Lot 2 McGregor Street & Lot 5474 Thompson Street Development Plan

Planning Report

15 August 2011

Prepared for Blaxland Property Pty Ltd

Lot 2 Development Plan 2011/427

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This document is for discussion purposes only unless signed and dated by the persons identified.

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1 Introduction

1.1 Background

On 27 January 2011, the Town of Port Hedland Council resolved to prepare Scheme Amendment No.38 to rezone the subject site to 'Urban Development' under the Town of Port Hedland Planning Scheme No.5.

The Scheme Amendment was placed on Public Exhibition from 15 April 2011 to 25 May 2011.

After consideration of the submissions made during the exhibition period, Council on 22 June 2011 resolved to adopt the Scheme Amendment and directed the proponent to prepare a Development Plan in accordance with Section 6.4.2 of the Town of Port Hedland Planning Scheme No.5.

The Scheme Amendment was referred to WAPC on 27th July 2011.

This Development Plan has been prepared in accordance with Council's resolution in order to facilitate the development of the site for urban purposes.

Council's resolution dealt with two separate rezoning requests – one covering the subject sites, the other addressing the adjacent Lot 4 McGregor Street. Council resolved to endorse an 'Urban Development' zoning for both rezoning applications.

As per the rezoning requests, it is intended to lodge two separate Development Plans for the properties. This Development Plan deals with the form of development now proposed for Lot 2 McGregor Street and Lot 5474 Thompson Street.

2 Site Context

2.1 Subject Site

The land subject to this Development Plan comprises two (2) properties being:

Lot No.	Street	Area (Ha)
Lot 2	McGregor Street	7.87
Lot 5474	Thompson Street	0.33
TOTAL AREA		**8.20**

The subject land is located approximately 4.5km east of Port Hedland harbour and 8.8km north of Port Hedland International Airport and has a combined area of 8.2 hectares.

The site is situated 200m from the coast, and is bounded by freestanding residential dwelling development to its northern and eastern boundaries, Clark Street to the west and McGregor Street to the south.

2.2 Ownership & Title

Lot No.	Certificate of Title	Owner
Lot 2	1327/627	Telstra Corporation Ltd
Lot 5474	3008/360	State of WA

2.3 Site Analysis

The land is predominantly open grassland, cleared of native vegetation.

Part of Lot 2 McGregor Street (approximately 0.32ha) is currently occupied by a Telstra Exchange which incorporates a transmission tower and building. The site is otherwise undeveloped.

The land slopes from a plateau at Relative Level (RL) of 11.5 m at its northern boundary down to an RL of 4.5 m at its southern boundary and is partly subject to potential impacts from storm surge. The issue is addressed in more detail in Chapter 4 of this report, but essentially involves the elevation of habitable floor levels above the 1:100yr surge event.

It is intended to excise the Telstra Exchange site in order that development may occur on the remaining land. The Telstra facility incorporates a transmission tower and an exchange building and is the termination point of the undersea fibre optic cable from Indonesia. It is intended that the telecommunications exchange will remain on the site and will continue to operate. Easements will be created as part of the subdivision to protect existing assets (cables).

Figure 1. Development Plan Area

Source: Google Earth (2011)

2.4 Surrounding Locality

To the north, west and north-east of the subject lands, the land is zoned Residential with R-Codes ranging from R15 to R30. Traditional detached residential dwellings are the predominant feature of this area.

Land to the west and south west of the subject site is zoned 'Parks and Recreation' and comprises the Port Hedland race track, skate park, dog club and expansive open space lands. The Spinifex Hill STP is located immediately south of the subject lands.

On 19 January 2011 the Regional Development Minister Brendon Grylls and Water Minister Bill Marmion announced a $106 million project to relocate the STP facility to South Hedland. The purpose of this is to ensure that the site and surrounding lands can be used to address the Town of Port Hedland's housing shortages.

The Water Corporation is committed to decommissioning the STP and aims to transfer flows from Port Hedland to South Hedland by at least 2014.

It is possible (under TPS No.5 and Amendment 38) and practical, for site subdivision, construction works and occupation of the dwellings to occur simultaneously with the decommissioning of the STP with knowledge that the STP will be relocated.

3 Statutory Planning

3.1 Development Plan

The proposed Development Plan for Lot 2 McGregor Street and Lot 5474 Thompson Street is included at ***Appendix 1***.

3.2 Aims & Objectives

The objectives of the Development Plan are to:

- facilitate the development of the subject site for a diversity of 0housing typologies
- facilitate the provision of internal road layouts to service the development and provide for future access to adjoining lands consistent with the strategic aims of the Town of Port Hedland;
- facilitate development works in order that the provision of new housing coincides with the decommissioning of the Spinifex Hill STP.

3.3 Relationship with the Scheme

This Development Plan has been prepared in accordance with clause 5.2 and Appendix 6 of Town Planning Scheme No.5.

In the event of there being any inconsistencies between the provisions of the Scheme and the provisions of the Lot 2 McGregor Street & Lot 5474 Thompson Street Development Plan then the provisions of the Lot 2 McGregor Street & Lot 5474 Thompson Street Development Plan shall prevail.

3.4 Zones & Reservations

The Development Plan proposes the following land use provisions and adopts the relevant zone objectives and land use controls contained with the Scheme:

- Residential – R25
- Residential – R50
- Residential – R100
- Other Public Purposes – Telecommunications

3.5 Variations to R-Codes

In order to enable the concept masterplan to be achieved through subsequent subdivision and planning applications, a number of variations to the State Planning Policy 3.1 are required.

The following two tables identify the current R-Code controls and the proposed R-Code controls which shall be applied to subsequent development within the Development Plan Area. Notwithstanding these requirements, further variations where identified shall be supported by Council where consistent with the general aims of this Development Plan.

Figure 2. Standard R-Code Provisions

	Lot Type	Structure Plan Zoning	R – Coding
Lots 1 - 54	Green Title	Residential	R25
Lots 55 – 58	Strata Title	Residential	R50
Lots 59 – 62	Strata Title	Residential	R50
Lots 63 – 66	Strata Title	Residential	R50
Lots 67 – 72	Strata Title	Residential	R50
Lots 73 – 76	Strata Title	Residential	R50
Lots 77 – 80	Strata Title	Residential	R50
Lots 81 – 84	Strata Title	Residential	R50
Lot 85	Strata Title	Residential	R100
Lot 86	Green Title	Public Purpose	Telecommunica
Lot 87	Strata Title	Residential	R100

Figure 3. Proposed Variations

	Lot Type	Structure Plan Zoning	R – Coding
Lots 1 - 54	Green Title	Residential	R25
Lots 55 – 58	Strata Title	Residential	R50
Lots 59 – 62	Strata Title	Residential	R50
Lots 63 – 66	Strata Title	Residential	R50
Lots 67 – 72	Strata Title	Residential	R50
Lots 73 – 76	Strata Title	Residential	R50
Lots 77 – 80	Strata Title	Residential	R50
Lots 81 – 84	Strata Title	Residential	R50
Lot 85	Strata Title	Residential	R100
Lot 86	Green Title	Public Purpose	Telecommunicatic
Lot 87	Strata Title	Residential	R100

3.6 Supporting Technical Information

This Development Plan should be read in conjunction with the plans and technical reports contained in the appendices of this report.

3.7 Commencement

This Development Plan shall come into effect when it is adopted by the Council and endorsed by the Western Australian Planning Commission (WAPC).

3.8 Timing & Staging

- The Development Plan Area will be initially subdivided into several individual green title 'super-lots'. This will enable the excision of the Telstra facility from the balance of the Development Plan area.
- Several super-lots are proposed over the balance of the Development Plan area to facilitate development of different land parcels.
- The Development Plan Area will either be developed as individual lots under separate Planning Applications or, subject to market conditions, at the one time.
- This approach provides flexibility and the ability to produce new housing quickly to meet market demand. It enables the timing of development stages to suit market conditions.
- The delivery of new housing to market will be coordinated with the decommissioning of the Spinifex Hill STP.
- Site subdivision and construction works to be undertaken prior to or simultaneously with the decommissioning of the STP and occupation of dwellings will occur with knowledge that the STP will be relocated.

3.9 Market Demand

Port Hedland's recent population growth has placed considerable strain on housing market conditions. Port Hedland's current resident population is around 14,000 people although its real day/night population is as high as 19,500 persons. It is expected to reach 25,000 by 2013.

A further $170 billion in oil and gas projects are currently under consideration in Western Australia, several of which are located in close proximity to Port Hedland and which will continue to drive economic activity, employment and population growth in the region.

An anecdote to this growth is manifest in housing market pressure, as demonstrated by:

- Housing prices in Port Hedland having doubled in the 5 years to 2010. House prices far exceed the Western Australian regional and Perth metropolitan averages.
- Housing costs contributing to the diminishing value of working in the Pilbara.
- A current mismatch between housing stock and demand.
- Excessive rental and house prices – presently over $1,800 rental per week for a 3-bedroom dwelling which has a median sale price of over $800,000.

An additional 3,743 households are expected to be generated across the region between 2010-2015, accommodating an additional 9,601 persons. It is expected that more than 1,500 of these

additional households (accommodating over 4,000 persons) will be required in Port Hedland during this period alone.

There is insufficient housing supply expected to come on line to satisfy current and expected demand in the short-medium term. Most new housing projects are low-yielding and represent small infill or add-on developments.

This Development Plan seeks to provide for a range of housing types and styles to meet underlying housing demand and the diverse housing needs of the Port Hedland community.

4 Matters Addressed by Development Plan

4.1 Topography

The land slopes from a plateau at RL 11.5 metres (AHD) at its northern boundary down to an RL of 4.5m at its southern boundary. The change in elevation is most pronounced at the northern end of the site (A survey plan is included at ***Appendix 2***).

Relevant Development Principles

- Modification of the site's land form is required to achieve appropriate grades for residential development.
- Land levels and the configuration of roads need to be considered in order to minimise the importation of fill and to facilitate the ongoing operation of the Telstra Exchange with minimal site disturbances.

4.2 Storm Surge

The Development Plan Area is in part subject to impacts from storm surge. As part of the preparation this Development Plan, detailed investigation of the storm surge potential has been undertaken by Cardno Pty Ltd (refer to Local Water Management Strategy Report in ***Appendix 3***).

Cyclonic activity impacts the study area during the wet season (November-May). Due to the proximity of the site to the Pretty Pool estuary, it is susceptible to ocean inundation occurring as a result of a storm surge in extreme events.

Cardno's assessment and modelling of site conditions has taken into consideration both current events and events under a future sea level rise situation (a 2110 climate condition scenario).

Under pre-development conditions the site is not inundated in the 100 year Recurrence Interval event, but would be partially inundated in the 100 year and 500 year events for the 2110 planning period.

Based on Cardno's advice, the design flood level criteria for the site is currently considered to be 5.9m AHD with a 500mm freeboard allowance, making the habitable floor level 6.4 metres AHD for the Development Plan Area. This design flood level is based on the level specified flood level for East Port Hedland (reported in the Port Hedland Coastal Vulnerability Study (Cardno in prep)). The subject site is upstream from the Pretty Pool Estuary entrance at which the 5.9m AHD 1:100yr level has been modelled. Accordingly, dissipation of storm surge would occur across the low lying areas of Pretty Pool, therefore reducing the inundation level at the subject site. Further modelling is likely to demonstrate that the inundation level at the subject site could be lower than 5.9m AHD. A reduction in the assessed 1:100yr level may be modelled in future having regard to possible changes to entrance to the Pretty Pool Estuary.

The nature of the storm tide flooding is not characterised by high velocities so the risk of debris and fast moving water causing damage to car parking areas at approximately the 20-year ARI condition is an acceptable risk.

The duration of the peak of the design storm tide event is relatively short, meaning that residents in the elevated dwellings will not be isolated for prolonged periods.

Due to the warning time associated with design storm tide events, parking areas located below the design flood level are deemed an acceptable risk as vehicles can be moved to higher ground in extreme events. It has been recommended that car parking areas may be provided at a level which is equivalent to a 20 year ARI.

Relevant Development Principles

- Maintain a habitable floor level with 500mm freeboard above the established 100 year ARI.
- This can be achieved by elevating individual building floor levels above ground level parking or by filling of the property to achieve appropriate ground floor levels.
- Parking is acceptable at the 1:20 year ARI level given that the warning times for storm surge events are long (i.e. 24 to 48 hours). It is also possible to move cars to 'higher ground' within the Development Plan Area or elsewhere, away from the inundation area.
- As peak inundation is tidal the duration of an inundation event is relatively short, meaning that occupants will not be "isolated" in the elevated dwellings.
- Apply higher density allocations (R100) to the lower areas of the site, enabling the above design principles to be implemented. Three to five storey buildings are proposed within this area with car parking located at ground level, predominantly under the apartments.
- Allocate R-50 provisions to the middle of the site, providing for townhouse-type development with car parking at grade level. Import fill as required to achieve the 1:20 year ARI level.

4.3 Stormwater Management

Cardno Pty Ltd has prepared a Local Water Management Strategy (LWMS) for the site's development. This is included at ***Appendix 3***.

The objectives for the development are to:

- Retain low flow events (i.e. the first 15mm) on site.
- Convey the 5 year Average Recurrence Interval (ARI) event within roadside drainage.
- Convey the 100 year ARI event within road reserves and overland flowpaths so as to avoid flooding of Cooke Point Drive.

The LWMS specifies that habitable floor levels must be above the 100 year combined flood and storm surge level, with an additional 500mm freeboard.

Relevant Development Principles

- The first 15mm of rainfall (equivalent to a 1 year in 20 ARI storm event) is to be retained using an above-ground or below ground storage strategy.
- Pre-development ground water monitoring is required for a period of twelve months if underground storage is proposed. In the event that under-ground storage is not proposed, no pre-development ground water monitoring is required.
- Appropriate measures are to be employed to minimise the transportation of sediments and to reduce applied nutrient loads.
- Conserve water use through appropriate landscaping species selection and through household appliance efficiencies.

4.4 Road Network & Design

A traffic assessment was undertaken by Transcore Pty Ltd to assess the impacts of intended development and the appropriate design response.

The subsequent report confirmed that anticipated traffic volumes on local roads are within desirable thresholds for the relevant road classifications. As such, no upgrades are required for McGregor Street and Clarke Street which will continue to operate with spare capacity in the post development stage.

The proposed 3-way roundabout at McGregor Street / Subdivision Access Road is anticipated to operate satisfactorily and will provide speed management along McGregor Street.

In response to the scheme amendment referral Main Roads requested that a detailed capacity assessment of the Port Hedland / Cooke Point Drive intersection in Port Hedland be undertaken. Transcore has undertaken such an assessment (refer to ***Appendices 4 and 5***) and has concluded that the traffic from the proposed development will not have any adverse impacts on the performance of this intersection.

Relevant Development Principles

- Create a north/south road to an Access Street "C" standard through Lot 2
- The access road from McGregor Street (southern leg of the proposed McGregor Street 4-way roundabout) conforms with Access Street "B" standard
- All other internal roads should meet or exceed Access Street "D" standards

4.5 Geotechnical & Contamination

Douglas Partners have undertaken Geotechnical and Environmental Investigation of the site which is attached in the appendices of the report found at ***Appendix 6***. The investigation found:

- A low risk of broad scale soil contamination.
- A low risk of acid sulphate soils occurring to a depth of 3.0 metres below surface level, consistent with published risk mapping.

Relevant Development Principles

- The site is suitable for the proposed development provided its variable soil conditions are taken into consideration, in particular those in Zone B where there is shallow groundwater soft clay.
- Site works to be undertaken in accordance with measures identified in the Douglas Partners report.

4.6 Residential Codes

The development density able to be achieved at the subject site is influenced by a number of factors including site topography, the required design response to storm surge potential, surrounding land uses and the intended future character of the Spinifex Hill Commercial Community Precinct.

Relevant Development Principles

- Development along the northern boundary abuts low density residential dwellings where the topography of the site is at its highest. The bulk and scale of development along this boundary and in the northern portion of Lot 2 should therefore not be more than R25.
- Development of the southern portion of Lot 2 & Lot 5474 should graduate from R50 up to R100 as the land slopes further away towards McGregor Street. Building form of this scale is appropriate for this part of the site which has a lower RL and is distant from neighbouring development. Development at this scale will support the supply of housing in Port Hedland.

4.7 Open Space & Landscaping

Public open space and recreational areas are not required to be provided within the Development Plan Area given the close proximity of existing recreational facilities and open space areas. This provision includes a skate park, playing fields and public foreshore areas along Cemetery Beach, all of which are within walking distance of the Development Plan Area.

Relevant Development Principles

- The Development Plan should seek to maximise the utilisation of the Development Plan Area for housing purposes.
- Private open spaces can provide sufficient shading throughout the estate and relief from hard surfaces. Private open space ought to be considered in the estate masterplan.

4.8 Liveable Neighbourhoods

The subdivision and development masterplan have been prepared in accordance with the design principles of the Liveable Neighbourhoods Policy. Relevant design features incorporated into the development approach for the site are identified below:

Connectivity and Pedestrian Access

- The Development Plan provides for a series of compact neighbourhoods within walking distance of recreational facilities and urban services (Spinifex Hill/McGregor Street Commercial precinct).
- A permeable road network to encourage pedestrian linkages.
- Street planting to encourage comfortable pedestrian movements.

Social Sustainability

- A diverse mix of dwelling types and styles to accommodate the different housing needs of the Port Hedland community.
- Suitable housing densities are achieved in buildings of a suitable scale which respond to the site's landform characteristics and which take into account the nature and form of adjoining development.
- The proposal contributes significantly to Port Hedland's much-needed housing supply.
- The proposal incorporates a series of landscaped, shaded common areas, able to be used both actively and passively, which encourage social interaction.

Land Use Efficiency

- The Development Plan seeks to optimise the utilisation of the site for housing purposes, addressing Port Hedland's housing shortage.
- Appropriate re-shaping of the site's land form is proposed in order to ensure that low-lying portions of the site can be rendered suitable for development.
- The Development Plan sets a minimum floor level of 500mm above the 100 year ARI of 5.9 metres, ensuring that the site is developable in a manner that is protected from storm surge affectation.

Development and Building Sustainability

- The indicative site masterplan seeks to maximise the north-south orientation of lots, enabling buildings to capture available views and to benefit from effective passive solar design principles.
- Dwellings are orientated with primary living spaces facing north where possible, avoiding low level sun and featuring dual aspect planning to maximise cross ventilation.
- A water conservation strategy will ensure that all dwellings are fitted with appropriate water efficient tap-ware and that water use within households meets the Western Australian Government's consumption targets. Water efficient gardens will also be incorporated in to site landscaping works.

Heritage

- A review of Town of Port Hedland Municipal Inventory of Heritage Places Review (2007) has confirmed that there are no items or places of heritage significance within the Development Plan Area.

4.9 Environmental Considerations

VDM has undertaken an environmental review of the site to determine its environmental significance and appropriate design considerations. VDM's report is attached at ***Appendix 7***.

Potential impacts, their significance and suggested management and mitigation strategies are outlined in the following table. Generally, VDM's review has not disclosed any specific environmental threats that are attributable to the proposed development. Appropriate measures however need to be taken to address stormwater management and the potential for acid sulphate soils. These matters are to be managed as part of the regular environmental construction techniques that are ordinarily applied for a development of this type and size.

Correspondence from the DEC (dated 07 June 2011) at the time of exhibition of the rezoning request identified a possible concern regarding the development's impact on flatback turtles. The site is located approximately 200 metres (two streets back) from Cemetery Beach, which is a known nesting beach for flatback turtles. DEC has raised concerns that artificial lighting from the construction of multiple storey dwellings at the site may impact nesting habits of the turtles.

Since the original submission of the Environmental Review (Issue 1 dated November 2010) alterations have been made to the scope and nature of development now planned for the site. Notably, the intensity and height of development has been reduced. The highest buildings on the site are now five storeys instead of the previous six. These are located at the lowest portion of the site, the result being that their elevation from the beach is essentially hidden.

The distance from the five storey buildings to the beach is approximately 220 m. Light transmitted from the buildings will be obscured by the existing residential buildings between the site and the beach.

Potential Impact	Significance of Impact	Management/Mitigation Strategy and Frequency
Flora and Fauna	None	Landscape in accordance with the requirements of the Town of Port Hedland.
Conservation	None	None required.
Socio-Economic	Positive	Extend existing development and provide additional land with the opportunity for residential and business development and local employment
Visual Amenity	Positive	Incorporate the Town of Port Hedland Town Planning Scheme No 5.
Stakeholders	None	Undertake development in accordance with planning and approvals processes.
Soils/Geology	Surface Soils: likely, local Acid Sulfate Soils: present, local	Contamination of surface soils is not evident. Implement a Construction Environmental Management Plan to control sediment and dust during construction. Investigate, prepare and obtain approvals for Acid Sulfate Soils and Dewatering Management including Dewatering and Disposal Licenses.
Surface Water	Regional flooding and inundation	Implement an Urban Water Management Strategy incorporating Water Sensitive Urban Design. Undertake Hydraulic Impact Assessment to facilitate detailed design. Design and construct to incorporate requirements of existing water supply and sewage infrastructure.
Ground Water	Local	Undertake ground water investigation and monitoring to support the detailed planning and design of urban water management measures. Implement a Dewatering Management Plan during construction
Air Quality Noise and Vibration	Local	Site is located within the Waste Water Treatment Plant Buffer Special Control Area. Blaxland Pty Ltd indicated that the existing Waste Water Treatment Plant is currently being relocated. Once the plant and disposal ponds be decommissioned in accordance with acceptable environmental practice, odour assessments and management may not be required. Implement Demolition/Construction Environmental Management Plan to control dust, noise and vibration
Rehabilitation	None	None required.
Other: Hazardous Materials Site Contamination	 None Local	 Existing infrastructure remains as part of development. Limited soil and ground water sampling to be included in Acid Sulfate Soils Investigation.

4.10Urban Services

Spinifex Hill Wastewater Treatment Plant

The Spinifex Hill Wastewater Treatment Plant (WWTP) is located immediately adjacent to the southern boundary of the Development Plan Area. The Development Plan Area is located wholly within the odour exclusion zone of the WWTP. A small western portion of the Development Plan Area is affected by the chlorine exclusion zone.

The Regional Development Minister Brendon Grylls and Water Minister Bill Marmion on 19 January 2011 announced a $106 million project to relocate the STP facility to South Hedland to facilitate new residential development at the site.

The Water Corporation is committed to transferring flows from the Port Hedland STP to South Hedland by no later than June 2014. Subdivision and construction of the development is intended to occur simultaneously with the decommissioning of the STP plant in order that housing product can be brought to market in a timely manner.

The necessary scope of works to decommission the STP could be achieved earlier than mid-2014. Blaxland is working with stakeholders to bring the completion of these works forward.

Power

The Development Plan Area is within an area that is currently supplied by underground power via two 22kV High Voltage (HV) feeders.

The final power connection requirements will be confirmed when a Design Information Package or Preliminary Assessment request is submitted to Horizon Power.

Gas

WA Gas Networks has advised there are no assets in the area, and thus a domestic supply to each residence will not be available.

Water

Water Corporation has advised the East Pilbara Water Scheme is currently unable to service the development. Water Corporation has indicated, however, that planning studies and the business case to augment the water conveyance systems will be completed in 2011.

Telecommunications

As a result of the implementation of the National Broadband Network (NBN) the ownership issues for delivering the wholesale fibre to the home system have been transferred to the Government (NBN Co). In the event that the NBN roll-out is delayed, it will be possible to provide Telstra services to the site.

Telstra Infrastructure

A separate allotment will be created for the Telstra Exchange facility. Easements will be provided to ensure the ongoing operation of the facility. These will be created as part of a future subdivision application.

An Infrastructure Report prepared by JDSI Consulting Engineers is included in full at ***Appendix 8.***

5 Indicative Design Response

5.1 Architectural Masterplan

An architectural masterplan has been prepared to demonstrate the potential built form of the site based on the density allowances and design principles incorporated in this Development Plan (refer ***Appendix 9***).

The design response achieves a mix of low-medium density dwelling formats, ranging from 3 and 4 bedroom houses to 4 bedroom townhouses and 3 bedroom apartments in 3 and 5 storey buildings.

The masterplan seeks to maximise the north-south orientation of lots, enabling buildings to capture available views and to benefit from effective passive solar access principles.

The siting and location of buildings within the site is appropriate to their surroundings in terms of building bulk, height and scale. The internal street network is complemented by a series of pedestrian pathways which lead to common outdoor recreation areas. These areas are available to all residents and offer shaded spaces which cater for both active and passive use.

A total of 308 dwellings are indicated as being able to be provided on the site. The masterplan's indicative dwelling yield is:

Dwelling Format	Yield	%
3 Bedroom houses	8	3%
4 Bedroom houses	46	15%
4 Bedroom Townhouses	30	10%
3 Bedroom apartments	224	72%
TOTAL	**308**	**100%**

Note: 2 car spaces are provided for each dwelling, as well as visitor parking.

5.2 Housing Typologies

Houses

The house forms that have been developed for the site are a semi detached dwelling type. This form utilises a common or party wall between a pair of dwellings, maximising the use of available site area by eliminating the often found narrow side setback zone between dwellings.

The consequent reduction in perimeter wall which is in contact with outside elements enables a more efficient response to climate control. Dwellings are orientated with primary living spaces facing either north or south, thus avoiding the low level sun and taking advantage of available views and cooling breezes. All dwellings are part single storey and part double storey, achieving an articulated form and variation in streetscape. Furthermore, the external finishes, roof pitches and setbacks of each dwelling can be varied to achieve variation to the streetscape. Each dwelling provides shaded parking for two vehicles, as well as opportunity for boat storage in many instances.

3 Bedroom House plus family room (R-25)

This house type is applied to various lot sizes with a typical lot width of 10.9m and variable lot depths. The dwelling is setback from the street with two shaded car parking spaces located in parallel format beside the dwelling.

The ground level features open plan kitchen, dining and living spaces, together with the third bedroom and a separate study/family room. This level also includes a bathroom and laundry as well as an enclosed outdoor living space. A storage room is accessed from the exterior. The upper storey includes a master bedroom with robe and ensuite as well as second bedroom and family bathroom.

4 Bedroom House plus family room (R-25)

This house type is applied to various lot sizes. The lot widths are typically 11.9m with variable lot depths. The dwelling is setback from the street with two shaded car parking spaces located in parallel format beside the dwelling.

The ground level features open plan kitchen, dining and living spaces, together with the third and fourth bedrooms and a separate study/family room. This level also includes a bathroom and laundry as well as an enclosed outdoor living space. A storage room is accessed from the exterior with allowance for small boats within many of the sites. The upper storey includes a master bedroom with robe and ensuite as well as second bedroom and family bathroom.

4 Bedroom Townhouses (R-50)

The 4 bedroom townhouses are configured in clusters of 4 and 6 dwellings. Typical lots are 198m^2 in area with a minimum 7.9m width and a minimum 25m depth.

The ground level features an access lobby with laundry and store room. Car parking is placed in tandem format beside the lobby, covered by the building level above. The first floor above ground features an open plan kitchen, dining and living space, as well as a versatile fourth bedroom or family/study space and a bathroom. The living space opens onto a protected external living space (enclosed deck).

The second floor above ground features the master bedroom with robe and en-suite, as well as second and third bedrooms and a separate bathroom and toilet.

3 Bedroom Apartments – Stair Access to 3-level Apartments (R-100)

The 3 bedroom apartments are configured as building components of 12 or 24 dwellings. Each building is served by a ground level lobby with stair access to three levels of apartments. Elevators could be installed if required by the market. Each level of the building has four apartments. Car parking is located at ground level, predominantly under the apartments.

Each apartment is a single level, dual aspect configuration, with open plan kitchen, dining and living areas opening onto a covered outdoor space.

The master bedroom, robe and en-suite are located adjacent to living spaces where they benefit from the primary outlook.

Two bedrooms are located at the opposite end of the apartment and served by a family bathroom.

The ground level parking of these buildings will be screened with landscaping. The density of landscaping will balance the need for screening and passive surveillance.

The McGregor Street frontage will incorporate a landscaped bank to screen the undercroft car park.

3 Bedroom Apartments – Lift Access to 5-level Apartments (R-100)

5-level apartment buildings are provided at the eastern end of the site, providing a 'gateway' statement for the approach to East Port Hedland from Cooke Point Road.

This building type is served by a ground level lobby with lift access to five levels of apartments. Each level of the building has sixteen apartments. Car parking is located at ground level, predominantly under the apartments.

Each apartment is a single level, dual aspect configuration, using the same plan format as the 3 storey buildings.

5.3 Landscape Concept Plan

The landscape design prepared by UDLA at ***Appendix 10*** reinforces the definition of the street network and provides appropriate shade for pedestrian amenity. Landscaping around buildings serves to enhance their setting as well as contributing to the screening of vehicle parking bays and providing privacy between the public and the private domain, whilst maintaining sufficient permeability to achieve passive surveillance.

Common areas are differentiated by variation in planting types.

6 Conclusion - Key Outcomes

Development of the subject sites for residential purposes has been identified in several of The Town of Port Hedland's strategic planning documents for some time.

The current "Hedland's Future Today – 2010" identifies the relocation of the Spinifex Hill STP as a priority project expected to deliver up to 1,500 residential lots initially, and up to 3,800 lots eventually.

The proponents have now thoroughly investigated the physical capacity of the site to accommodate residential development. The resultant Development Plan seeks to allocate appropriate dwelling yields to address Port Hedland's pressing housing shortages whilst at the same time respecting the site's physical constraints and its relationship with adjoining land.

Importantly, the Development Plan facilitates the re-shaping of the site to best manage its potential affectation by storm surge events, essentially involving the elevation of habitable floor levels above the 1:100yr surge event. This is achieved both through a re-shaping of the site and by the judicious placement of building forms to suit design outcomes, i.e. by applying higher density form to the lower areas of the site, enabling individual building floor levels to be placed above ground level parking.

The Development Plan also allocates R-50 provisions to the middle of the site, providing for townhouse-type development with car parking at grade level. Some imported fill will be required to achieve an appropriate floor level at this part of the site. No fill is required for the upper northern end of the site where individual dwellings are proposed.

The site is serviceable, does not contain threatened vegetative communities or species and is able to be developed without impacting negatively on local traffic flows.

The Development Plan provides for a much-needed range of housing typologies to meet the future requirements of Port Hedland's residents.

It is proposed that site subdivision and construction works will be undertaken prior to or simultaneously with the decommissioning of the adjacent Spinifex Hill STP and that occupation of dwellings will occur either upon final decommissioning or once this is imminent.

ADOPTION OF DEVELOPMENT PLAN

MCGREGOR STREET DEVELOPMENT PLAN
WAS ADOPTED BY
RESOLUTION OF THE COUNCIL OF THE TOWN OF PORT HEDLAND ON

.....Date

AND THE SEAL OF THE MUNICIPALITY WAS PURSUANT
TO THE COUNCIL'S RESOLUTION HEREUNTO AFFIXED IN THE
PRESENCE OF:

.....
Mayor, Town of Port Hedland

.....
Chief Executive Officer, Town of Port Hedland

..... Date

AND BY
RESOLUTION OF THE WESTERN AUSTRALIAN PLANNING COMMISSION ON

.....Date

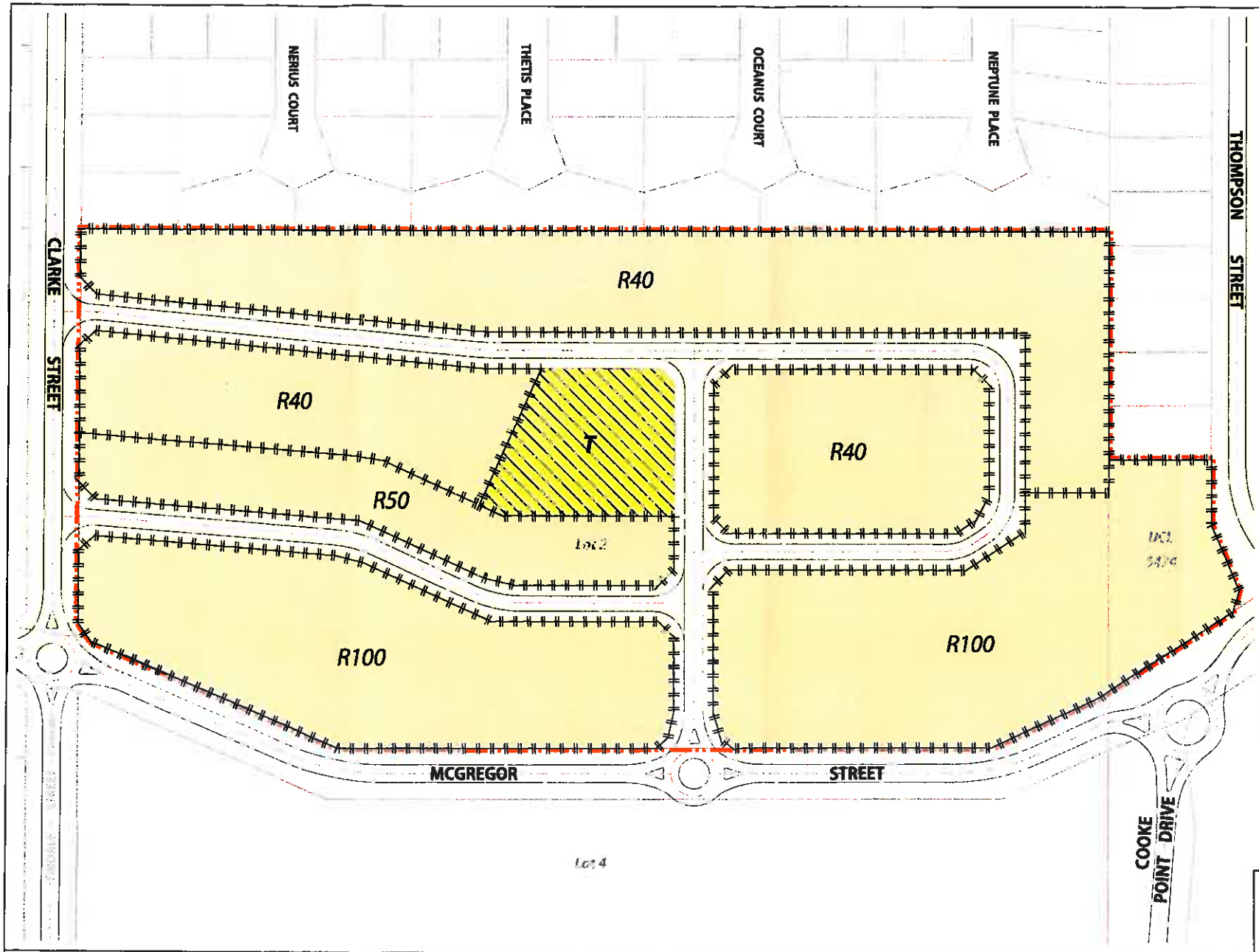
Signed for and on behalf of the Western Australian Planning Commission

.....
an officer of the Commission duly authorized by the Commission pursuant to section 57 of the Western Australian Planning Commission Act 1985 for that purpose, in the presence of:

..... Witness

..... Date

Appendix 1 - Development Plan



DEVELOPMENT PLAN
PLANNING CONDITIONS

DEVELOPMENT PLAN – LOT 2 & LOT 5474 MCGREGOR STREET

1. This Development Plan (Plan) applies to the land contained within the inner edge of the red dotted line.

2. The purpose of this Plan is to detail the how the development of the site will be undertaken. In particular this Plan applies residential density codes, road layout and subdivision pattern.

3. The Plan depicts indicative design for residential development and other land uses, local roads and may be subject to further refinement and modification at the subdivision stage.

4. The Development Requirements detailed at Sections 3.1-5.3 (inclusive) of the accompanying Planning Report apply to the development of thoroughfares, landscape, cut and fill and built form where shown within the Development Plan area.

APPLICATION OF R-CODES

5. In order to enable the concept master plan to be achieved through subsequent subdivision and planning applications, a number of variations to the State Planning Policy 3.1 are required in accordance with Figure 3 of the accompanying Planning Report.

TIMING AND STAGING

6. Site subdivision and construction works may be undertaken prior to or simultaneously with the decommissioning of the STP and occupation of dwellings will occur with knowledge that the STP will be relocated.

SUBDIVISION

7. The Development Plan Area will be subdivided into 54 smaller lots ranging in size from 319 m^2 to 1294 m^2, 15 superlots ranging from 890 m^2 to 6778 m^2 and 1 lot for the Telstra facility being 4053 m^2.

CUT AND FILL

8. Modification of the site's land form is required to achieve appropriate grades for residential development.

9. Land levels and the configuration of roads need to be considered in order to minimise the importation of fill.

STORM SURGE & FLOODING

10. All development will maintain a habitable floor level with 500mm freeboard above the established 100 year ARI.

11. Parking is acceptable at the 4.5m AHD level given that the warning times for storm surge events are long (i.e. 24 to 48 hours).

12. The first 15mm of rainfall is to be retained using an above-ground or below ground storage strategy.

13. Conserve water use through appropriate landscaping species selection and through household appliance efficiencies.

ROAD NETWORKS

14. Create a north/south road to an Access Street "C" standard through Lot 2.

15. The access road from McGregor Street (southern leg of the proposed McGregor Street 4-way roundabout) conforms with Access Street "B" standard.

16. All other internal roads should meet or exceed Access Street "D" standards.

GEOTECHNICAL & CONTAMINATION

17. Site works to be undertaken in accordance with measures identified in the Douglas Partners report contained in the accompanying planning report.

OPEN SPACE

18. The Development Plan should seek to maximise the utilisation of the Development Plan Area for housing purposes and provide open space through private open space only associated with residential dwellings.

ENDORSEMENT OF REGISTERED TOWN PLANNER

SIGNATURE: _____ DATE: _____

LOCAL DEVELOPMENT PLAN

Lot 2 McGregor Street and Lot 5474 Thompson Street, PORT HEDLAND

for: blaxland

LOCAL SCHEME RESERVES
- Other Public Purposes
- T — DENOTED AS TELECOMMUNICATIONS
- Local Road

ZONES
- Residential

OTHER
- R40 — R-Codes

NOTES:
- SITE BOUNDARY
- AREAS AND DIMENSIONS SUBJECT TO SURVEY
- CARRIAGEWAYS ARE DIAGRAMMATIC ONLY
- BASE DATA SUPPLIED BY LANDGATE

NORTH

Scale 1: 1,500 @ A3

0 10 20 30 40 50 metres

COMPILED:	DPS	DRAWN BY:	MDH
DATE:	13/07/2011	REVISED:	9/09/2011
GRID:	MGA 50	DATUM:	AHD
DRAWING NUMBER:	BLAPH002d	JOBCODE:	BLAPHLSP
FILE ID:	M:\BLAPH\BLAPH002d.dgn		

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Appendix 2 – Survey Plan

SERVICE LEGEND	SEWERAGE	TELSTRA
WATER	POWER	GAS
DRAINAGE		SURVEY

SERVICE RECORD			
STATUS / SERVICE	LOCATED	AVAILABLE	NO SERVICE / CONFIRM
WATER	✓		✓
SEWERAGE	✓		✓
GAS	✓		✓
TELSTRA	✓		✓
POWER MSL	✓		✓
POWER DH			

AHD FROM STANDARD SURVEY MARK PH97.

WARNING!
BOUNDARY RE-ESTABLISHMENT SURVEY REQUIRED TO CONFIRM LOT BOUNDARY POSITION AND DIMENSIONS.

CLIENT : WATSON PROPERTIES PH Pty Ltd	SURVEYED ON : 03/09/2010	LOT : 2 (& 20) CLARK STREET	
AUTHORITY : TOWN OF PORT HEDLAND	PROCESSED BY : MD	TOWN : PORT HEDLAND	C/T : 1327/827
MAP REF : COUNTRY	SURVEYED BY : RH / WH	BUILDER :	DIAGRAM 42803
BUILDERS/CLIENTS			

Land Surveys

SCALE :	BUILDER REF No :	JOB No :	DWG No :	REV.
1:600 @ A1 Landscape		LS563994	563994	C

Appendix 3 – Local Water Management Strategy

Cardno
Shaping the Future

Lot 4 & Lot 20 Clark Street, & Lot 5474 Thompson St, Port Hedland

Local Water Management Strategy

Prepared for Blaxland Property

August 2011

Project Number LJ15028

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Document Control

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1.0	29/07/2011	Aisha Chalmers	ASC	David van Senden	DVS
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Filename	Lj15028--Asc110037.30-Final				

Author: Aisha Chalmers
Position Title: Environmental Engineer

Reviewer: David Taylor
Position Title: Project Manager

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Executive Summary

Blaxland Property has commenced structure planning of Lot 4 Clark Street, Lot 20 Clark Street and Lot 5474 Thompson St, Port Hedland. The study area is situated in Port Hedland within the municipality of the Town of Port Hedland. The study area is bound by Clark Street to the west, Tindale Street and the Spinifex Hill Water Treatment Plant to the south, Thompson Street to the east and existing development to the north. An existing regional road, McGregor Street, runs through the development.

The study area is zoned "Public Purpose – Telecommunications" under the Town of Port Hedland's *Town Planning Scheme No. 5* (TPH 2001). An application for the rezoning of the study area to Urban Development under the *Town Planning Scheme No. 5* is being prepared and is supported by this Local Water Management Strategy (LWMS).

A number of broad level information sources, that include the study area, provide a regional context for the Local Water Management Strategy. These were reviewed in order to gather suitable background information for the study area, and also to provide an indication of the issues requiring further and more detailed investigation. In summary, these investigations indicate that:

- The study area has been utilised for telecommunications purposes.
- The natural surface height ranges from 11.5mAHD in the north to 3.5mAHD in the south. The gradient at the northern boundary is approximately 10%, whereas the rest of the study area is approximately 2%.
- The dominant soil types are sand or clayey sand/sandy. The geotechnical study found that these clays generally have a high shrink/swell potential (Douglas Partners 2011).
- The study area is defined as having "moderate to low risk" of acid sulfate soils occurring within the first 3m below the surface. However, an acid sulfate soil assessment including both screening and laboratory tests found no occurrence of potential or actual acid sulfate soil within the samples tested.
- Runoff from the study area is directed by overland flow towards the south-west and conveyed along the western and southern boundaries of the Spinifex Hill Water Treatment Plant prior to discharging under Cooke Point Drive (through a culvert) into Pretty Pool.
- Under pre-development conditions the study area is not inundated by storm tide in the current, 2010, 100 year Average Recurrence Interval (ARI) event. However, for the 2110 planning period (incorporating a projected 0.9 m sea level rise) the study area would be inundated in the 100 year and 500 year events.
- The design flood level criteria for the site is currently considered to be 5.9m AHD with a 500mm freeboard allowance. This design flood level is based on the level specified flood level for East Port Hedland (reported in the Port Hedland Coastal Vulnerability Study (Cardno in prep.)). The subject site is upstream from the Pretty Pool Estuary entrance at which the 5.9mAHD 1:100yr level has been modelled. Accordingly, dissipation of storm surge would occur across the low lying areas of Pretty Pool, therefore reducing the inundation level at the subject site. Further modelling is likely to demonstrate that the inundation level at the subject site could be lower than 5.9mAHD. A reduction in the assessed 1:100yr level may be modelled in future having regard to possible changes to entrance to the Pretty Pool Estuary.
- Currently the Masterplan layout incorporates a mixture of housing types with habitable floor levels set above this recommended level of 5.9m AHD which provides a low level of risk to habitable areas.
- The nature of the storm tide flooding is not characterised by high velocities so the risk of debris and fast moving water causing damage to car parking areas at approximately the 20-year ARI condition is an acceptable risk.

- The duration of the peak of the design storm tide event is relatively short, meaning that residents in the elevated dwellings will not be isolated for prolonged periods.
- Due to the warning time associated with design storm tide events, parking areas located below the design flood level are deemed an acceptable risk as vehicles can be moved to higher ground in extreme events.
- No historical groundwater monitoring has been conducted at the study area. During the geotechnical investigation, three test pits were thought to have encountered the permanent groundwater level. These test pits had a groundwater level of between 1.9mAHD and 2.8mAHD. These are likely to provide an adequate estimation of maximum groundwater levels as the investigation was undertaken near the end of the wet season.
- The study area has been cleared of all native vegetation.

The LWMS has determined appropriate Water Conservation, Stormwater Management and Groundwater Management design criteria based on overarching guideline documents, requirements of the Town of Port Hedland and Department of Water, and consideration of designs in similar developments.

The use of water within the development will be minimised wherever possible. This will be achieved through considered landscaping to minimise areas requiring irrigation. In addition, water efficient appliances and water efficient gardens will be promoted at the lot scale so that the development meets the net use of water within households target of 100kL/person/year (Government of Western Australia, 2007).

The stormwater management objectives for the development are to retain low flow events (i.e. the first 15mm) on site, to convey the 5 year Average Recurrence Event within roadside drainage, to convey the 100 year Average Recurrence Interval storm events within road reserves and overland flowpaths and avoid flooding of Cooke Point Drive.

The road network will direct runoff into underground storages via roadside swales. The underground storages will contain low flow events and will be installed with silt traps to capture sediments. Vegetated roadside swales will convey 5 year flows from the development and mitigate sediment transport offsite. Discharges from the study area will follow existing flowpaths to a culvert under Cook Point Drive. If the proposed development levels change, it may be possible to contain low flow events within above ground storage structures provided they are of sufficient capacity to meet the design criteria specified within this document.

Other strategies to minimise erosion and mitigate sediment transport have also been identified within the Local Water Management Strategy, such as the installation of sediment control devices prior to construction and the need for an Erosion and Sediment Control Program to be referred to within future Urban Water Management Plans.

The Local Water Management Strategy specifies that habitable floor levels must be above the 100 year combined flood and storm surge level, with an additional 500mm freeboard. In addition, the present groundwater management design criteria developed for the Masterplan layout specify that the underground storage structures are to be installed with a minimum clearance of 300mm above the Maximum Groundwater Level. These design criteria are proposed to be achieved through a combination of fill, appropriate building design and the use of shallow underground storage systems.

Future subdivision designs and the supportive Urban Water Management Plan will clarify details not provided within this document. The main areas that will require further clarification are:

- Maximum Groundwater Level.
- Final earthwork and habitable floor levels.

- Detailed drainage design.
- Modelling of the local drainage.
- Implementation of water conservation strategies.
- Non-structural water quality improvement measures.
- Management and maintenance requirements.
- Construction period management strategies.
- Monitoring and evaluation program.

Should future sub-division detailed designs propose underground storage structures then a twelve month pre-development monitoring program will be undertaken at the study area prior to construction works. Four groundwater bores will be installed and groundwater levels will be monitored on a monthly basis to capture the Maximum Groundwater Level. It is not proposed to conduct a post-development hydrological monitoring program given that there are no surface water features or above ground infiltration basins within the study area. The overall condition of landscaped areas will be monitored on a bi-annual basis from completion of the civil and landscaping works for a period of two years to ensure that the high amenity value of the development is maintained prior to handover.

The Local Water Management Strategy provides a framework that the proponents can utilise to assist in establishing stormwater management methods. It is the responsibility of the developer to demonstrate that the proposed subdivision designs, Urban Water Management Plan and Erosion and Sediment Control Program comply with the objectives and management approaches provided in this document.

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Abbreviations

ABS	Australian Bureau of Statistics
AHD	Australian Height Datum
ARI	Average Recurrence Interval
ASS	Acid Sulfate Soils
BGS	Below Ground Surface
BoM	Bureau of Meteorology
BMP	Best Management Practice
DoT	Department of Transport
DoP	Department of Planning
DoW	Department of Water
LWMS	Local Water Management Strategy
POS	Public Open Space
TSWL	Total Still Water Level
TPH	Town of Port Hedland
TPS	*Town Planning Scheme No. 5* (TPH 2001)
UWMP	Urban Water Management Plan
WAPC	Western Australian Planning Commission
WSUD	Water Sensitive Urban Design

1 Introduction

Blaxland Property has commenced structure planning of Lot 4 Clark Street, Lot 20 Clark Street and Lot 5474 Thompson St, Port Hedland. Lots 4, 20 and 5474 are owned by Telstra Corporation Limited, Roy Hill Infrastructure Pty Ltd and the State of Western Australia respectively (the "proponents"). The study area is situated in Port Hedland within the municipality of the Town of Port Hedland (TPH). The locality of the study area is shown in **Figure 1**. The study area is bound by Clark Street to the west, Tindale Street and the Spinifex Hill Water Treatment Plant to the south, Thompson Street to the east and existing development to the north and is shown in **Figure 2**. An existing regional road, McGregor Street, runs through the development.

Though changing the land use from a cleared lot to urban development is not as significant as from bushland to urban development, any change can have implications for the quality and quantity of stormwater generated from the study area. These changes can affect the local and downstream environments. In addition, development of the study area will require the sustainable use of water resources within the study area.

The overall aim of the Local Water Management Strategy (LWMS) is to ensure that any potential impacts on the local and downstream environments from the proposed land use change, and subsequent development of the study area, are minimised.

1.1 Town Planning Context

The study area is zoned "Public Purpose – Telecommunications" under the TPH *Town Planning Scheme No. 5* (TPS) (TPH 2001). However, the study area is also located within the Spinifex Hill Commercial/Community Precinct, one of the Development Plan Areas located within the TPS. An application for the rezoning of the study area to "Urban Development" under the TPS is being prepared and is supported by this LWMS. The development of a LWMS is considered to be the appropriate mechanism to establish the concept designs and management measures for flood mitigation and effective stormwater management. This LWMS provides the framework for actions and measures to achieve the desired outcomes at future planning stages.

1.2 Policy Framework

There are a number of State Government documents that relate to the developmentincluding:

- *State Water Plan* (Government of WA 2007).
- *Acid Sulphate Risk Mapping* (WAPC 2007).
- *Guidance Statement 33: Environmental Guidance for Planning and Development* (WAPC 2006).
- *State Planning Policy No 3: Urban Growth and Settlement* (WAPC 2006).
- *Liveable Neighbourhoods* (WAPC 2007).
- *State Planning Policy No 2.6: State Coastal Planning* (WAPC 2003).

In addition to the above documents, there are a number of published guidelines and standards available that provide direction regarding the objectives that stormwater management should aim to achieve. These are key inputs and include:

- *Decision Process for Stormwater Management in Western Australia* (DoW 2009).
- *Stormwater Management Manual of Western Australia* (DoW 2007).
- *Better Urban Water Management* (WAPC 2008).
- *National Water Quality Management Strategy* (ANZECC 2000).

These guidance documents, together with information from the TPH and Department of Water (DoW), were reviewed to determine the likely data requirements for the area within the proponent's landholdings that are proposed for future urban development.

1.3 LWMS Objectives

The LWMS for the development has been developed to meet the following major objectives:

- Develop a stormwater management strategy for flood protection of the study area and downstream environments.
- Incorporate appropriate Best Management Practices (BMPs) into the drainage system that address erosion and sediment transport within the development.
- Develop a water conservation strategy for the development.
- Gain support from the DoW and TPH for the proposed method to manage stormwater within the study area and potential impacts on the study area and downstream environments.

2 Proposed Development

Development Plans are usually focused on a neighbourhood scale and provide a comprehensive physical framework for the assessment of subdivision and development applications in respect to light industrial or residential development areas (TPH 2001). The Masterplan has been based on environmental investigations undertaken across the study area and in consideration of the principles outlined in the TPS (TPH 2001). The key elements of the Masterplan include:

- A total of 308 dwellings.
- A mixture of housing typologies.
- Consideration of neighbouring dwellings when determining development plan.
- The provision of pedestrian pathways between dwellings and towards the coastline.

The proposed Masterplan is shown in **Appendix A**.

3 Pre-development Environment

3.1 Sources of Information

A number of broad level information sources, that include the study area, provide a regional context for the LWMS. These were reviewed in order to gather suitable background information for the study area, and also to provide an indication of the issues requiring further and more detailed investigation. The background information was sourced from a variety of references, including:

- *Acid Sulfate Soils Risk Mapping* (WAPC 2007).
- DoW WIN Database Search.

In addition to the above information, site-specific investigations into various aspects of the study area have recently been conducted as part of the Masterplan formulation process. These have been aimed at providing more detail to the existing environmental information. These site-specific investigations include:

- *Report on Geotechnical Study and Environmental Investigation: Proposed Residential Development, Lot 2 McGregor Street, Port Hedland* (Douglas Partners 2011).
- *Port Hedland Coastal Vulnerability Study* (Cardno in prep.).

3.2 Land Use

Historical land use within with study area has been predominantly telecommunications and the area has been cleared of any native vegetation. A Telstra exchange site is located within the northern portion of the study area, with two cable easements providing connectivity to nearby roads.

3.3 Geotechnical Conditions

3.3.1 Topography

Natural surface height within the study area ranges from 11.5m Australian Height Datum (AHD) along the northern boundary to 3.5mAHD along the boundary with the Spinifex Hill Water Treatment Plant. Filling of the adjacent development along the northern boundary resulted in the raised road and shoulderat level 11.5mAHD that quickly drops to 9mAHD within the study area. The gradient at the northern boundary is approximately 10%, whereas the gradient for the majority of the study area is approximately 2%. Topographical contours for the study area are shown in **Figure 2**.

3.3.2 Geology and Soils

The test pits excavated during the geotechnical investigation found the dominant soil types to be sand or clayey sand/sandy clay (Douglas Partners 2011). The sand soil type was characterised as orange to brown, medium grained sand. The clayey sand/sandy clay soil type was characterised as "dense to hard, light brown, medium grained, low plasticity, clayey sand/sandy clay." The Douglas Partners (2011) geotechnical report is presented in **Appendix B**.

The central portion of the site includes areas where the sand layer overlies soft clay, which has implications for settlement of these soils under loads. The remaining area can be characterised by sand to approximately 3m overlying stiff to hard clay or dense sands. The clays on site were found to have a high shrink/swell potential and hence have implications for the site classification. Due to the presence of these low permeability clays underneath the site, the geotechnical report recommends that subsurface drainage be utilised in preference to infiltration measures (Douglas Partners 2011).

3.3.3 Acid Sulphate Soils

Acid Sulfate Soils (ASS) risk maps published by the Western Australian Planning Commission (WAPC) (2007) indicate that the study area is located within an area defined as "moderate to low risk" of ASS occurring up to 3.0m Below Ground Surface (BGS). The Douglas Partners (2011) ASS assessment found that neither the screening nor laboratory tests indicated the occurrence of potential or actual ASS within the samples tested. On this basis the report suggests an ASS management plan would not be required for onsite excavations of less than 3m depth. The WAPC ASS risk mapping is shown in **Figure 3** and the acid sulfate soil assessment is discussed in Section 10 of **Appendix B**.

3.4 Hydrology

3.4.1 Stormwater

3.4.1.1 Runoff

A review of LiDAR and detailed survey data of the study area identified that the south-west corner is the low point of the development. Runoff from rainfall that falls on the study area is directed by overland flow towards this area and conveyed along the western and southern boundaries of the Spinifex Hill Water Treatment Plant in unallocated crown land. Runoff then discharges under Cooke Point Drive (through a culvert) and into Pretty Pool (see **Figure 4**).

3.4.1.2 Storm Surge Inundation

Cyclonic activity impacts the study area during the wet season (between November and May each year). Due to the proximity of the site to the Pretty Pool Estuary, it is susceptible to ocean inundation resulting from extreme storm surge events. Under future sea level rise scenarios provided by WAPC (0.9m rise by 2110), the likelihood of inundation at the site is increased.

The WAPC *State Coastal Planning Policy 2.6* (WAPC 2003), provides the following recommendation for development in cyclone prone areas:

"Development should be set back from any areas that would potentially be inundated by the ocean during the passage of a Category 5 cyclone tracking to maximise its associated storm surge"

WAPC SPP2.6 Section F.4

For the Blaxland site an assessment of the inundation of the current site topography for the 100 years (2110) planning period was undertaken, with a 2110 scenario based on adopting a sea level rise component of 0.9m as recommended in current WAPC SPP2.6 guidelines.

A detailed investigation of impacts from cyclones including storm surge and catchment based flooding for the Port Hedland area was completed by Cardno in April 2011, and reported in the *Port Hedland Coastal Vulnerability Study* (PHCVS Cardno in prep.). At present this report is in draft form and is with government agencies for review.

A site specific review was undertaken for the Blaxland development site, to determine the maximum flood levels during extreme Average Recurrence Interval (ARI) events for the present (2010) and 2110 planning periods. **Appendix D** provides the modelling methodology and detailed results.

Cardno's recommended design flood level criteria for the Blaxland site is 5.9mAHD. This level is based on model outcomes for the East Port Hedland region that surrounds the Pretty Pool estuary - the primary ocean inundation flow path to the Blaxland site. The model outcomes represent the 100 year combined flood and storm surge level for the 2110 Climate Change scenario as defined

in the PHCVS. This is consistent with recent discussion within the steering committee for the *Port Hedland Coastal Vulnerability Study* (Cardno in prep.), comprised of representatives from the DoW, TPH, Department of Transport (DoT) and Department of Planning (DoP). The habitable floor levels for buildings across the site would then be set at a minimum 500mm above this height, providing a freeboard allowance. This approach is consistent with the outcomes of the *Port Hedland Coastal Vulnerability Study* (Cardno in prep.) and the TPS (TPH 2001) which recommends using the 100 year event as the basis for development in flood and storm surge prone areas.

The subject site is upstream from the Pretty Pool Estuary entrance at which the 5.9mAHD 1:100yr level has been modelled. Accordingly, dissipation of storm surge would occur across the low lying areas of Pretty Pool, therefore reducing the inundation level at the subject site. Further modelling is likely to demonstrate that the inundation level at the subject site could be lower than 5.9mAHD. A reduction in the assessed 1:100yr level may be modelled in future having regard to possible changes to entrance to the Pretty Pool Estuary

An overview of the results from the storm surge inundation modelling is provided below, with detailed outcomes available in **Appendix D**.

Under present (2010) pre-development conditions the Blaxland site is not inundated in the 100 year ARI event (shown in the upper panel of **Figure D.1**), but would be partly inundated in 2110 (shown in the lower panel of **Figure D.1**). Flood extents for the pre-development case for 2010 and 2110 time periods for the 500 year event (**Figure D.2**) show the 2110 scenario results ininundation across the site south of McGregor Street and about 50% flooding of the area north of McGregor Street.

To mitigate this potential flooding Blaxland proposed a masterplan development layout that combines a mix of building types (see **Appendix A**), with individual lots complying to the recommended 100 year ARI design level of 5.9m AHD. Multiple storey buildings in which the lower level is utilised for under croft parking have also been used across the site. For these building types the habitable floor level is on the first floor allowing a ground level below the 5.9mAHD site recommendation. The post-developed site elevation from the Masterplan is shown in **Figure D.3** .

Modelled 100 and 500 year ARI inundation extents for the current (2010) Climate Condition on the post-developed layouts are shown in **Figures D.4** and **D.5**. The 2 panels in these figures show the maximum water depth (upper panel) and flood hazard (lower panel). In the 100 year ARI event **(Figure D.4)** there is no impact to the site, whilst the 500 year ARI event **(Figure D.5)** results in minor inundation (<0.20m) in the southeast corner of the site.

Modelled 100 and 500 year ARI inundation extents for the 2110 climate condition are shown in **Figures D.6** and **D.7**. The inundation associated with the 100 and 500 year ARI events (with 0.9m, 2110 sea level rise) is significantly higher than the 2010 developed scenario, however the storm tide level does not impact the individual lots south of McGregor Street or the lots north of the Telstra site. It is noted that these model results indicate access to and from the site from McGregor Street and Cooke Point Drive in the 2110 100 year ARI event is limited, whilst in the 2110 500 year ARI event site access would not be possible.

The nature of the storm tide flooding is not characterised by high velocities so the risk of debris and fast moving water causing damage to car parking structures is an acceptable risk. The duration of the peak of the design storm tide event is relatively short, meaning that residents in the elevated dwellings will not be isolated for prolonged periods. Due to the long warning time associated with design storm tide events (ie up to 48 hours), parking areas located below the design flood level are deemed an acceptable risk as vehicles can be moved to higher ground in extreme events. Parking

areas set at the 20 year ARI level at the site are deemed acceptable since vehicles can be relocated to nearby higher ground on Sutherland Street and elsewhere nearby in high risk events.

A post developed scenario investigating the removal of the Spinifex Hill Water Treatment Plant in the inundation cases assessed for the 2110 climate condition showed there was minimal change to the inundation impacts across the Blaxland site.

3.4.2 Groundwater

A search of DoW's WIN database found a number of bores located in the Spinifex Hill Development Area. However, the data is limited and the most recent monitoring period was conducted approximately 30 years ago. In addition, no groundwater monitoring has been conducted within the area by the TPH (*Pers. Comm.* Butler Henderson, TPH, 25/5/2011).

The geotechnical investigation provided comment on the groundwater levels encountered during cone penetration tests and test pits carried out on 13th - 16th of April 2011. This corresponds to the end of the wet season and is anticipated to provide a good estimate of the maximum groundwater level. Groundwater was only encountered at seven of the 24 test locations, though four of these were observed to be seepage (Douglas Partners 2011). The three test locations that were most likely to have encountered the permanent groundwater level found groundwater at 2.1mBGS to 2.5mBGS, corresponding to groundwater levels of between 1.9mAHD and 2.8mAHD (Douglas Partners 2011).

Douglas Partners (2011) recommended that monitoring wells be installed during other pre-development investigations to determine maximum groundwater levels and seasonal fluctuations. The DoW has also suggested that pre-development groundwater level monitoring is necessary prior to construction works if low flow events are to be retained within underground storage structures (*Pers. Comm.* Peter Kata, DoW, 21/7/2011). Further information regarding proposed monitoring works is given in **Section 8**.

3.5 Environmental Assets

3.5.1 Flora and Fauna

The study area has been cleared of all native vegetation and is characterised by grasses and low lying shrubs. The few trees located within the study area are associated with the Testra exchange building. It is not anticipated that significant native fauna species inhabit the study area due to the lack of significant native habitat and the development's location within an urban area.

3.6 Summary of Existing Environment

In summary, the environmental investigations conducted to date indicate that:

- The study area has been utilised for telecommunications purposes.
- The natural surface height ranges from 11.5mAHD in the north to 3.5mAHD in the south. The gradient at the northern boundary is approximately 10%, whereas the rest of the study area is approximately 2%.
- The dominant soil types are sand or clayey sand/sandy. These clays were found to have a high shrink/swell potential.
- The study area is defined as having "moderate to low risk" of ASS occurring within the first 3m below ground surface. However, neither the screening nor laboratory tests conducted for ASS assessment indicated occurrence of potential or actual ASS in the samples tested.

- Runoff from the study area is directed by overland flow towards the south-west and conveyed along the western and southern boundaries of the Spinifex Hill Water Treatment Plant prior to discharging under Cooke Point Drive (through a culvert) into Pretty Pool.
- Under present (2010) pre-development conditions the study area is not inundated in the 100 year ARI event, but would be inundated in the 100 year and 500 year ARI events for the 2110 planning period.
- No historical groundwater monitoring has been conducted at the study area. During the geotechnical investigation, three test pits were most likely to have encountered the permanent groundwater level. These have a groundwater level of between 1.9mAHD and 2.8mAHD.
- The study area has been cleared of all native vegetation.

4 Design Criteria and Objectives

4.1 Total Water Cycle Management

Total water cycle management recognises the finite limit to a region's water resources, and the inter-relationships between the uses of water and its role in the natural environment. The *State Water Plan* (DoW 2007) endorses the promotion of total water cycle management and application of Water Sensitive Urban Design (WSUD) principles to provide improvement in the management of stormwater, and to increase the efficient use of other existing water supplies. Total water cycle management addresses not only physical and environmental aspects of water resources use and planning, but also integrates other social and economic concerns. Stormwater management design objectives should therefore seek to deliver better outcomes in terms of:

- Non-potable and potable water consumption.
- Stormwater quality management.
- Flood mitigation.

The overall objective for preparing a total water cycle management plan for the proposed residential development is to mitigate flooding, minimise sediment transport and maintain an appropriate water balance. This objective is central to the Blaxland LWMS.

4.2 Water Conservation

The overall aim of total water cycle management includes the sustainable consumption of potable water and consideration of all water sources. Therefore the use of potable water within the development will be minimised wherever possible. The design criteria for water conservation are:

- Ensure efficient use of all water resources in newly developing urban form.
- Minimise the net use of water within households to meet the consumption target of 100kL/person/year (Government of Western Australia 2007).
- Minimise water requirements for the landscaped areas.

4.3 Stormwater Management

The overall guiding document for the development of stormwater management strategies is the *Stormwater Management Manual of Western Australia* (Dow 2007). Of equal importance for this development is the *State Planning Policy No 2.6: State Coastal Planning* (WAPC 2003), which provides guidance to protection of the development from coastal processes.

4.3.1 Stormwater Quality

Water treatment systems and WSUD structures must be designed in accordance with the *Stormwater Management Manual of Western Australia* (DoW 2007) and *Australian Runoff Quality* (Engineers Australia 2006). *Better Urban Water Management* (WAPC 2008) advocates a water quality management principle where existing surface and groundwater quality be maintained at a minimum, and preferably improved prior to discharge from the development area. Through consideration of these guidelines, the primary objective for the Blaxland development is to avoid further deterioration of water quality within receiving water bodies.

The key design criteria that will be adopted to maintain stormwater quality include:

- Treat runoff prior to discharge by detaining low flow events. The first 15mm of rainfall should be retained (this is equivalent to the 1 year 20 minute ARI storm event) (*Pers. Comm.* Peter Kata, DoW, 19/7/2011).
- Apply appropriate structural and non-structural measures to minimise the transportation of sediments off-site and reduce applied nutrient loads.

4.3.2 Stormwater Quantity

Stormwater retention and detention structures must be designed in accordance with the *Stormwater Management Manual of Western Australia* (DoW 2007) and *Australian Rainfall and Runoff* (AR&R) (Engineers Australia 1997). *Better Urban Water Management* (WAPC 2008) advocates a water quantity management principle where pre-development peak flows are maintained in the post-development environment. This principle has not been adopted for this study as detention of stormwater from the large rainfall events experienced in Port Hedland is impractical (*Pers. Comm.* Peter Kata, DoW, 1/6/2011).

Developments along the West Australian coast are required to consider the influence of coastal processes in accordance with the *State Planning Policy No 2.6: State Coastal Planning* (WAPC 2003). It provides guidance to determine the appropriate coastal processes setback distance for the development, taking into account the areas potentially inundated by storm surge. This guidance has been utilised to determine the storm surge level (**Section 3.4.1.2**) and design criteria for the development.

The key design criteria that will be adopted to manage stormwater quantity include:

- Soil at base of soakwells to be replaced with graded gravel if infiltration at source is practical.
- Habitable floor levels to have a clearance of 300mm from the crest of the road reserve.
- Habitable floor levels to be above the 100 year combined flood and storm surge level for the 2110 scenario (i.e. 5.9mAHD) with an additional 500mm freeboard.
- Convey catchment runoff from the the 5 year ARI storm event within roadside drainage.
- Convey catchment runoff from the 100 year ARI storm event within the road reserve and overland flow paths.
- Flooding of Cooke Point Drive due to discharges from the development should be avoided.

4.4 Groundwater Management

The general philosophy for managing groundwater is to minimise changes to the existing system and it is recommended that the Maximum Groundwater Level (MGL) be utilised as the benchmark. The MGL is determined through pre-development groundwater monitoring, which was initially mentioned in **Section 3.4.2** and is detailed further in **Section 8**.

The key design criteria that will be adopted to manage groundwater include:

- Lot levels to have a clearance of 1.2m above the MGL.
- Detention structures to have a clearance of 0.3m above the MGL.

5 Water Conservation Strategy

A residential development will use water within lots (for external and internal uses) and landscaped areas. The total water consumption can be reduced through the water conservation measures discussed in the following sections. The conservation strategy has been designed to meet the objectives and criteria stated in **Section 4.2**.

5.1 Development Scale Water Conservation Measures

5.1.1 Landscaping

Landscaping design and management measures that can be implemented to achieve the design criteria stated in **Section 4.2** are:

- A minimal proportion of the POS areas will be turfed to reduce the annual irrigation demand. The selected turf species will require minimal water and fertiliser.
- POS will be vegetated within local native species to enhance the environmental values of the area.
- All roadside swales are to be revegetated with local planting or minimal lawn where appropriate.

5.1.2 Irrigation

There are a number of irrigation management measures that can be implemented to achieve the design criteria stated in **Section 4.2**:

- The irrigation system shall be designed and installed according to the best water efficient practices. Subterranean drip systems are recommended for garden beds.
- Management of irrigation practices to minimise losses to evaporation (e.g. volume applied is not excessive, timed irrigation to avoid wastage, metered system to monitor for leaks, emitters disperse coarse droplets or are subterranean).

Conservation of potable water through fit-for-purpose use is encouraged so that water is not wasted. The term fit-for-purpose describes the use of water that is of a quality suitable for the required use of the water. Therefore, the irrigation of landscaped areas can be achieved through the use of groundwater from the Pilbara - Alluvial aquifer within the Pilbara Groundwater Area and Ashburton Subarea.

It was assumed that 7,500kL/ha/annum will be required for irrigation of POS areas. However, this rate applies to turfed areas and would decrease to approximately 1,000kL/ha/annum for native garden beds. Therefore, a maximum of 12,705kL/annum will be required to irrigate the 1.7ha POS areas, assuming it was all lawn, which is currently available within this unconfined aquifer (*Pers. Comm.* Chris Parker, DoW, 25/7/2011).

At this stage it is not proposed that POS areas be irrigated with groundwater until the salinity of the groundwater is determined through pre-development monitoring (**Section 8**). Saline groundwater can be utilised for irrigation depending on the salinity and as long as the appropriate species are utilised (e.g. *Papspalum vaginatum*). The detailed landscape plan will be required to determine whether groundwater irrigation would occur and which species would be utilised.

5.2 Lot Scale Water Conservation Measures

5.2.1 Water Efficient Appliances

Significant reductions in in-house water uses can be achieved with the use of water efficient appliances. **Table 1** gives an example of the water uses of typical appliances versus water efficient appliances. These water use rates have been used in the water balance investigation.

Table 1: Water Efficient Appliances

Appliance	Water Consumption (kL/year)	
	Standard Device	Water Efficient Device
Toilet	12 L/flush	4 L/flush
Washing Machine	130 L/wash	40 L/wash
Shower Head	15 - 25L/minute	6 - 7L/minute
Taps	15 - 18L/minute	5 - 6L/minute

The water conservation strategy proposes that all dwellings use water efficient appliances. Water efficient shower heads and tap fittings are already mandated as part of the *Building Code of Australia* (ABCB 2011). However, uptake of the other devices can be encouraged by state and local government rebates, as well as through education from the developers.

5.2.2 Water Efficient Gardens

Studies by the Water Corporation (Water Corporation 2003) have found that for a typical dwelling, 56% of water consumed by the lot is used on gardens. Therefore, reductions in water irrigation by employing water efficient garden measures can significantly reduce the total water usage of the lot. The following water efficiency measures should be used on lot gardens:

- Installing an irrigation system that was designed and installed according to best water efficient practices. The controller must be able to irrigate different zones with different irrigation rates. Emitters must disperse coarse drops or be subterranean.
- Gardens should include large permeable areas such as lawn, gravel, dry creek bed features or swales.
- Limiting the amount of turfed area within the design and consider the use of mulch or gravel as alternatives.
- Garden beds to be mulched to 75mm with a product certified to Australian Standard AS4454.
- It is strongly encouraged that gardens be planted with local plant species.

5.3 Water Balance

A potable water balance was conducted to determine the effectiveness of the water conservation strategy when compared to a standard development without any water conservation measures. Thus the strategies presented in the water balance are:

- Option 1 - Business as Usual (BAU).
- Option 2 - Water Efficient Appliances and Water Efficient Gardens (WEA and WEG).
- Option 3 - Water Efficient Appliances, Water Efficient Gardens and Groundwater irrigation for POS areas (WEA, WEG, GW).

The water balance analysis has been based on the rates and calculation methodology presented in the Water Corporation Spreadsheet *AltWaterSupply_Water_Use_Model.xls*. This spreadsheet has

been adapted to model the effects of using water efficient appliances and gardens within each lot. Rainfall data was sourced from the Bureau of Meteorology for the Port Hedland Airport and household sizes were sourced from the Australian Bureau of Statistics (BoM 2011; ABS 2011). Modelling assumptions regarding land use areas have been described in **Appendix D**. The assumed area of lawn and irrigation rates were provided in **Section 5.1.2**. The potable water consumption for the development is presented in **Table 2**.

The results of the water balance indicate that, on average, a dwelling within the development using WEAs and WEGs, as is proposed, will achieve the target of using less than 100kL/person/year given in **Section 4.2**. It will be the developers' responsibility to inform the lot owners through educational material, at time of sale, about water efficient practices in order to reduce their consumption.

Table 2: Total Potable Water Consumption

Scale	Water Balance Option	Option 1 - BAU	Option 2 - WEA and WEG*	Option 3 - WEA, WEG* and GW
Household Scale	In-house Consumption (ML/year)	82.0	39.0	39.0
	Ex-house Consumption (ML/year)	12.7	8.3	8.3
	Water Required per Capita (kL/person/year)	95.6	47.7	47.7
Development Scale	POS Consumption (ML/year)	12.7	12.7	0
	Total Water Required (ML/year)	107.4	60.0	47.3

*Not all lots are proposed to have gardens. WEGs have only been applied to those lots that do.

6 Stormwater Management Strategy

Surface water runoff will be managed on a development scale. The principles behind the stormwater management strategy are to mitigate flooding and minimise sediment transport by discharging large flows offsite and detaining low flows onsite. Other strategies to minimise sediment transport are also discussed in the following sections. The drainage system has been designed to achieve the objectives and criteria stated in **Section 4.3**.

6.1 Drainage Strategy

The Masterplan (**Appendix A**) was segmented into four proposed hydrological catchments for the post-development environment. Overall, the drainage strategy proposed for this development is to retain a volume equivalent to the first 15mm of rainfall that falls on the development and discharge runoff from the development along existing drainage flow paths (**Figure 4**). The use of existing flow paths through unallocated crown land, which does not disturb surrounding landholders, is a strategy recommended by the DoW. The drainage strategy for each catchment is detailed below. The catchment boundaries and drainage strategy for the study area is shown in **Figure 5**.

6.1.1 Catchments 1 and 2

Runoff from lots and roads within Catchment 1 and 2 will be directed towards underground storage located at the downstream end of either catchment. Runoff will enter these systems via roadside grates and a localised pipe network. Silt traps and drop structures are to be installed beneath the grate system to capture transported sediment. The silt traps will therefore be routinely maintained by removing sediment captured by the system. The silt traps will ensure the capacity of the underground storage units are maintained for the life of the system. It is proposed the underground storage units be located beneath verges, parkland or amenity areas to minimise the loads that each unit would need to be designed for.

These systems are not proposed to retain stormwater runoff from large rainfall events, but will be designed to retain a certain volume. The volume required to be stored by these systems is provided in **Section 6.3**. The detailed design of an underground storage system that provides the required volume will be described within future Urban Water Management Plans (UWMPs), as is discussed in **Section 8**. However, an example system, from one of many suppliers, is provided in **Appendix C**.

Once the underground storage capacity has been exceeded, runoff from Catchment 1 will enter Catchment 3 (and ultimately McGregor Street) and runoff from Catchment 2 will discharge onto Clark Street. A roadside swale will be constructed along Clark Street to direct runoff from the development towards the western boundary of the Spinifex Hill Water Treatment Plant. This will ensure the maintenance of existing flow paths (shown in **Figure 4**).

6.1.2 Catchment 3

Runoff from lots and roads within Catchment 3 flow towards McGregor Street in a sheet flow manner. Roadside swales along McGregor Street will direct flows west towards the intersection of McGregor Street, Clark Street and Tindale Street. The roadside swale will be sized to convey runoff from the 5 year ARI storm event with appropriately sized culverts to be constructed underneath road crossings. This will ensure the roads are trafficable during the 5 year event and adhere to the design criteria in **Section 4.3.2**. Runoff within the roadside swale will be directed towards the western boundary of the Spinifex Hill Water Treatment Plant and along existing flow paths (**Figure 4**).

6.1.3 Catchment 4

Runoff from lots and roads within Catchment 4 will be directed west towards Tindale Street. Similarly to Catchments 1 and 2, underground storage will be located at the downstream end of the catchment. This storage is proposed to be located underneath the road reserve and consequently, the design of this underground storage will be required to consider loads from traffic.

This system is not proposed to retain stormwater runoff from large rainfall events, but will be designed to retain a specified volume (see **Section 6.3**). Once the storage capacity has been exceeded, runoff from Catchment 4 will discharge onto Tindale Street via a drop structure. This drop structure will minimise the erosion and transport of sediment at this location, which will have a relatively steep slope. The roadside swale along Tindale Street will direct runoff towards the western boundary of the Spinifex Hill Water Treatment Plant to ensure the existing flow paths are maintained (shown in **Figure 4**).

6.2 Stormwater Quality Management

Management of erosion and sediment transport within this development must occur at all levels of planning from pre-construction until handover of the POS areas to the TPH. Strategies that will be adopted to minimise erosion and control sediment transport prior to and during construction include:

- Ground disturbance activities will be avoided during intense rainfall events.
- Sediment control devices will be installed prior to construction and may include straw bale barriers, fibre rolls or silt fences.
- Temporary offline sedimentation basins could be utilised to collect fine sediments in the event that drainage from the stage being developed cannot follow the drainage strategy described above (i.e. prior to constructin of roadside swales).
- Revegetation will occur as soon as possible.

In order to refine the strategies that should be utilised at this development, it is recommended that an Erosion and Sediment Control Program be developed for the development as a whole and referenced within future UWMP documents. The Erosion and Sediment Control Program is to be endorsed and regulated by the TPH.

Long-term stormwater quality management within this development will occur within silt traps and roadside swales. The proposed silt traps were discussed in **Section 6.1.1**. Swales are to be revegetated with local plant species or lawn to assist with nutrient stripping and sediment control. Swales will include erosion and sediment control features such as check dams, rock armour baffled drop structures in gullies and catch pits. For example, as was mentioned in **Section 6.1.3**, a drop structure will be utilised to discharge runoff from the development into the swale to minimise potential erosion and sediment transport from the slope.

These strategies meet the design criteria given in **Section 4.3.1**.

6.3 Post-development Modelling

In order to demonstrate the performance of the proposed drainage strategy, hydrological modelling of the post-development environment has been undertaken. An XPSWMM hydrological model was set up to characterise the hydrological behaviour of the post-development environment. The four post-development hydrological catchments are shown in **Figure 5**. Modelling parameters and assumptions are given in **Appendix D**.

6.3.1 Runoff Retention

The design criterion for stormwater management approved by the DoW is to retain the first 15mm of rainfall on the development (**Section 4.3.1**). The volumes required to be retained for the study area is estimated by the model as teh difference between the total rainfall volume falling on each catchment minus the catchment infiltration volume. Based on the infiltration loss parameters chosen for the development, **Table 3** details the volumes required to be retained for the study area.

Table 3: Connected Impervious Area and Storage Volume Requirements

Catchment	Connected Impervious Area (ha)	Storage Volume Requirement (m^3)
1	2.109	295
2	0.909	127
3	1.834	257
4	1.815	254
Total	*6.668*	*934*

The total volume required to be stored within underground storage units across the development is 934m^3. This could be accomplished by a number of systems, such as the Humes StormTrap® system detailed in **Appendix C** and **D**. The example system provides 951m^3 or storage, which is greater than the volume equivalent to the first 15mm of rainfall. Therefore, the drainage design proposed within this LWMS can meet the design criteria given in **Section 4.3.1**.

6.3.2 Conveyance of 5 year Event

The peak flows discharging from the catchments onto the existing road reserves for the critical duration for the 5 year ARI storm event, modelled as 60min, are outlined in **Table 4**.

Table 4: Post-Development 5 year Peak Flow Rates

Catchment	Peak Flows (m^3/s)
1+3	1.644
2	0.401
4	0.790
Existing road reserve	0.844
Total	1.770

Based on the peak flows, nominal roadside swale dimensions required to convey flows, from Catchments 1 and 3, along McGregor Street , and to convey flows ,from Catchment 2, along Clark Street, , are detailed in **Table 5**.

Table 5: Indicative Roadside Swale Designs

Road	Slope	Manning's n	Side Slope	Depth (m)	Cross-section Area (m^2)
McGregor Street	0.030	0.015	1:4	0.75	1.09
Clark Street	0.005	0.015	1:4.5	0.30	0.20

The ocean inundation modelling shows that Cooke Point Drive will not be overtopped in the 5 year ARI storm event. Given the culverts underneath Cooke Point Drive have one way gates on them, the flooding from ocean inundation will only occur from overtopping of Cooke Point Drive. By providing roadside swales consistent with the dimensions detailed above, McGregor Street and Clark Street will remain passable in the 5 year ARI storm event, ensuring that the development is accessible.

6.3.3 Downstream Discharge Flows

The drainage strategy specifies that runoff from the development will follow the existing flow paths and discharge underneath Cook Point Drive via the existing culvert (**Figure 4**). The pre-development catchments were modelled to determine the peak flows and water depths at the culvert in the 100 year ARI storm event. The Cooke Point Drive culverts consist of two 0.825mm circular culverts with one way flood gates on the downstream end (see **Plate 1**). The elevation of Cooke Point Drive is 4.5mAHD. The land use types and areas for the pre-development catchments are provided in **Appendix D**. These land use types and catchments are based on the work undertaken for the *Port Hedland Coastal Vulnerability Study* (Cardno in prep.).

Plate 1: Cooke Point Drive Culverts

Peak flows through these culverts for the 100 year ARI were found to occur in the 1440min duration event. The peak flows and maximum water depths for the pre- and post-development scenarios are shown in **Table 6**.

Table 6: 100 year Peak Flow Rates and Water Depths at Cooke Point Drive Culvert

Land Use Scenario	Peak Flows (m^3/s)	Water Depth (m)
Pre-development	3.48	1.94
Post-development	3.47	1.93

With the retention of the first 15mm of rainfall on the development site, and the fact that the flows through the Cooke Point Drive culverts are generated from a much larger catchment, the post-development peak flows and water depths do not differ from those calculated in the pre-development

scenario. The total rainfall in the 100 year 1440min storm event is 397mm based on the Intensity Frequency Duration (IFD) curve for the Port Hedland area (see **Appendix D**).

The area upstream of Cooke Point Drive will be inundated by the flooding, draining slowly as flows are discharged through the culverts. The model has incorporated the floodplain area to ensure the water depth at the culvert is accurately modelled in the 1D hydrology XPSWMM model. This modelling does not include the storm surge inundation for the 100 year ARI event as the purpose of this section was to determine if Cooke Point Drive is passable in the 100 year event based on the land based flooding. The design of the development therefore ensures the flooding of Cooke Point Drive does not occur from the runoff in the 100 year ARI storm event and hence meets the design criterion given in **Section 4.3.2**.

7 Groundwater Management Strategy

Groundwater underlying the development is expected to range from 1.9mAHD to 2.8mAHD (Douglas Partners 2011). However, this will be refined following completion of the proposed pre-development monitoring program (**Section 8**). The groundwater management design criteria given in **Section 4.4** specified that the underground storage structures are to be installed with a minimum clearance of 0.3m above the MGL. Therefore, it is recommended that the final design of these underground storages be shallow (e.g. 1.5m depth system) instead of utilising the deeper option (e.g. 3m depth system). Utilising a shallow system option will ensure a suitable clearance to the MGL is achieved.

The Masterplan given in **Appendix A** will achieve a 1.2m separation to lots. Firstly, depth to groundwater was found to range from 2.1mBGS to 2.8mAHD (Douglas Partners 2011). Secondly, the recommended habitable floor level of 5.9mAHD (plus 500mm freeboard) is being met through a combination of fill and appropriate building design. For example, three storey walk-ups with undercroft parking below the 5.9 mAHD level can be utilised where only the top two levels are considered habitable. Clearance to the MGL will be confirmed in the UWMP once the monitoring program is complete.

8 Monitoring

8.1 Pre-development Monitoring

Pre-development monitoring will be undertaken at the study area to define the MGL and groundwater salinity if the underground storage strategy is utilised. A twelve month pre-development monitoring program will be undertaken at the study area prior to construction works.

The program will be scheduled to ensure that the annual groundwater peak is captured and is anticipated to occur during the wet season. Four groundwater bores will be installed within the study area and groundwater levels will be monitored on a monthly basis. The proposed location of these bores is shown in **Figure 6**.

A full suite of groundwater quality parameters (i.e. *in situ* physio-chemical parameters, nutrient species, dissolved metals, hydrocarbons and pesticides) will be sampled on one occasion to characterise the groundwater quality and determine whether the salinity of the groundwater is suitable for irrigation.

In the event that underground storage strategy given in Section 6.1 is not utilised to meet the design criteria presented within this LWMS and above ground storage is proposed, a pre-development monitoring program would not be necessary.

8.2 Post-development Monitoring

It is proposed that the overall condition of landscaped areas be monitored on a bi-annual basis from completion of the civil and landscaping works. Condition monitoring will continue for a period of two years to ensure that the high amenity value of the development is maintained prior to handover of the POS areas to the TPH. A visual assessment will be undertaken to monitor POS condition to ascertain that the maintenance activities specified within future UWMPs achieve the objectives of the Management and Maintenance Plan. An example rapid visual assessment sheet is given in **Appendix F**. The parameters that will be monitored and their remedial actions that will be implemented if required are to be detailed in the UWMP.

It is not proposed to conduct a post-development hydrological monitoring program. Given that there are no surface water features or above ground infiltration basins within the study area, it will not be possible to provide a comparison of pre-development and post-development surface water or groundwater quality. Should an alternate drainage strategy be promoted which results in the retention of stormwater above ground (as indicated in **Section 0**), a post-development groundwater level monitoring program will be undertaken to determine the potential for groundwater level rise through the imported fill. This is consistent with the direction provided by the DoW (*Pers. Comm.* Peter Kata, DoW, 1/6/2011).

However, a new drainage strategy (e.g. with above ground storage) will require modification of the proposed post-development monitoring program. Post-development groundwater monitoring would be required to monitor groundwater level rise through the imported sand fill (*Pers. Comm.* Peter Kata, DoW, 17/7/2011). This is to ensure that any basins maintain an adequate clearance to groundwater.

9 Requirements for the Urban Water Management Plan

The requirement to undertake preparation of more detailed water management plans to support subdivision is generally imposed as a condition of subdivision. The development of the UWMP should follow the guidance provided in the *Urban Water Management Plans: Guidelines for Preparing Plans and for Complying with Subdivision Conditions* (DoW 2008).

While strategies have been provided within this LWMS that address planning for water management within the study area, it is a logical progression that future subdivision designs and the supportive UWMP will clarify details not provided within the LWMS. The main areas that will require further clarification within future UWMPs are detailed in the following sections and include:

- Maximum Groundwater Level.
- Final earthwork and habitable floor levels.
- Detailed drainage design.
- Modelling of the local drainage.
- Implementation of water conservations strategies.
- Non-structural water quality improvement measures.
- Management and maintenance requirements.
- Construction period management strategies.
- Monitoring and evaluation program.

9.1 Maximum Groundwater Level

If underground storage is proposed, the pre-development monitoring program described within **Section 8** will be completed prior to construction and the results of this monitoring will be documented within future UWMPs. The MGLs across the study area will also be determined and included. However, pre-development monitoring is not required if fill meets the requirements detailed in **Section 4.3.2** and above ground storage structures are utilised to retain the firm 15mm of rainfall.

9.2 Final Earthwork and Habitable Floor Levels

Nominal invert levels have been provided in the Masterplan (**Appendix A**). However, the final earthwork levels, which have considered the MGLs across the study area, must be provided within future UWMPs.

It is anticipated that lots will meet the 1.2m clearance to MGL.. It will be important to confirm that lots with "walk-up" style houses meet this 1.2m clearance from the MGL. The "walk-up" style features multiple stories where lower levels are below 5.9mAHD (with 500mm freeboard) and only habitable floors are above this level.

9.3 Detailed Drainage Design

While the proposed post-development catchments have been defined based on the current nominal invert levels and the current Masterplan, it is possible that these could undergo some change to accommodate stakeholder feedback prior to final subdivision design.

The exact location and shape of underground storage structures and swales will still need to be specified and presented within the future UWMPs. In order to review the final configurations, the hydrological model that has been developed to support this LWMS may need to be refined and rerun to update the design volumes and flows for these features. It is expected that the storages and swales

will be designed to a level that provides detailed cross-sections, sizes of storage areas, culvert sizes, inverts etc. The ultimate aim of revising the hydrological model will be to confirm that the final detailed drainage design meets the design criteria and drainage strategy presented in this LWMS.

9.4 Modelling of Local Drainage

It is acknowledged that the drainage strategies documented in this LWMS are based upon broad assumptions and data. These assumptions are considered adequate for development of the proposed drainage design and of an appropriate level of detail. However, verification of proposed subdivision drainage designs within the Masterplan should be undertaken by modelling the detailed drainage design. Such modelling will allow verification that development undertaken within the study area is consistent with this LWMS.

9.5 Water Conservation Strategies

A number of potential measures to conserve water have been presented in this LWMS. This LWMS proposed the implementation of Option 2 (i.e. WEAs and WEGs) as is it assumed that the groundwater quality is not suitable for irrigation and hence Option 3 is not viable. However, proposed pre-development groundwater monitoring (**Section 8**) may find that the salinity of groundwater underlying the study area is suitable for irrigation purposes. If this is the case, it is recommended that Option 3 be implemented within the study area. This should be documented within the UWMP. The manner in which the developer intends to promote water conservation measures discussed in this LWMS to future lot owners should also be discussed.

9.6 Non-structural Measures

Guidance for the development and implementation of non-structural water quality improvement measures is provided within the *Stormwater Management Manual for Western Australia* (DoW 2007). Some measures will be more appropriately implemented at a local government level, such as street sweeping, however many can be implemented relatively easily within the design and maintenance of the development and landscaped areas. These measures are expected to be detailed within future UWMPs.

9.7 Management and Maintenance

The management measures to be implemented address surface water quality, such as the use of vegetation in swales, will require ongoing maintenance. It is therefore expected that the future UWMPs will provide detailed management and maintenance plans that will set out maintenance actions (e.g. weeding and removal of trapped sediment), timing (i.e. how often it will occur), locations (i.e. exactly where it will occur) and responsibilities (i.e. who will be responsible for carrying out the actions). Given that approval from the TPH and DoW will be sought for the proposed measures, it is anticipated that consultation with these agencies will be undertaken and referral to guiding policies and documents will be made.

9.8 Construction Period Management Strategy

It is anticipated that the construction stage will require some management of various aspects (e.g. sediment, dust, surface runoff, noise, traffic etc). In particular, sediment transport and dust generation must be minimised during construction works.

Measures to control dust generation during construction may include:

- Not undertaking earthworks during dry, windy conditions.
- Water down cleared areas will occur as necessary during dry dusty periods.
- Covering materials during construction to reduce dust emissions.

Measures to prevent erosion and minimise sediment transport during construction must be documented within an Erosion and Sediment Control Program which is to be endorsed and regulated by the TPH and can include a number of measures stated in **Section 6.2**.

9.9 Monitoring and Evaluation Program

It will be necessary to confirm that the landscaped areas are in a satisfactory condition at handover to the TPH. A monitoring program should be developed to provide this information, and should include details of the objectives of the monitoring program, relevant issues and information, proposed methodology, monitoring frequency and reporting obligations. The post-development monitoring program outlined in **Section 8.2** will be further detailed at the UWMP stage.

10 implementation

The LWMS is a key supportive document for the Masterplan. The development of the LWMS has been undertaken with the intention of providing a structure within which subsequent development can occur. It is also intended to provide overall guidance to the general stormwater management principles for the area and to guide the development of any future UWMP.

10.1 Roles and Responsibility

The LWMS provides a framework that the proponents can utilise to assist in establishing stormwater management methods that have been based upon site-specific investigations and are consistent with relevant state and TPH policies. The responsibility for working within the framework established within the LWMS rests with the proponents, although it is anticipated that future UWMP documents (where required) will be developed in consultation with the TPH and DoW and in consideration of other relevant policies and documents.

It will be the responsibility of the developer to prepare detailed subdivision designs supported by an UWMP and Erosion and Sediment Control Program at the appropriate time (i.e. at subdivision stage). It is also the responsibility of the developer to demonstrate that the proposed subdivision designs, UWMP and Erosion and Sediment Control Program not only comply with the objectives and management approaches provided in the LWMS, but that they are also consistent with the stormwater management strategy given in this LWMS.

10.2 Funding

The study area constitutes three landholdings and three different proponents. It is the responsibility of each proponent to provide funding for the strategies located within their landholding. However, the management strategies outlined in the LWMS that are located beyond either landholding will be borne by the proponents on a pro rata basis.

10.3 Review

The next stage of water management is anticipated to be lot planning through subdivision. Subdivision approvals should be supported by an UWMP. The UWMP is largely an extension of the LWMS, as it should provide detail to the design proposed in this LWMS.

It is recognised that certain elements (e.g. non-structural controls) of the LWMS will not be finalised until subdivision stage, and that there is little to no statutory control that can be applied to ensure the implementation of remaining measures. While the remaining measures are unlikely to be enforced at this stage, their implementation could be encouraged by the TPH through policy (or modification of these where necessary) or awareness programs.

As was stated in **Section 0**, Blaxland Property would be required to resubmit an updated LWMS in the unlikely event that the underground storage strategy is not implemented. The updated LWMS would need to meet the design criteria specified in this document (**Section 4**) and the new drainage strategy would need to provide enough storage to retain the volumes specified in **Table 3**.

11 References

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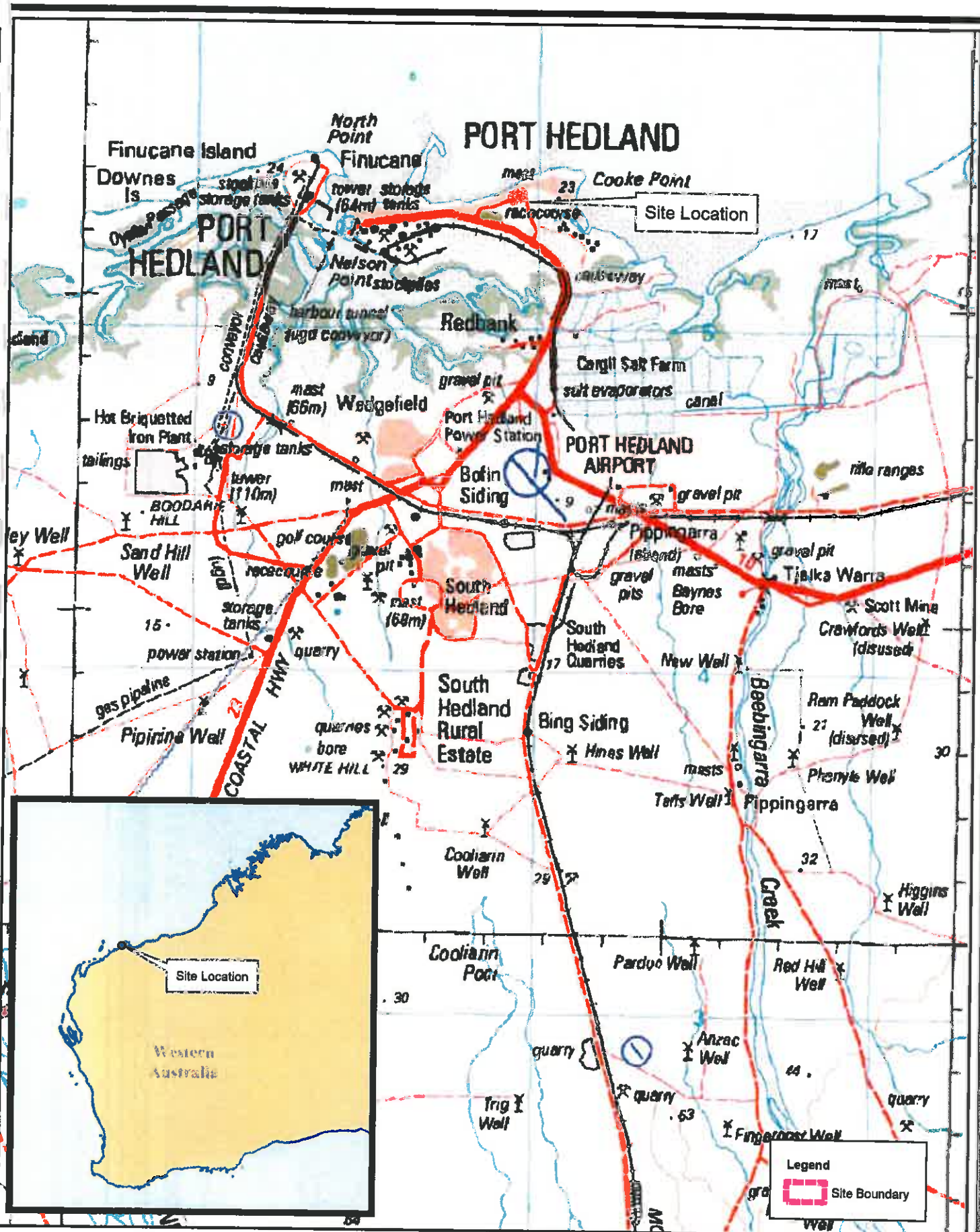
Figures



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

Cardno

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Scale: 1:150,000

0 1 2 4 6 8 10 12 14 Kilometres

PROJECT: Lot 4 Clark St, Lot 20 Clark St & Lot 5474 Thompson St, Port Hedland - LWMS

DRAWING TITLE: FIGURE 1 : Locality Plan

PRINCIPAL: Blaxland Property

Project Number: LJ15028
Original: A4
Drawing Number: SK01
Revision:
Designed: ASC
Checked:
Drawn: MGW
Approved:
Local Authority: Town of Port Hedland
Sheet 1 of 1
Date: 1/08/2011

DATE	No.	ACTIVITY	REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

DATE	No.	ACTIVITY	REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

DATE	No.	ACTIVITY	REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

PROJECT: Lot 4 Clark St, Lot 20 Clark St & Lot 5474 Thompson St, Port Hedland - LWMS

DRAWING TITLE: FIGURE 2 : Study Area Boundary and Topography

PRINCIPAL: Blaxland Property

Scale: 1:6,000

0 50 100 200 300 400 500 600 Metres

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Project Number	Drawing Number	Revision	Original
LJ15028	SK02	00	A4

Designed	ASC	Checked	Date: 1/06/2011
Drawn	MGW	Approved	
Local Authority	Town of Port Hedland		Sheet 1 of 1

DATE	No.	ACTIVITY	REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

DATE	No.	ACTIVITY	REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

DATE	No	ACTIVITY	REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

PROJECT: **Lot 4 Clark St, Lot 20 Clark St & Lot 5474 Thompson St, Port Hedland - LWMS**

DRAWING TITLE: **FIGURE 3 : Acid Sulfate Soil Risk Mapping**

PRINCIPAL: **Blaxland Property**

Scale: 1:6,000

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Project Number	Drawing Number	Revision	Original
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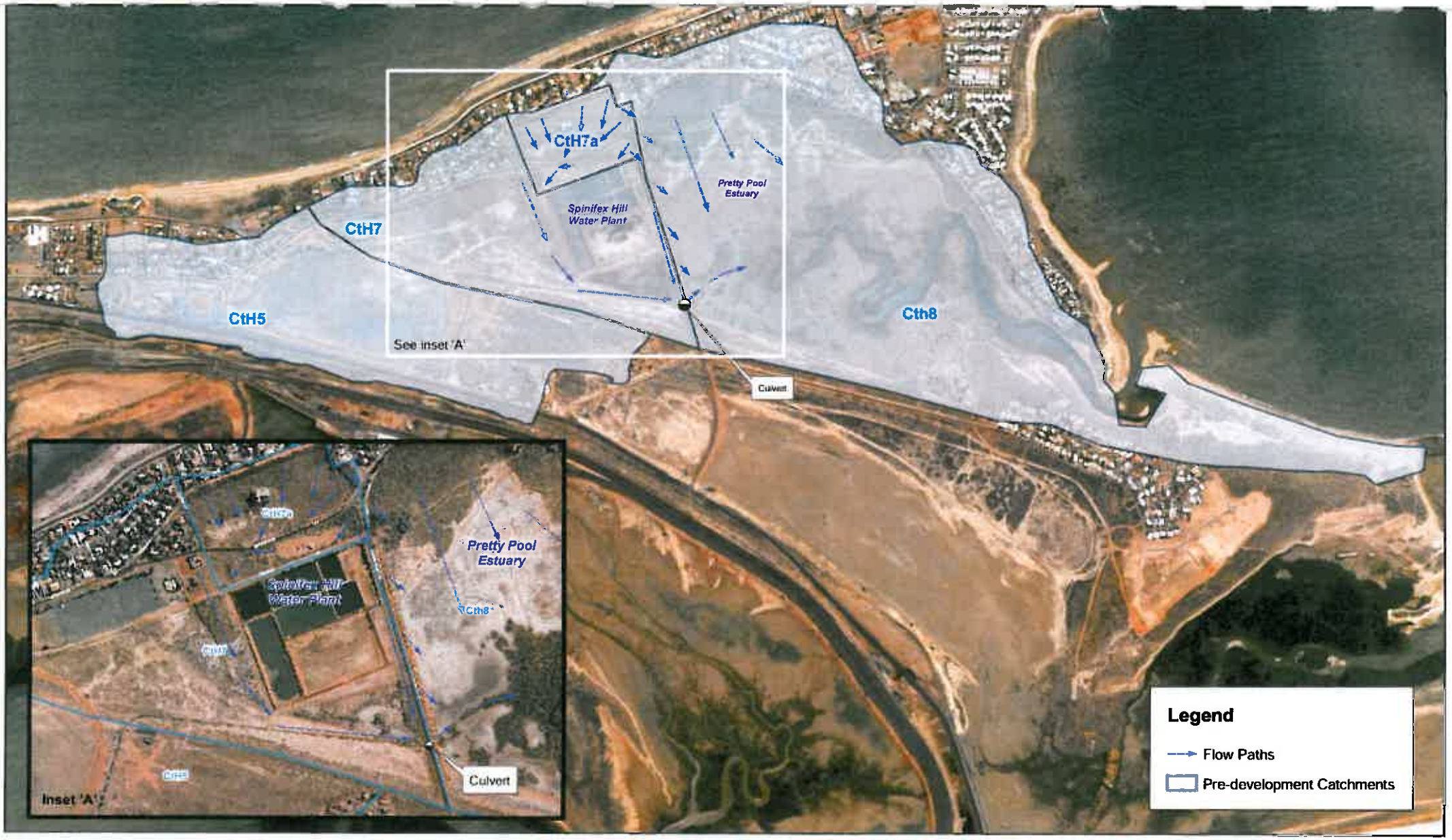
Drawn	MGW	Approved	
Local Authority	Town of Port Hedland		Sheet 1 of 1



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DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

PROJECT: **Lot 4 Clark St, Lot 20 Clark St & Lot 5474 Thompson St, Port Hedland - LWMS**

DRAWING TITLE: **FIGURE 4 : Existing Drainage Characteristics**

PRINCIPAL: **Blaxland Property**

Scale: 1:14,000

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Project Number	Drawing Number	Revision	Original
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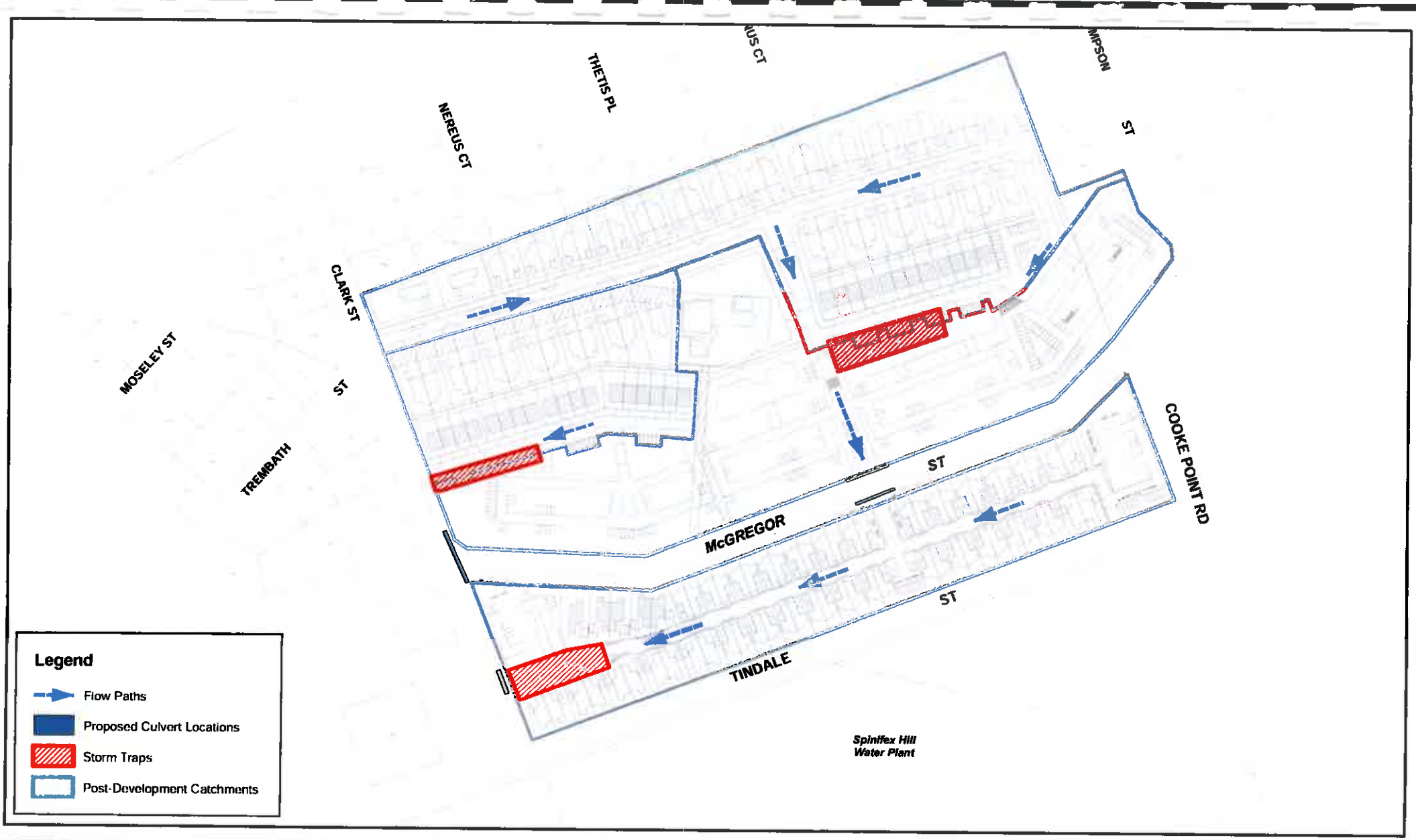
Designed	ASC	Checked	Date: 1/08/2011
Drawn	MGW	Approved	
Local Authority	Town of Port Hedland		Sheet 1 of 1



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DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

PROJECT: **Lot 4 Clark St, Lot 20 Clark St & Lot 5474 Thompson St, Port Hedland - LWMS**

DRAWING TITLE: **FIGURE 5 : Drainage Strategy**

PRINCIPAL: **Blaxland Property**

Scale: 1:3,000

0 50 100 200 300 Metres

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Project Number	Drawing Number	Revision	Original
WA15028	SK05	00	A4

Designed: ASC | Checked: | Date: 14/08/2011
Drawn: MGW | Approved:
Local Authority: Town of Port Hedland
Sheet 1 of 1

DATE	No	ACTIVITY	REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

DATE	No	ACTIVITY	REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

DATE	No	ACTIVITY	REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D

PROJECT: Lot 4 Clark St, Lot 20 Clark St & Lot 5474 Thompson St, Port Hedland - LWMS

DRAWING TITLE: FIGURE 6 : Proposed Pre-development Monitoring Locations

PRINCIPAL: Blaxland Property

Scale: 1:6,000

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Project Number	Drawing Number	Revision	Original
LJ15028	SK06	00	A4

Designed: ASC | Checked: | Date: 1/08/2011
Drawn: MGW | Approved:
Local Authority: Town of Port Hedland | Sheet 1 of 1

Land Water Management Strategy (LWMS) - Appendices

PLEASE NOTE: Several of the below appendices are duplicated in this Development Plan report. Full copies of the LWMS (and all of its appendices) will be forwarded to Council under separate cover. These appendices include:

Appendix A Masterplan

Appendix B Geotechnical Investigation

Appendix C Humes Storm Trap Design

Appendix D Modelling Methodology & Results

Appendix E Communications with DoW

Appendix F Rapid Visual Assessment Sheet

Appendix 4 – Traffic Report

PROPOSED REZONING
LOTS 2 MCGREGOR STREET & 5474 THOMPSON STREET, PORT HEDLAND

TRAFFIC REPORT - REVISED

Proposed Rezoning

Lots 2 McGregor Street & 5474 Thompson Street, Port Hedland

Traffic Report
Revised

Prepared for:
Blaxland Pty Ltd

July 2011

Prepared by:
TRANSCORE PTY LTD
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Document history and status

Author	Version	Approved by	Date	Version type
V Baltic	r01	B Bordbar	13/07/2011	First draft
V Baltic	r01a	B Bordbar	14/07/2011	Second draft
V Baltic	r01b	B Bordbar	21/07/2011	Final

File name: t11.098a.vb.r01b.doc

Author: Vladimir Baltic

Project manager: Behnam Bordbar

Client: Blaxland Pty Ltd

Name of project: Lots 2 McGregor Street & 5474 Thompson Street, Port Hedland

Document version: r01b

Project number: t11.098a

TABLE OF CONTENTS

1. INTRODUCTION

This traffic report has been prepared by Transcore, on behalf of Blaxland Pty Ltd with regard to the rezoning applications and the proposed development plan for the "Telstra Site" - Lots 2 McGregor Street & 5474 Thompson Street in Spinifex Hill, Port Hedland (subject site). The rezoning application entails a proposed change from existing zoning into residential/urban.

The original traffic report for the proposed subdivision was prepared in November 2010. The proponent has subsequently amended the development plans to introduce changes to the internal subdivision layout, access system and housing stock. Total dwelling yield has since been reduced from 526 to 307 units. Accordingly, the proposed changes warranted a revision of the original traffic report.

The subject area is bounded by McGregor Street to the south, Clark Street to the west, (part of) Thompson Street to the east and the existing residential area to the north. Total subject area is approximately 8ha in size. Refer **Figure 1** for details.

Figure 1. Aerial photo of the subject site

This report aims to assess the impact of the proposed change of zoning with respect to traffic generation upon the adjacent road network and to identify any road network and traffic management improvements that may be required to accommodate the additional traffic. This report has been prepared in consultation with the Town of Port Hedland.

2. PROPOSED SITUATION

According to the information provided by Blaxland Pty Ltd, the proposed rezoning application for the subject area includes redevelopment of the property into a residential subdivision comprising a mix of low, medium and high density residential lots. Total yield for this development is 307 dwellings.

The development proposal intends to retain existing Telstra exchange complex and integrate it into the subdivision design.

The proposed internal subdivision road system takes access from the external road system via three access points, with a pair of access points located on Clark Street and a single access point on McGregor Street.

Access on McGregor Street is located approximately 250m east of McGregor Street/Clark Street intersection, while Clark Street access points are proposed 55m and 110m north of McGregor Street/Clark Street intersection.

The entry into the development from McGregor Street access point is initially proposed to take form of a 3-way roundabout intersection. The fourth (southern) leg of the intersection is reserved as a potential access road into the future development south of McGregor Street. The proposed roundabout will act to regulate the traffic at this intersection as well as control the speed of traffic along this section of McGregor Street.

The northern Clark Street access forms a staggered intersection with the existing Trembath Street/Clark Street T-intersection. The section of Clark Street south of McGregor is currently unmade road; however, this rezoning application allows (land) for the future upgrading of McGregor Street/Clark Street intersection into a four-way roundabout.

Refer to the proposed concept plan (drawing number: 1211 SK134 issue 03) from June 2011 prepared by KT Architects (**Appendix A**).

3. EXISTING SITUATION

The rezoning application is for the "Telstra's Site" located in Spinifex Hill, approximately 4.5km east of the Port Hedland town centre. It is bounded by McGregor Street to the south, Clark Street to the west and Thompson Street (part of) to the east. The areas surrounding the subject site to the west, north and east are existing residential uses, while the land to the south is the Water Corporation Effluent Water Ponds site (EWP), which is earmarked for future residential development.

Telstra's office complex is located centrally within the subject site with the reminder of the area vacant. This locality is also illustrated in **Figure 3.**

Figure 2. The subject site

McGregor Street is an undivided two-lane two-way road, with a pavement width of approximately 7m, road reserve of 20m and operating under a speed limit of 60km/hr. A concrete pedestrian footpath is in place along the northern verge of McGregor Street at this location.

According to Main Roads WA *Functional Road Hierarchy* this road is classified as a *Local Distributor* road and as such intended to carry maximum desirable traffic volume of 6,000 vehicles per day (vpd).

Traffic count information provided by Main Roads WA states that McGregor Street (west of Crawford Street) carried approximately AWT 5,060vpd in May 2009. It is however estimated that the traffic volumes in the immediate vicinity of the subject site are somewhat lower and most likely at the level of 4,500vpd.

Clark Street is a typical residential single carriageway road with a pavement width of approximately 6m and operating under speed limit of 50km/h. It entails a concrete footpath along its eastern verge. According to Main Roads WA *Functional Road Hierarchy*, this road is classified as *Access Road* designed to carry traffic volumes of up to 3,000vpd. There is no traffic count information available for this road; however, based on its location it is estimated that Clark Street presently carries up to 300vpd.

McGregor Street and Clark Street form a priority-controlled T-intersection with Clark Street terminating on its southbound approach. There are no crash records available for this intersection.

McGregor Street forms a 3-way roundabout intersection with Cooke Point Drive and Athol Street near the southeast corner of the subject site. According to the intersection crash report sourced from Main Roads WA for the 5-year period to December 2009, this intersection experienced a total of 5 crashes with no casualty. Two of the five crashes occurred during wet and night-time conditions. It is ranked 3,023rd in the State Frequency Rank.

4. TRAFFIC ASSESSMENT

This section of the report provides an estimation of the traffic expected to be generated by the proposed rezoning and the residential subdivision and assesses the potential impact of this traffic on the immediate road network at the locality. An assessment of the internal subdivision road hierarchy and the road reservation requirements will also from part of this assessment.

4.1 Traffic Generation and Distribution

In order to assess the traffic impact from the proposed residential subdivision onto the abutting road network a traffic generation and distribution exercise was undertaken.

To estimate the future traffic that would be generated from the proposed development, the document *"Guide to Traffic Generating Developments, Roads and Traffic Authority NSW, 2002 (RTA-NSW)"* was sourced. This document proposes a variety of trip generation rates for different types of the residential dwellings which range from 3 to 9 trips per dwelling per day. However, in order to provide for a robust assessment an average rate of 6 trips per day is adopted for this residential subdivision.

Accordingly, the proposed residential development is estimated to generate approximately **1,840** total daily vehicular trips (inbound and outbound combined) for a typical weekday.

Based on the actual location of the subject site, the existing road network at this locality and the local attractions, the following assumptions were made for the distribution and assignment of the subdivision-generated traffic:

- Approximately 60% of the traffic generated from the subject site would travel to/from the west;
- Approximately 40% of the traffic generated from the subject site would travel to/from the east;

Accordingly the anticipated total daily traffic for the internal subdivision and external road network (existing plus subdivision traffic) are illustrated in **Figure 3.**

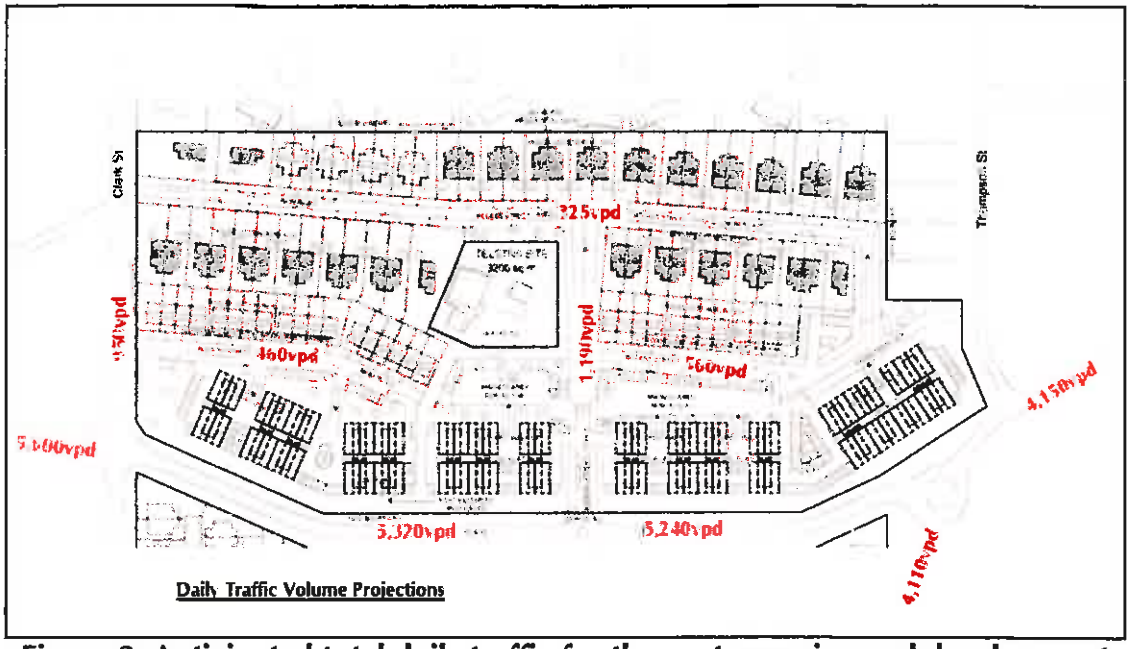


Figure 3. Anticipated total daily traffic for the post rezoning and development period

The analysis undertaken in this report demonstrates that the anticipated traffic from the proposed rezoning of the subject site would impact the immediate road network at this locality as following:

- The estimated ultimate daily traffic volume on McGregor Street will generally be within the desirable capacity for *Local Distributor* class of road. The total daily traffic will not exceed the projected threshold for this type of road;
- The projected traffic volumes on McGregor Street in the vicinity of the subject site do not warrant re-classification of this road to *District Distributor* standard (traffic volume range of 6,000vpd to 8,000vpd) and upgrading of this road; however, as other developments occur in the area and traffic volumes increase further, it is suggested that McGregor Street should be reclassified and upgraded accordingly.
- The traffic volume on Clark Street will increase to 950vpd, which is well within the desirable threshold for the *Access Road* class and with ample spare capacity for future growth.

4.2 Intersection Capacity Analysis

At-grade, unsignalised intersections rely on gap selection for the entry of minor road traffic into or across the major road and for right-turn movements from the major road. As such, high conflicting movements directly impact on the overall performance of the intersection, resulting in increased delays, queuing and risk of crashes. It is therefore important to assess the capacity of relevant intersections to ensure the anticipated traffic volumes can be accommodated.

Reference to Table 2.4 from AUSTROADS *"Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings"* document illustrates the traffic volume thresholds above which a detailed intersection capacity assessment is required to confirm that adequate capacity is in fact available (refer **Table 1**). However, it is considered that sufficient capacity is available if the anticipated traffic volumes through intersections are below the indicative thresholds in which case a detailed capacity assessment is not required.

Major Road type	Major Road Flow (vph[1])	Minor Road Flow (vph)
Two-lane	400	250
	500	200
	650	100
Four-lane	1,000	100
	1,500	50
	2,000	25

Table 1. Traffic volume threshold for detailed intersection analysis

Assuming that typical peak hour traffic represents approximately 10% of the total daily traffic volume, it is confirmed that uninterrupted traffic flow conditions can be expected at all key internal subdivision intersections and that detailed assessment or capacity analysis is not warranted (refer **Figure 3** for internal subdivision roads daily traffic projections). It is further confirmed that the internal subdivision road network layout ensures efficient traffic distribution throughout the development with no bottlenecks or traffic congestion.

Similarly, it is established that uninterrupted traffic flow conditions can be expected at both external subdivision intersections on Clark Street and McGregor Street. Furthermore, the proposed 3-way roundabout at McGregor Street/Subdivision Access Road is anticipated to operate satisfactorily and provide speed management along the McGregor Street and subdivision entry road.

4.3 Internal Subdivision Road Network

The projected traffic volumes on the internal subdivision road network were used to determine the road hierarchy and the required road reservations within the subject site.

The analysis shows that, in accordance with the WAPC *"Liveable Neighbourhoods"* document, all internal subdivision roads can be classified either as *Access Streets C* or *Access Streets D* with typical road reservations of 15.4m and 14.2m, respectively.

The typical road reserve for *Access Street C* entails a 7.2m wide road pavement with the 4.1m wide verges on both sides. These streets are designed to carry up

[1] *vph – vehicles per hour, typically represent 10% of total daily traffic volume*

to 3,000vpd. The typical cross-section of the *Access Street C* is illustrated in **Figure 4.**

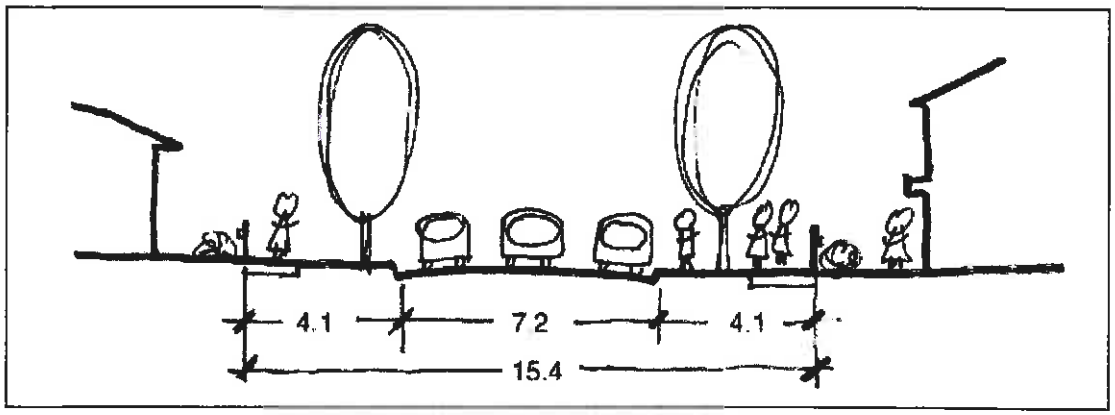


Figure 4. Access Street C – yield or give way street with target speed of 40 km/hr (<3,000vpd)

The typical road reserve for *Access Street D* entails a 6m wide road pavement with the 4.1m wide verges on both sides. As such, maximum desirable traffic volume for this type of streets is 1,000vpd. The typical cross-section of the *Access Street D* is illustrated in **Figure 5.**

Narrower access streets are typically intended for shorter lengths and low parking demand. When fronting P.O.S., access street verges may be reduced to 1.0m effectively reducing the road reserve to 11.1m. Low speed environment enables on street cycling; however, in this case a principal shared path (PSP) is proposed along the western side of this street as it provides access to the recreational facilities. The subdivision PSP should connect at its southern end to the external pedestrian path on McGregor Street which should be upgraded to PSP standard along the subdivision frontage.

Visitor on-street parking for high density sites should be provided on internal subdivision roads, preferably in the form of indented parking bays and parking lots.

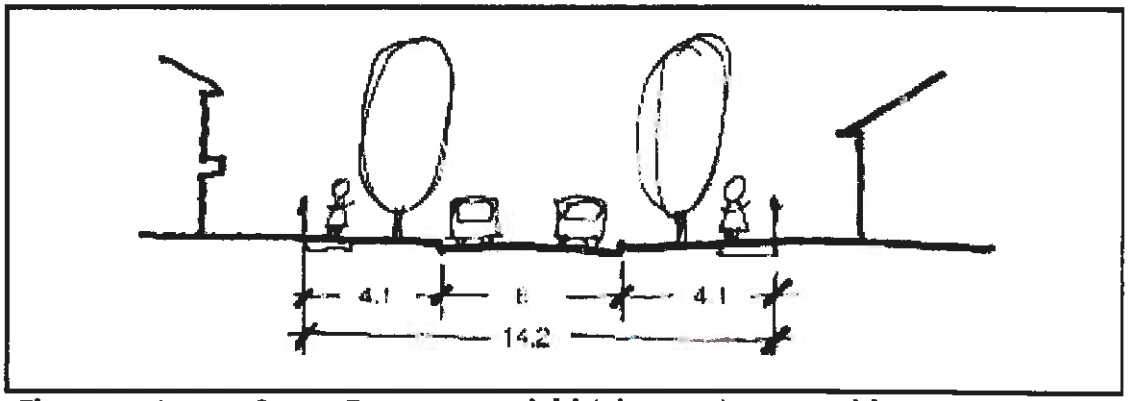


Figure 5. Access Street D – narrow yield (give way) street with target speed of 30 km/hr (<1,000vpd)

The design and standard of internal subdivision roads should be such that safe access and operation of the service vehicles within the subdivision is ensured. The proposed internal subdivision road classification is illustrated in **Figure 6.**

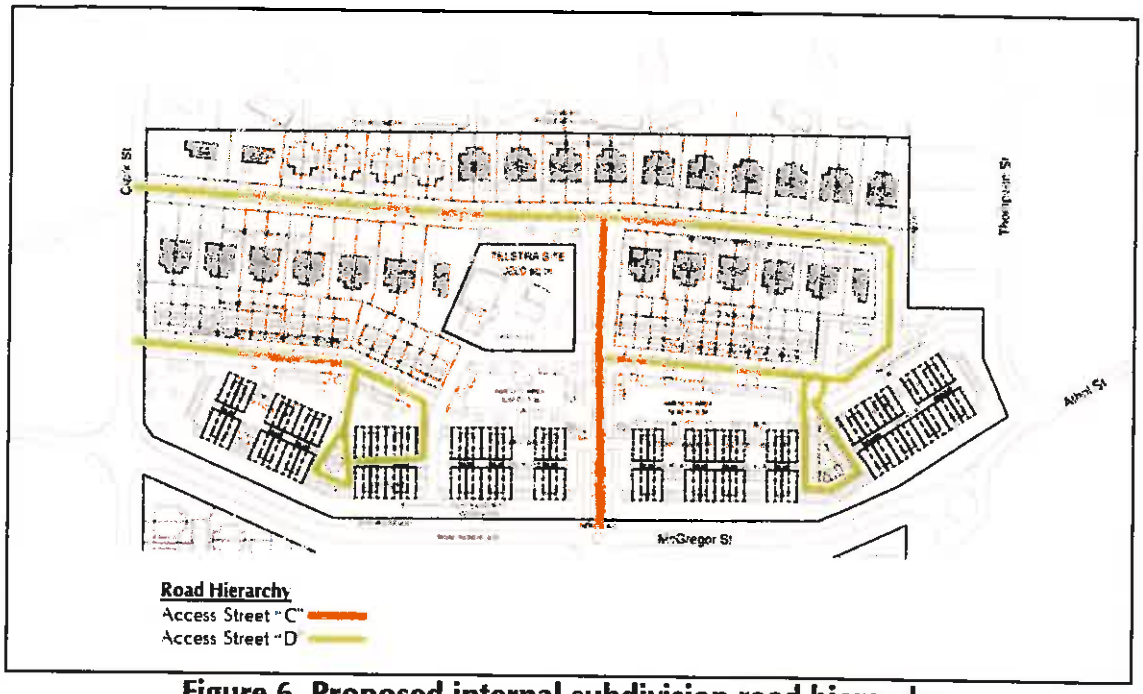


Figure 6. Proposed internal subdivision road hierarchy

4.4 Pedestrian Network

The pedestrian connectivity of the proposed subdivision is achieved through integration with existing external footpath system at this location. Accordingly, external connections to existing pedestrian facilities on Clark Street, Thompson Street and McGregor Street are proposed. As part of the proposed pedestrian/cyclist system for the subdivision, it is proposed that the existing footpath on the northern verge of McGregor Street be upgraded to shared path standard.

5. CONCLUSIONS

This Traffic Report has been prepared by Transcore on behalf of Watson Properties in support of the proposed rezoning application and the proposed structure plan the for the Lots 2 McGregor Street & 5474 Thompson Street in Spinifex Hill, Town of Port Hedland.

The proponent intends to redevelop the subject site into a residential subdivision comprising a mix of low, medium and high density residential lots. Total yield for this development is 307 dwellings.

Accordingly, the proposed residential subdivision is estimated to generate approximately **1,840** total daily vehicular trips (both inbound and outbound) for a typical weekday.

The traffic assessment for the post-development stage of the project confirmed that anticipated traffic volumes on the abutting roads are within the desirable thresholds for the relevant road classifications. As such, no upgrades are required for McGregor Street or Clark Street which will continue to operate with some spare capacity in the post-development stage.

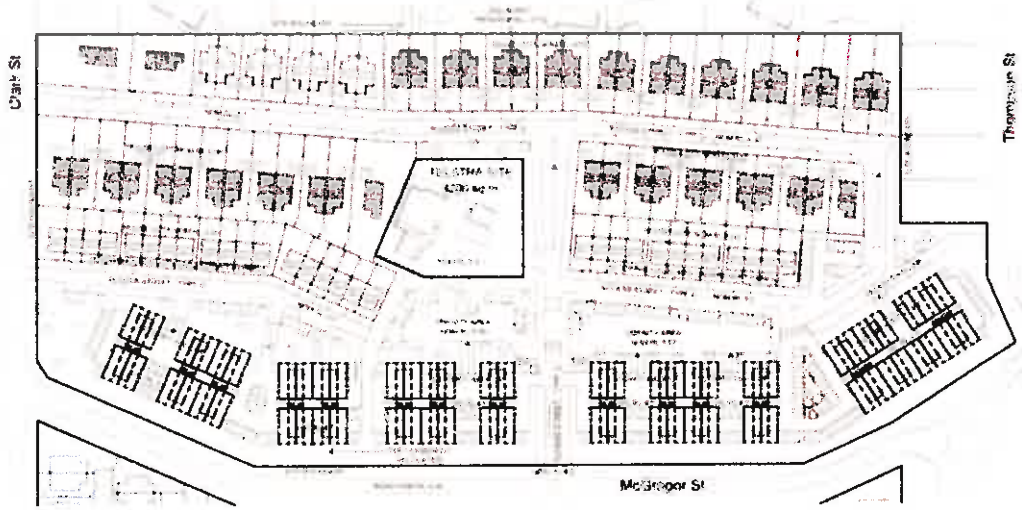
The proposed 3-way roundabout at McGregor Street/Subdivision Access Road is anticipated to operate satisfactory and provide speed management along the McGregor Street and subdivision entry.

However, the following traffic management measures/road network upgrades are proposed to be implemented so to improve the traffic operation and safety at this location during the post-development stage:

- Upgrade the existing footpath along northern verge of McGregor Street to a PSP standard;
- Ensure subdivision design includes corner truncations at McGregor Street/Clark Street intersection to provide for future upgrade of this intersection to a roundabout standard;
- Ensure that sufficient parking supply within the development is provided to match anticipated demand so that all parking is catered for within the development and there is no negative impact on the operations of the external road network;
- Sometime in the future and as a result of other major developments in the area, consideration should be given to re-classify McGregor Street to *District Distributor* standard with implementation of the necessary upgrades to accommodate the anticipated future traffic volumes.

APPENDIX A

Subdivision Concept Plan



ACCESS STREET TYPES

TYPE C - 15.4m WIDE - 7.2m CARRIAGE WAY WITH 4.1m WIDE LANDSCAPE / PAVEMENT EITHER SIDES (ALLOWS FREQUENT ON-STREET PARKING)
TYPE D - 14.2M WIDE - 6.0m CARRIAGE WAY WITH 4.1m WIDE LANDSCAPE / PAVEMENT EITHER SIDES

RESIDENT CAR PARKING SPACES	REQUIRED	PROVIDED
HOUSES	[illegible]	[illegible]
3 STOREY WALK-UPS	[illegible]	204
5 STOREY LIFT UP	154	157

VISITOR CAR PARKING SPACES	REQUIRED	PROVIDED ON-STREET
HOUSES	17	17
3 STOREY WALK UPS	29	29
5 STOREY LIFT UP	16	12

LEGEND

- EASEMENT ZONE
- 4 BED HOUSE
- 4 BED TOWN HOUSE
- 3 BED HOUSE

SCHEME YIELD:

4 BED HOUSES	= 46	- 15% APPROX
4 BED TOWNHOUSES	= 29	- 10% APPROX
3 BED HOUSES	= 08	- 3% APPROX
3 STOREY WALK-UPS	= 144	- 46% APPROX
5 STOREY LIFT UP	= 78	- 25% APPROX
TOTAL DWELLINGS	= 307	

PORT HEDLAND MASTERPLAN

OPTION K.2
LOW RISE (HOUSES, WALK-UPS & 5 STOREY LIFT UP)

blaxland

kda

1211 SK134 05

A1

Appendix 5 – Traffic Technical Note 1

transcore pty ltd

Technical Note: No 1 **Date:** 28/07/2011
Project No: t11.098
Project: Telstra Site & Tindale Street Developments, Port Hedland

Subject: Port Hedland/Cooke Point Drive Intersection Assessment

INTRODUCTON

Transcore has been commissioned by Blaxland Pty Ltd to prepare Traffic Reports for the proposed Telstra Site and Tindale Street residential subdivisions as part of the rezoning application for the subject sites. Accordingly, Transcore prepared traffic reports for previous development options for these sites in November 2010. In their response to the rezoning application (letter from 05 May 2011, Ref: 06/3513-04) Main Roads WA requested that, as part of the traffic assessment for the proposed developments, a detailed capacity assessment of the Port Hedland/Cooke Point Drive intersection in Port Hedland be undertaken to assess the impact from the proposed developments on this intersection.

Hence the purpose of this technical note is to estimate the combined traffic impact from the residential developments resulting from the proposed rezoning on Port Hedland/Cooke Point Drive intersection and assess the capacity of this intersection to accommodate the additional traffic. Refer **Figure 1** for locality plan.

Figure 1. Aerial photo of the locality

EXISTING SITUATION

The Port Hedland Road/Cooke Point Drive intersection is located approximately 5km southeast of the Port Hedland town centre (refer **Figure 1**).

Port Hedland Road is an important link in the local road network connecting Port Hedland and South Hedland town sites. It is also a major heavy haulage route providing access to Port Hedland port. This road is currently is a single carriageway with a pavement width of approximately 8m. There are wide gravel shoulders on both sides of this road. According to Main Roads WA *Functional Road Hierarchy* it is classified as a *Primary Distributor*. At this location, Port Hedland Road operates under 110km/h speed limit.

Cooke Point Drive provides a link between Port Hedland Road and residential areas at the east end of Port Hedland town site. This road is a single carriageway with a pavement width of approximately 7m. This road also entails wide gravel shoulders on both sides. According to Main Roads WA *Functional Road Hierarchy* it is classified as a *Local Distributor*. At this location, Cooke Point Drive operates under 80km/h speed limit.

The latest available traffic count data sourced from Main Roads WA and Town of Port Hedland for Port Hedland Road and Cooke Point Drive in the vicinity of the subject intersection is shown in **Table 1**.

Road Section	Date	AWT[1]	HV%	Source
Port Hedland Rd (E of Cooke Point Dr)	24/9/2007	12,921	13.6	MRWA
Port Hedland Rd (W of Cooke Point Dr)	24/9/2009	10,615	11.4	MRWA
Cooke Point Dr (N of Port Hedland Rd)	9/3/2011	4,002	6.3	ToPH

Table 1. Traffic count data for relevant roads

Port Hedland Road and Cooke Point Drive form a priority-controlled, partially channelised T-intersection with Cooke Point Drive terminating at its southern approach to the intersection. This intersection is designed as a Channelised Right Turn (CHR) Type rural intersection with a 150m right-turn pocket on Port Hedland Road (westbound direction). Cooke Point Drive flares on its approach to the intersection.

Due to the relatively flat terrain at this locality available sightlines on all approaches to the intersection are satisfactory with no impediments.

[1] AWT – Average Weekday Traffic (vehicles)

transcore pty ltd

INTERSECTION ANALYSIS

In order to assess existing and future traffic conditions of Port Hedland Road/Cooke Point Drive intersection, existing morning and afternoon peak hour traffic volumes were derived from the relevant traffic count data sourced from Main Roads WA and Town of Port Hedland.

As available traffic count data reports only combined total daily traffic flows (no directional split), *Furness method* was applied to derive peak hour turn volumes from daily volumes. Additionally, further adjustments were made to reflect the typical peak directional traffic split. It should be noted that, morning and afternoon peak hours for the two roads do not coincide; however, in order to allow for a robust assessment it is assumed that peak periods for both roads fall within the same hour.

Furthermore, as traffic count data for Port Hedland Road dates back to 2007 and 2009, a default growth factor of 2% per annum was applied to estimate 2011 traffic volumes for this road. Accordingly, the estimated morning and afternoon peak hour volumes at the Port Hedland Rd/Cooke Point Dr intersection are shown in **Figure 2.**

The anticipated combined traffic impact of the proposed residential developments at Telstra Site and Tindale Street on the Port Hedland Road/Cooke Point Drive intersection is estimated to be in order of approximately 720 vehicles per day. Assuming a typical 10% factor for peak hour traffic, it is estimated that the proposed residential developments would generate approximately 72 vehicle trips through this intersection in the morning and afternoon peak hour periods respectively. **Figure 3** illustrates projected traffic volumes for the post-development period with inclusion of the additional traffic from the Telstra Site and Tindale Street developments.

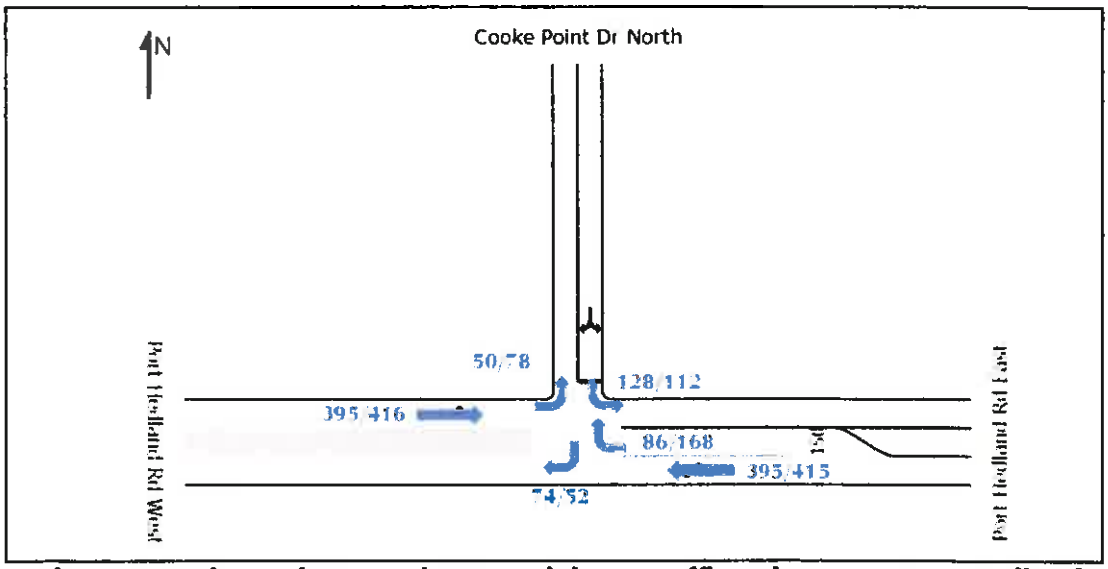


Figure 2. Estimated AM and PM peak hour traffic volumes at Port Hedland Road/Cooke Point Drive intersection - existing

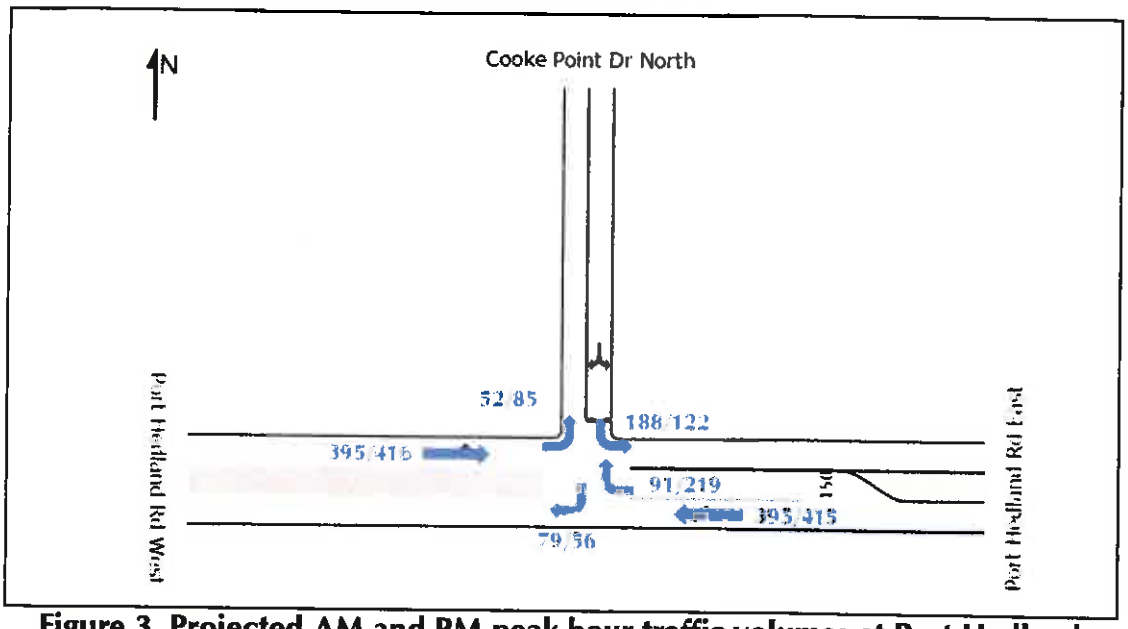


Figure 3. Projected AM and PM peak hour traffic volumes at Port Hedland Road/Cooke Point Drive intersection – post development

The capacity analysis of the Port Hedland Road/Cooke Point Drive intersection, during the peak weekday morning and afternoon peak period, was undertaken using the SIDRA intersection-modelling software. Heavy vehicle factor used in SIDRA analysis was derived from the Main Roads and ToPH traffic count data.

SIDRA is an intersection-modelling tool commonly used by traffic engineers for all types of intersections. SIDRA outputs are presented in the form of Degree of Saturation, Level of Service, Average Delay and 95% Queue. These characteristics are defined as follows:

- **Degree of Saturation**: is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The Degree of Saturation ranges from close to zero for varied traffic flow up to one for saturated flow or capacity.
- **Level of Service**: is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of service, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).
- **Average Delay**: is the average of all travel time delays for vehicles through the intersection.
- **95% Queue**: is the queue length below which 95% of all observed queue lengths fall.

The existing and post-development SIDRA results for the Port Hedland Road/Cooke Point Drive intersection are shown in **Tables 3** to **6.**

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Port Hedland Rd East											
11	T	416	6.3	0.222	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
12	R	91	6.3	0.085	15.4	LOS C	0.4	2.7	0.51	0.79	63.9
Approach		506	6.3	0.222	2.7	NA	0.4	2.7	0.09	0.14	99.5
North: Cooke Point Dr North											
1	L	135	6.3	0.303	16.2	LOS C	1.3	9.6	0.59	0.86	60.1
3	R	78	6.3	0.303	16.0	LOS C	1.3	9.6	0.59	0.92	60.6
Approach		213	6.3	0.303	16.1	LOS C	1.3	9.6	0.59	0.89	60.3
West: Port Hedland Rd West											
4	L	53	6.3	0.259	13.5	LOS B	0.0	0.0	0.00	2.04	67.2
5	T	416	12.0	0.259	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
Approach		468	11.4	0.259	1.5	NA	0.0	0.0	0.00	0.23	104.0
All Vehicles		1187	8.3	0.303	4.7	NA	1.3	9.6	0.14	0.31	90.4

Table 3. SIDRA results for Port Hedland Road/Cooke Point Drive intersection – AM peak existing

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Port Hedland Rd East											
11	T	437	6.3	0.233	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
12	R	177	6.3	0.179	15.9	LOS C	0.8	5.7	0.56	0.84	62.0
Approach		614	6.3	0.233	4.6	NA	0.8	5.7	0.16	0.24	93.2
North: Cooke Point Dr North											
1	L	118	6.3	0.267	16.5	LOS C	1.1	8.0	0.60	0.87	59.8
3	R	55	6.3	0.267	16.3	LOS C	1.1	8.0	0.60	0.92	60.3
Approach		173	6.3	0.267	16.4	LOS C	1.1	8.0	0.60	0.88	59.9
West: Port Hedland Rd West											
4	L	82	6.3	0.268	13.5	LOS B	0.0	0.0	0.00	1.83	67.2
5	T	438	12.0	0.268	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
Approach		520	11.1	0.268	2.1	NA	0.0	0.0	0.00	0.29	101.6
All Vehicles		1306	8.2	0.268	5.2	NA	1.1	8.0	0.16	0.35	89.4

Table 4. SIDRA results for Port Hedland Road/Cooke Point Drive intersection – PM peak existing

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Port Hedland Rd East											
11	T	416	6.3	0.222	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
12	R	96	6.3	0.091	15.4	LOS C	0.4	2.8	0.51	0.79	63.0
Approach		512	6.3	0.222	2.9	NA	0.4	2.8	0.10	0.15	99.0
North: Cooke Point Dr North											
1	L	198	6.3	0.379	16.4	LOS C	1.9	14.2	0.60	0.91	59.9
3	R	83	6.3	0.379	16.2	LOS C	1.9	14.2	0.60	0.95	60.3
Approach		281	6.3	0.379	16.4	LOS C	1.9	14.2	0.60	0.92	60.0
West: Port Hedland Rd West											
4	L	55	6.3	0.261	13.5	LOS B	0.0	0.0	0.00	2.02	67.2
5	T	416	12.0	0.261	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
Approach		471	11.3	0.261	1.6	NA	0.0	0.0	0.00	0.23	103.6
All Vehicles		1263	8.2	0.379	5.4	NA	1.9	14.2	0.17	0.35	87.6

Table 5. SIDRA results for Port Hedland Road/Cooke Point Drive intersection – AM peak post-development

Movement Performance - Vehicles											
Mov ID	Turn	Demand Flow veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
East: Port Hedland Rd East											
11	T	437	6.3	0.233	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
12	R	231	6.3	0.235	16.1	LOS C	1.1	7.8	0.58	0.86	62.7
Approach		667	6.3	0.235	5.6	NA	1.1	7.8	0.20	0.30	90.0
North: Cooke Point Dr North											
1	L	128	6.3	0.302	17.1	LOS C	1.3	9.5	0.61	0.89	59.0
3	R	59	6.3	0.302	16.9	LOS C	1.3	9.5	0.61	0.83	59.5
Approach		187	6.3	0.302	17.1	LOS C	1.3	9.5	0.61	0.91	59.2
West: Port Hedland Rd West											
4	L	89	6.3	0.282	13.5	LOS B	0.0	0.0	0.00	1.78	67.2
5	T	438	12.0	0.282	0.0	LOS A	0.0	0.0	0.00	0.00	110.0
Approach		527	11.0	0.282	2.3	NA	0.0	0.0	0.00	0.30	101.0
All Vehicles		1382	8.1	0.302	5.9	NA	1.3	9.5	0.16	0.36	87.3

Table 6. SIDRA results for Port Hedland Road/Cooke Point Drive intersection – PM peak post-development

The results of the intersection capacity analysis indicate that Port Hedland Road/Cooke Point Drive intersection presently operate with a good overall Level of Service C (LoS C) during both morning and afternoon peak hour periods. Moderate queuing and delays are reported only for the right-turn movements from Cooke Point Drive.

With the addition of the development-generated traffic this intersection maintains the existing overall LoS C with expected increases in delays and queues for the relevant movements. The increase in delays and queues are expected and are moderate during both peak hours. Importantly, the spare capacity available for this intersection in the post-development stage remains above 62% suggesting that other future developments in this area and further general growth in traffic can be accommodated.

It is therefore concluded that the traffic from the proposed Telstra Site and Tindale Street developments will not have any adverse impacts on the future operation of Port Hedland Road/Cooke Point Drive intersection.

Appendix 6 – Geotechnical Investigation

Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on Preliminary Geotechnical and Environmental Investigation

Proposed Residential Development Lot 2 McGregor Street, Port Hedland

Prepared for
Watson Properties Pty Ltd

Project 76176
August 2011

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

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Report prepared for	Watson Properties Pty Ltd		
File name	P:\76176 Telstra Site, Port Hedland\Docs\76176 Report.doc		

Document status and review

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The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author	James Lawrence	9 August 2011
Reviewer	pp. [illegible]	9 August 2011

NCS INTERNATIONAL CERTIFIED QUALITY MANAGEMENT SYSTEM

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