



DARDANUP WEST / CROOKED BROOK STRUCTURE PLAN



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ENDORSEMENT PAGE

This structure plan is prepared under the provisions of the Shire of Dardanup
Local Planning Scheme No. 9

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE
WESTERN AUSTRALIAN PLANNING COMMISSION ON:

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In accordance with Schedule 2, Part 4, Clause 28 (2) and refer to Part 1, 2. (b) of the
Planning and Development (Local Planning Schemes) Regulations 2015.

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DARDANUP WEST / CROOKED BROOK STRUCTURE PLAN

1. INTRODUCTION

1.1 General

The Structure Plan encompasses an area to the west of Dardanup townsite and is bound in part by the Picton-Boyanup Road on the east and the Preston River on the west. In order to integrate the past development with the future development the Plan includes the existing rural residential developments in the Dardanup West locality.

It provides a framework for the rezoning, subdivision and development of land for rural residential lots to cater for some of the expected lot demand within the Shire of Dardanup over the next ten years.

1.2 Structure Plan Boundary

The Structure Plan boundary was determined after consideration of the following matters.

Need of More Rural Residential Lots

The draft Local Planning Strategy indicates that around 450 additional lots will be required in the Shire up to 2016. This is in accord with the lower range of lot demand that was estimated in the approved Rural Strategy (p66).

The Strategy proposes to allocate two thirds of the lots, or 300 lots, in the Structure Plan area. The remaining one third of the lots will be allocated in other areas of the Shire.

The area of land required to yield the 300 lots needs to be about one third greater to account for landowners who, for many reasons, do not wish to develop their land within the planning timeframes. The Shire sought expressions of interest from landowners who might develop over the planning timeframe. The response indicated that around 255 lots might be created.

On the basis of an additional one third, there will have to be enough land to generate around 450 lots.

Consolidation of Existing Rural Residential Development

Consolidating rural residential development in this area is consistent with Commission policy. Two thirds of the area is identified in the Rural Strategy as an area where rural residential development is a preferred land use. Adding to this area is considered sensible planning.

The area is adjacent to the town of Dardanup. The State Planning Policy No.2.5, Agricultural and Rural Land Use Planning (2002), has an objective to: *Plan and provide for rural settlement where it can –*

- a. *benefit and support existing communities, and*
- b. *have access to appropriate community services and infrastructure.*

Appendix 2 of the Policy sets out criteria for the identification and planning of rural settlements. Appropriate criteria for this matter are *achieving denser forms of rural settlement and rural residential....areas should be located where they are accessible to urban services and employment opportunities....the location of settlements likely to support existing townsites or service centres in nodal or clustered estates is preferred.*

Western Boundary

The western boundary was determined by the existing Rural Strategy boundary, the adjoining industrial area and the Shire boundary.

Eastern Boundary North of Garvey Road

This boundary north of Garvey Road was determined as the Picton-Boyanup Road. To the east of this road is the major part of the Collie Irrigation District which is a Priority Agricultural Area.

Inside this section of the eastern boundary is a small amount of the Collie Irrigation District. However it is recognised that this area is most likely to be retired from irrigation. It was therefore logical to integrate it with the adjoining rural residential lot development and the town of Dardanup.

Eastern Boundary South of Garvey Road

This boundary was determined after eliminating areas of land west of the Picton-Boyanup Road that were predominantly poorly drained with little or no established main drains and very little of the Bassendean Sand Dune soil/landform unit. Also the area of the eliminated south-east sector was in excess of the area required to provide the lot target.

1.3 Attributes

The Dardanup West/Crooked Brook area has been the principal area of rural residential lot development in the Shire for approximately 30 years. It has the following attributes that satisfy the requirements of the State Planning Policy No.2.5, *Agricultural and Rural Land Use Planning*.

- The land is not prime agricultural land even though there is a small part in the South West Irrigation Area.
- It is close to the town of Dardanup and the rural residential population can benefit and support the community and commercial facilities of the town.

- There are job opportunities in the town and surrounding rural land, the adjoining industrial area and in Bunbury which is 20 minutes driving time away.
- The physical environment provides for an attractive semi-rural lifestyle. Also the lot sizes and proximity to the Dardanup Equestrian Centre make it an attractive area for the keeping of recreational horses.

1.4 Terminology

The Shire of Dardanup Town Planning Scheme No.3 has a Small Holding zone and does not differentiate between rural residential and smallholding lots as required under the State Planning Policy No.2.5. The Structure Plan uses the Policy terminology even though rezonings will occur under the Small Holding zone until the Scheme is reviewed.

2.0 PLANNING CONTEXT

The following planning documents have guided the preparation of the Structure Plan.

2.1 Bunbury-Wellington Region Plan

The Bunbury Wellington Region Plan (BWRP) recognised that there would be population growth in the rural areas surrounding the Dardanup townsite (see page 145 of BWRP) and that careful planning of rural residential development was needed to minimise the impact on this growth on the natural environment and not constrain the future expansion of Dardanup (see page 91 of BWRP).

The Western Australian Planning Commission have determined that the future expansion of the Dardanup townsite should only occur east of the Picton-Boyanup Road. The Structure Plan does not impact on this land.

2.2 Draft Greater Bunbury Region Scheme

The Structure Plan area is zoned Rural under the Region Scheme. A portion of land on the western edge of the Structure Plan area is within the South West Irrigation Area. The irrigation area is identified as priority agricultural land under the Region Scheme and is protected for long-term agriculture. However it is recognised that because of the location and proximity of this land to existing rural residential development that it is likely to revert to the same land use in the future although the timing of that change may not be within the next ten years.

2.3 Statement of Planning Policy 2.5 Agricultural and Rural Land Use Planning

This Policy is the principal planning document. It sets out objectives and matters to be addressed in the identification and planning of areas for rural settlement.

The planning of the area has taken into account the need to protect prime agricultural land, provide good access to existing centres and locate rural settlement where it can benefit from and support existing centres.

It also proposes lot sizes that are predominantly in the range of 1 to 4 hectares, that is, rural residential lots. The Plan addresses a range of issues including reticulated water, lot demand, road access, land

capability, on-site effluent disposal, stormwater drainage and the physical environment.

2.4 Shire of Dardanup Rural Strategy

The land north of Garvey and Dardanup Road West is included in the Rural Strategy as an area where "Council will support rural residential development as a mechanism to encourage revegetation and create an environmental buffer to the Preston River subject to" there being suitable sites for houses, resolving where necessary nutrient export, on-site effluent disposal and providing for revegetation. The Plan addresses these matters.

2.5 Dardanup West Planning Strategy

In 2001, the Dardanup West Planning Strategy was prepared. The Department for Planning and Infrastructure requested further work to address the rationale for the area chosen, the relationship to the Local Planning Strategy, the possibility of lot re-subdivision, wetlands and drainage, land capability, infrastructure and the adjoining industrial area. These matters have been addressed in the Structure Plan.

2.6 Shire of Dardanup Local Planning Strategy

The Local Planning Strategy is yet to be finalised however, the following findings are relevant to the Structure Plan.

- Almost 60% of all the small holding lots in the Shire are located in the Structure Plan area.
- There is demand in the area for more lots. The occupancy rate is over 75%.
- There is an estimated demand for 470 rural residential lots up to 2016. This Plan provides land for approximately 400 rural residential lots although for many reasons it is usual for between one quarter and one third of all potential lots not to be developed within the planning timeframes. Therefore the lot yield from the Structure Plan up to 2016 is likely to be between 270 and 300 lots. This data is sourced from the Shire of Dardanup Rural Strategy, June 2000.

3.0 ADJOINING INDUSTRIAL LAND

To the north-west of the Structure Plan area is a sawmill, particleboard factory and sand blasting plant (Figure 5). There are planning proposals, that are currently being reviewed, to zone additional land for general and light industry and for some of the land between the sawmill and the existing rural residential lots to be a buffer area ("Industry 2030 – Greater Bunbury Industrial Land and Port Access Planning", Western Australian Planning Commission, 2000"). The outcome of the review was not available at the time of preparation of the Plan.

The existing and future industries will have to ensure that emission levels are not exceeded at the lot boundaries of the rural residential lots.

4.0 EXISTING INFRASTRUCTURE

4.1 Main Drains

Much of the Structure Plan area has been artificially drained. The network of main drains is shown in Figure 2.

The drains in the northern part of the Structure Plan area have no constraints. However the sub-drains that discharge water northwards from the central and southern parts of the Structure Plan area are constrained by limited capacity. A hydrological study (appended) was undertaken by JDA Consultant Hydrologists that proposes measures to address this issue.

4.2 Roads

The Structure Plan area is serviced by the main Picton-Boyanup Road. The Garvey Road/Dardanup Road West Road link is a local distributor that connects the Picton-Boyanup Road to the South West Highway and is one of the few roads to cross the Preston River.

This link has two right-angle corners that create potential safety problems. An alternative alignment is proposed.

The Structure Plan area is well serviced by numerous internal subdivision roads. However, connection with the Dardanup townsite is poor with only Venn Road from the north. The Structure Plan proposes an additional road connection from the central area to the town.

4.3 Reticulated Water and Sewerage

Both services are available in Dardanup townsite but it is not economically viable to supply these services to the future rural residential lots. Also it is considered unnecessary to supply them because the respective functions can adequately handled by household water tanks and on-site effluent disposal systems.

4.4 Power and Telecommunications

The Structure Plan area is serviced with both power and telecommunications.

4.5 Fire Response Units

There are fire response units located in the Dardanup townsite and at the western end of Garvey Road in the centre of the Structure Plan

area. The Fire and Emergency Authority advise that no additional facilities will be required.

4.6 Community and Commercial Facilities

Except for the equestrian centre, there are no community or commercial facilities in the Structure Plan area. The nearest facilities are located in the Dardanup townsite which will be readily accessible from the rural residential lots.

There is a need for a small area where community members can meet. A picnic area along the Preston River is the preferred location. Such an area should be part of a Foreshore Management Plan.

4.7 Dardanup Equestrian Centre

The location of the Equestrian Centre is shown in Figure 1. It is a major centre in the South West for equestrian activities. Its location within the Structure Plan area is a major attraction. Many existing residents in the area keep recreational horses.

5.0 PHYSICAL ENVIRONMENT

5.1 Soil/Landform Units and Drainage

The landforms within the Structure Plan area are a mosaic of the Bassendean Dune and Pinjarra Plain systems (Figure 3). The Bassendean Dune system consists of dunes and sand plains interspersed with swampy flats. The Pinjarra Plain system consists of old alluvial deposits of loams and clays that are overlain in areas by sand. The system is flat and often poorly drained.

These landforms create a perched water table of varying depth. Many of the soils become saturated at times during winter and there are some areas of inundation. There is slow off-site drainage that is facilitated in much of the Structure Plan area by the artificial drains that take away the excess water.

The minimum summer level of the perched watertable is generally around 1.5 to 2 metres below the natural surface level. In the deeper sandy areas it can be further down. The regional watertable is several metres below the perched watertable (see the appended report by JDA Consultant Hydrologists).

The Structure Plan has been divided into three areas for the purposes of describing the soil/landform units and drainage.

The soil/landform units have been mapped and described by B.A. Barnesby, P.D. King, P.J. Tille and M.E. Proulx-Nixon (Agriculture Western Australia 1998) and comprise the Pinjarra Plain and Bassendean Sand Dune Systems (Figure 3).

Northern Area

Soil/Landform Units

The dominant Pinjarra Plain Subsystem is Pj3 (Figure 3a). It consists of a flat to very gently undulating plain of loam and clay loam surface horizons over gradational earths and duplex soils.

There are also small areas of Pinjarra Plain Subsystems Pj1a, Pj1b and Pj8. Subsystem Pj1a has shallower sandy loams of less than 50 cms over clay. Subsystems Pj1b and Pj8 have moderately deep sands and sandy loams of between 50 and 100 cms over clay.

All of the Pinjarra Plain soils are poorly drained and can be prone to saturation following rainfall. The sub-soil clays create lower permeability that can lead to waterlogging. In some very small areas there can be seasonal surface inundation.

The Bassendean Sand Dune System consists of very low sandy rises or dunes and sandplains generally with comparatively deep sands. There are some small areas of closed depressions.

The majority of the System consists of low sandy rises and dunes (Bs1) or very gently undulating sandplain (Bs2). Both have deep sands that are generally greater than 1 metre with some greater than 2 metre. These Subsystems have high permeability.

Some sandplain country (Bs6) have deep sands that have high permeability although they can have imperfect drainage.

There are some areas that are closed depressions (Bs3) with moderately deep sands with clay generally less than one metre deep. These areas are poorly drained.

Groundwater

From work undertaken by JDA Consultant Hydrologists (JDA Report) there is in some areas, particularly the Pinjarra Plain System, a perched water table that is above the regional water table.

Surface Drainage

As described in the JDA Report, the natural drainage system comprises the lower parts of the landscape where the perched water table intercepts the natural surface resulting in inundation and slow drainage generally in a north-west direction towards the Preston River

The surface drainage is intercepted by artificial drains. Figure 7 of the JDA Report shows the Water Corporation drains in this northern area being Gavins Gully Drain, Tiger Drain and Busher Drain.

Although these drains are main drains with substantial capacity, they were constructed to function as “rural drains” to remove surface water and reduce pasture waterlogging.

The JDA Report points out the existing drainage was not intended for rural residential or higher density development.

Central Area

Soil/Landform Units

The Pinjarra Plain System consists primarily of two subsystems that are distinguished by the depth of permeable sand and loamy sand overlying a clay subsoil that has low permeability. Subsystem Pj1b consists of moderately deep sands or sandy loams over clay. Subsystem Pj2 has shallower sands or sandy loams of less than 50cm over clay. Both are characterised by imperfect drainage during the winter months and waterlogging and some areas of inundation are likely. These comprise about 80% of the central area.

The Bassendean System consists of very low sand rises or dunes of deep leached grey sands with high permeability (subsystems Bs1, Bs1a and Bs2). Interdunal sandy and clay swamps (Bs3) have low permeability.

Groundwater and Surface Drainage

These are described in detail in the JDA Report.

South West Area

Soil/Landform Units

The soil/landform units have been mapped and described by Barnesby et al (1998) and comprise the Pinjarra Plain and Bassendean Sand Dune Systems (Figure 3).

This land consists of a mosaic of Pinjarra Plain and Bassendean Sand Dune Systems. Through this mosaic is the Crooked Brook and minor tributaries to the Brook and the Preston River.

The major Pinjarra Plain Subsystem is Pj6a. It is described as very gently to undulating alluvial terraces contiguous with the plain, with moderately well to well drained soils that are predominantly acidic red and yellow duplex soils.

There is a very small area of Pinjarra Plain Subsystem Pj6c consisting of very gently undulating alluvial terraces and fans. The soils are brown loams or earths that are moderately well drained.

The Pinjarra Plain Subsystem Pj9 shallow incised stream channels of minor creeks and the Crooked Brook with deep mottled yellow duplex soils.

These alluvial terrace subsystems and the stream channel subsystem contain some Conservation and Resource Enhancement wetlands.

Over half the area is covered by Bassendean Sand Dune Subsystem Bs1 or Bs1a. These are described as extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands. Underlying this in some areas can be a weak iron-organic hardpan. It is generally at depths greater than two metres.

There are some areas that are closed depressions (Bs3) with moderately deep sands with clay generally less than one metre deep. These areas are poorly drained.

Some areas of these Bassendean Sand Dune Subsystems are covered with native remnant vegetation.

Groundwater

From work undertaken by JDA Consultant Hydrologists (JDA Report) there is in some areas, particularly the Pinjarra Plain System, a perched water table that is above the regional water table.

Surface Drainage

Surface drainage in this area varies. In the north there are small areas where the system comprises the lower parts of the landscape where

the perched water table intercepts the natural surface resulting in inundation and slow drainage towards the Preston River

The central and southern sections comprise drainage via the watercourses of Crooked Brook and minor streams.

5.2 Significant Wetlands and Waterways

The significant wetlands within the Structure Plan area are shown in Figure 4. They have been identified by the Department for Environment and Conservation. There may be other minor wetlands that could be identified at the rezoning or subdivision stages. At this stage the Department for Environment and Conservation could not indicate the significance of any other wetlands.

There are several Environmental Protection Policy (EPP) wetlands and Conservation wetlands where the objective is preservation. EPP wetlands are protected by policy made under the Environment Protection Act.

Resource Enhancement wetlands are classed as priority where the “ultimate objective is for management, restoration and protection” (Position Statement: Wetlands, Water and Rivers Commission).

In order that wetlands be pro-actively managed they should be the subject of conservation covenants. This mechanism is one of several suggested in the position statement and is considered the one that will result in the most positive results.

The significant waterways within the Structure Plan area are Crooked Brook and the Preston River. These waterways are considered to be ecologically significant and the Preston River was identified as significant open space (Environmental Protection Authority, Bulletin 1108, 2003 and Bunbury-Wellington Region Plan, Western Australian Planning Commission, 1995). Both of these waterways have a conservation status and are precluded from development, horses and stock. At the rezoning and subdivision stages a foreshore reserve may be required.

No dwelling should be constructed within 50 metres of the fringing vegetation of a waterway. Also, where necessary, revegetation of the fringing vegetation is to be undertaken to the specifications and satisfaction of the Department for Environment and Conservation.

5.3 Remnant Native Vegetation

Remnant vegetation within the Structure Plan area is shown in Figure 4. Where possible subdivision and development should minimise the amount of remnant vegetation cleared however where it is inevitable, revegetation should be carried out. Vegetation around wetlands and waterways should be protected as described in section 5.2. This includes the fringing vegetation along Crooked Brook and the Preston River.

5.4 Acid Sulphate Soils

Western Australian Planning Commission Bulletin No. 64 identifies possible areas where there could be a high risk of encountering acid sulphate soils. These are shown in Figure 4. At the development stage testing for acid sulphate soils should be carried out and if found, mitigating measures outlined by the Department for Environment and Conservation should be undertaken.

6.0 LAND CAPABILITY FOR SMALL HOLDING LOTS

The land capability of the various soil/landform units has been described by M R Wells (Land Capability Study of the Shires of Mandurah and Murray, Department of Agriculture, 1989) and P Tille (Rural Strategy Appendix 2 Land Resources & Suitability, Shire of Dardanup, 2000).

Except for small areas such as the closed depressions (Pj3) and stream channels (Pj9) that are not suitable for development, the Pinjarra Plain subsystems in general have a fair rating for rural residential development with the major limitations being created from poor drainage in some areas. This can cause potential problems for house construction and conventional septic on-site effluent disposal.

The Bassendean Sands Dune subsystems have a fair to high capability for house construction and a low capability for conventional septic on-site effluent disposal. The low capability is caused largely by the high permeability of the sandy soils of the low rises and dunes and/or the poor drainage of small areas of closed basins.

These land capability limitations have been encountered and readily managed on land that has been developed for rural residential lots within the Structure Plan area. The measures that have been successfully used to manage the limitations include house pads, alternative effluent disposal systems and lot sizes that suit the physical conditions. These measures, where appropriate, will be applied to future rural residential development.

7.0 OPPORTUNITIES AND CONSTRAINTS

There are a range of opportunities and constraints for future small holding development within the Structure Plan area. These are described in Figure 5.

The development of rural residential lots on the land currently within the South West Irrigation System (eastern most portion of the Structure Plan area adjacent to the Boyanup-Picton Road) is expected to be beyond 2016. .

Land in the lower south-west sector of the Structure Plan area has a range of environmental constraints but there are opportunities for innovative design and management to create small holding lots. It is considered that this area would be best developed using lot clustering within strata title management.

The remainder of the Structure Plan area has opportunities for small holding lots providing the physical conditions are taken into account. This is discussed in the next section of this report.

8.0 STRUCTURE PLAN

8.1 Lot Yield

This Plan provides land for approximately 400 rural residential lots although for many reasons it is usual for between one quarter and one third of all potential lots not to be developed. Therefore the lot yield from the Structure Plan up to 2016 is likely to be between 270 and 300 lots.

8.2 Lot Sizes

It is proposed that lot sizes will be an average of 2 hectares and minimum of 1 hectare. However each rezoning will have different soil, landform and drainage conditions and lots may need to be greater than two hectares to accommodate suitable building sites with access.

Each rezoning application should contain a landform evaluation and demonstrate that the proposed lot sizes will satisfy the intent of this Structure Plan. Each rezoning proposal will be treated on its merit.

8.3 Lots Fronting Established Roads

Some of the established roads have trees and shrubs along the verges that provide an attractive environment. Although road widening and other road improvements will be carried out on some of these roads every endeavour will be made to retain this vegetation.

However in some instances, there may be situations where there is minimal driver visibility for vehicles entering the road. In these cases lots fronting established roads will have to be designed to ensure that vehicle access onto those roads can be carried out safely with suitable driver visibility along the road. Where this cannot be achieved then alternative points of access from lots will have to be designed. This may involve fronting the lots onto internal subdivision roads rather than the established road.

8.4 Battleaxe Lots

Battleaxe lots are not encouraged, particularly along the Preston River foreshore however in certain circumstances they could be an appropriate design solution. For example, battleaxe configuration could minimise the amount of road and stormwater drainage required or minimise clearing of vegetation. The use of battleaxe lots will be assessed on the merits of each case.

8.5 Boyanup AA Lot and Part Wellington Location 293

This land is affected by the Dardanup Pine Log Sawmill Agreement Act, 1992 where the creation of small holding lots will be restricted. The landowners, Shire and the sawmill proprietors have been in consultation to find a satisfactory solution enabling some land to be purchased by the sawmill and the rest subdivided. A rezoning amendment (Amendment No.135 to Town Planning Scheme No.3 and Amendment No.3 to Town Planning Scheme No.4) is currently being processed to achieve future subdivision of part of the land.

8.6 Drainage

The drainage study conducted by JDA Consulting Hydrologists proposes a new drainage system for the central area. Also, from this report the drainage principles and measures for the Structure Plan as a whole have been developed.

Central Area Stormwater Drainage

The central area drainage created by the rural residential development is proposed to be discharged west rather than north (the JDA Report is appended).

Internal subdivisional roads have been designed to run parallel to drains wherever possible. Roads can discharge directly into the drains or via roadside drains. Locating the roads and drains as close as possible will facilitate water discharge in a major storm event. It will also facilitate easy drain maintenance.

It is proposed that the drains, including the roadside drains, will be constructed as swales. As the summer perched watertable is about 1.5 to 2 metres below natural ground level, the drainage works will not lower the groundwater table.

In order to accommodate the roadside swales the road reserve may need to be wider than 20 metres.

The existing main drains presently discharge excess water from farming land. While small holding development will occur on some land, other land will remain as agricultural holdings. The drains that are constructed for the small holding lots must be capable of effectively draining farm land.

The hydrologist's report indicates that post-development conditions will be at least the same as the pre-development conditions.

Stormwater Drainage and Measures

The drainage proposals for the development of additional rural residential lots will be based on the principles outlined in the JDA Report.

These principles will be applied at the stage of a rezoning proposal to demonstrate that the particular land can be satisfactorily developed.

The two key principles are:

1. the post-development discharge into the Water Corporation drains should be the same or very similar to the pre-development drainage; and
2. sub-soil drainage will not be permitted because of the risk that it could significantly modify the water balance and have detrimental environmental impacts.

Water will have to be discharged via an attenuation system of roadside swales and detention areas (not basins) before being discharged into the Water Corporation drains. The natural areas of inundation could be identified and developed as detention areas.

The depth of the swales and detention areas will be limited by the depth to the sub-surface clay layer so that it is not penetrated.

These principles and measures are included in the Planning Policy.

8.7 Drainage Detention Areas

The hydrological report for the land south of Garvey Road has divided the land into a number of sub-catchments each with a detention basin. These 'basins' should be understood as detention areas or swale areas the primary function of which is water attenuation. The characteristics of these areas, including their possible size, are shown in the hydrologist's report although each rezoning application will be required to determine these drainage areas.

These areas should be developed as annual wetlands with appropriate vegetation. They can be significant public open space features and provide amenity and recreating opportunities for local residents or remain parts of private property with easements in favour of the Shire to enable maintenance to occur.

8.8 Tenure of Drains and Drainage Areas

Where the drains are existing then they will probably require reserves or easements. Generally these will be in favour of the Shire which will have the maintenance responsibility. Some of the drains such as Gavins Gully may require fencing. Many of the existing drains are on the register of the Water Corporation. When subdivision occurs then it is likely that the responsibility for the drain will revert to the Shire.

The newly constructed drainage swales and drainage swale areas will also require reserves or easements. Roadside swales could be part of the road reserve.

8.9 Notification on Certificate of Title

Because of the low-lying nature of the area and the generally slow off-site discharge there will be times when waterlogging occurs and even possibly some inundation. It is considered advisable that lot owners are aware of these possibilities. At the stage of subdivision, at notification should be placed on all newly created Certificates of Title advising of this potential.

8.10 Road Network

An indicative network of subdivision roads is shown on the Structure Plan which may be changed at the detailed design stage. However there are several key objectives that will apply.

- a) Wherever possible roads should be aligned with the drains;
- b) An additional connection between Dardanup townsite and the Structure Plan area is required;
- c) The Garvey Road/Dardanup west Road realignment is to occur on an alignment agreed to between the subdivider and the Shire; and
- d) A road following the Preston River foreshore reserve is to abut the reserve wherever possible.

The Garvey Road/Dardanup Road West link is an important local distributor road. It provides one of the few crossings of the Preston River. From observation it already carries a range of traffic including moderate to heavier vehicles. The Shire considers that the link will become more important in the future with the growth of the region.

The link has developed along two rural roads and it needs to be realigned to proper distributor road standards. It is proposed to realign this link as indicated on the Structure Plan. The final alignment is to be agreed between the subdivider and the Shire.

The foreshore road is for access of the public, shire maintenance vehicles and fire fighting vehicles. The road will also act as a separation between the high fire hazard of the river bushland and the small holding lots (see AS 3.4.1(ii) in WAPC Policy D.C 3.7, Fire and Emergency Services Authority and Western Australian Planning Commission).

Due to topographic constraints, there will be places where the road will not be able to abut the foreshore reserve. Where this occurs, alternative access must be provided in accord with the access track standards (ibid AS 3.4.3).

8.11 Bridle Paths

One of the major attractions of this area is the equestrian centre and the keeping of recreational horses. A network of bridle paths is therefore necessary for the safety and amenity of horse riders. A network of bridle paths already exists north of Garvey Road and it will be a requirement of subdivision that the bridle path network connect to the equestrian centre. The proposed connections are shown on the Structure Plan

8.12 Public Open Space – Preston River\Crooked Brook Foreshore Reserve

Public open space is to be provided along the Preston River and Crooked Brook in the form of a foreshore reserve. The width of the reserve is to be determined to the satisfaction of the Western Australian Planning Commission after considering the need for detention areas in the open space and matters of the foreshore road and access.

8.13 Public Open Space – Drainage Swales and Drainage Areas

Drainage swales and detention areas/swales could be open space reservations. However, the Shire should be consulted prior to any such open space being created.

8.14 Open Space Management Plans

The subdivider is to prepare a management plan for the Preston River and Crooked Brook foreshore and any drainage open space. These plans are to be prepared to the specifications and satisfaction of the Shire and in the case of the Preston River foreshore plan, also the specifications and satisfaction of the Fire and Emergency Services Authority.

The foreshore management plan for the Preston River is to incorporate a community picnic area and any other community facilities required by Council. The cost of the development of the picnic area and any other facilities will be the subject of the Council's Contribution Policy.

8.15 Vegetation Protection and Revegetation

Vegetation is to be protected wherever possible however some will inevitably be destroyed by development. Where this occurs revegetation should be carried out so that there is no net loss of vegetation. To ensure minimal loss of vegetation, development should

be sited in areas already cleared wherever possible and horses and stock should be fenced off from vegetation.

Revegetation of road reserves, open space and existing lots should be a requirement of subdivision and development respectively. Landscaping plans should be prepared by the subdivider and lot owners.

8.16 Bush Fire Protection

Generally, the Structure Plan area has a medium bush fire hazard classification (M McNamara, FESA, 2006) with areas of vegetation along the Preston River and several groupings of remnant vegetation being classified as a high bush fire hazard. The proposed road along the Preston River foreshore reserve will act as a hazard separation. Building setbacks may be applied to achieve additional separation. Similarly, with vegetation groupings there will need to be measures that in combination provide satisfactory bush fire protection.

There are fire response units in Dardanup townsite and on Garvey Road in the centre of the Structure Plan area. The Fire and Emergency Services Authority have advised that no additional fire fighting facilities will be required.

Reticulated water will not be supplied to the Structure Plan area and as such, water for fire fighting purposes will need to be supplemented from household rain water tanks. It is to be a requirement of subdivision that household rain water tanks are to be designed and fitted to supply at least 10,000 litres of water for fire fighting purposes. The tanks are to be constructed with a hardstand and turnaround area and provision made for the easy access of fire fighting vehicles.

At the stage of subdivision a fire management plan should be prepared by the subdivider and to the specifications and satisfaction of the Shire and the Fire and Emergency Services Authority.

8.17 Land Use Constraints

Some land use restrictions are proposed to ensure that residential amenity is maintained and to ensure that certain land uses do not adversely affect water quality. These restrictions are as follows.

- a) The commercial production of fruit and vegetables will not be permitted.
- b) The numbers of stock will be restricted to the stocking rates prescribed by the Department of Agriculture.
- c) The number of horses is to be restricted to one per hectare with a maximum of three.

- d) Commercial horse studs and horse racing stables will not be permitted.
- e) Dog kennels will not be permitted.
- f) Owners of horses and stock are to ensure that measures are in place to prevent dust pollution and soil erosion.
- g) Remedial action will be required to be undertaken by the lot owner if soil erosion and land degradation occurs.

8.18 Road and Infrastructure Upgrades

The subdivider will be required to contribute to the cost of road and community facility upgrades at the stage of subdivision in accordance with Council policy.

9.0 DARDANUP WEST CROOKED BROOK PLANNING POLICY STATEMENTS

(To be read in conjunction with Figure 6)

IMPLEMENTATION

Prior to subdivision or development being considered for Rural Small Holdings, a town planning scheme amendment shall be required to appropriately zone the land: This will include the requirement for the first amendment to insert land use provisions within Appendix VIII of the Shire's Town Planning Scheme No.3 as outlined below.

Subsequent rezoning applications will add lot details within the "Area" column of Appendix VIII.

The following are suggested provisions to be inserted in Appendix VIII

1. Subdivision and Development Criteria
 - (a) Subdivision shall be generally in accordance with a Subdivision Guide Plan, adopted by Council and the WAPC.
 - (b) The minimum lot size shall be 1ha, with a required average of 2ha. Larger lots may be required to preserve or enhance landscape qualities or other site specific issues.
 - (c) Council may adopt or refuse any proposed modifications to the approved Subdivision Guide Plan by way of resolution of Council where the modifications are consistent with the purpose and objectives of the zone. Where modifications to the Subdivision Guide Plan are proposed, the Council shall require the modifications to be advertised for public comment for a period of 21 days prior to considering the proposed modification.
 - (d) The Council shall forward a copy of any modifications referred to in clause (c) above, once these have been considered by Council, to the Western Australian Planning Commission for its consideration. The modified Subdivision Guide Plan will not come into effect until adopted by the Western Australian Planning Commission.
 - (e) Council will require a Subdivision Guide Plan to address the following issues where applicable:
 - a) drainage and stormwater disposal
 - b) heritage
 - c) areas of environmental significant
 - d) areas of Acid Sulphate Soil
 - e) wetlands
 - f) potential land use conflicts
 - g) bushfire hazard assessment
 - h) bushfire hazard
 - i) flora and fauna
 - j) land capability
 - k) effluent disposal

- l) boundary fencing
- m) design guidelines for buildings
- n) setbacks from areas of significance
- o) foreshore setbacks, management and interface
- p) provision and location of community facilities
- q) building envelopes
- r) minimising use of battleaxe lots
- s) bridle path networks
- t) tree preservation areas and revegetation, buffer planting

2. Land Use Controls

- (a) As for the zoning table and Clause 3.14.1 except that:

- (i) Dog kennels will not be permitted.
- (ii) Stables will only be permitted where horses are for hobby purposes. Commercial stud or racing stables will not be permitted.

The number of horses permitted is one per hectare up to a maximum of three horses.

If in the opinion of Council or the Department of Agriculture, the activities of livestock on any lot are contributing to erosion, pollution or the degradation of vegetation, the landowner may be required to erect and maintain a fence of satisfactory standard in order to protect the area and exclude livestock. Alternatively, the landowner may be required to remove, or Council may remove livestock from the lot.

- (iii) The number of allowable stock, excluding horses, shall be restricted to the stock rates prescribed by the Department of Agriculture. The area of the lot is to be calculated excluding any areas that are fenced off for vegetation/wetland protection.

3. Development Provisions

Effluent Disposal

- (a) Disposal of onsite effluent is to be via aerobic treatment units (ATUs) or alternative systems except where otherwise recommended by a geotechnical report to the specifications and satisfaction of Council and the Department of Health.
- (b) Effluent disposal systems are to be located a minimum of 50m from any watercourse or wetland. A greater setback may be required depending on the outcome of a site assessment.
- (c) The subdivider is to submit with a subdivision application a site and soil evaluation for each lot, prepared by a suitably qualified consultant in accordance with Australian Standards and Government guidelines to determine an appropriate onsite domestic waste water treatment system and its location to meet health and environmental objectives to the satisfaction of the Council and Department of Health

Drainage

- (d) Council will request that the WAPC impose a condition of subdivision requiring the preparation and implementation of a drainage strategy to the satisfaction of Council.

The drainage strategy shall be generally in accordance with the principles and philosophies detailed in the Dardanup West/Crooked Brook Structure Plan which promotes the use of drainage swales.

Building

- (e) No more than one dwelling is permitted on each new lot.
- (f) All buildings, structures and on-site effluent disposal systems on each lot shall be contained within the envelope as identified on the applicable Outline Development Plan, unless Council approves a variation to the envelope. Where a building envelope is approved the envelope shall supersede setback requirements.

Vegetation

- (g) No trees or substantial vegetation shall be felled or removed from the site except where:
 - a) required for approved development works;
 - b) required to fulfil the provisions of an approved Fire Management Plan;
 - c) required by a Council fire break order; or
 - d) trees are dead, diseased or dangerous.
- (h) Council will request that the WAPC impose a condition of subdivision requiring the preparation and implementation of a tree planting programme.

Foreshore Management

- (i) Council may request the WAPC impose a condition of subdivision for the preparation and implementation of a foreshore management plan to determine the edge of the Preston River, wetland, waterway vegetation line and the conservation requirements for the protection and enhancement of the wetland, waterway.
- (j) Council will request the WAPC impose a condition of subdivision for requirement to cede land free of cost for foreshore purposes consistent with WAPC Policy.

Fire Management

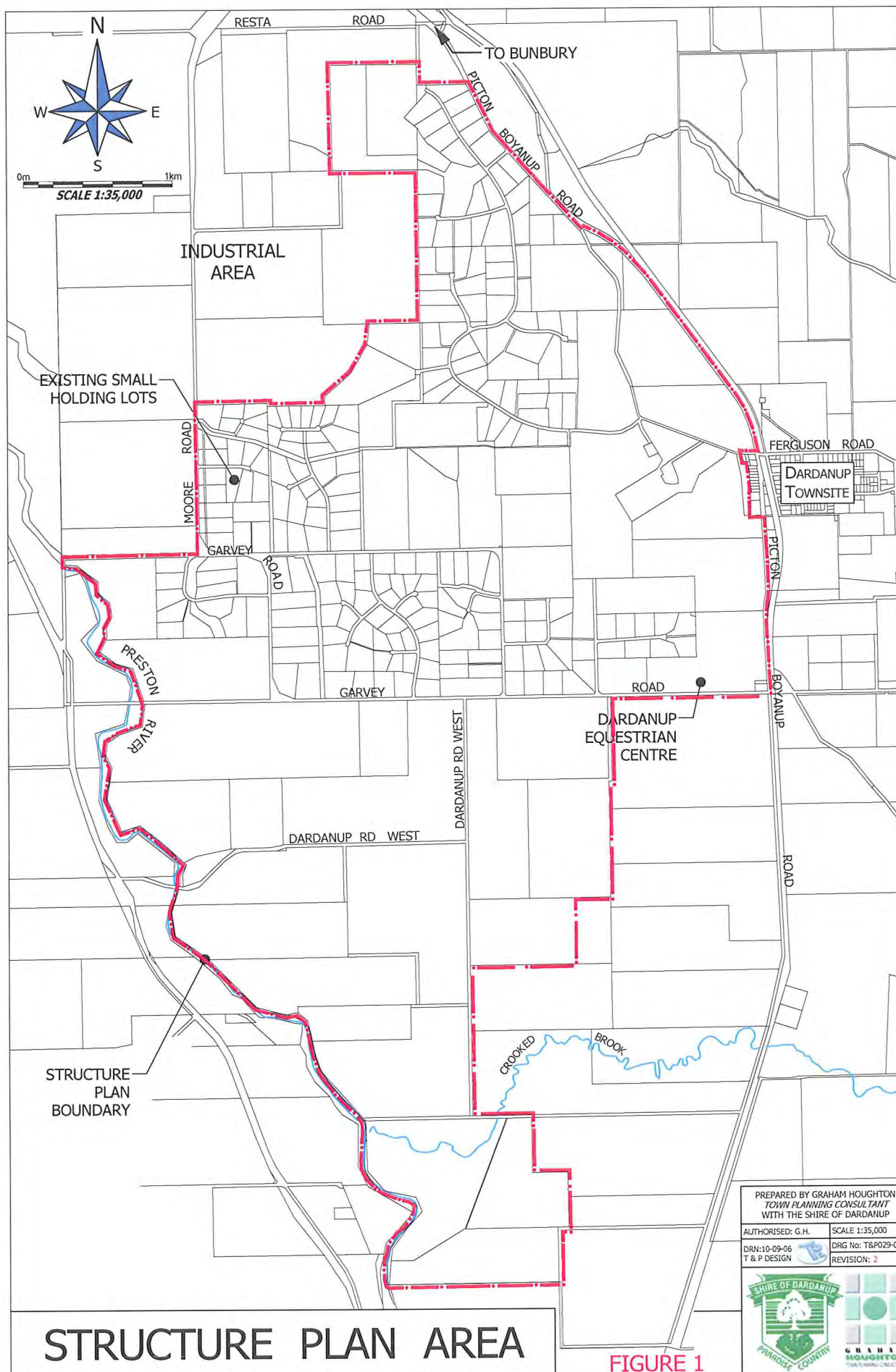
- (k) Council will request that the WAPC impose a condition of subdivision requiring the implementation of an approved fire management plan to the satisfaction of Council.

Road and Infrastructure requirements

- (l) Council may request that the WAPC impose a condition of subdivision requiring the provision and construction of bridle paths.
- (m) Council will request that the WAPC impose a condition of subdivision requiring a contribution towards road upgrading for locations identified in the Structure Plan area in accordance with Council Policy.
- (n) Council will request that the WAPC impose a condition of subdivision requiring a contribution towards the upgrading and construction of foreshore facilities identified in the Structure Plan area in accordance with Council Policy.

Fencing

- (o) Boundary fencing shall be post and four strand wire 1.0 to 1.3m high or post and ringlock or similar approved by Council. Solid fencing such as super six or pickets shall not be permitted on boundaries and shall only be permitted in proximity to buildings where Council determines that it will not adversely affect the rural amenity of the area. Fencing to be built to a standard to ensure that all pets are contained on site to minimise conflict with adjoining stock.



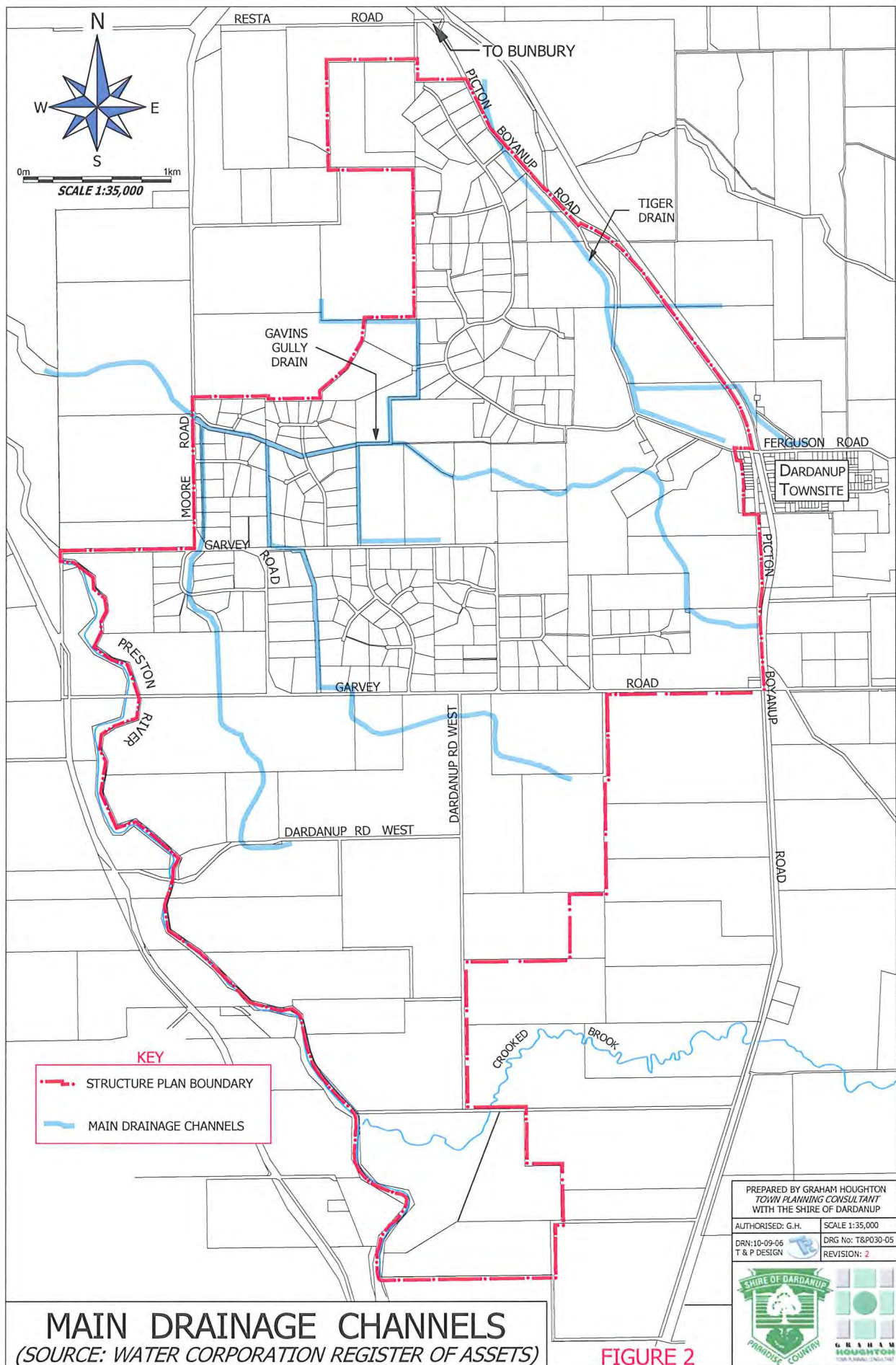
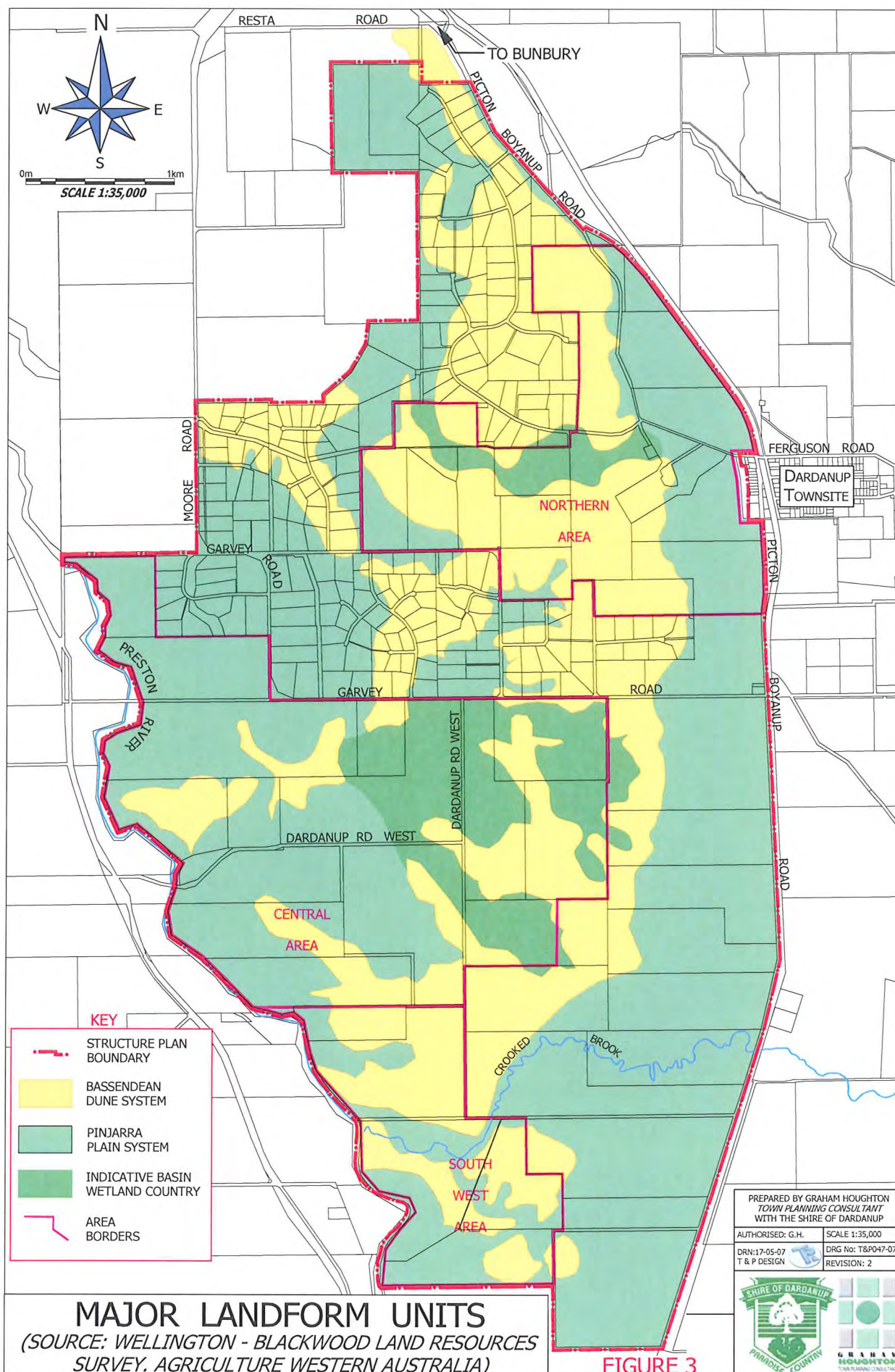
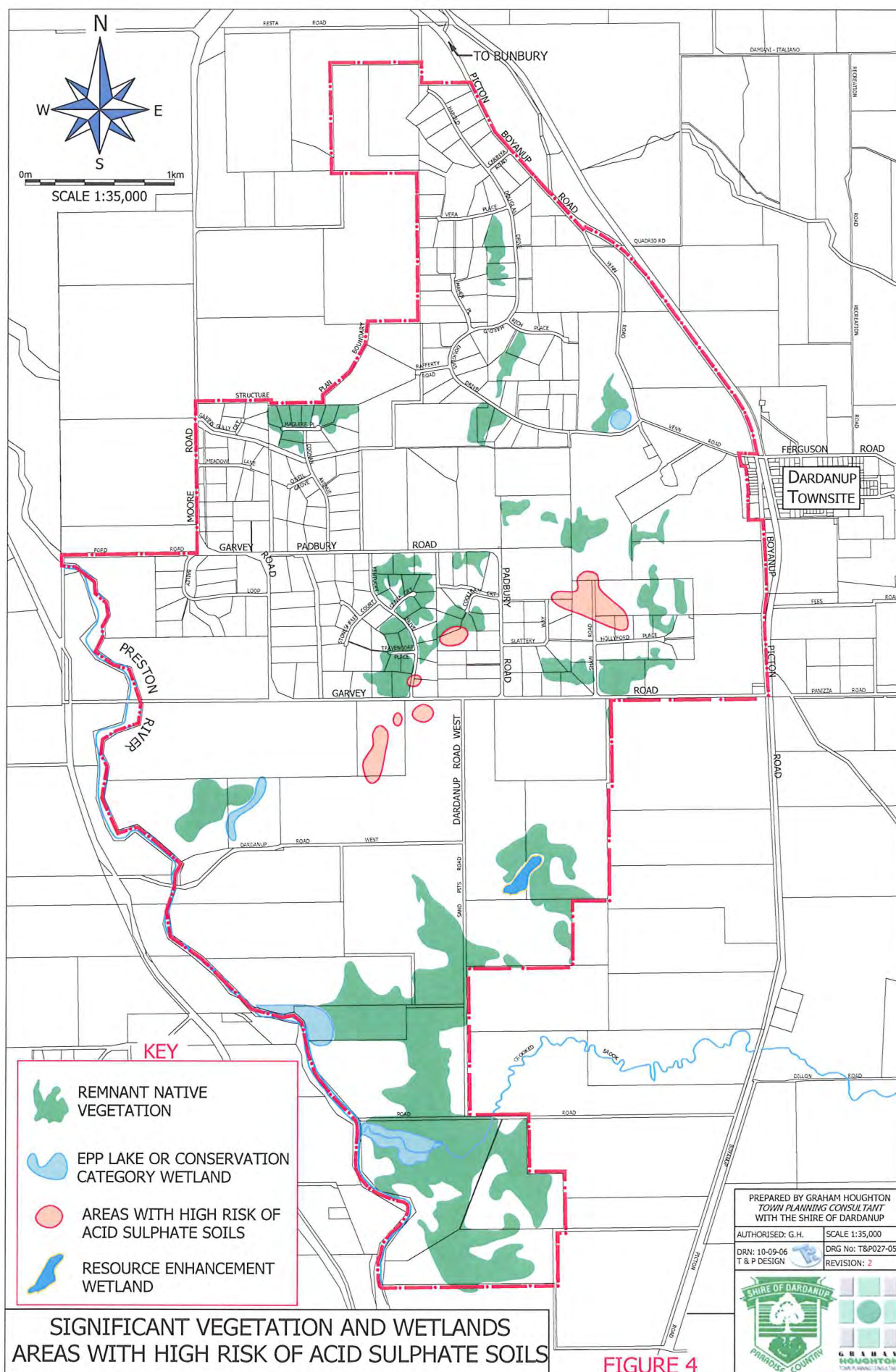
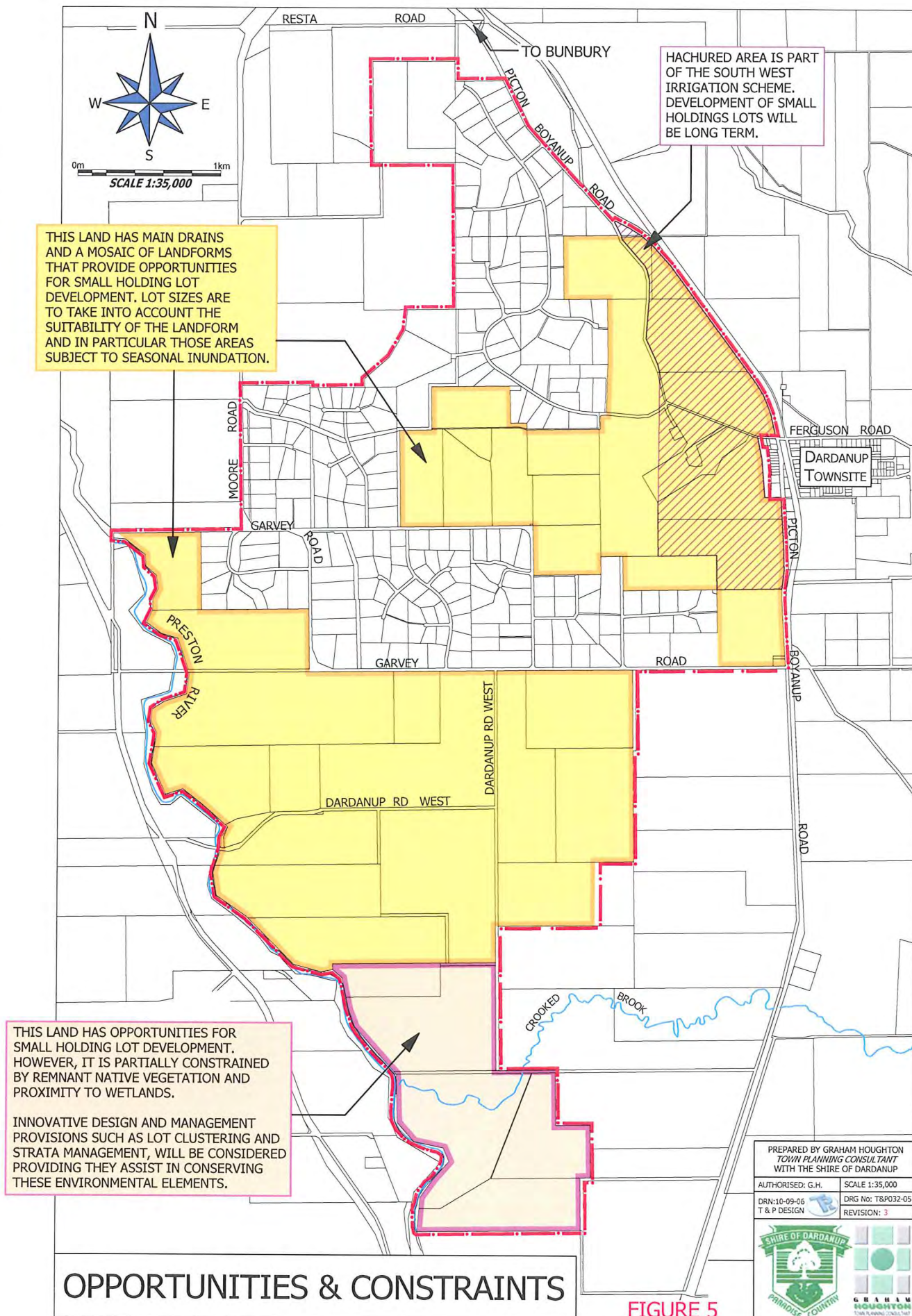


FIGURE 2







NOTES: REFER TO DARDANUP WEST/CROOKED BROOK PLANNING POLICY STANDARDS, WHICH FORM PART OF THIS STRUCTURE PLAN

Further subdivision under Town planning scheme No 4 the subject of consultation between the landowner, the Shire and the parties to the Dardanup Pine Log Sawmill Agreement Act, 1992

APPROVED BY SHIRE OF DARDANUP
CHIEF EXECUTIVE OFFICER
9-2-06
DATE

ENDORSED STRUCTURE PLAN TO PROVIDE
A FRAMEWORK FOR FUTURE DETAILED
SUBDIVISION AND DEVELOPMENT
CHAIRPERSON
WEST AUSTRALIAN PLANNING COMMISSION
7/8/2007
DATE

This land has main drains and a mosaic of landforms that provide opportunities for lots with a range of lot sizes.
Each proposal will be treated on its merits but in general terms where there is a mix of landform types then lots should be a minimum of 1 ha and an average of 2 ha.
Revegetation conditions will apply.

Preston River Foreshore
Foreshore along the Preston River to be determined by the WIA Planning Commission in consultation with the Department for Environment and Conservation.

Foreshore Road
A road is to be provided that abuts the foreshore wherever possible. This road serves access to the Open Space and access for Shire maintenance and for fire fighting vehicles and personnel. Where a public road cannot abut the foreshore then an alternative form of access is to be provided that provides a similar level of access.

KEY

- CONSTRUCTED DISTRIBUTOR ROADS
- CONSTRUCTED OTHER ROADS
- PROPOSED DISTRIBUTOR ROADS (indicative)
- PROPOSED OTHER ROADS (indicative)
- SIGNIFICANT WETLANDS
- STRUCTURE PLAN BOUNDARY
- AREAS OF POSSIBLE HIGH RISK OF ACID SULPHATE SOILS
- POSSIBLE SITES FOR DETENTION BASINS
- COMMUNITY PICNIC AREAS
- INDICATIVE LOCATIONS
- BRIDLE PATHS - EXISTING
- BRIDLE PATHS - PROPOSED

This land has opportunities for small lot development but is constrained by remnant native vegetation, wetlands and proximity to Crooked Brook.
Proposals for small holding lot development will be considered providing they assist in long-term management of these environmental assets.
Lot clustering with small lots and strata management could be considered.

Significant Wetlands (Shown Indicatively)
Wetlands shown on this plan are to be protected from development and stock. Where necessary, revegetation of the fringing vegetation is to be undertaken to the specifications and satisfaction of the Department for Environment and Conservation.
No dwelling is to be within 50 metres of the wetlands are fringing vegetation.

Acid Sulphate Soils
Areas where there could be a high risk of acid sulphate soils should be accessed prior to a rezoning application and remedial and planning measures proposed in accordance with the Department for Environment and Conservation recommendations.

No further subdivision of existing lots zoned small holdings will be supported

The design of lots fronting established roads is to ensure that vehicle access onto those roads can be carried out safely with suitable driver visibility along the road

The West Australian Planning Commission does not support subdivision of the southern cell contained within the double lines

Figure 6

THIS PLAN SHOWS AN INDICATIVE FRAMEWORK FOR FUTURE DEVELOPMENT. DETAILED PLANNING, WHICH WILL FORMALISE DEVELOPMENT PROPOSALS, WILL BE UNDERTAKEN AT THE REZONING AND SUBDIVISION STAGE

DARDANUP SMALL HOLDINGS STRUCTURE PLAN

PREPARED BY GRAHAM HOUGHTON
TOWN PLANNING CONSULTANT
WITH THE SHIRE OF DARDANUP
AUTHORISED: R. QUINN
SCALE: AS SHOWN
DRN: 11-07-07
T & P DESIGN
REVISION: B

(Appendix 1)

Record

No

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File No

PL160002

Shire of Dardanup

Crooked Brook Structure Plan

Hydrological Review

June 2005



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1. INTRODUCTION

The Crooked Brook Structure Plan is part of the Dardanup Settlement Node Planning Strategy which has been prepared as a settlement proposal in the Local Planning Strategy of the Shire of Dardanup.

The objectives of the Structure Plan are to facilitate the provision of rural residential lots varying in size within the constraints and opportunities of the land, to make provision for public amenity and infrastructure and to ensure that the drainage infrastructure serving farming properties continues to operate effectively.

The Structure Plan was prepared in 2004 by Graham Houghton, Town Planning Consultant to the Shire.

In preparation of the Structure Plan, discussions were held with Officers of Department of Environment with respect to appropriate drainage infrastructure. The use of swales rather than detention basins was recommended to maintain the hydrological balance of the area. The Shire has concerns regarding the effectiveness and maintenance of such swales and has engaged JDA Consultant Hydrologists to provide independent assessment of the Structure Plan drainage requirements.

This report represents Stage 1 of JDA's scope including the following tasks:

- Obtaining and reviewing original PW drain designs, if available.
- Obtaining and reviewing DoE monitor bore data
- Calculation of detention basins, storage requirements.
- Liaison with DoE regarding drainage design criteria.
- Preparation of draft drainage strategy to support the Structure Plan.

This report is effectively a desk-top assessment following two site visits by JDA staff. No additional survey to better define topography or gradient of drains has been performed. This may be required to finalise the drainage strategy or at detailed design stage.

2. EXISTING HYDROLOGY AND DRAINAGE

2.1 Setting

The Structure Plan area is on the eastern side and adjacent to the Preston River approximately 4 kms east of Dardanup (Figure 1).

2.2 Topography

The Structure Plan area slopes gently from east to west towards the Preston River. Maximum and minimum elevations are 37 and 15 m AHD respectively and typical gradients are less than 1:500. Only 5 m contours are available for the whole of the Structure Plan area. One metre contours over part of the Structure Plan area are contained in Koltasz Smith (2003).

2.3 Soil Mapping

The soil-landscape units have been mapped and described by Barnesby et al. (1998) and comprise the Pinjarra Plain and Bassendean Systems (see Figure 2).

The Pinjarra Plain System consists primarily of two subsystems distinguished by the depth of permeable sand and loamy sand overlaying a clay subsoil that has low permeability. Subsystem Pj1b consists of moderately deep sands or sandy loams (50 to 100 cm) over clay. Subsystem Pj2 has shallower sands or sandy loams of less than 50 cm over clay. The Pinjarra Plain System is characterised by poor drainage such that during wetter months waterlogging and inundation is likely.

The Bassendean System (Bs) consists of very low sand rises or dunes of deep leached grey sands with high permeability. Interdunal sandy and clay swamps (Bs3) have low permeability. Figure 2 shows that the Pinjarra Systems (Pj1b and Pj2) comprise most of the Structure Plan area. The Bassendean subsystem comprises perhaps 20% of the area.

The duplex soils of Pinjarra Plain system are prone to saturation following rainfall. Lower permeability sub-soil clays prevent downward infiltration and lead to waterlogging and surface inundation.

2.4 Wetlands Mapping

Figure 3 shows that the majority of the Structure Plan area is mapped as wetland, as opposed to dry land. Wetlands are generally defined as areas where saturation of the soil profile occurs, such that the land is either waterlogged or inundated at the surface for part of the year. These definitions generally apply to average rainfall years rather than the drier climate experienced since approximately 1975 in the SW of Western Australia.

All three geomorphic categories (Channel, Basin & Flatlands) are represented within the Structure Plan area (Figure 3):

- North-south drain between Dardanup West Road and Ford Road as a channel wetland.

- A large part of the western half of the Structure Plan area as palusplain, being flat wetland.
- A large part of the eastern half of the study area being basin wetland.

With respect to Wetland Management Categories, Figure 4 shows the vast majority of the mapped wetland to be Multiple Use Category, where the management objective is to plan for use, develop and management "in the context of ecologically sustainable development and best management practice catchment planning through landcare".

Figure 4 shows one Resource Enhancement Category wetland where the management objective is "for management, restoration and protection" with a view of restoring the wetland to Conservation Category.

Figure 4 shows one wetland having Conservation Category, the objective of which is the "preservation of wetland attributes and functions through various mechanism including reservation... protection under Environmental Protection Policies and ... covenants..". These areas are to be protected from development. The Preston River (beyond the western boundary of the Structure Plan Area) is also classified as Conservation Category wetland.

The Conservation Category wetland is an EPP lake and subject to the provisions of the Environmental Protection Policy (Swan Coastal Plain Lakes) Policy 1992. This wetland forms part of a Water Corporation rural drain, which drains a large part of the Plan area.

2.5 Groundwater

As discussed above, a large part of the Structure Plan Study area becomes waterlogged or inundated particularly during winter months.

Figure 5 shows the location of DoE groundwater monitoring bores.

Figure 6 shows time series of these DoE monitor bore water levels indicating a seasonal variation of approximately 1 m and maximum levels approximately 1-2 m below natural surface. Onsite investigation confirmed a summer minimum of 2 m below natural surface, indicating a winter maximum of 1 m below natural surface. This would suggest that the regional water table does not reach the ground surface and cause the observed waterlogging and inundation.

Rather it appears that saturation of the shallow soil profile occurs in winter leading to the development of the perched water table several metres above the regional water table which results in waterlogging and surface inundation.

The regional water table contours are confirmed by regional mapping by Commander (1984).

2.6 Surface Drainage

The natural drainage system comprises the lower parts of the landscape where the perched water table intercepts the natural surface resulting in inundation and slow drainage generally towards the Preston River or basin wetlands.

Waterlogging and inundation would have restricted agriculture in the past. Artificial drainage channels have been created to remove excess surface water. There are two principal drainage channels, both of which are Water Corporation rural drains.

Figure 7 shows the location of Water Corporation rural drains. These are sub branches A and B of the Gavins Gully drain. Water Corporation is responsible for drainage structures associated with these rural drains.

Figure 8 shows the catchment boundaries associated with the existing surface drains based on available mapping and our site visits.

Private farm drains and local authority road drains discharge into the Water Corporation drains or into the Preston River itself. The two Water Corporation drains discharge into the major Gavins Gully Drain which discharges into the Preston River.

The Water Corporation rural drains were constructed in 1950's only to remove surface water and prevent pasture demise caused by waterlogging. In general a "three day inundation" rule was applied, such that if landholders experienced paddocks having more than three days surface water, the (then) Public Works Department would seek to construct a drain to reduce the period of inundation.

It follows that the existing drainage was not intended for rural residential or higher density settlement.

3. PRE DEVELOPMENT DRAINAGE

The existing catchments were modelled in XP-STORM to estimate peak runoff rates for the 5, 10 and 100 year ARI storm events. The estimated catchment areas, slopes and lengths were estimated from the topological contours of the site, and are shown in Table 1.

TABLE 1: SUMMARY OF SURFACE WATER CATCHMENT AREAS

No.	Sub Catchment	Catchment Area (ha)	Slope (m/m)	Length (m)
1	Sub B Drain (upstream of Garvey Rd)	339.7	0.0043	2700
2	Sub B Drain (main branch upstream of Dardanup West Road)	130.0	0.0047	1600
3	Sub B Drain (main branch between Garvey Rd and West Dardanup Rd)	26.1	0.0018	1100
4	Sub B Drain (South West catchment)	26.5	0.0040	550
5	Sub B Drain (South catchment)	135.2	0.0040	2000
6	Sub B Drain (East catchment)	21.9	0.0050	1000
	Sub A Drain (Upstream of Garvey Rd)	182.2	0.0033	2800
7	Sub A Drain (Downstream of Garvey Rd)	19.5	0.0037	540
8	Sub A Drain (Between Dardanup West Rd and Garvey Rd)	51.5	0.0031	1250
9	Sub A Drain (East catchment)	15.8	0.0044	510
10	Sub A Drain (South East catchment, upstream of Dardanup West Rd)	43.8	0.0040	1400
11	Sub A Drain (South catchment, upstream of Dardanup West Rd)	71.2	0.0027	1900
12	Garvey West Catchment (outlet into Preston River near Garvey Rd reserve)	24.7	0.0060	880
13	Padbury West catchment (outlet into Preston River near Padbury Rd reserve)	18.0	0.0049	700
14	Mid catchment (outlet into Preston R between Garvey West & Padbury West catchments)	18.7	0.0029	900
15	Dardanup West Rd catchment (outlet into Preston R south of Dardanup West Rd)	50	0.0046	1400

Note: 1. Sub B Drain (upstream of Garvey Rd) combines all catchments upstream, ie main branch, South West, South and East.
2. Sub A Drain (upstream of Garvey Rd) combines all catchments upstream, ie between Garvey and Dardanup West Rds, East, South East and South.

Table 2 shows the estimates of peak flood flows for the existing catchments.

The peak flow from the Sub A branch of Water Corporation Gavins Gully Main Drain upstream of downstream boundary is estimated as being 2.46 m³/s for the 100 yr ARI event and 1.81 m³/s for the 10 yr ARI event.

The peak flow for the Sub B branch of the Gavins Gully Main Drain upstream of Garvey Rd is estimated as being 3.86 m³/s for the 100 yr ARI event and 2.85 m³/s for the 10 yr ARI event.

In addition to these flows into the Water Corporation Main Drain, there are also catchments flowing directly into the Preston River, with total peak flows of 2.15 m³/s for the 100 yr ARI event and 1.56 m³/s for the 10 yr ARI event.

TABLE 2: ESTIMATES OF PEAK FLOWS IN DRAINS (m³/s)

No.	Sub Catchment	5 Year ARI	10 Year ARI	100 Year ARI
	Sub B Drain (upstream of Garvey Rd)	2.55 (36)	2.85 (36)	3.86 (6)
2	Sub B Drain (main branch upstream of Dardanup West Road)	1.23 (36)	1.38 (36)	1.91 (6)
4	Sub B Drain (South West catchment)	0.32 (36)	0.36 (36)	0.50 (6)
5	Sub B Drain (South catchment)	1.18 (36)	1.31 (36)	1.80 (6)
6	Sub B Drain (East catchment)	0.30 (36)	0.33 (48)	0.46 (6)
	Sub A Drain (Upstream of Garvey Rd)	1.38 (36)	1.54 (36)	2.09 (6)
7	Sub A Drain (Downstream of Garvey Rd)	0.24 (36)	0.27 (36)	0.37 (6)
8	Sub A Drain (Between Dardanup West Rd and Garvey Rd)	0.49 (36)	0.55 (36)	0.76 (6)
9	Sub A Drain (East catchment)	0.22 (36)	0.24 (48)	0.33 (6)
10	Sub A Drain (South East catchment, upstream of Dardanup West Rd)	0.49 (36)	0.54 (36)	0.75 (6)
11	Sub A Drain (South catchment, upstream of Dardanup West Rd)	0.60 (36)	0.67 (36)	0.92 (6)
12	Garvey West Catchment (outlet into Preston River near Garvey Rd reserve)	0.35 (48)	0.40 (48)	0.55 (6)
13	Padbury West catchment (outlet into Preston River near Padbury Rd reserve)	0.25 (48)	0.28 (48)	0.39 (6)
14	Mid catchment (outlet into Preston R between Garvey West & Padbury West catchments)	0.20 (36)	0.24 (36)	0.33 (6)
15	Dardanup West Rd catchment (outlet into Preston R south of Dardanup West Rd)	0.58 (36)	0.64 (36)	0.88 (6)

Note: 1. Brackets indicate the critical duration, in hours

2. Sub B Drain (upstream of Garvey Rd) combines all catchments upstream, ie main branch, South West, South and East.

3. Sub A Drain (upstream of Garvey Rd) combines all catchments upstream, ie between Garvey and Dardanup West Rds, East, South East and South.

4. STRUCTURE PLAN DRAINAGE PROPOSAL

The Structure Plan took as its objectives for water quality and quantity from WRC (2003) as follows:

- Water Quantity – to maintain the total water cycle balance within development areas relative to the pre-development conditions.
- Water Quality – to maintain or improve the surface and groundwater quality within development areas relative to pre-development conditions.

The Structure Plan used the following principles:

- Retain and restore natural drainage systems – retain and restore existing valuable elements of the natural drainage system, including waterways, wetland and groundwater features and processes.
- Implement non-structural source controls – minimise pollutant inputs principally via planning, organisational and behavioural techniques, to minimise the amount of pollution entering the drainage system.
- Minimise runoff – infiltrate or reuse rainfall as high in the catchment as possible. Install structural controls at or near the source to minimise pollutant inputs and the volume of stormwater.
- Use of "in-system" management measures – includes vegetative measures, such as swales and riparian zones, and structural quality improvement devices such as gross pollutant traps (Interim Position Statement – Urban Stormwater Management in WA, Principles & Objectives, Water & Rivers Commission, 2003).

The Structure Plan adopted the additional principle that artificial drainage channels should continue to drain farmland to ensure long term effective drainage of that land.

For rural residential lot and road design the Structure Plan stressed the need for drainage mechanisms to take into account the existing drainage characteristics:

- Low infiltration for much of the year;
- water detention in inundation areas and in the soil profile;
- fairly rapid discharge of overflow water into man-made drains;
- the slow discharge of soil profile water into lower elevation areas, maybe areas of inundation, and into man-made drains;
- the limited capacity in the off-site drains; and
- the need to ensure that, where necessary, the drains function effectively on farming property.

The need for maintaining the water balance was identified. Sub-soil drainage was considered "not permitted", on the basis it would significantly modify the water balance causing environmental impacts.

The Structure Plan noted the increase in amount of runoff that would need to be discharged compared to pre-development agricultural conditions as a result of impervious roads and access tracks, house pads and other built-up areas. It was identified that this additional water could be difficult to manage given the environment of low infiltration and limited capacity of the off-site discharge drains.

It was noted that several of the existing drains feeding directly into the Preston River which are west of the alignment of the Water Corporation north/south rural drain.

It was considered that this direct discharge is not "environmentally satisfactory" and it was proposed to allow stormwater discharge into swales in the proposed river foreshore.

The Structure Plan noted that some properties may remain as farming while others will convert to rural residential lots. The rural residential development should not prevent effective draining of the farmland.

The Structure Plan noted there is little existing roadside drainage along Garvey Road and Dardenup West Roads which would need to be upgraded at the sub-dividers expense. Roadside swales were proposed for internal sub-division roads to collect and slowly channel water towards the discharge point. The swales were to act as detention areas to attenuate the peak flow so that post-development flows do not exceed existing pre-development flows. It was noted that waterlogging would continue to occur over several months of winter and a notification on new titles created would be required to the effect that waterlogging and inundation may be experienced.

Existing flow paths into basins and from basins into drainage channels were proposed to be modified to create swales. Similarly swales along the Preston River Foreshore were proposed to discharge water into the river by pipes to lower erosion risk over the steep river banks.

It was proposed that at the sub-division stage the sub-divider would be required to construct the swales including the individual lot swales and revegetate the land to avoid the risk of soil erosion.

Swale design was to be to the satisfaction of Council and DoE with the guideline of depth to top width ratio of 1 in 6 or greater.

The depth of swales would be limited by the depth to the sub-surface clay layer such that it is not penetrated. It was envisaged that to do so would significantly alter the water balance. The issue of acid sulphate soils was also raised as the basin wetlands are particularly considered high risk areas and disturbance could result in ASS mobilisation. The created swales would be protected by easements.

With respect to water quality source controls to minimise pollutant inputs were recommended rather than nutrient stripping basins. The Structure Plan therefore did not recommend any new drains to be constructed to drain to the Preston River to alleviate the present waterlogging and inundation issues. Rather the philosophy was to create shallow surface drains (swales) which would slowly discharge surface water and provide flood storage during times of heavy rainfall.

5. JDA DRAINAGE PROPOSAL

JDA considers that there is an excess of surface water created largely by a perched water table reaching the surface in winter, which needs to be dealt with by additional drainage outlets to the Preston River.

Such new outlets should discharge safely after attenuation in detention basins to prevent erosion of Preston River banks.

JDA has identified two possible locations which should both be considered for further analysis.

These are:

- Westward extension of road drain along Garvey Road to the Preston River.
- Westward extension of road drain along Dardanup West Road to the Preston River.

Both of these possible new drains are indicated on Figure 9 together with the surface catchments which they would serve. Also indicated on Figure 9 are tentative locations for surface water flood detention basins.

The drain along Dardanup West Road would capture all the catchments south of Dardanup West Road that currently drain to the Gavins Gully A Sub Branch. The drain along Garvey Road would capture all catchments between Garvey Rd and Dardanup West Rd and catchments east of Dardanup West Rd.

There are seven possible detention basin site, three for the southern Dardanup West Rd drain, and four for the central Garvey Rd drain. An eighth may be required for the northern section of the Gavins Gully A Sub Branch, and other smaller basins maybe required for the catchments discharging directly to the Preston River.

The proposed drainage system has been modelled in XP-STORM. Basins were sized so that no overflow occurs in basins or channels for the critical 10 yr ARI storm event. The downstream basins were sized so that post development outflow is less than or equal to pre development outflows. The proposed detention basin sizes are summarised in Table 3. Channels were assumed to be "V" channels with 1 in 3 side slopes, with maximum depth of 1 m. Exact profiles and geometry of the new drains will need to be considered at detailed design stage.

These proposed drains will not lower the perched water table on which the wetlands depend but rather slowly remove excess surface water from the landscape.

This will protect rural residential roads base course from saturation and reduce the areas of surface water within the newly created properties, while protecting wetland water balance.

JDA does not consider that such drains should only be within the sand horizon but that they could extend into the clay subsoil of the Pinjarra land system.

Long sections of natural surface and proposed drain inverts of the Garvey Road and Dardanup West Road are shown in Figure 10, together with detention basin invert and overflow pipe to allow complete drainage.

Protection works or drop structure within the Preston River foreshore reserve will be required to minimise erosion.

Acid sulphate soil assessment would be required to verify the acceptability of this proposal.

JDA considers the attenuation of surface flow in detention basin to be at least comparable with attenuation in swales and to be an acceptable and proven method in other parts of the southwest of WA.

Table 4 compares the estimates of flood flows from the Study Area for pre development and the proposed post development.

TABLE 3: PROPOSED DETENTION BASIN CHARACTERISTICS

Basin	Area (ha)	Depth (m)	Volume (m ³)	Base Elevation (mAHD)	Outlet Pipe (mm)	Peak Outflow Rate (m ³ /s)		Peak Basin Water Depth (m)	
						10 yr ARI	100 yr ARI	10 yr ARI	100 yr ARI
A	2.96	1.0	27,600	24.0	450	0.43	0.55	0.70	0.94
B	1.49	1.0	13,500	21.0	525	0.64	0.80	0.78	1.00 ¹
C	2.96	1.0	27,600	20.3	525	0.42	0.58	0.71	0.91
D	1.74	1.0	15,900	19.0	900	1.49	2.10	0.81	0.87
E	0.3	1.0	2,300	18.0	750	1.51	1.83	0.79	1.00 ¹
F	1.49	1.0	13,500	22.0	450	0.49	0.57	0.86	1.00 ¹
G	1.49	1.0	13,500	20.0	450	0.36	0.46	0.61	0.79
H	0.3	1.0	2,300	18.0	750	1.61	1.70	0.90	1.00 ¹

Note: 1. Basins overflows during 100 yr ARI event.

TABLE 4: COMPARISON OF PRE AND POST DEVELOPMENT RUNOFF RATES (m³/s)

Outlet	Pre Development		Post Development	
	10 yr ARI	100 yr ARI	10 yr ARI	100 yr ARI
Sub A Drain	1.81	2.46	0.38	0.51
Sub B Drain	2.85	3.86	0.19	0.27
Garvey Outlet	0.40	0.55	1.51	1.83
Dardanup West Rd	0.64	0.88	1.61	1.70
Padbury Outlet	0.28	0.39	0.30	0.40
Mid Outlet	0.24	0.33	0.26	0.34
Total	6.38	8.47	4.25	5.05

6. CONCLUSIONS

- The Structure Plan area is subject to waterlogging and inundation associated with a perched water table due to low permeability clay sub-soils. Much of the area is mapped as wetland, supported by this perched water table.
- The perched water table rises to the surface and results in considerable surface inundation and flow in existing drainage channels.

This surface drainage has limited conveyance routes to the Preston River due to lack of maintenance on Water Corporation rural drains over the years and the limited number of outlets to the Preston River.

- The Structure Plan describes surface water management in shallow swales in an attempt to protect the existing water balance. The plan does not recommend new surface drainage outlets to the Preston River.
- JDA considers that new surface water outlets to the Preston River are required to facilitate better surface water management in the context of land use change from agriculture to rural residential with associated road infrastructure.
- JDA's proposal is therefore new drainage outlets to the Preston River with reduction of peak flow rates in detention basins and erosion control structures at outlets.

7. REFERENCES

Barnesby B.A. et al. (1998), *Land Resources from Harvey to Capel on the Swan Coastal Plain*, Agriculture Western Australia.

Commander, D.P. (1985), *The Bunbury Shallow-Drilling Groundwater Investigation*, Western Australia Geological Survey.

DoE (1992), *Environmental Protection Policy (Swan Coastal Plain Lakes)*.

Houghton, G. (2004), *Crooked Brook Structure Plan*. Report to Shire of Dardanup, March 2004.

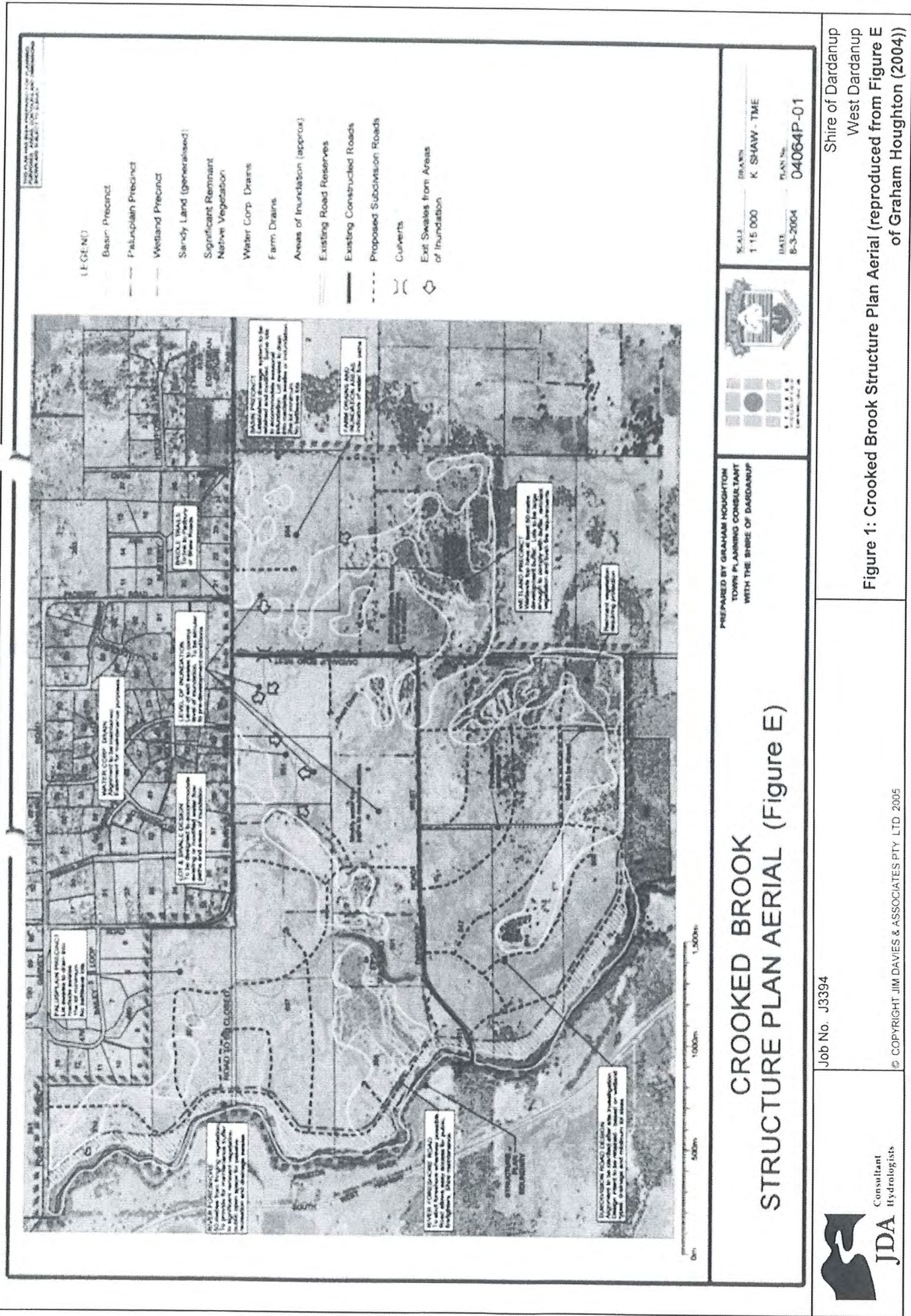
Institution of Engineers Australia (2000), *Australian Rainfall and Runoff – A Guide to Flood Estimation*.

Koltasz Smith (2003), *Development Guide Plan – Garvey Road – Dardanup*.

WAPC (2001), *Position Statement: Wetlands*.

WAPC (2000), *Greater Bunbury Region Scheme Environmental Review*.

Water & Rivers Commission (2003), *Interim position statement – Urban Stormwater Management in WA – Principles and Objectives*.



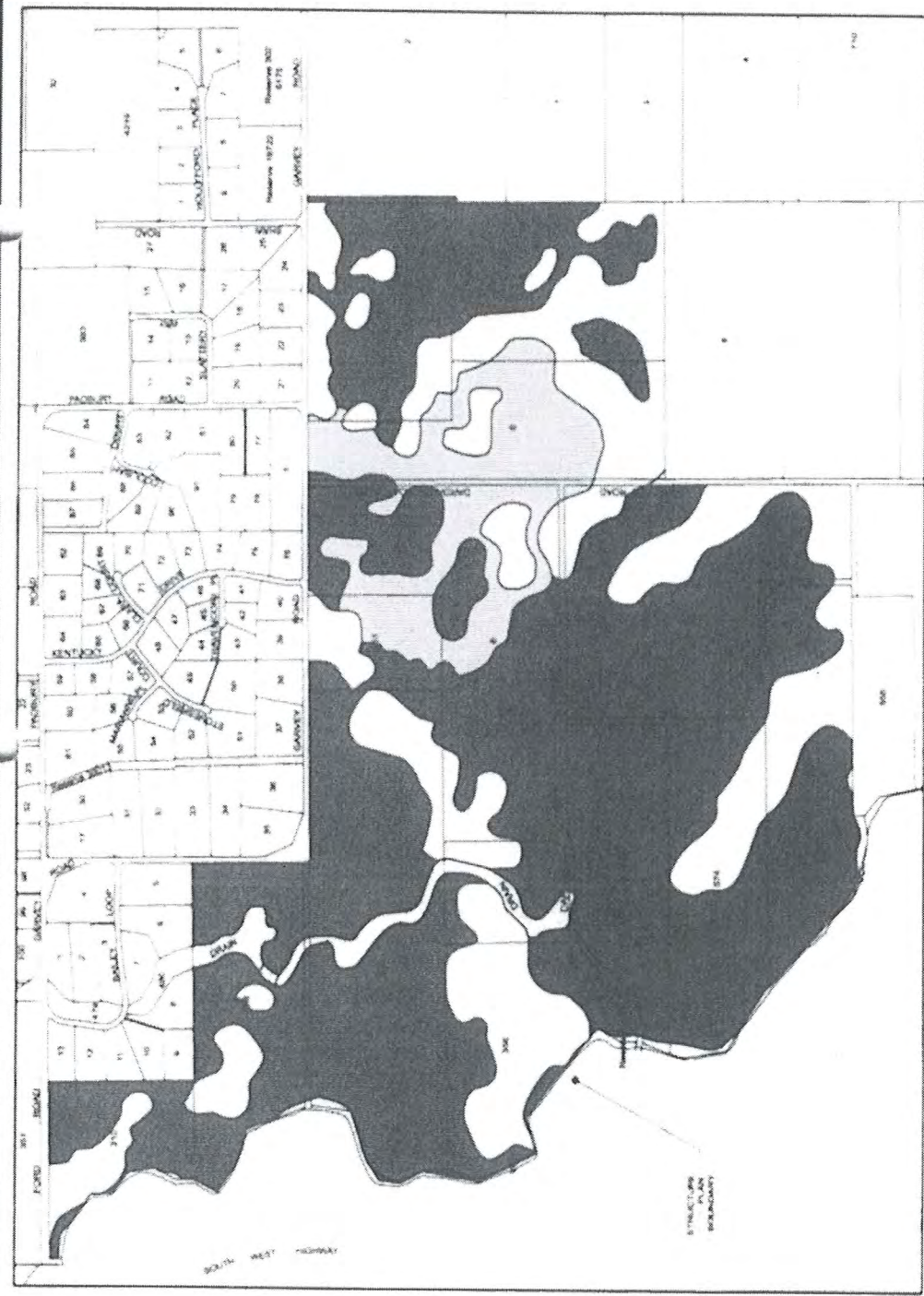
Map of the Shire of Dardanup
 showing the location of the
 Crooked Brook Catchment
 within the Shire of Dardanup

LEGEND

- Pinjarra Subsystem (P1b)
- Pinjarra Subsystem (P2)
- Bassendean Subsystem

Note: Within P1b are other minor Pinjarra Subsystems and minor poorly drained Bassendean Subsystems

Source: Agrimap Land Profiles
 for the Shires of Marmion, Harvey and Dardanup



CROOKED BROOK SOIL AND LANDFORM UNITS (Figure B)

PREPARED BY GRAHAM HOUGHTON
 TOWN PLANNING CONSULTANT
 WITH THE SHIRE OF DARDANUP



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 DATE: 8-3-2004
 DRAWN BY: J. HARKNESS - TME
 PLAN NO.: 04064P-02

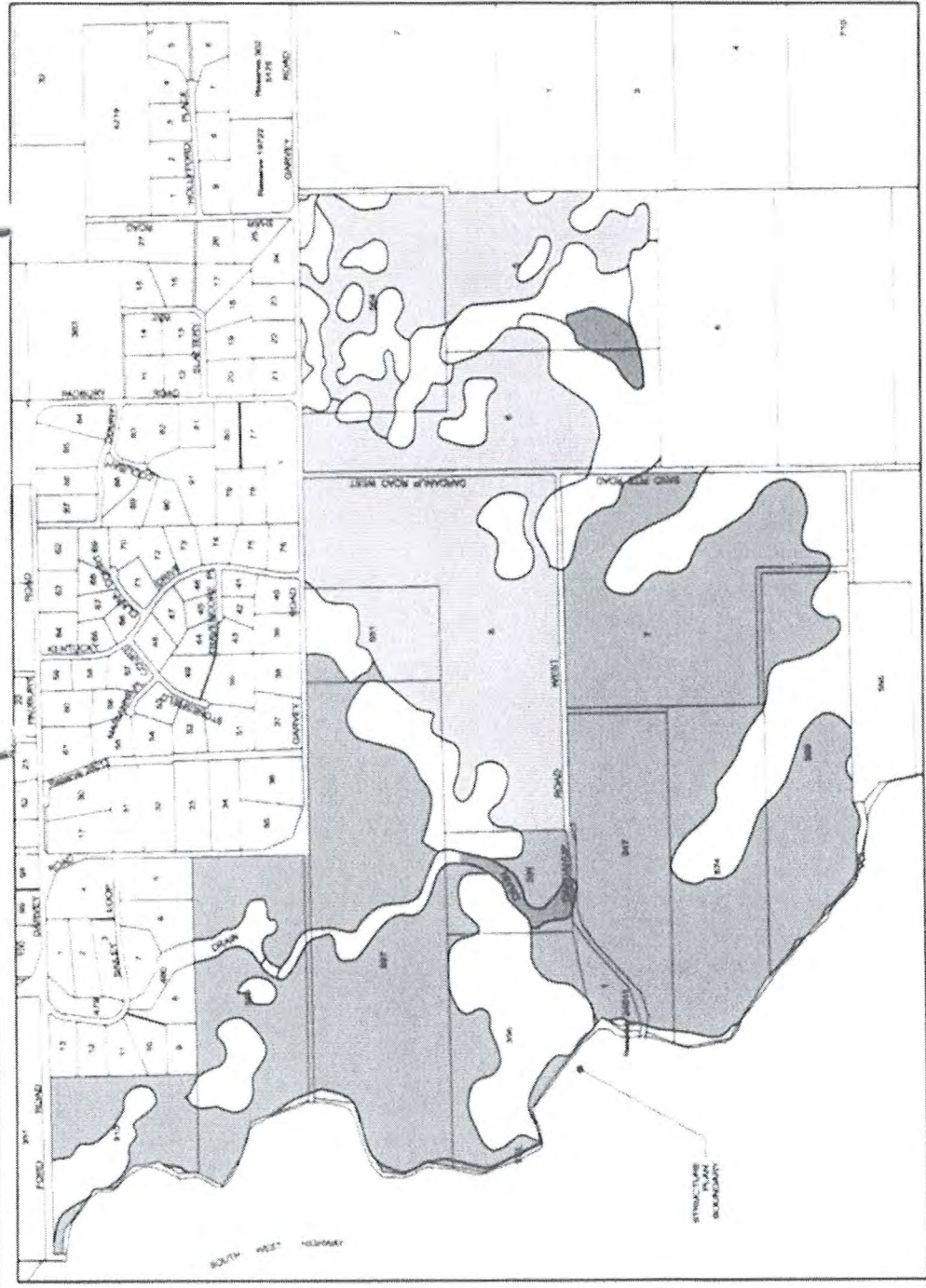
JDA Consultant Hydrologists	Job No. J3394 © COPYRIGHT JIM DAVIES & ASSOCIATES PTY LTD 2005	Shire of Dardanup West Dardanup Figure 2: Soil & Landscape Units (reproduced from Figure B of Graham Houghton (2004))
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LEGEND

	Basin (Generalised)
	Palusplain
	Wetlands of Significance

Source: Aerials and Profile
For the Shire of Dardanup, Harvey and District



Scale: 0m 500m 1000m 1500m

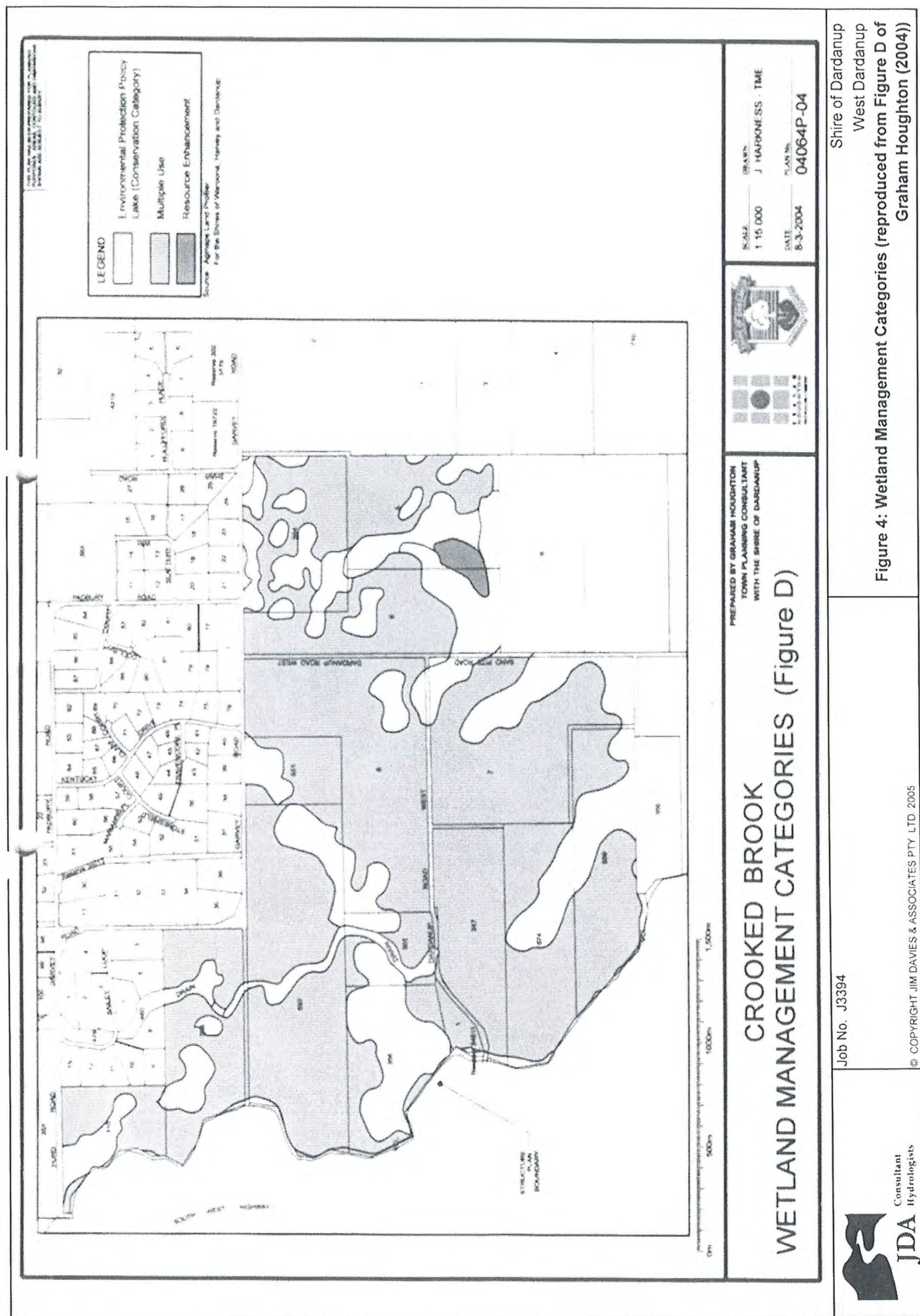
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WITH THE SHIRE OF DARDANUP



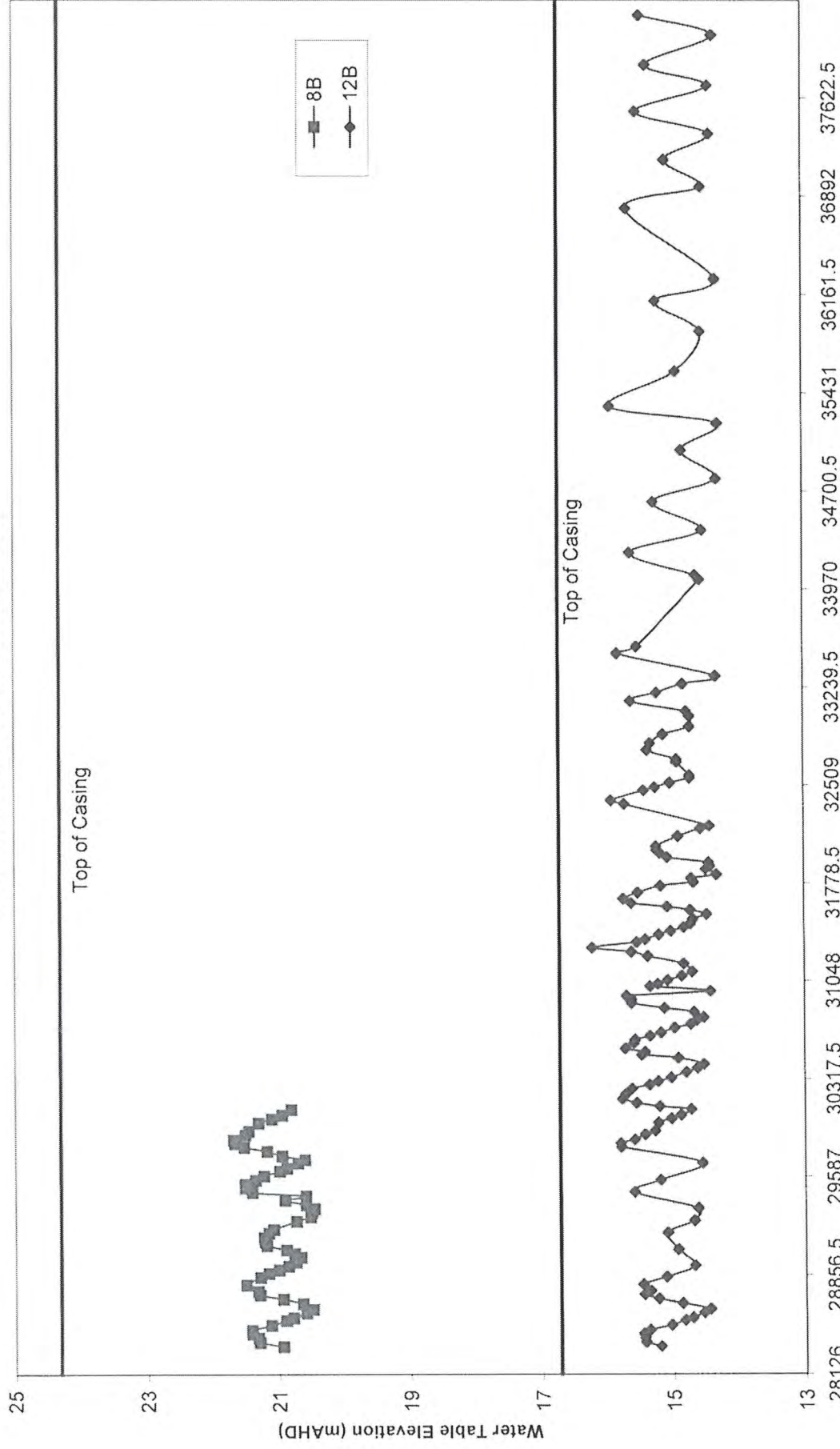
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PLAN No: 04064P-03

CROOKED BROOK WETLAND TYPES (Figure C)

	Job No. J3394	Shire of Dardanup West Dardanup	Figure 3: Wetland Types (reproduced from Figure C of Graham Houghton (2004))
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Dardanup Shallow Monitoring Bores



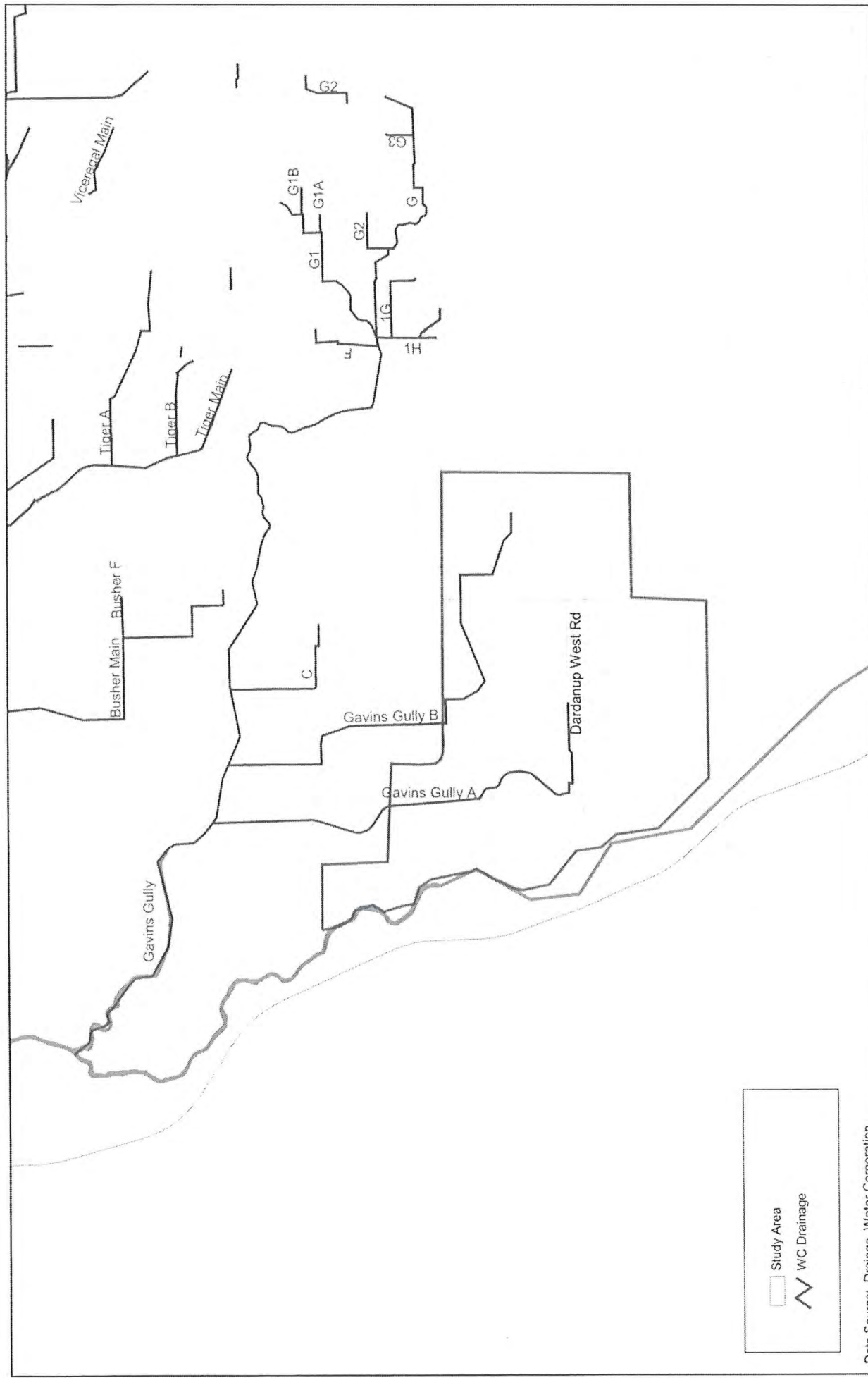
Data Source: DoE



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Shire of Dardanup
West Dardanup - Crooked Brook
Figure 6: DoE Monitoring Bore Data



Study Area

WC Drainage

JDA
Consultant
Hydrologists

Data Source: Drainage, Water Corporation

Job No. J3394

Scale 1:40000

0 1 2 3 Kilometres

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Shire of Dardanup

West Dardanup

Figure 7: Water Corporation Rural Drains

