	+
Gompholobium aristatum		+
Gompholobium tomentosum	+	
Hovea trisperma	+	
Isotropis cuneifolia	+	
Jacksonia angulata		
Jacksonia densiflora	+	
Jacksonia furcellata	+	
Jacksonia sternbergiana	+	
Kennedia prostrata	+	+
Nemsia capitata	+	+
Viminaria juncea	+	+
175 FAMILY RUTACEAE.		
Boronia crenulata	+	
Eriostemon spicatus	+	+
183 FAMILY POLYGALACEAE.		
Comesperma ciliatum		+

	YULE BROOK	BRIXTON ST.
221 FAMILY MALVACEAE.		
Lawrencia squamata	+	
226 FAMILY DILLENIACEAE		
Hibbertia hypericoides	+	+
263 FAMILY THYMELAEACEAE.		
Pimelia ?imbricata	+	+
273 FAMILY MYRTACEAE.		
Astartea fascicularis	+	+
Baeckea camphorosmae	+	+
Calothamnus hirsutus	+	
Calytrix aurea	+	+
Eremaea pauciflora	+	
Eucalyptus calophylla	+	+
Hypocalymma angustifolium	+	+
Kunzea micrantha	+	+
Kunzea recurva		+
Melaleuca acerosa		
Melaleuca lanceolata		
Melaleuca lateriflora	+	
Melaleuca lateritia	+	
Melaleuca raphiophylla	+	+
Melaleuca viminea	+	
Pericalymma ellipticum	+	+
Verticordia acerosa	+	+
Verticordia densiflora	+	+
Verticordia huegelii	+	+
276 FAMILY HALORAGACEAE.		
Gonocarpus pithyoides	+	+
281 FAMILY APIACEAE.		
Eryngium pinnatifida ssp. palustris(MS)		+
Hydrocotyle diantha		+
Trachymene pilosa	+	
288 FAMILY EPACRIDACEAE.		
Leucopogon polymorphus	+	
Lysinema ciliatum	+	

	YULE BROOK	BRIXTON ST.
293 FAMILY PRIMULACEAE.		
Samolus junceus	+	
303A FAMILY MENYANTHACEAE.		
Villarsia capitata		+
316 FAMILY SCROPHULARIACEAE.		
Glossostigma drummondii		+
323 FAMILY LENTIBULARIACEAE.		
Polypompholyx multifida	+	+
Polypompholyx tenella	+	+
Utricularia violacea	+	+
326 FAMILY MYOPORACEAE.		
Eremophila glabra		
331 FAMILY RUBIACEAE.		
Opercularia vaginata	+	+
339 FAMILY CAMPANULACEAE.		
Wahlenbergia sp.		
340 FAMILY LOBELIACEAE.		
Isotoma scapigera		+
341 FAMILY GOODENIACEAE		
Dampiera linearis	+	+
Lechenaultia expansa	+	
Scaevola lanceolata	+	+
Velleia trinervis	+	+
343 FAMILY STYLIDACEAE.		
Levenhookia preissii	+	
Stylidium bulbiferum	+	+
Stylidium calcaratum	+	+
Stylidium dichotomum	+	+
Stylidium petiolare	+	+

	YULE BROOK	BRIXTON ST.
345 FAMILY ASTERACEAE.		
Angianthus preissianus		
Brachycome iberidifolia		
Brachycome pusilla	+	
Cotula coronopifolia	+	
Hyalospermum cotula	+	+
Podolepis gracilis	+	+
Podolepis sp.		
Waitzia paniculata	+	

APPENDIX 2.

CHECKLIST OF NATURALISED SPECIES

LOTS 48 AND PT 35 BRIXTON STREET, KENWICK.

31 FAMILY POACEAE.

Arundo donax
Avena fatua
Briza maxima
Briza minor
Cynodon dactylon
Ehrharta longifolia
Eragrostis curvula
Lolium perenne
Paspalpalum dilatatum
Poa annua
Stenotaphrum secundatum

35 FAMILY ARACEAE.

Zantedeschia aethiopica

60 FAMILY IRIDACEAE.

Gladiolus caryophyllaceus
Hesperantha falcata
Homeria flaccida
Ixia maculata
Romuulea rosea
Sparaxis bulbifera
Watsonia bulbillifera

63 FAMILY CANNACEAE.

Canna x orchioides

103 FAMILY POLYGONACEAE.

Rumex crispus

113 FAMILY CARYOPHYLLACEAE.

Petrorhagia velutina
Silene gallica
Spergula arvensis

136 FAMILY FUMARIACEAE.

Fumaria sp.

138 FAMILY BRASSICACEAE.

Raphanis raphanistrum

149 FAMILY CRASSULACEAE.

Crassula natans

165 FAMILY PAPILIONACEAE.

Lotus uliginosus
Lupinus consentinii
Medicago polymorpha
Trifolium angustifolium
Trifolium arvense
Trifolium campestre

167 FAMILY GERANIACEAE.

Erodium botrys

168 FAMILY OXALICACEAE

Oxalis pes-caprae

169 FAMILY TROPAEOLACEAE.

Tropaeolum majus

273 FAMILY MYRTACEAE.

Leptospermum laevigatum

293 FAMILY PRIMULACEAE.

Anagallis arvensis

310 FAMILY BORAGINACEAE.

Echium plantagineum

315 FAMILY SOLANACEAE.

Solanum nigrum

316 FAMILY SCROPHULARIACEAE.

Parentucellia latifolia

339 FAMILY CAMPANULACEAE.

Wahlenbergia capensis

345 FAMILY ASTERACEAE.

Arctotheca calendula
Carduus tenuifloris
Helipterum roseum
Hypochaeris glabra
Osteospermum clandestinum
Ursinia anthemoides

APPENDIX 3

LIST OF VERTEBRATES RECORDED OR LIKELY TO OCCUR

LOTS 48 AND PT 35, BRIXTON STREET, KENWICK.

KEY + = Species recorded during site inspection
U = Species uncommon on the Swan Coastal Plain
* = Gazetted species
I = Introduced species

BIRDS

ARDEIDAE		
Ardea pacifica,	Pacific Heron	
A. novaehollandiae,	White-faced Heron	+
Egretta alba,	Great Egret	
E. garzetta,	Little Egret	U
PLATALEIDAE		
Threskiornis aethiopica,	Sacred Ibis	
T. spinicollis,	Straw-necked Ibis	
ANATIDAE		
Tadorna tadornoides,	Australian Shelduck	
Anas superciliosa,	Pacific Black Duck	+
A. gibberfrons,	Grey Teal	
Chenonetta jubata,	Maned Duck	
ACCIPITRIDAE		
Elanus notatus,	Black-shouldered Kite	+
Haliastur sphenurus,	Whistling Kite	
Accipiter fasciatus,	Brown Goshawk	U
A. cirrhocephalus,	Collared Sparrowhawk	U
Hieraaetus morphnoides,	Little Eagle	U
Circus aeruginosus,	Marsh Harrier	
FALCONIDAE		
Falco peregrinus,	Peregrine Falcon	*
F. longipennis,	Australian Hobby	
F. cenchroides,	Australian Kestrel	+
RECURVIROSTRIDAE		
Himantopus himantopus,	Black-winged Stilt	
COLUMBIDAE		
Columba livia,	Feral Pigeon	I
Streptopelia chinensis,	Spotted Turtle-Dove	I
S. senegalensis,	Laughing Turtle-Dove	I
Phaps chalcoptera,	Common Bronzewing	
CACATUIDAE		
Cacatua roseicapilla,	Galah	

PLATYCERCIDAE
Purpureicephalus spurius, Red-capped Parrot
Barnardius zonarius, Port Lincoln Ringneck

CUCULIDAE
Cuculus pallidus, Pallid Cuckoo +
C. pyrrhophanus, Fan-tailed Cuckoo
Chrysococcyx basalis, Horsfield's Bronze-Cuckoo
C. lucidus, Shining Bronze-Cuckoo

ALCEDINIDAE
Halcyon sancta, Sacred Kingfisher

MEROPIDAE
Merops ornatus, Rainbow Bee-eater

HIRUNDINIDAE
Hirundo neoxena, Welcome Swallow +
Cecropis nigricans, Tree Martin

MOTACILLIDAE
Anthus novaeseelandiae, Richard's Pipit +

CAMPEPHAGIDAE
Coracina novaehollandiae, Black-faced Cuckoo-shrike +

MUSCICAPIDAE
Pachycephala rufiventris, Rufous Whistler +
Rhipidura fuliginosa, Grey Fantail
R. leucophrys, Willie Wagtail

SYLVIIDAE
Cinclorhamphus mathewsi, Rufous Songlark

MALURIDAE
Malurus splendens, Splendid Fairy-wren
Stipiturus malachurus, Southern Emu-wren U

ACANTHIZIDAE
Smicrornis brevirostris, Weebill
Gerygone fusca, Western Gerygone +
Acanthiza apicalis, Inland Thornbill
A. chrysorrhoa, Yellow-rumped Thornbill

MELIPHAGIDAE
Anthochaera carunculata, Red Wattlebird
A. chrysoptera, Little Wattlebird
Lichenostomus virescens, Singing Honeyeater +

Lichmera indistincta, Brown Honeyeater +
Phylidonyris novaehollandiae, New Holland Honeyeater
P. nigra, White-cheeked Honeyeater +
P. melanops, Tawny-crowned Honeyeater
Acanthorhynchus superciliosus, Western Spinebill

EPHTHIANURIDAE
Ephthianura albifrons, White-fronted Chat

ZOSTEROPIDAE
Zosterops lateralis, Silvereye +

GRALLINIDAE
Grallina cyanoleuca, Australian Magpie-lark +

ARTAMIDAE
Artamus cinereus, Black-faced Woodswallow +
A. cyanopterus, Dusky Woodswallow

CRACTICIDAE
Cracticus torquatus, Grey Butcherbird +
Gymnorhina tibicen, Australian Magpie +

CORVIDAE
Corvus coronoides, Australian Raven +

MAMMALS

PERAMELIDAE
Isoodon obesulus, Southern Brown Bandicoot +*

TARSIPEDIDAE
Tarsipes rostratus, Honey-possum

MOLOSSIDAE
Tadarida australis, White-striped Mastiff-bat
Mormopterus planiceps, Little Mastiff-bat

VESPERTILIONIDAE
Nyctophilus major, Greater Long-eared Bat
N. gouldi, Gould's Long-eared Bat
N. geoffroyi, Lesser Long-eared Bat
Chalinolobus gouldii, Gould's Wattled Bat
C. morio, Chocolate Wattled Bat
Falsistrellus mackenziei, Great Pipistrelle
Eptesicus regulus, King River Eptesicus

MURIDAE
Mus musculus, House Mouse I

LEPORIDAE
Oryctolagus cuniculus, Rabbit +I

CANIDAE
Vulpes vulpes, Fox I

FELIDAE
Felis catus, Feral Cat I

AMPHIBIANS

LEPTODACTYLIDAE Frogs
Crinia georgiana
C. glauerti +
C. insignifera
Heleioporus eyrei
Limnodynastes dorsalis
Neobatrachus pelobatoides
Pseudophryne guentheri +

REPTILES

GEKKONIDAE Geckos
Diplodactylus spinigerus spinigerus
Phyllodactylus marmoratus

PYGOPODIDAE Legless Lizards
Aprasia repens
Delma grayii +
Lialis burtonis
Pygopus lepidopodus

AGAMIDAE Dragon Lizards
Pogona m. minor

SCINCIDAE Skinks
Cryptoblepharus plagiocephalus
Ctenotus fallens
C. impar
Egernia napoleonis
Hemiergis quadrilineata
Lerista elegans
L. lineata
Menetia greyii
Morethia obscura
Tiliqua r. rugosa +

VARANIDAE Monitors
Varanus gouldii

TYPHLOPIDAE Blind Snakes
Ramphotyphlops australis
R. waitii

ELAPIDAE Elapid Snakes	
Demansia psammophis reticulata	
Drysdalia coronata	U
Neelaps bimaculatus	
Pseudonaja affinis affinis	
Rhinoplocephalus gouldii	
R. nigriceps	
Simoselaps bertholdi	
S. s. semifasciatus	