Alkimos Eglinton District Structure Plan. Appendix 5 Engineering Infrastructure.

ALKIMOS EGLINTON

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ALKIMOS EGLINTON DISTRICT STRUCTURE PLAN

ENGINEERING INFRASTRUCTURE

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1.0 INTRODUCTION

This report has been prepared by Cossill & Webley Pty Ltd (CW) for the Alkimos Eglinton District Structure Plan (AEDSP). It summarises the results of a review of the engineering infrastructure required to facilitate the implementation of the AEDSP proposals.

The preparation of the AEDSP has been carried out by a team of consultants, led by Development Planning Strategies, on behalf of the major landowners within the area; LandCorp, Eglinton Estates Pty Ltd and WR Carpenter Landholdings Pty Ltd. The boundary of the AEDSP area is shown on Figure 1.

The AEDSP is a further phase in the processes to prepare the landholdings for urban development and it follows past concept structure planning and Metropolitan Region Scheme (MRS) amendments which define the current reserves for regional roads, regional open space and the Alkimos Regional Centre. The most recent of these is the current MRS Amendment 1029/33 which was finalised in June 2006.

This report covers the engineering infrastructure requirements to service the urban development proposals in the AEDSP based on an ultimate residential population of some 60,000 people.

Reference has been made in this report to the results of the past and present work undertaken by other members of the consultant team and by Water Corporation of WA, which also owns Lot 101 within the area.

The proposed AEDSP is shown on Figure 2.

2.0 DESCRIPTION OF THE LAND

2.1 Topography

The topography of the Alkimos Eglinton land is varied. Along the coast it comprises a series of beaches and short low cliffs backed by a Quindalup Dune system of tall sand dunes. This system is about one kilometre in width and with elevations up to 20-25 metres AHD.

Further inland the topography comprises a ridge, of the Spearwood Dune system, running generally south-east to north-west through the eastern half of the land. Elevations of this ridge peak at about 50-60 metres AHD.

The Quindalup Dune system includes a series of parabolic sand dunes extending up to 3.5 kilometres inland. On Lot 102 the most prominent of these inland dunes is a dominant landscape feature of the Alkimos portion of the area. Maximum elevations of these dunes are 55-60 metres AHD.

In general the Quindalup dunes are irregular shaped with narrow ridges. Side slopes vary significantly with maximum slopes of up to 10%.

The inland Spearwood ridge is more regular and broader in shape with uniform slopes, east and west, of up to 5%.

The above topography is shown on Figure 3.

2.2 Ground Conditions

The ground conditions within the area have been assessed by Coffey Geosciences. This has been based on a desktop study of existing geological maps and on Coffey's experience with past site investigations within the North-West corridor.

A copy of Coffey's report on the results of its assessment is included in Appendix A.

3.1 General

Siteworks for urban development comprises the clearing of existing vegetation and the earthworking of existing ground to facilitate a required form of development.

In Perth it is often the case that the extent of siteworks is dictated by the density and nature of development and by the finished ground shape required for building houses, etc. Increased densities and decreasing lot sizes has led to the current trend for the development areas to be fully earthworked to create level lots which are terraced between retaining walls.

This approach provides a number of positive outcomes:-

- It reduces house building costs
- It rationalises retaining wall layouts and designs consistent with Local Authority specifications
- It enables lots to be terraced up natural slopes to maintain elevation and views.

What it doesn't allow for, however, is the retention of existing vegetation and topography within the lot areas. This is particularly the case within the coastal areas where the topography comprises the irregular shapes and heights of Quindalup sand dunes.

3.2 Development Options

Notwithstanding the above, there is a growing appreciation of the importance to retain existing vegetation and topography to provide 'sense of place' within development areas and to meet 'sustainability' objectives.

To a large extent this has been a basis for the establishment of the Regional Open Space reserves at Alkimos Eglinton. These protect a range of existing natural attributes include the coastal foreshore dunes and inland sand dunes and vegetation.

Beyond this, the Alkimos Eglinton project will inevitably comprise the full range of development forms and densities necessary to meet the demands of a diverse community. The current siteworks approach, outlined in 3.1 above, will apply to the larger part of this development. The scale of the project will, however, provide opportunities for different approaches based on different development forms, as follows:-

- Retention of landmark landform features and/or vegetation within areas of local public open space.
- Retention of existing landform and vegetation within lower density (R5 say) development with designated building envelopes to control clearing and earthworks.
- Alternative building forms including framed and split level housing to better suit existing slopes.
- More 'organic' subdivision layouts locating roads through valleys and retaining existing landform within varying sized and shaped lots.

In all cases, it is invariably the development density which dictates. If landform retention is considered important then lower density development and larger lot sizes (1,000 square metres minimum) will need to be considered together with controls to protect the private open space outside of building envelopes.

Lower density development, as above, is typical of the older coastal suburbs of North Beach, Watermans Bay, Sorrento, Quinns Rocks, etc which are often cited as good examples of existing landform/vegetation retention.

3.3 Major Features of the AEDSP

The major features of the AEDSP include the primary roads and railway, the secondary transit line and the regional and district centres. These are located to best suit the overall structure plan layout and where possible, to have least impact on the major topographical features of the site.

Within the Alkimos area the main sections of the steep sided northern ridge of the parabolic dune is protected in an area of ROS, which extends east-west across the site.

A preliminary design of the vertical geometry for Marmion Avenue was carried out by Cossill & Webley for the MRS Amendment 1029/33. This was based on the adoption of design speeds appropriate for initial speed limits of 70kph through the area of the Alkimos Regional Centre and 90kph north of this. Ultimately, the speed limits along the total section of the road will be 60-70 kph.

Based on these criteria, the proposed road geometry is such that it reflects the undulations of the existing topography. Substantial earthworks will be required as the road cuts through the parabolic dune ridges within Alkimos and management plans will be required to make provision for the environmental impacts of this through the designated ROS area.

Through the Alkimos Regional centre the road is flat graded to suit the centre landuses and frontage development. Further north the road grades up and over the high dune ridge through the southern part of Lot 11, and ocean views from the road should be possible along this section.

Within the proposed Alkimos Regional Centre area earthworks will be required to provide development sites with grades of less than 3% say. The Regional Centre levels would need to tie in with the levels of Marmion Avenue, the railway and the Mitchell Freeway as well as the parabolic dune ridges along its northern boundary. The existing topography is such that these development grades could be achieved without the need for major earthworks.

The Eglinton District Centre is located on land which grades up from Marmion Avenue and earthworks will be required to provide benched development sites with appropriate finished grades.

In general, the preliminary levels of the railway are such that it will be in cutting for most of its length through the area. This is certainly the case through the Regional and District Centres, where it is expected that the railway line will be 'built over' as part of the development of the centres.

Where the railway levels are at or above existing ground levels, it is expected that the adjacent development areas will be filled such that their finished levels are raised above the railway.

In addition to the ROS areas the AEDSP includes provision to retain existing topography and vegetation within development areas. A particular example of this is the development concepts reflected in the structure plan layout of the southern coastal area of Lot 11, Eglinton.

Dunes with landscape value have been identified and incorporated into the development layout. This provides the opportunity for the existing dunal topography and vegetation to be retained in POS and/or private open space as outlined in Section 3.2.

Figure 4 shows some options of how this might be achieved.

The AEDSP includes an alignment for a possible secondary transit route linking to the Alkimos and Eglinton railway stations from the coastal areas. This proposal is described in detail by Sinclair Knight Merz in its report on the transportation aspects of the structure plan proposals.

The transit system could comprise buses or possibly a future light rail system, if required on dedicated lanes within neighbourhood connector road reserves. The vertical geometry of the roads will need to be designed to suit with maximum grades of 5-6%. The alignment of the transit line shown on the AEDSP has been adopted to minimise, as much as possible, the earthworks which would be required to achieve these grades, particularly through the coastal area.

Notwithstanding this, earthworks will be required where the transit line cuts through dunal ridges.

The earthworks will need to extend beyond the road reserve where higher density, frontal development is proposed as per the coastal centre area on Lots 101 and 102, Alkimos. The finished levels of these development sites will probably involve earthworks benching, either side of the transit line.

4.1 Existing Roads

Road access to the Alkimos Eglinton Project Area is currently by Wanneroo Road which links the northern part of the north-west corridor with the Perth central area. Through the area and north of Wanneroo the road comprises sections of two lane rural standard road and sections which have been upgraded by Main Roads WA to a four land divided standard. It is in good condition generally and provides for an operating speed of up to 90 kilometres per hour, the sign posted speed limit. South of Wanneroo the road provides for four lane divided movement of traffic, and is constructed to an urban standard with kerbed and drained carriageways, etc.

Existing road links to the eastern boundary of the area from Wanneroo Road include Romeo Road, north of Lot 3 at Alkimos, and Pipidinny Road, north of Lot 11 at Eglinton.

Romeo Road is constructed to a rural standard, with a two lane sealed carriageway between Wanneroo Road and the land, where its reserve currently ends, at the north-east corner of Lot 3.

Pipidinny Road extends along the northern boundary of Lot 11 to within some 500 metres of the coast. The road is constructed to a rural standard with a two lane, sealed carriageway which is in good condition.

4.2 Proposed Primary Roads

The AEDSP shown on Figure 2 incorporates a network of proposed primary roads comprising regional and major district distributor roads.

The Mitchell Freeway along the eastern boundary will be the north-south regional road linked to the district distributor roads, Marmion Avenue, Eglinton Avenue, Alkimos Drive and Romeo Road.

The reserve for the freeway is based on past planning and design work carried out by Main Roads WA and is as provided for in the current MRS.

The district distributor roads, except for Romeo Road, form a part of MRS Amendment 1029/33 with their alignments and reserves established from past planning and design work carried out by the Alkimos Eglinton consultant team.

Marmion Avenue, Eglinton Avenue, Alkimos Drive and Romeo Road will ultimately all be four lane divided roads with reserve widths varying from 36 to 53 metres. These roads will function as 'Integrator Arterial A, Major Arterial' roads as defined in Liveable Neighbourhoods, Edition 3.

The design of the district distributor roads will be based on an ultimate operating speed of 60-70 kph, with the lower speeds applying through the Regional and District Centres. These operating speeds are also consistent with the intended function of the roads to integrate more with the surrounding landuses as well as cater for district traffic movements.

Through urban areas and the centres the district distributor roads will ultimately have frontage landuse, with service roads and associated pedestrian activity.

The alignment of Marmion Avenue follows an undulating route which aims to take account of the existing topography. The proposed, lower operating speeds will allow the road to be designed and constructed to be less devisive in terms of its fit with the topography and its integration with the adjacent development.

The vertical geometry of district distributor roads will also be designed to suit the levels of the adjacent land development, particularly through the Regional and District Centres and where development is frontal to the roads. Through the ROS it will be designed to minimise the extent of earthworks and, therefore, clearing of vegetation.

The road reserve for Marmion Avenue will be widened at its intersections with the other district distributor roads for the ultimate construction of signalised intersections with Romeo Road and Eglinton Avenue and either signals or a roundabout at Alkimos Drive.

Romeo Road has been realigned in the AEDSP compared to the current MRS. This allows for the road to better service the Alkimos Regional Centre and the Alkimos Coastal Village by providing more direct access to and from the Mitchell Freeway and Marmion Avenue. The realignment of the road reserve will be part of a future MRS Amendment.

The above regional and district distributor road network is shown on Figure 5.

4.3 Proposed District Roads

Figure 5 also shows the network of district roads proposed in the AEDSP.

District roads comprise the 'Integrator B, Arterial Neighbourhood Connector' roads as defined in Liveable Neighbourhoods.

Operating speeds of 50-60 kph apply to these roads which have reserve widths of 20 to 30 metres. Carriageway configurations vary from two lane boulevards to single, two-way carriageways to accommodate traffic volumes from 2,000-15,000 vehicles per day.

5.0 NORTHERN SUBURBS RAILWAY EXTENSION

The AEDSP shown on Figure 2 includes an alignment for the extension of the Northern Suburbs Railway through the area. This varies from the alignment in the current MRS and is based on a review, by the Department for Planning and Infrastructure (DPI) of the railway as part of its overall review of the structure planning for the North-West Corridor.

The DPI railway review has been carried out by GHD, Consulting Engineers, with the results embodied in a report entitled 'Northern Suburbs Railway Alignment Definition – Alkimos to Yanchep' and dated August 2005.

In general the railway alignment defined by GHD follows the preliminary alignment proposed in the Alkimos Eglinton Concept Structure Plan. It is an extension of the alignment proposed through the Jindalee Butler area and itself extends beyond Eglinton to the proposed Town Centre within the Yanchep landholding to the north. The alignment is shown on Figure 6.

The GHD definition of the horizontal railway alignment has been adopted for the AEDSP and it includes provision for the tracks, a principal shared path, access road, earthworks and retaining walls, generally within a 35 metre wide reserve. The alignment has been designed for train speeds up to 140 kph.

The vertical alignment proposed by GHD has been based on the existing ground levels. No provision has been made for the likely future levels of the adjacent urban development.

Provision has been made, however, for the levels of the district distributor roads shown in the AEDSP. This has been based on the preliminary road design work carried out by Cossill & Webley for the Alkimos Eglinton Concept Structure Plan and MRS Amendment 1029/33.

The GHD definition work also includes concept layouts for railway stations to be located within the Alkimos Regional Centre, at Alkimos Drive and within the Eglinton District Centre. Provision for these three stations is included in the AEDSP.

6.1 Wastewater Collection

The Water Corporation of WA's (WCWA) planning for the sewerage of the Alkimos Eglinton Project Area comprises a system of pumping stations and pressure main connections to gravity trunk sewers. The areas of development would be serviced with a conventional system of reticulation sewers connected to the various pumping stations or directly to the trunk gravity sewers. Provision for the pumping station sites will need to be made in the ongoing detailed subdivision planning and development of the area.

The trunk sewers will discharge to the proposed Alkimos Wastewater Treatment Plant (AWWTP) to be located on Lots 101 and 102 at Alkimos.

The southern trunk sewer connection to the AWWTP is the extension of the Quinns Main Sewer from the Jindalee Butler area to the south. WCWA is currently finalising the preliminary design of the alignment of this sewer as part of a program of work to design and construct it within the next 3-4 years.

The preliminary Quinns Main Sewer alignment is shown on Figure 7 and comprises a main section through Lot 102 which will be constructed by tunnelling at depths greater than 6-8 metres below the surface. This will not constrain the urban development other than a requirement by WCWA for the sewer to be protected by a subterranean easement prohibiting groundwater bores from being constructed within the area of the easement.

The sewer will be constructed prior to any urban development of this area of Lot 102 and therefore, the construction works, tunnel portal requirements, etc will not have any impact on that development.

Beyond the tunnel the Quinns Main Sewer's preliminary alignment has been located within future road reserves within the AEDSP. This avoids the need to create surface easements for the sewer through development areas. Through this section the sewer is shallower and will be constructed by open trench methods.

Figure 7 also shows an alignment for the Yanchep Main Sewer which is proposed by WCWA to extend through Alkimos and Eglinton to the Yanchep Two Rocks area. To date, only a very preliminary alignment has been defined by WCWA based on existing topography.

The alignment shown on Figure 7 has been prepared by Cossill & Webley based on WCWA design criteria and to best suit the AEDSP in terms of road layout, etc. The Yanchep Main Sewer may not be constructed for some time and will generally be by open trench method rather than tunnelling.

The sewer construction is likely to follow the urban development of some of the land along its alignment. It is important, therefore, that the sewer is located within road reserves or public open space to ensure that the impact of its future construction, through urban development areas, is minimised.

6.2 Wastewater Treatment and Disposal

As indicated above, WCWA proposes to construct the AWWTP on the eastern edge of its Lot 101 at Alkimos. Current planning is for this plant to ultimately serve the development of both the north-west and north-east corridors.

The location of the treatment plant site shown on the AEDSP is the subject of a Public Environmental Review, prepared by WCWA, which has been assessed by the Environmental Protection Authority. The review also covers an alternative site closer to the coast on Lot 101.

WCWA has indicated its intention to design and construct the AWWTP in line with state of the art technology treatment processes and odour control facilities.

WCWA proposes that the disposal of treated wastewater will be via an ocean outfall pipeline with a landside area also located on Lot 101 and as shown on Figure 7. The outfall proposal is also included in the Public Environmental Review.

The wastewater treatment plant site, its odour buffer and the ocean outfall site shown on the AEDSP are all included in MRS Amendment 1029/33 which, was gazetted in 2006 and will result in those areas being zoned for 'Public Purposes'.

WCWA's program for development of the AWWTP is for the Stage 1 construction to be completed by the end of 2010, ready to receive sewage flows, from the south, via the then newly completed Quinns Main Sewer.

6.3 Treated Wastewater Reuse

Under the State Water Strategy 2003 and the State Water Plan 2007 the Western Australian Government aims to have Perth recycling 20 percent of its total wastewater by 2012.

WCWA aims to achieve this target largely by recharging groundwater aquifers with treated wastewater (managed aquifer recharge) and the ongoing design and construction of the AWWTP will take account of this. At this stage it is intended that the recharged groundwater would only be used for irrigation, agriculture or industrial purposes.

At Alkimos, the opportunities for treated wastewater reuse include irrigation water for the Carabooda market gardens and the recharge of the Gnangara Mound groundwater aquifer to the east of Wanneroo Road.

WCWA will continue to investigate these opportunities to develop the most sustainable approaches for reuse on a regional basis. In the shorter term, any such approaches will be more suited to the Beenyup Wastewater Treatment Plant since the initial treated wastewater flows from the AWWTP will be only minor in comparison.

Information on water reuse scenarios is also included in the East Wanneroo Land Use and Water Management Strategy.

7.1 Water Resources

The Alkimos Eglinton Project Area is within the Perth Coastal Groundwater Area and the Yanchep Underground Water Pollution Control Area (UWPCA) which extends from the northern boundary of the Metropolitan Region Scheme to Gwelup and from Wanneroo Road to within some 1-2 kilometres of the coast. The Department of Water with the support of WCWA is responsible for ensuring that activities which may pollute the groundwater system are either not permitted within the area, or are regulated. Regulation will be in accordance with the Department of Water Land Use Guidelines.

The groundwater area is designated a Priority 3 source Protection Area by the WCWA. The Priority 3 areas contain substantial resources of water supply, but are within areas proposed for urban development. Within the Alkimos Eglinton Project Area the groundwater resource is proposed to be used as a public supply of potable water for the development of the area. Regulation of development includes the following controls:-

- Installation of reticulation sewerage for all urban development with appropriate disposal of wastewater effluent, preferably off-catchment;
- Septic tank densities and location in non-urban areas to comply with WCWA recommendations;
- Restrictions on development of industries handling or processing noxious, toxic or polluting materials;
- Restrictions on the establishment of underground and above ground fuel storage tanks;
- Restrictions on intensive agricultural development; and
- Exclusion of disposal sites for polluting wastes.

The AEDSP shown on Figure 2 has been designed to suit the above controls.

WCWA has confirmed that the coastal groundwater resource has adequate capacity to supply the urban development of the Alkimos Eglinton Project Area.

7.2 Water Supply

WCWA's planning for water supply comprises a series of groundwater bores, located generally along Marmion Avenue, linked by collector bore watermains to a central treatment plant within the Alkimos District Structure Plan area storage reservoir at Carabooda. Areas of development will be serviced by a network of distribution watermains from the reservoir connected to reticulation systems within those areas.

The reservoir site is located within the Carabooda area east of Wanneroo road with the treatment plant to be located either within the AWWTP site or within the ROS area at the south-west corner of the interchange between the Mitchell Freeway and Alkimos Drive.

Groundwater bores at each bore site will comprise a shallow bore into the unconfined aquifer and a deep bore into the confined Leederville aquifer. In general, these will occupy a combined site of approximately 50 x 20 metre size.

Each bore will be protected by a 'Well Head Protection Zone' (WHPZ) to minimise the risk of pollution incidents close to the water supply infrastructure. WHPZ's within Priority 3 areas are set at 300 metres radius around each bore. Landuses within these zones are restricted and are subject to special approval processes. Restrictions prohibiting service stations or the storage of chemicals, etc, may apply within the zones.

The location of the Carabooda reservoir, treatment plant site options and approximate bore sites are shown on Figure 8. The figure also shows options for the locations of the main inlet and outlet watermains to/from the reservoir. In general, these will comprise large 1,200 millimetre diameter pipelines located within the district distributor road reserves and along the boundary of the Mitchell Freeway.

Where these watermains are not located in road reserves, they will need to be protected by an easement 5-10 metres wide depending on the pipe depth.

7.3 Groundwater Treatment Plant

The Eglinton Groundwater Treatment Plant (EGWTP) will be located within the ROS area at the south-west corner of the intersection of the Mitchell Freeway and Alkimos Drive.

In both cases, the EGWTP will occupy an area of some 12 hectares with an additional 500 metre radius chlorine hazard buffer. Land uses within this buffer would generally be restricted to open space and recreational facilities within 350 metres of the treatment plant boundary and non-residential uses beyond this.

Again in both cases, the chlorine hazard buffer will be contained within either the area covered by the AWWTP odour buffer or the ROS area. The chlorine buffer will not therefore be a constraint on urban development outside of those areas.

8.1 Urban Water Management

Urban Water Management (UWM) is now a key part of the urban development process incorporating principles of integrating water and land use planning, considering all water sources in water planning, integrating water use and natural water processes and a total catchment integration of natural resource use and management (Ref. Stormwater Management Manual for Western Australia, DoE, April 2004 the State Water Strategy 2003 and the State Water Plan 2007).

Stormwater drainage management is a major component of an overall UWM plan for which achievement of the principals of the plan may be facilitated through the application of Water Sensitive Urban Design (WSUD) techniques during planning, design and construction of urban development projects. Objectives of WSUD include:-

- Detention of stormwater rather than rapid conveyance;
- Use of stormwater to conserve potable water;
- Use of vegetation for filtering purposes; and
- Water efficient landscaping.

At a District Structure Planning level the Western Australian Planning Commission's objectives for UWM are defined in its Draft Statement of Planning Policy No. 29 Water Resources, 2004. These comprise the development of broad stormwater management strategies for major flood control and guidelines for water quality management at a district scale. This assumes that more detailed implementation plans will be prepared as a part of the ongoing subdivision planning when the local level landuse pattern is being defined.

For the Alkimos Eglinton Project Area the main WSUD practices which should be incorporated into the ongoing implementation of the district structure plan proposals are as follows:-

Stormwater Management

The maximisation of stormwater recharge of the shallow aquifer through the adoption of 'Best Management Practices', which promote the dispersion and infiltration of runoff. These include the use of porous paving for roads and carparks, the diversion of runoff into road medians and road-side swales, drainage soakwells to infiltrate runoff from building roofs and private open space areas and the disposal of road runoff into infiltration basins within POS areas.

Water Quality Management

The maximisation of the quality of recharge water through the adoption of 'Best Management Practices' which promote the disposal of runoff via water pollution control facilities (including vegetated swales and basins, detention storages and gross pollutant traps) and the implementation of non-structural source controls (including urban design, street sweeping, community education, low fertiliser landscaping regimes, etc).

8.2 Stormwater Collection and Disposal

The Alkimos Eglinton Project Area proposed for urban development is generally free draining with no low-lying areas with high groundwater levels or defined watercourses. The existing sandy ground is permeable and the depth from the ground surface to groundwater is significant.

Overall, therefore, the land is highly suited to the implementation of the WSUD management practices outlined above.

8.0 DRAINAGE

In all areas of development it is expected that runoff within developed sites will be contained within the lots. This includes the Regional and District Centres and the Coastal Villages. Stormwater disposal will be via soakwells or other infiltration facilities which form a part of the building and private open space development.

Drainage from public roads and lanes would be collected via conventional gullies or open swales depending on the nature of the adjacent land uses, the extent of traffic and pedestrian activity, etc.

In all cases disposal would be via infiltration to the ground to maximise effective recharge of the shallow groundwater aquifer. Infiltration mechanisms would include swales and basins dispersed throughout each drainage catchment.

Within the coastal area the options for drainage disposal could include the utilisation of natural swales within the foreshore reserve to infiltrate stormwater from the adjacent development catchment. This would need to be the subject of detailed investigation, as a part of ongoing foreshore management planning, to assess the environmental impacts of such drainage proposals. Notwithstanding this it is, as a concept, consistent with Water Sensitive Urban Design principles and is an approach which has been successfully adopted elsewhere within the state.

The drainage collection and conveyance system will be designed to cater for the runoff from storms with up to a 1 in 5 year recurrence interval. Infiltration basins would be designed to store runoff from up to 1 in 10 year storms. In all cases roads and POS would be designed to cater for the surface overflow for more severe storms with building pad levels set at least 300 millimetres above the 1 in 100 year flood or storage level at any location.

The dispersion of stormwater disposal will maximise the area of recharge down through the soil profile to the shallow aquifer, thereby, maximising the potential for nutrient stripping and water quality improvements.

9.1 Electricity

Electricity supply to the Alkimos Eglinton Project Areas would currently be via existing 22kV overhead lines in Romeo Road and Pipidinny Drive. These are both feeders from Western Power Corporations (WPC) zone substation in Romeo Road.

Urban development of the area could be supplied from the existing system, although its capacity is limited and would need to be upgraded. In the short term this may involve upgrading of the existing supply from the sub-station to the existing feeder lines followed by the provision of additional lines.

Beyond this, it will be necessary to extend 132kV transmission lines to supply a new zone sub-station within the area. From this a network of new 22kV feeder lines will extend throughout the areas of development to supply the local network of padmount transformers, switchgear and low voltage lines.

In all cases, the 22kV feeder and low voltage lines would be underground within road reserves.

The zone sub-station will be a substantial facility occupying a site 1-1.5 hectares in area. WPC's preference is for this to be located centrally within the urban development area to maximise the efficiency of the 22kV feeder network. For Alkimos Eglinton, this would mean a site in the vicinity of Marmion Avenue north of Romeo Road.

The 132kV transmission lines will be overhead on single steel poles. WPC consider that it is cost prohibitive for these to be underground although, it is technically feasible. Underground transmission lines are common within the inner city areas of Perth, Subiaco, etc. WPC's preference at Alkimos Eglinton is for the overhead line to be located in Romeo Road to supply the new sub-station and to then extend north to Yanchep in Marmion Avenue.

The Alkimos Eglinton landowners and their consultant team's strong preference is to locate the above infrastructure, particularly the transmission lines, along the eastern boundary of the urban development area as shown on Figure 9.

A key objective of the development planning is to maximise the amenity of residential and commercial areas through good urban design, adopting Liveable Neighbourhood principles. It is considered that this would be put at risk if unsightly, overhead transmission lines were installed through the area. The transmission lines comprise very high, large diameter poles which would be very much out of scale with the urban development. This is particularly the case for the Marmion Avenue streetscape which will be designed to maximise pedestrian amenity and the integration of frontage landuse.

The sub-station site and transmission line routes would be further defined as a part of the ongoing local structure planning and subdivision planning. At this stage it is envisaged that the transmission line would be located alongside the western boundary of the Mitchell Freeway reserve, either within a local frontage road or within a services corridor.

The AEDSP objectives require that all utility services be installed underground, including the transmission lines and that the sub-stations be screened with adequate landscaping to minimise their visual impact.

The landowners approach to the development of Alkimos Eglinton will also be to seek the highest level of efficiency in energy use as a part of the sustainability objectives for the project.

Clearly, therefore, the location of the electricity headworks infrastructure needs to be a balance of the technical efficiency of WPC's network and the broader planning and environmental objectives for the project. The proposal shown on Figure 9 is considered to best achieve this.

9.2 Gas

Natural gas has been extended by Alinta to service the Clarkson-Butler area to the south and would be available therefore for further extension to also supply the Alkimos Eglinton Project Area. High pressure gas mains would be located within the distributor road reserves with reticulation systems of underground pipes within each area of development.

9.3 Telecommunications

Telecommunications for the Alkimos Eglinton Project Area would be via the extension of main cables, from Telstra's existing Neerabup exchange and the existing optic fibre cable in Wanneroo Road, to additional exchanges and switching stations within the area.

The local system of distribution and local network cables would be connected to the switching stations with all cables located underground in road reserves.

Exchanges and switching stations would be housed within buildings generally located within commercial/industrial centres. The buildings would be designed and constructed to be integrated with the other buildings within each centre.

The main optic fibre cable has the capacity to service development growth within the north-west corridor for some 20-30 years at the forecast development rates. In the longer term it would need to be duplicated as part of Telstra's ongoing program for headworks upgrading.

Advances in communications technology has the potential, more than many other technologies, to redefine the lifestyle for suburban development over the next 20-30 years, the life of the Alkimos Eglinton project. Whilst this may have only a marginal impact on the current Structure Planning it is clear that the longer term implications for the planning of transportation, employment, retail and other development facilities will be substantial.

In the shorter term, the opportunities lie in the provision of the services infrastructure necessary to accommodate the technology trends as they emerge including; home PC's, CATV Satellite TV, electronic banking and shopping, tele-working and telecommuting, central security systems with remote monitoring and CCTV, video conferencing, 'smart' house systems incorporating automatic systems and metering controls, etc.

Access to these technologies will require every type of building to have access to broadband communication carriers via optic fibre cables and cellular services antennae.

Maximum flexibility will be provided in the ongoing implementation of the AEDSP to ensure that adequate allowance is made for these systems in the detailed design and installation of the services infrastructure.

Sites for mobile phone antenna's would be located on higher land, or on buildings, within commercial and industrial areas, where possible, to minimise their impact on residential areas.

10.1 Staging and Costs

The urban development of the Alkimos Eglinton Project Area will be implemented in stages over a period of time the duration of which will be dependent on the demand, for residential housing and the services and facilities that are associated with it.

The provision of engineering infrastructure will also need to be staged to suit the development demand and a detailed program for this will need to be prepared as a part of ongoing detailed planning and design of the infrastructure.

The Metropolitan Development Program (MDP) is prepared by DPI to provide information to government and the public on projected residential land development activity and the provision of services and infrastructure requirements, within a rolling five year time horizon. The aim of the MDP is to facilitate orderly and economic development through the timely provision of land, services and infrastructure.

The MDP should form a basis for the planning and provision of engineering headworks infrastructure by the various government authorities.

The current MDP includes an estimated production of 1,500 residential lots within the Alkimos Eglinton Project Area during the period of 2009-2014. This will be reviewed and updated on an annual basis by DPI and the landowners.

The more recent estimates of development growth for the area are as follows:-

Stage	Approx. Development Yield (Residential Dwellings)	Period
1	5,000	0-5 years
2	5,000	5-10 years
3	4,905	10-15 years
4	5,130	15-20 years
5	3,450	20-25 years
Totals	**23,485**	**0-25 years**

The current programs for infrastructure provision are as follows:-

Regional and District Roads

Capricorn Village Joint Venture (JV) is developing the Capricorn Project at Yanchep. As a part of this the JV proposes to prefund and facilitate the extension of Marmion Avenue from Butler to Yanchep.

The extension would comprise the bulk earthworks for the ultimate dual carriageway road, a single two-way carriageway constructed to a rural standard and drainage road crossings. These roadworks are normally funded by developers as a condition of subdivision.

The current program for the road extension is to complete its construction by late 2007.

The JV is now finalising a prefunding agreement with the Alkimos Eglinton landowners.

Main Road WA's program for the extension of the Mitchell Freeway is to complete construction to Burns Beach Road by 2008. There is no current program to extend the freeway beyond Burns Beach Road.

On this basis, therefore, Marmion Avenue would be available to provide district and regional road access for the development of the Alkimos Eglinton Project Area until the freeway is constructed in the longer term.

Northern Suburbs Railway

The Public Transport Authority (PTA) is now preparing a program to carry out the master planning for the extension of the railway to Butler. The planning should be completed by mid 2007. The PTA does not have a program at this stage for any work beyond the master planning.

Wastewater Treatment

Water Corporation is planning and designing the first stage of the Alkimos WWTP. This is the subject of a current Public Environmental Review.

The Corporation's program is for the Stage 1 plant to be operating by late 2009/early 2010.

Any urban development within the Alkimos Eglinton Project Area prior to this would need to include interim arrangements for wastewater disposal until the wastewater treatment plant was operating. These arrangements would probably comprise tankering of the wastewater to the Beenyup WWTP.

Wastewater Conveyance

Water Corporation's program for the Quinns Main Sewer is to construct it to the Alkimos WWTP by the time that the plant is operating in 2009/2010.

The sewer would be available, therefore, to receive wastewater flows from the urban development of the southern part of the Alkimos area. Connections from the areas of development would be via a network of headworks infrastructure including pumping stations, pressure mains and gravity outfall sewers.

These headworks would be funded by Water Corporation although prefunding by developers may be required to service 'non-frontal' development.

Water Corporation does not have a program to construct the Yanchep Main Sewer. This will be something generated by development within the northern part of Alkimos and the Eglinton area. Initial development, prior to construction of the main sewer, may need to include connections to the Alkimos WWTP via interim pressure mains and gravity outfall sewers. Interim headworks facilities would be funded by Water Corporation although, again, prefunding by developers may be required.

Water Supply

The Carabooda reservoir is programmed to be constructed by Water Corporation in 2007/2008. Initially this would be supplied by the trunk watermain shown on Figure 9 which links the reservoir to the Neerabup groundwater treatment plant. The watermain will initially function as both an inlet and outlet watermain, supplying water from the reservoir to the Butler area.

Supply to the Alkimos area will be provided by another outlet watermain in Romeo Road to be constructed, to suit the urban development program, after 2008.

Beyond this, the Water Corporation's program is to construct the Eglinton groundwater treatment plant and additional outlet watermains by 2013.

The reservoir and treatment plant will ultimately be supplied from groundwater bores within the Alkimos Eglinton Project Area.

All of the above headworks will be funded by Water Corporation.

Development within Alkimos Eglinton prior to construction of the outlet watermain in Romeo Road will need to be supplied from the existing system in Jindalee Butler, via the extension of distribution watermains in Marmion Avenue. These would be headworks funded by Water Corporation and may be required to be prefunded by developers for 'non-frontal' development.

Electricity, Gas and Telecommunications

In all cases the initial development of Alkimos Eglinton would be serviced via extensions to the existing electricity, gas and telephone networks within the Jindalee Butler area. This would include the extension of cables and pipelines in Marmion Avenue.

The servicing authorities have no current programs for these extensions which would be provided to suit the development demand.

The funding of the services extensions for 'frontal' development would be by the servicing authorities. For 'non-frontal' development the associated costs may need to be funded or prefunded by developers subject to negotiations with the authorities.

Broadband Communications

Broadband communication services should ultimately be via optic fibre cables in Marmion Avenue connected through to the Perth central transmission/receiver facilities by the optic fibre cable link to Joondalup. For initial development the services may be provided by interim microwave (wireless) systems until it is economical to 'roll out' the cable.

Based on recent experience with other large urban development projects it is expected that the broadband system would be owned and operated by either licensed telecommunication carriers or the developers themselves.

A strategy for the implementation of a broadband network could involve:-

- Review of options and decisions regarding the ownership of infrastructure and services provision.
- Review options for telecommunications infrastructure and services models.
- Develop design specifications and implementation plans for staged infrastructure and services provision.
- Select infrastructure suppliers, carriers and service providers.
- Institute formal contracts for infrastructure supply and services provision.

This strategy would preferably be implemented by developers in close consultation with both State and Local Government, to ensure that services infrastructure and provision is integrated at all levels. The formation of a 'Steering Committee' with participation from developers and government, particularly local government, would be a good first step in this process.

10.2 Infrastructure Funding

Funding arrangements which would apply for the provision of the infrastructure referred to in Section 10.1 are summarised as follows:-

Item	Funding Responsibility	Comments
· Regional Roads (Mitchell Freeway)	Main Roads WA	· State and Federal funds for land and construction.
· District Distributor Roads	Developers	· First stage; full earthworks and one carriageway to a rural standard.
	Local Authority	· Final stage, second carriageway and upgrade to an urban standard.
· Northern Suburbs Railway	State Government	· Land and construction.
· Wastewater Treatment	Water Corporation	· Standard headworks charges apply to development.
· Wastewater headworks, sewers, pumping stations, etc	Water Corporation	· To service frontal development.
	Developers	· Prefunding of permanent/interim headworks for non-frontal development.
		· Funding temporary works for non-frontal headworks.
· Water Supply Reservoirs and Treatment Plants	Water Corporation	· Standard headworks charges apply to development.
· Water Supply Headworks	Water Corporation	· To service frontal development.
	Developers	· Prefunding of permanent/interim headworks for non-frontal development.
		· Funding temporary works for non-frontal development.
· Drainage	Developers	· Local roads drainage collection, conveyance and disposal including land for disposal basins, swales or sumps.
· Electricity Headworks	Western Power Corporation	· Power generation, transmission lines and zone sub-stations including land.
· Electricity Distribution	Developers	· Included in 'Scheme Charges'.
· Gas	Alinta	· To service frontal development.
	Alinta/Developer	· By agreement for non-frontal development.
· Telephone	Telstra	· To service frontal development.
	Telstra/Developer	· By agreement for non-frontal development.
· Broadband Communications	Developers	· Subject to negotiation between Developers and service providers.

The above provisions are as generally set out in WAPC Planning Bulletin 18, February 1997.

10.3 Developer Contribution Schemes

In large development areas with multiple landownership the funding of engineering infrastructure, which is the responsibility of the developers, is often implemented via Developer Contribution Schemes (DCS). These normally apply to district distributor roads, arterial drainage and drainage disposal sites, the prefunding of services headworks and temporary services headworks.

The DCS provides the basis for the apportionment of the infrastructure costs between the various landowners and can include details of works programs, timings for payments, prefunding arrangements between landowners, etc.

The need for a DCS for Alkimos Eglinton is less relevant. There are only a small number of different landowners and their landholdings are large in area. Formal DCS arrangements are not normally necessary under these circumstances where direct negotiation and agreements between adjacent landowners is the usual approach to cost sharing for engineering infrastructure.

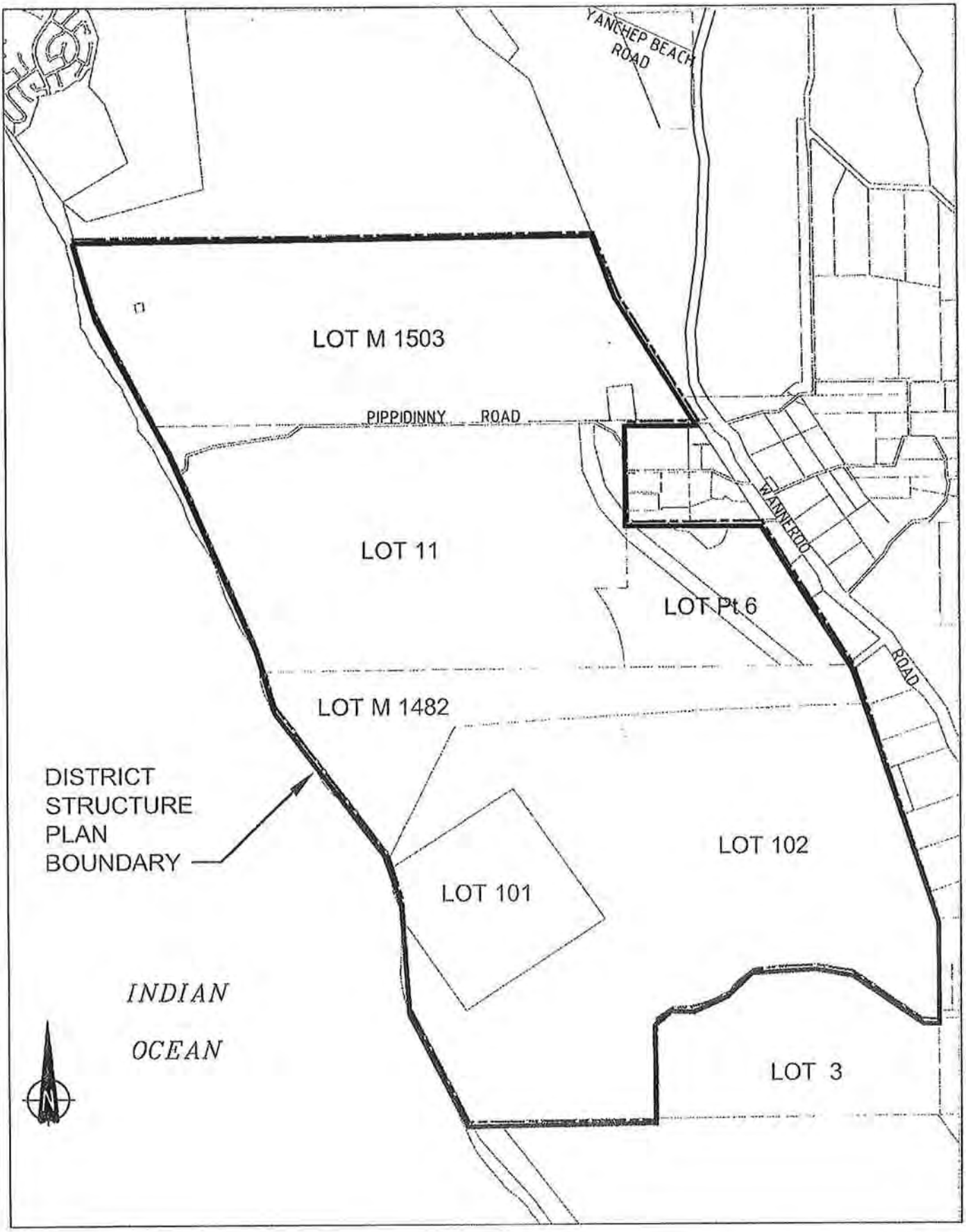
Examples of this approach include:-

- The funding arrangements for the extension of Marmion Avenue, as proposed by the Capricorn Village Joint Venture, is for the cost of the section through Alkimos Eglinton to be shared by the landowners on an area of landholding basis (nett of ROS regional road, railway and Public Purposes reserves). It is proposed that the details of the cost sharing will be embodied in a legal agreement between the landowners and the JV.
- The extension of Marmion Avenue will provide the opportunity to extend services, including gas, broadband, etc, within the road reserve through Alkimos Eglinton to Yanchep. The landowners agreement for the road could be supplemented by a similar agreement to cost share these services, whether the costs are prefunds or non-refundable costs.
- Other private agreements between the Alkimos Eglinton landowners could be for drainage disposal sites for joint catchments and the non-frontal funding of services headworks, water, wastewater, electricity, etc.

In all of the above cases and overall, it is considered that it will be unlikely that cost sharing arrangements will need to involve state or local government via statutory town planning schemes, guided development schemes, etc.

Figure 1

Landholdings Plan



ALKIMOS EGLINTON DISTRICT STRUCTURE PLAN

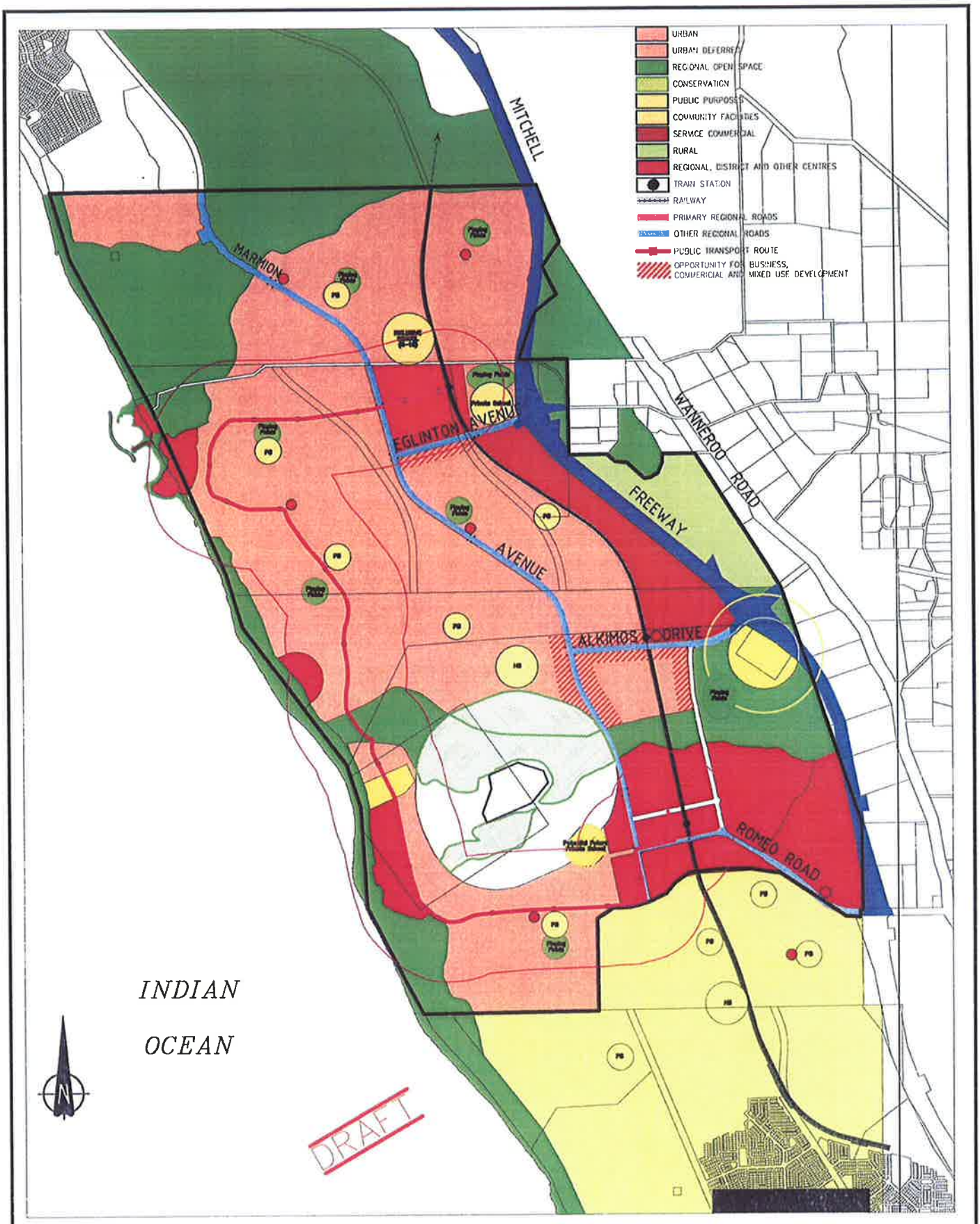
Cossill & Webley

FIGURE 1

DISTRICT STRUCTURE PLAN AREA

Figure 2

Alkimos Eglinton District Structure Plan



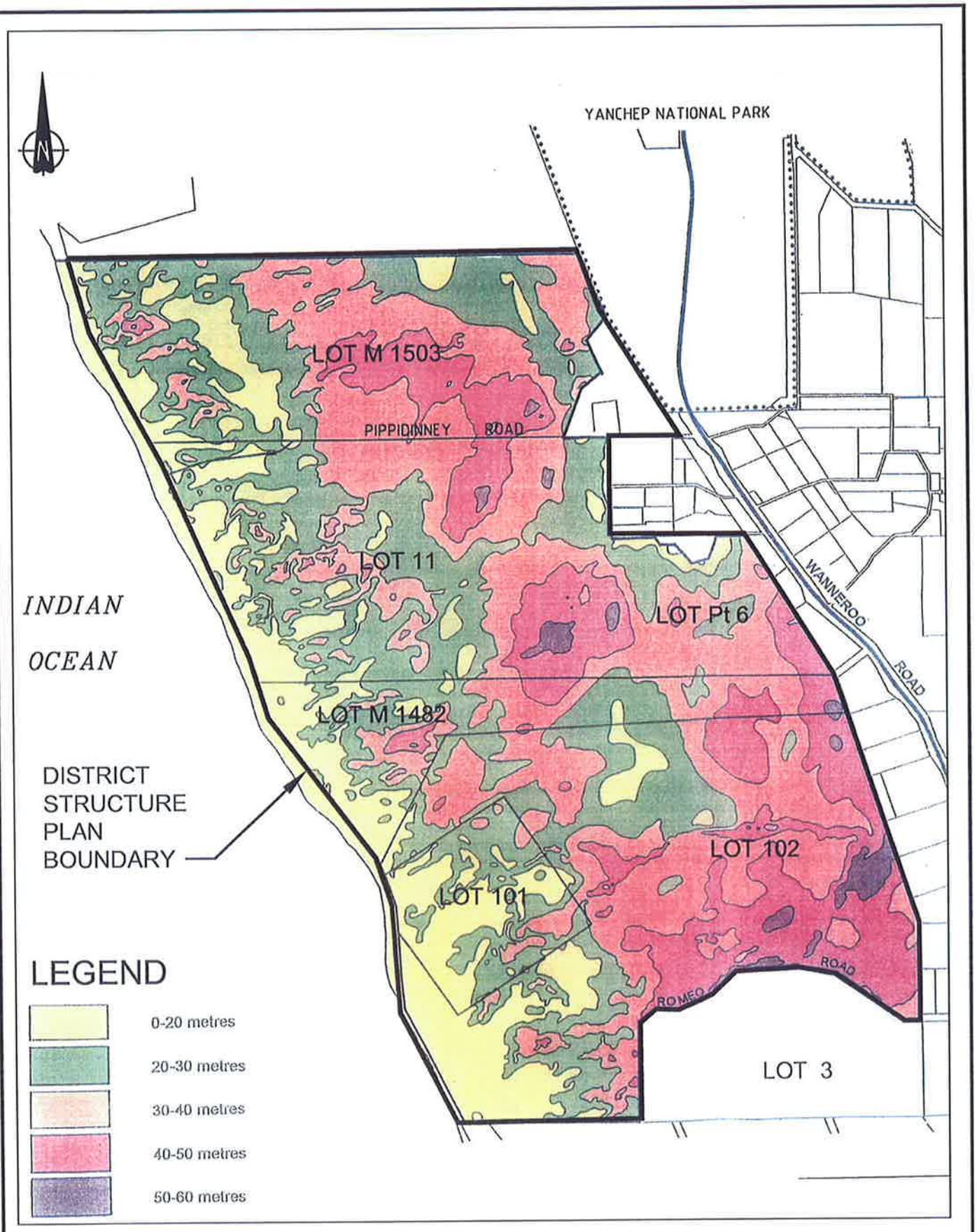
ALKIMOS EGLINTON
DISTRICT STRUCTURE
PLAN

Cossill & Webley
CONSULTING ENGINEERS

FIGURE 2
DISTRICT STRUCTURE
PLAN

Figure 3

Existing Topography



ALKIMOS EGLINTON
DISTRICT STRUCTURE
PLAN

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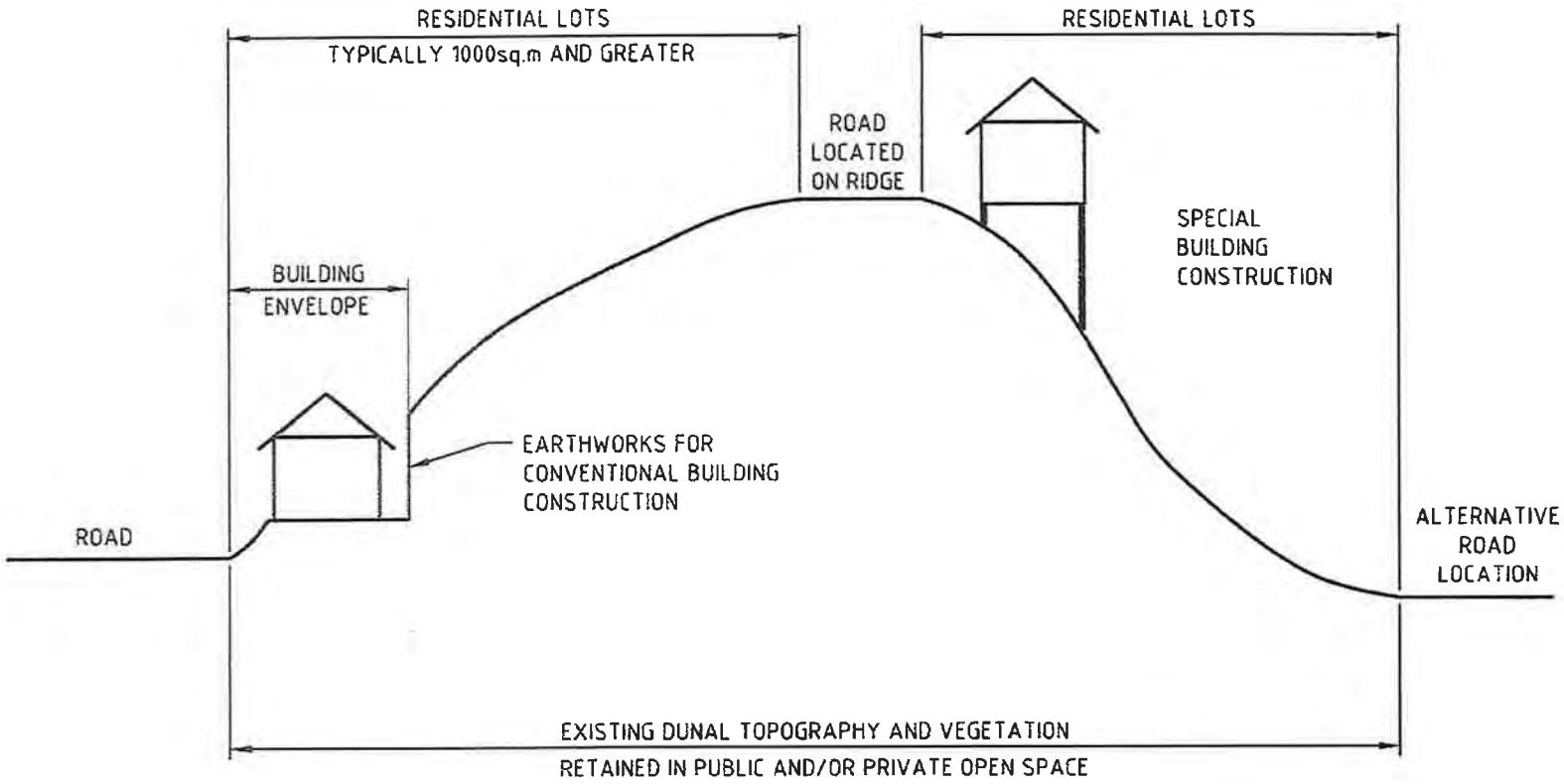
FIGURE 3

EXISTING
TOPOGRAPHY

Figure 4

Siteworks Options



5882_FIG4

ALKIMOS EGLINTON
DISTRICT STRUCTURE
PLAN

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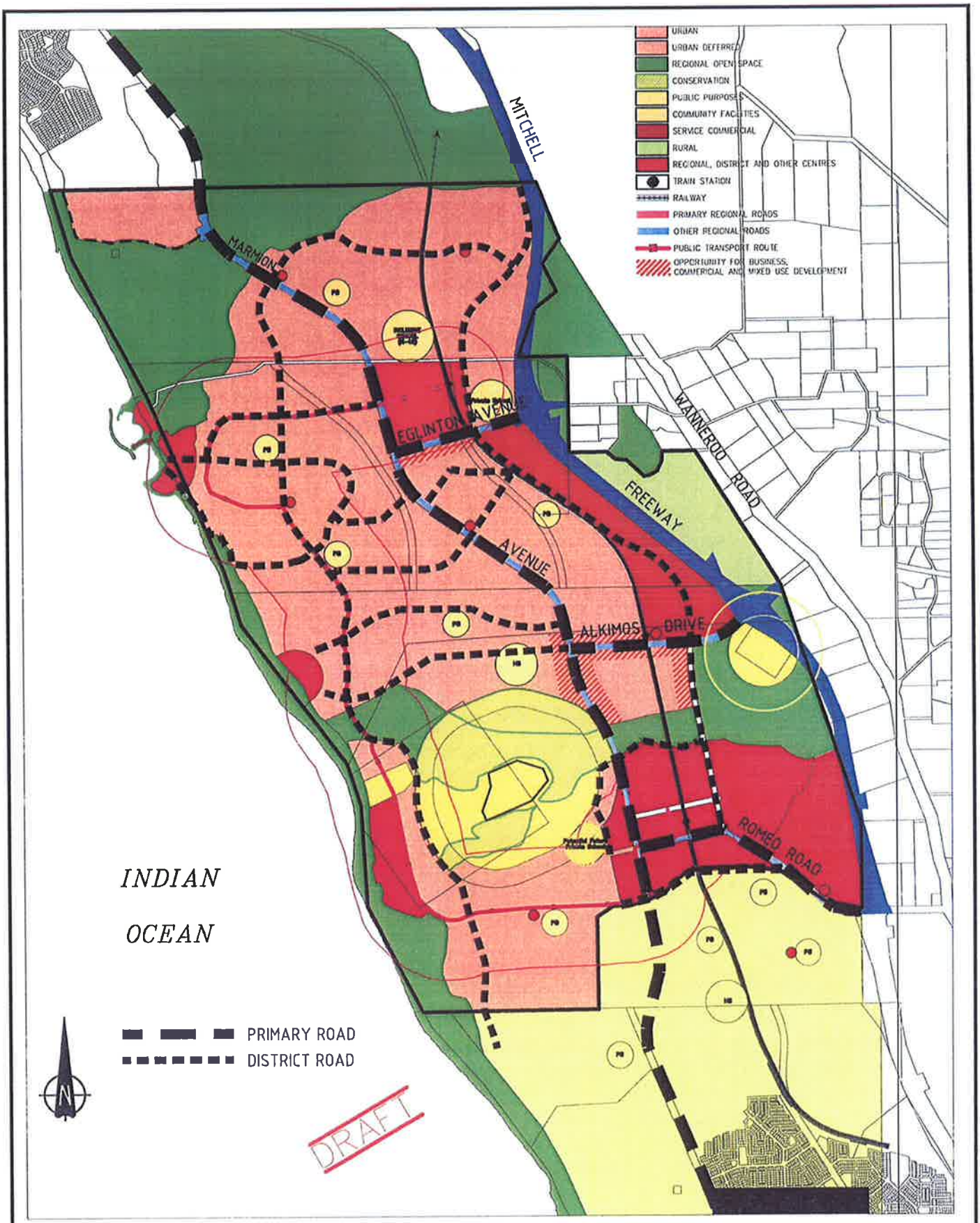
FIGURE 4

SITEWORKS OPTIONS

Figure 5

Regional and District Distributor Roads Network



ALKIMOS EGLINTON
DISTRICT STRUCTURE
PLAN

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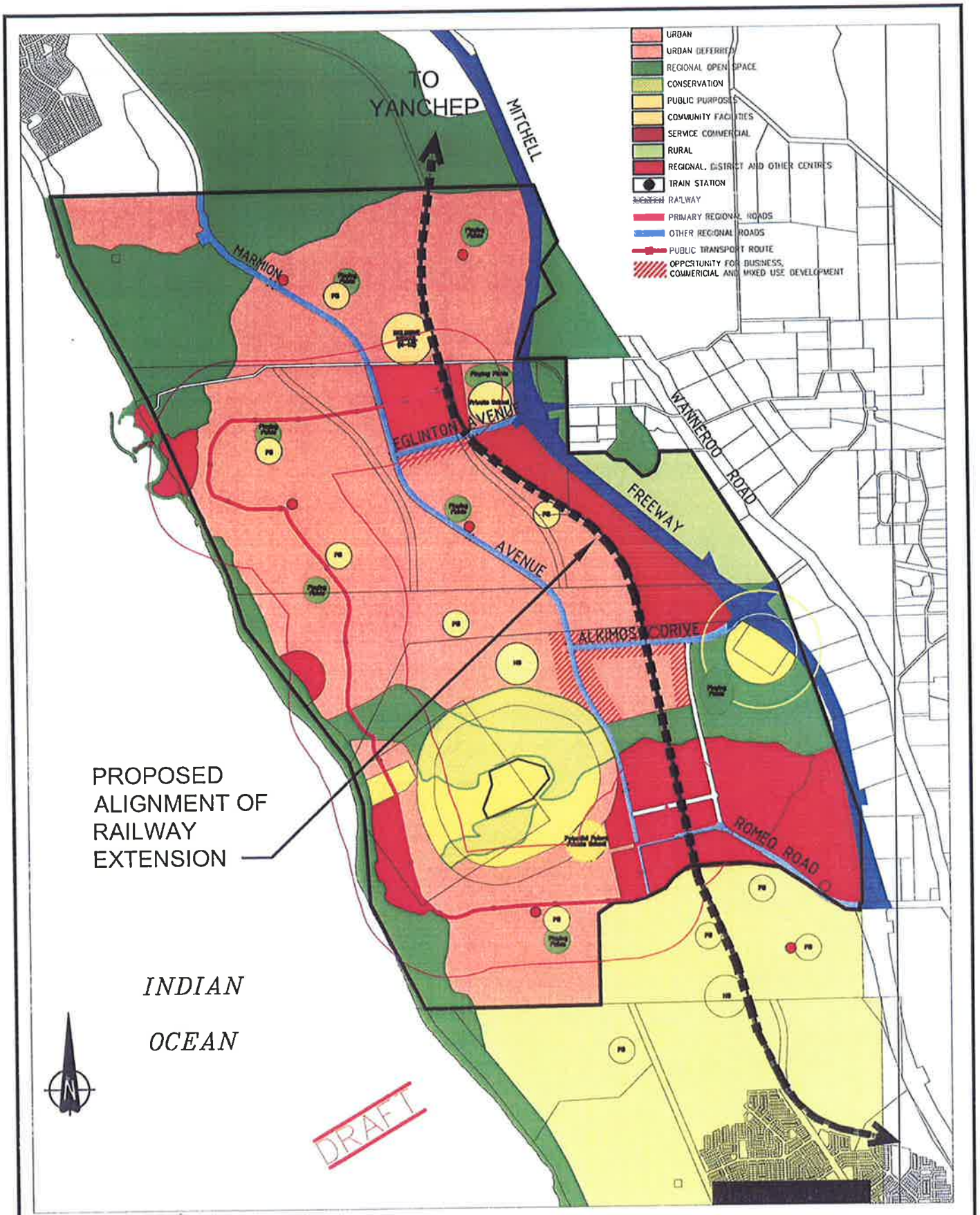
FIGURE 5

REGIONAL AND DISTRICT
DISTRIBUTOR ROADS
NETWORK

Figure 6

Northern Suburbs Railway Extension



ALKIMOS EGLINTON DISTRICT STRUCTURE PLAN

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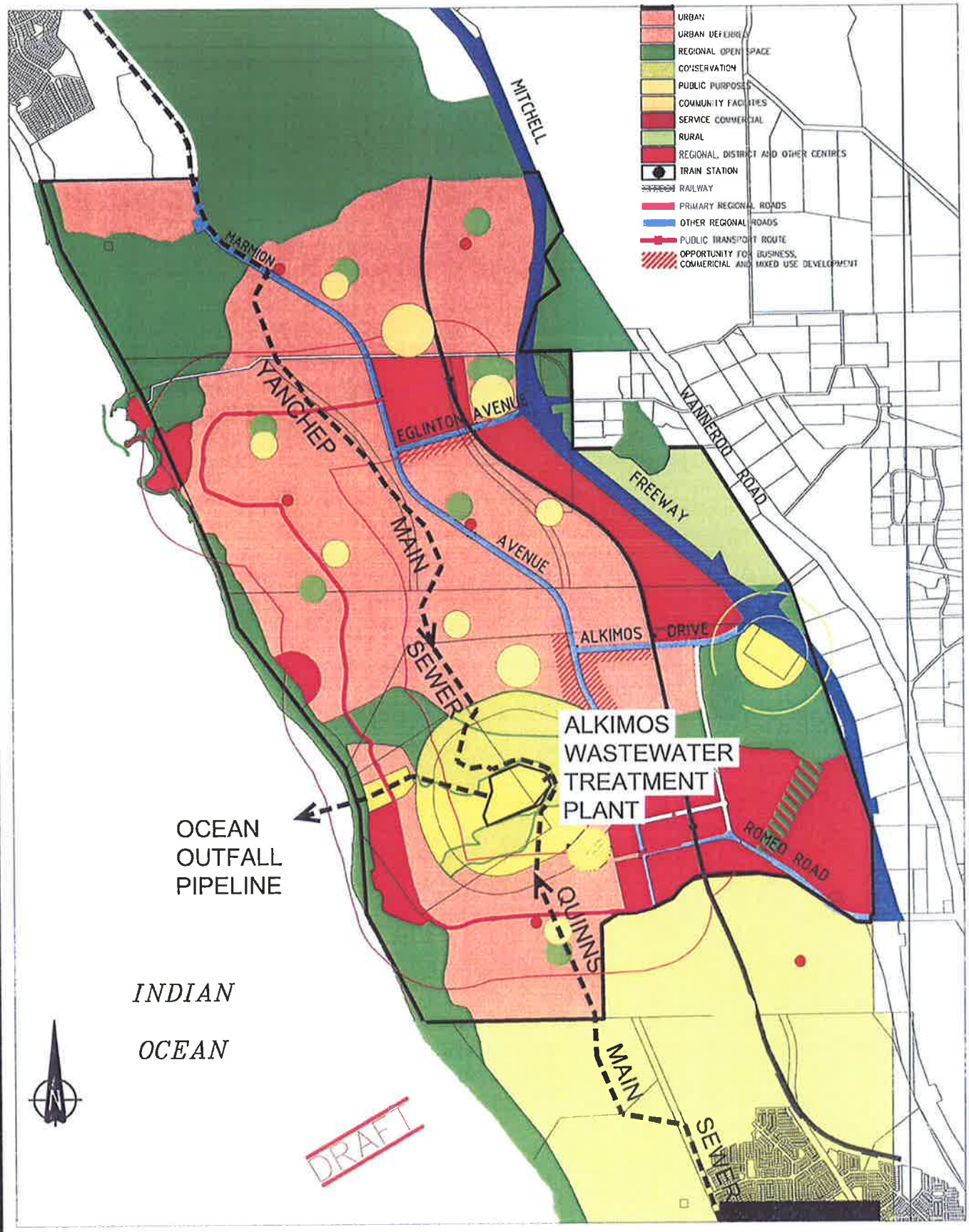
FIGURE 6

NORTHERN SUBURBS RAILWAY EXTENSION

Figure 7

Wastewater Headworks Infrastructure



ALKIMOS EGLINTON DISTRICT STRUCTURE PLAN

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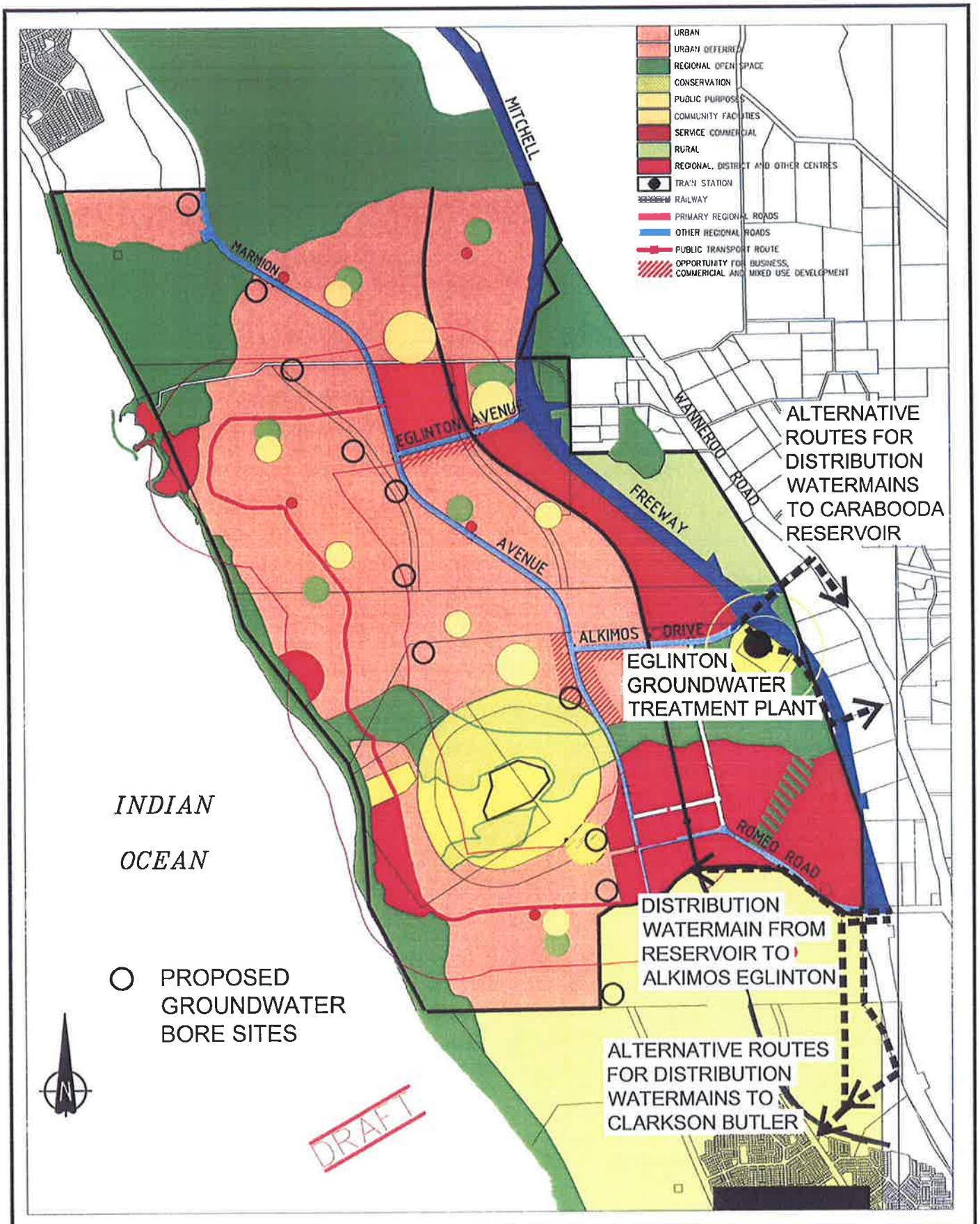
FIGURE 7

WASTEWATER HEADWORKS INFRASTRUCTURE

Figure 8

Water Supply Headworks Infrastructure



ALKIMOS EGLINTON DISTRICT STRUCTURE PLAN

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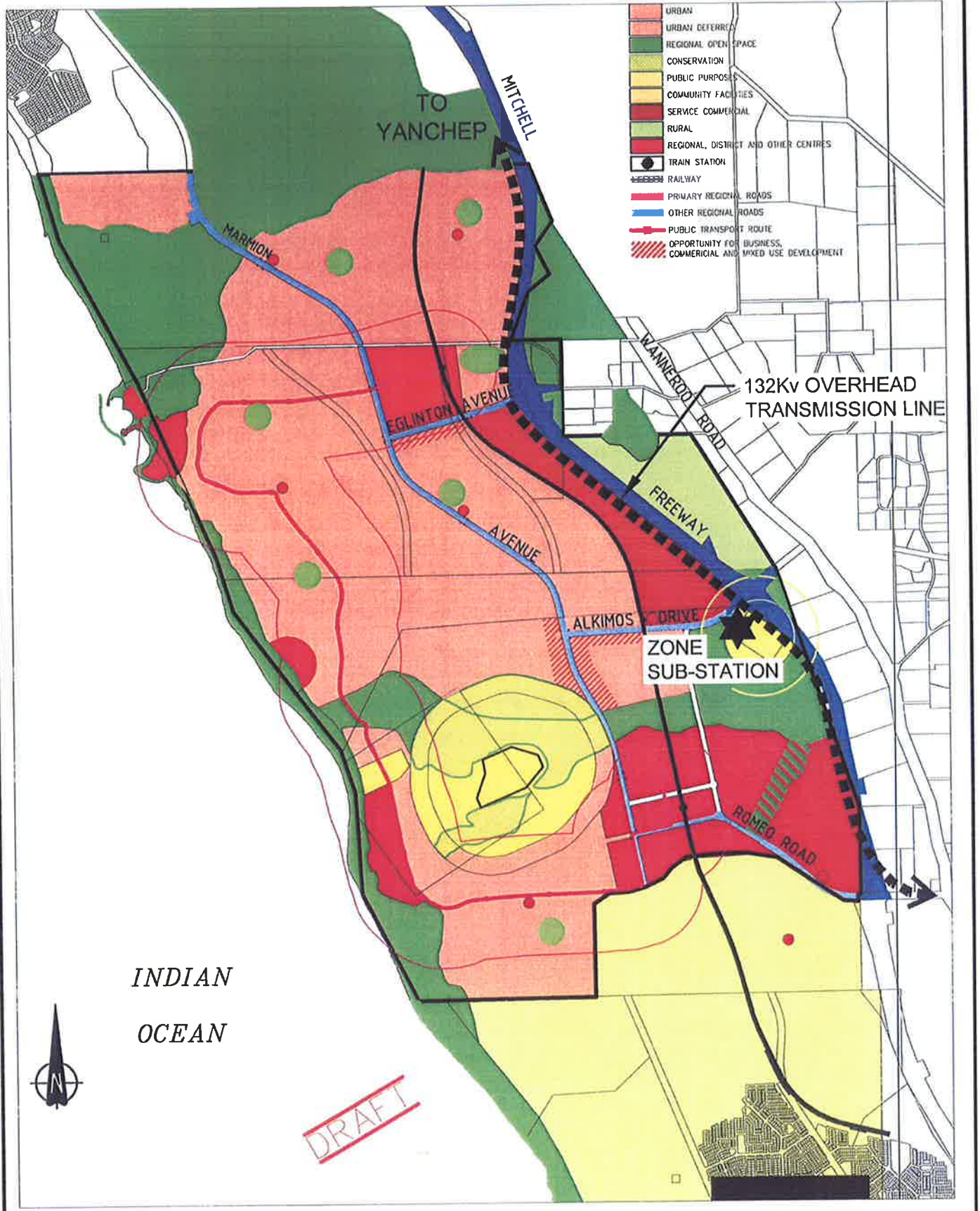
FIGURE 8

WATER SUPPLY HEADWORKS INFRASTRUCTURE

Figure 9

Electricity Transmission Infrastructure



ALKIMOS EGLINTON DISTRICT STRUCTURE PLAN

Cossill & Webley CONSULTING ENGINEERS

FIGURE 9

ELECTRICITY TRANSMISSION INFRASTRUCTURE

Appendix A
Desktop Geotechnical Assessment
Coffey Geosciences
2 March 2006

COSSILL & WEBLEY

ALKIMOS - EGLINTON

DESKTOP GEOTECHNICAL ASSESSMENT

P7346.02-AB

2 March 2006

Coffey

P7346.02-AB
2 March 2006

Cossill & Webley
68 Hay Street
SUBIACO WA 6008

Attention: Mr Roy Webley

Dear Sir

RE: ALKIMOS - EGLINTON
DESKTOP GEOTECHNICAL ASSESSMENT

This letter presents our report on a desktop geotechnical study carried out for the above.

If you have any questions related to the report or we can be of further assistance, please do not hesitate to contact the undersigned.

For and on behalf of

COFFEY GEOSCIENCES PTY LTD

PHILIP MATHER

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TABLE OF CONTENTS

1. INTRODUCTION

This report describes a desk top geotechnical assessment carried out by Coffey Geosciences Pty Ltd (Coffey) for Cossill & Webley for a parcel of land within the Alkimos Eglinton area. The work was commissioned by Mr Roy Webley of Cossill & Webley.

The site area comprises a 3km to 4km wide strip of land adjacent to the coast extending approximately 7.5km from Jindalee to about 2km south of Yanchep. It is understood that this study will provide input for the preparation of District Structure Plans. A map showing the extent of the study area including areas of existing or approved development was provided by Cossill & Webley. This map has been used as a base plan for Figure 1.

The desk top geotechnical assessment of the area, reported herein, is preliminary to assist in preparation of the District Structure Plan. Further geotechnical work is recommended prior to detailed development planning.

2. DATA SOURCES

Data sources viewed as part of this desk top study consisted of Geological maps at 1:50,000 scale (Yanchep Sheet) produced by the Geological Survey of Western Australia.

The study also incorporates experience gained from other geotechnical work undertaken by Coffey within the area or within similar geological environments.

3. SITE CONDITIONS

The 1:50,000 geology sheets indicate that the site is within an area of coastal sand dunes and calcarenite (Tamala Limestone). The coastal dune deposits can be broadly divided into two separate units (Quindalup and Tamala) based on their age, composition and landform. Encroaching partly along the eastern margin of the site is a linear chain of lakes and associated swamp deposits within a previously recognised zone with potential for significant karstic features within the surrounding limestone. The extent of these three subdivisions within the site is shown in Figure 1. An outline of geotechnical conditions within each of the areas shown in Figure 1 is as follows:

Quindalup Dunes. The Quindalup Dunes form a series of parabolic and nested parabolic sand dunes extending 1km to 4km inland from the coastline. They are geologically younger than the Tamala Limestone which occurs at depth, and as outcrop, further inland. Beyond about 1km inland from the coast, the Quindalup Dunes occur as large parabolic dunes that have migrated inland over the older, Tamala Limestone unit. The Quindalup Dunes are characterised by relatively steep dune slopes of generally 10° to 20° but extending up to 30°. The dunes are comprised of fine to medium grained, light brown to white, calcareous sand. The natural density of the sand is predominantly medium dense to dense however loose surface sand can occur on the lee (eastern) sides of dunes. The sand is comparatively high permeability (typically 2m/d to 20m/d), high void ratio, no shrinkage and low bearing capacity.

The sand is often weakly cemented at depth, preserving the cross bedded fabric formed within the dunes. Areas of outcrop occur and are comprised of well cemented cap rock zones formed by the dissolution and reprecipitation of calcium carbonate within the weathering profile to form calcrete deposits. The well cemented high strength calcrete layers are relatively less developed within the Quindalup Dunes and generally less than 0.5m thick.

Tamala Limestone. The area designated as Tamala Limestone and sand derived from Tamala Limestone is characterised siliceous sand overlying calcarenite (limestone) and includes areas of limestone outcrop predominantly along ridges extending sub parallel to the coastline. As with the Quindalup Dunes, outcrops are comprised of cap rock layers that have formed within and at the surface of the limestone. Of significance when considering the Tamala Limestone, is its significantly greater age compared to the Quindalup Dunes. The sand derived from Tamala Limestone has resulted from leaching of calcium carbonate from the calcarenite over geological time to form the residual siliceous sand observed overlying limestone today. The sand is typically yellow and is generally fine to coarse grained and noticeably coarser grained than the Quindalup Dune sand. The natural density of the sand is generally medium dense. The sand is comparatively high permeability (typically 2m/d to 20m/d), no shrinkage and no cohesion.

The cap rock layers result from re precipitation of the leached calcium carbonate, predominantly at the surface, but also within the limestone weathering profile. The additional geological age of the Tamala Limestone compared to the Quindalup Dunes has allowed for more well developed cap rock zones to form resulting in well cemented, high strength limestone extending over thicknesses generally about 2m. In some areas multiple generations of cap rock development has occurred within a single layer resulting in zones of high to very high strength massive rock extending up to 4m thick. In addition, cap rock layers may be encountered at depth within the Tamala Limestone representing palaeo land surfaces that have subsequently been buried (over geological time) by younger material as it migrates inland. The limestone immediately below the cap rock layers is often leached and of significantly lower strength. In addition, localised solution cavities and sand filled voids are common within the limestone.

Potential Karst Areas The zone shown on Figure 1 as being within an area of known karst phenomena comprises a chain of lakes within the Tamala Limestone occurring approximately 5km inland and sub parallel to the current day coastline. The limestone within this area is known to contain significant caves and voids and associated loose zones within the overlying sand. Localised sink holes within surface sands can be observed in the karst areas resulting from the movement of overlying sand into voids within the limestone leading to subsidence at the surface. The karst areas are within regional topographically low areas and the lakes are considered to be surface expressions of the regional groundwater table.

4. GEOTECHNICAL CONSTRAINTS

In general terms there are very few geotechnical constraints to urban development within the coastal sand dune landscape that dominates the study area. A discussion of geotechnical aspects within the study area is outlined below.

4.1 Rock

Surface rock is anticipated to occur predominantly as cemented limestone cap rock outcrops along ridge lines within the Tamala Limestone and to a lesser extent within the Quindalup Dunes. In addition, cemented cap rock, in the form of low cliffs occurs along some areas of shoreline. Below the cap rock layers the limestone is generally of lower strength. Within the Quindalup Dunes, limestone is generally weakly cemented to form a low strength rock. The Tamala Limestone is generally moderately cemented forming a medium strength rock. Within the Tamala Limestone are isolated occurrences of very high strength, massive cap rock as outlined in Section 3. These are inferred to be the result of multiple generations of cap rock development within Tamala Limestone and have been observed near the current day land surface and also at depth representing palaeo land surfaces. Previous work undertaken by Coffey within the study are has not encountered zones of these very high strength cap rock associated with palaeo land surfaces however it is likely that they occur.

Excavation conditions within the areas of rock are highly variable and are largely affected by the thickness of cap rock development. Within the Quindalup Dunes where cap rock development is thin (~0.5m) it is generally easily ripped with a large dozer (~D10) and the underlying, weakly cemented material can often be excavated with a large excavator (~40t).

Within the Tamala Limestone where cap rock thicknesses extend up to 2m hard ripping conditions are encountered ranging to moderate ripping within the underlying, moderately cemented material. Within the cap rock materials excavatability is assisted by the presence of solution features and less well cemented zones that occur in the rock. Within the very well cemented palaeo cap rock materials these natural "defects" are re-cemented during subsequent episodes of cap rock development resulting in a high to very high strength, massive rock zones that are greater than 2m thick. These thicker zones require drill and blast excavation techniques.

In very general terms excavation conditions are potentially more difficult with increasing age of the formation as the cap rock layers have had a greater length of time to develop. As a generalisation the potential for encountering difficult excavation conditions increases with further distance from the coast and with increasing depth of excavation due to the potential for encountering older cap rock formations.

4.2 Groundwater and Drainage

The hydraulic gradient west of the potential karstic areas has a comparatively gentle gradient, falling from about 10m AHD to mean sea level at the coast. Ground surface levels between the karstic area and the ocean are generally significantly higher than the water levels and therefore high water tables are unlikely to impact on development. As outlined in Section 3. lakes within the potential karstic area are a surface expression of the regional water table. Therefore development adjacent to these areas may require consideration of groundwater levels. The Indian Ocean occurs along the western boundary of the site. A shallow lens of fresh groundwater is likely to be overlying salt water from the ocean close to the coast. Development close to the coast and/or proposals to extract groundwater will need to make allowance for shallow groundwater and the potential for salt water intrusion near the coastline.

The dune sands within the study area are predominantly free draining and the massive limestone is predominantly of moderate permeability (extremely high permeabilities are possible in the karstic limestone). The majority of the site is therefore likely to suitable for disposal of stormwater via soakage. Exceptions to this could be within localised areas where water can perch on top of cemented cap rock layers. Soakage can often be improved in these areas by deep ripping the limestone cap rock to increase permeability.

4.3 Potential Karst

As outlined in Section 3. the zone of potential karst is characterised by caves and voids within Tamala Limestone and associated loose zones within the overlying sand. The formation of caves and voids within the limestone is considered to have been active in the geological past however the processes associated with creating loose sand and surface sinkholes is active today. The potential geotechnical risk in these areas arises from the movement of sand into voids within the rock creating voids and loose zones within the sand that can gradually migrate to the surface to form sink holes. This process is accelerated and sometimes triggered by increased surface water infiltration due to factors such as high rainfall events and the clearing of vegetation. Urban factors include the concentration of stormwater runoff from roads, paved areas and roofs, and prolonged dewatering inducing accelerated groundwater flow through karstic voids which can accelerate the formation of sink holes/karstic collapse.

Development within karstic areas requires consideration of the above factors. Measures to accommodate for karstic conditions include the provision of larger Lot sizes to allow building envelopes to be located within the Lot where "better" ground conditions are encountered, incorporation of stiffened footings for structures to accommodate minor surface movement, development set backs from areas where storm water is disposed and restrictions on dewatering activities.

4.4 Slope Stability and Erosion

Where it occurs in dunes, the Quindalup and to a lesser extent the Tamala sands are vulnerable to wind erosion. Stabilisation of the sand under and around new structures will be required. The natural angle of repose for the sands which are generally loose at the surface of the dune, dry and uncemented is considered to be approximately 30°. Some of the steeper Quindalup Dune slopes are close to the natural angle of repose and therefore vulnerable to instability when disturbed by human activity. As the majority of the site is covered by sandy soils, extensive removal of vegetation can lead to severe wind erosion. A significant risk to coastal stability in this area is a function of human activities. The current fore dunes of the Quindalup System are fixed by sparse, low scrub vegetation cover. Careless removal of vegetation can result in sand blow outs removing beach berm protection and lead to burial of existing inland developments.

Relatively steep cuts within Tamala Limestone are stable except where solution cavities, sand pockets or weakly cemented zones occur. Steep cuts become unstable with repeated wetting and drying and permanent cuts would require some stabilisation.

5. IMPORTANT INFORMATION ABOUT YOUR COFFEY REPORT

The reader's attention is drawn to the important information about this report which follows the main text.

* * * * *

Information

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of the subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

Coffey

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they have incorporated the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment. Contamination can create major health, safely and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

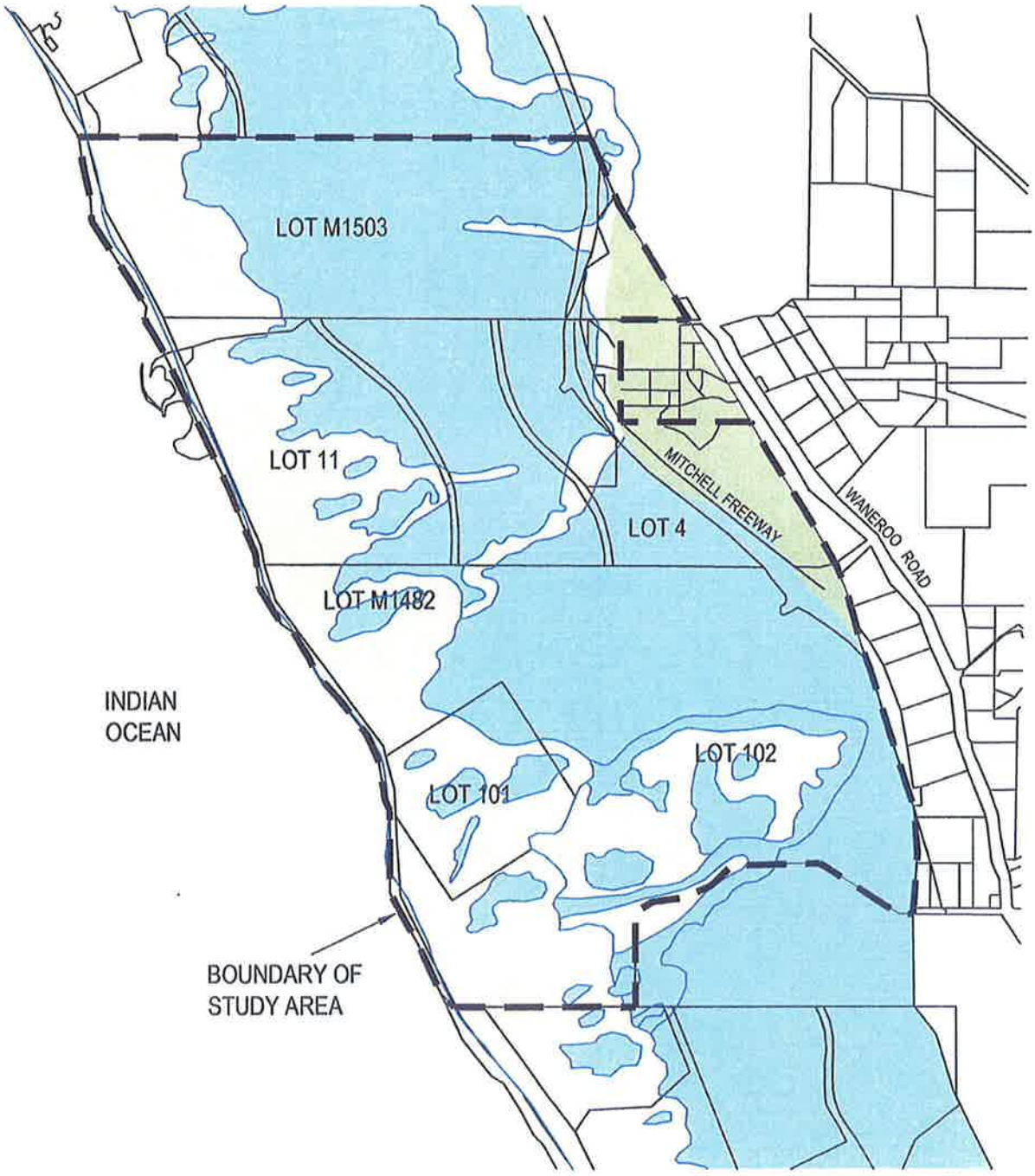
Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design toward construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

** For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, National Headquarters, Canberra, 1987.*



LEGEND

- PREDOMINANTLY QUINDALUP DUNES
- TAMALA LIMESTONE AND SAND DERIVED FROM TAMALA LIMESTONE
- AREA OF KNOWN KARSTIC PHENOMENA

DRAWING PATH: F:\Geotechnical\Jobs P7000 to P7500\P7346.02 Alkimos_Eglinton\DWG\P7346.02 FIG1.dwg

Coffey Geosciences Pty Ltd ACN 056 335 516 | Geotechnical | **Resources** | Environmental | **Technical** | Project Management |

Drawn	LB
Approved	
Date	27/2/06
Scale	1:50 000

COSSILL & WEBLEY
ALKIMOS - ELINTON
GENERALISED SITE GEOLOGY

Drawing No:
FIGURE 1

Job No: **P7346/02**